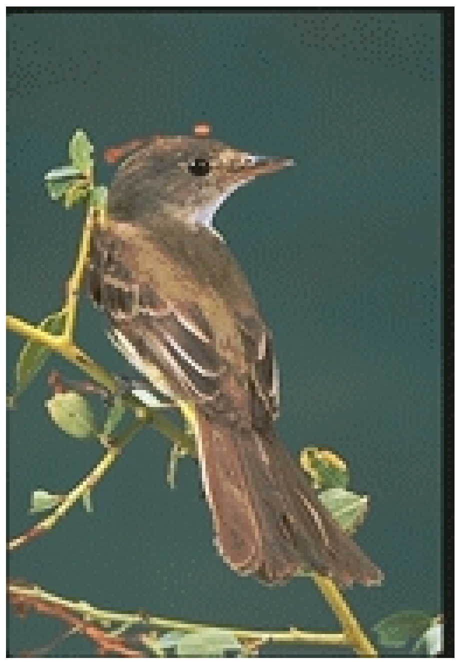
Final Recovery Plan
Southwestern Willow Flycatcher
(*Empidonax traillii extimus*)

August 2002

Prepared By

Southwestern Willow Flycatcher Recovery Team
Technical Subgroup



For

Region 2
U.S. Fish and Wildlife Service
Albuquerque, New Mexico 87103

Approved: H Dale Hall

Date: 8/30/02

Disclaimer

Recovery Plans delineate reasonable actions that are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved Recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Some of the techniques outlined for recovery efforts in this plan are completely new regarding this subspecies. Therefore, the cost and time estimates are approximations.

Citations

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Executive Summary
Southwestern Willow Flycatcher Recovery Plan

Current Status of the Species

The southwestern willow flycatcher (*Empidonax traillii extimus*) breeds in dense riparian habitats in southwestern North America, and winters in southern Mexico, Central America, and northern South America. Its breeding range includes far western Texas, New Mexico, Arizona, southern California, southern portions of Nevada and Utah, southwestern Colorado, and possibly extreme northern portions of the Mexican States of Baja California del Norte, Sonora, and Chihuahua. The subspecies was listed as endangered effective March 29, 1995. Approximately 900 to 1100 pairs exist.

Habitat Requirements, Threats, and Other Limiting factors

The southwestern willow flycatcher breeds in relatively dense riparian tree and shrub communities associated with rivers, swamps, and other wetlands, including lakes (e.g., reservoirs). Most of these habitats are classified as forested wetlands or scrub-shrub wetlands. Habitat requirements for wintering are not well known, but include brushy savanna edges, second growth, shrubby clearings and pastures, and woodlands near water. The southwestern willow flycatcher has experienced extensive loss and modification of breeding habitat, with consequent reductions in population levels. Destruction and modification of riparian habitats have been caused mainly by: reduction or elimination of surface and subsurface water due to diversion and groundwater pumping; changes in flood and fire regimes due to dams and stream channelization; clearing and controlling vegetation; livestock grazing; changes in water and soil chemistry due to disruption of natural hydrologic cycles; and establishment of invasive non-native plants. Concurrent with habitat loss have been increases in brood parasitism by the brown-headed cowbird (*Molothrus ater*), which inhibit reproductive success and further reduce population levels.

Recovery Objectives

1. Recovery to the point that reclassification to "threatened" is warranted.
2. Recovery to the point that delisting is warranted.

Recovery Criteria

Reclassification from endangered to threatened may be considered when either of the following criterion have been met:

Criterion A: Increase the total known population to a minimum of 1,950 territories (equating to approximately 3,900 individuals), geographically distributed to allow proper functioning as metapopulations, so that the flycatcher is no longer in danger of extinction. For reclassification to threatened status, these prescribed numbers and distributions must be reached *as a minimum*, *and maintained over a five year period*.

Criterion B: Increase the total known population to a minimum of 1,500 territories (equating to approximately 3,000 individuals), geographically distributed among Management Units and Recovery Units, so that the flycatcher is no longer in danger of extinction. For reclassification to threatened status, these prescribed numbers and distributions must be reached *as a minimum*, *and maintained over a three year period*, and the habitats supporting these flycatchers must be protected from threats and loss.

The southwestern willow flycatcher may be removed from the list of threatened and endangered species when both of the following criteria have been met:

Criterion 1. Meet and maintain, at a minimum, the population levels and geographic distribution specified under reclassification to threatened Criterion A; increase the total known population to a minimum of 1,950 territories (equating to approximately 3,900 individuals), geographically distributed to allow proper functioning as metapopulations, as presented in Table 10.

Criterion 2. Provide protection from threats and create/secure sufficient habitat to assure maintenance of these populations and/or habitats over time. The sites containing flycatcher breeding groups, in sufficient number and distribution to warrant downlisting, must be protected into the foreseeable future through development and implementation of conservation management agreements (e.g., public land management planning process for Federal lands, habitat conservation plans (under Section 10 of the ESA), conservation easements, and land acquisition agreements for private lands, and inter-governmental conservation agreements with Tribes). Prior to delisting, the USFWS must confirm that the agreements have been created and executed in such a way as to achieve their role in flycatcher recovery, and individual agreements for all areas within all Management Units (public, private, and Tribal) that are critical to metapopulation stability (including suitable, unoccupied habitat) must have demonstrated their effectiveness for a period of at least 5 years.

Actions Needed

Recovery actions in the Plan are categorized into nine types:

1. Increase and improve occupied, suitable, and potential breeding habitat; 2. Increase metapopulation stability; 3. Improve demographic parameters; 4. Minimize threats to wintering and migration habitat; 5. Survey and monitor; 6. Conduct research; 7. Provide public education and outreach; 8. Assure implementation of laws, policies, and agreements that benefit the flycatcher; 9. Track recovery progress.

Estimated Cost of Recovery ($1000s)

Costs associated with recovery are estimated for each of the nine categories listed above, based on the years in which specific actions are scheduled to occur. These costs are further detailed in the Implementation Schedule.

Year	Action 1	Action 2	Action 3	Action 4	Action 5	Action 6	Action 7	Action 8	Action 9	**Total**
FY01	8182*	1629	0*	225	835	2147	30*	183*	30	13261
FY02	8182*	1629	0*	225	835	2147	30*	183*	30	13261
FY03	7816*	4951	390*	225	835	2773	30*	183*	30	17233
FY04	7216*	4951	390*	225*	835	2348	30*	183*	50	16228
FY05	7216*	4951	390*	225*	850	2348	30*	183*	190	16383
FY 6-20	25430*	6300	1950*	0*	0	860*	25*	25*	0	34590
FY 21-30	16210*	0	0	0*	0	0*	50*	250*	0	16510
Total	80252*	24411	3120*	1125*	4190	12623*	225*	1190*	330	127466

*Does not represent total potential funds due to inability to estimate costs for specific recovery actions at this time. See Section V. Implementation Schedule for detailed estimate of funds and potential partners.

Date of Recovery

Reclassification to threatened could be initiated in 2020, or earlier.

Delisting could be accomplished within 10 years of reclassification.

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A. Overview

The Endangered Species Act of 1973 (ESA) calls for preparation of recovery plans for threatened and endangered species likely to benefit from the effort, and authorizes the Secretary of the Interior to appoint recovery teams to prepare the plans. A recovery plan must establish recovery goals and objectives, describe site-specific management actions recommended to achieve those goals, and estimate the time and cost required for recovery. A recovery plan is not self-implementing, but presents a set of recommendations for managers and the general public, which are endorsed by an approving official of the Department of Interior. Recovery plans also serve as a source of information on the overall biology, status, and threats of a species. It is the intent of the U.S. Fish and Wildlife Service (USFWS) to modify this Recovery Plan in response to management, monitoring, and research data, at 5-year intervals.

This Recovery Plan is comprised of the following major sections:

I. Introduction and Background

This section provides summary background information on the southwestern willow flycatcher's sensitive species status, and the general approach to recovery.

II. Biology, Ecology, and Status

This section provides background information on the biology, status, and reasons for decline of the southwestern willow flycatcher.

III. Conservation Measures

This section discusses current programs, measures, and legal mechanisms that contribute, or could contribute to conservation and recovery of the southwestern willow flycatcher and/or its habitat.

IV. Recovery

This section presents the details of the objectives, approach, criteria, and specific actions for recovering the flycatcher.

V. Implementation Schedule

This section outlines tasks, assigns responsibility for task implementation, and estimates the cost of the recovery program.

VI. Literature Cited

Full citations for all literature referenced in this Recovery Plan and associated Issue Papers (see Appendices) are listed.

VII. Appendices

The 13 Appendices to this Recovery Plan comprise this section. These Appendices include Issue Papers (see Section I.C.; Recovery Team Subgroup and "Issue Paper" Approach, below), data compilations, lists, a summary of comments on the draft plan, and other background information. Appendix B provides a key to all acronyms and abbreviations used in this Recovery Plan.

In this Recovery Plan, unless otherwise noted, the terms 'southwestern willow flycatcher,' 'flycatcher,' '*E. t. extimus*,' and 'the bird' all refer to the endangered southwestern subspecies of the willow flycatcher, *Empidonax traillii extimus*. The term 'willow flycatcher' is used to refer to the species level (*E. traillii*), or one or more of the other willow flycatcher subspecies, as noted in each use.

B. Ecosystem and Watershed Approaches

As directed in the ESA, the purpose of this Recovery Plan, and the ESA's other provisions, are to conserve the *ecosystems* upon which the southwestern willow flycatcher depends. The southwestern willow flycatcher depends upon one of the most critically endangered habitats in North America: southwestern riparian ecosystems. Southwestern riparian ecosystems have always comprised a very small portion of the landscape. Yet even in their current decimated state they are disproportionately important to wildlife and plants, typically supporting far greater species diversity than the surrounding upland ecosystems. Therefore, in addition to the flycatcher, many other species of birds, mammals, fish, plants, reptiles, amphibians, and invertebrates are imperiled by the destruction of southwestern riparian habitats brought about by regional high levels of human populations.

This Recovery Plan recognizes that not all riparian habitats are potential southwestern willow flycatcher habitat, and that flycatcher habitat may not be the same as, or compatible with, riparian and aquatic habitats for some other plant and wildlife species. Southwestern riparian habitats are by nature diverse, heterogeneous, and dynamic, providing a wide spectrum of habitats for a myriad of species. In addition to general drying of riparian habitats, a major impact of human developments has been elimination or modification of the natural processes that establish and maintain these natural levels of dynamism, diversity, and heterogeneity in riparian ecosystems. This Recovery Plan does not seek to make all riparian habitats into southwestern willow flycatcher habitat at the expense of other species. To do so would be ecologically impossible, and would constitute irresponsible conservation biology. This Recovery Plan seeks in part to protect, re-establish, mimic, and/or mitigate for the loss of the natural processes that establish, maintain, and recycle riparian ecosystems relevant to the flycatcher.

Due to the broad geographic range of the flycatcher, this Recovery Plan uses a watershed approach to organize recovery. Six Recovery Units, further subdivided into Management Units, are designated (see Section IV.A.; Recovery Strategy). These Recovery and Management Units are based on watershed and hydrologic units (Seaber et al. 1994) within the breeding range of the flycatcher. This provides a strategy to characterize flycatcher populations, structure recovery goals, and facilitate effective recovery actions that should closely parallel the physical, biological, and logistical realities on the ground. Further, using Recovery and Management Units assures that populations will be well distributed when recovery criteria are met.

Riparian habitats have high potential for restoration. They are by nature dynamic and fairly resilient, adapted to the dynamism of natural stream systems. Where natural or near-natural conditions of water flow, water chemistry, and sedimentation can be re-established, near-natural riparian ecosystems have a high likelihood of re-establishment. However, restoration ecology is a new science. Until we improve our ability to restore degraded riparian ecosystems, conservation of existing healthy riparian systems should be a high priority (USFWS 1998).

C. Recovery Team Subgroup and "Issue Paper" Approach

The Southwestern Willow Flycatcher Recovery Team is composed of a Technical Subgroup (pg. ii), six Implementation Subgroups (Appendix A), and a Tribal Working Group. The Technical Subgroup consists of 14 academic scientists, researchers, and resource managers with a wide range of expertise in avian biology and ecology, southwestern willow flycatcher ecology, cowbird ecology, riparian ecology, hydrology, range management, and conservation planning. The Implementation Subgroups consist of more than 200 community representatives across the Southwest including ranchers, environmental representatives, water and power interests, State and Federal land managers, and local governments. Each Implementation Subgroup is associated with a particular recovery unit (see Section IV. Recovery). The Technical Subgroup's function is to compile and review extensive scientific information and develop recovery goals, strategies and recommended actions. The role of the Implementation Subgroups is to advise the Regional Director and Technical Subgroup on the feasibility of recovery strategies and actions recommended by the Technical Subgroup, and to implement recovery actions in the United States portion of the flycatcher's geographic range.

The Technical Subgroup met 22 times between March 1998 and September 2000, to assimilate information and develop recovery strategies and goals. As part of that process, an additional five meetings between the Technical and Implementation Subgroups were held. The Tribal Working Group met with the Technical Subgroup on two occasions to discuss potential Tribal involvement and collaboration in the recovery process. Communication between the subgroups was facilitated by a USFWS Recovery Team Liaison, and a mutually-accessible Internet website. For each of the major issues involved in recovering the flycatcher, the Technical Subgroup developed in-depth "Issue Papers", which were submitted to the Implementation Subgroups for review. The Issue Papers were finalized incorporating feedback from the Implementation Subgroups, and are presented in Appendices D through M. An Issue Paper developed by the Tribal Working Group is presented in Appendix N. In some cases, synthesized information from an appendix has been brought forward to the body of the Recovery Plan, as it constitutes a crucial link between the biology/ecology of the flycatcher, threats to the flycatcher, and the management actions recommended in the Recovery Plan. In other cases, the appendix contains information that is useful for understanding the context of a threat, but may not be directly applicable to management recommendations. For all aspects of flycatcher recovery discussed in this Recovery Plan, these Issue Papers may be referred to for greater detail. Overall, the Subgroup and Issue Paper approach was used to incorporate the best possible science, and address the major technical and logistical challenges to recovery, before a draft of this Recovery Plan was circulated for full public review. For a conservation and recovery effort of this scope and complexity, this approach proved to be of great value.

On May 3, 2001, the completed draft Recovery Plan was made available to the Implementation Subgroups and Tribal Working Group. On June 6, 2001, the USFWS published in the Federal Register (66 FR 30477) an announcement of the availability of the draft Recovery Plan, and opened a 120-day comment period. The comment period was subsequently reopened for a period of 60 days extending through December 10, 2001 (66 FR 51683). During this period, the Technical Subgroup held an additional five meetings with Implementation Subgroup members, and participated in two official briefings for interested Tribes sponsored by the Bureau of Indian Affairs (BIA) and the Native American Fish and Wildlife Society. All comments received were reviewed by the Technical Subgroup and USFWS, significant and substantive issues identified, and changes to the draft Recovery Plan were made accordingly (see also Appendix O).

D. Species Description

The southwestern willow flycatcher (*Empidonax traillii extimus*) is a small Neotropical migratory bird, whose nesting habitat is restricted to relatively dense growths of trees and shrubs in riparian ecosystems in the arid southwestern United States and possibly extreme northwestern Mexico. These riparian habitats are associated with rivers, swamps, and other wetlands, including lakes and reservoirs (Bent 1960). Most of these habitats are classified as wetlands in the legal sense: palustrine and lacustrine forested wetlands and scrub-shrub wetlands (Cowardin et al. 1979). Some are non-wetland riparian forests. Surface water or saturated soil are typically, but not always, present year-round or seasonally and ground water is generally at a depth of less than 2 or 3 meters (6.5 to 9 ft) within or adjacent to nesting habitat.

The flycatcher is approximately 15 cm (5.75 in) long, and weighs about 12 g (0.42 oz). It has a grayish-green back and wings, whitish throat, light grey-olive breast, and pale yellowish belly. Two wingbars are visible; the eye ring is faint or absent. The upper mandible is dark, the lower is light with a yellowish tone. The song is a sneezy “fitz-bew," the call a repeated “whitt.” Other vocalizations, usually given by flycatchers in close interactions with one another, include “wheek-a-dee,” “wheeo” and rolling “brrrt” notes. Although males are the primary singers, females also sing occasionally (Seutin 1987, Paxton et al. 1997, Sogge et al. 1997b, SWCA 2000, M. Whitfield unpubl. data.).

E. Listing History

The USFWS included the southwestern willow flycatcher on its Animal Notice of Review as a category 2 candidate species on January 6, 1989 (USFWS 1989). The candidate category 2 designation has been discontinued, but at that time the designation identified a species for which listing may have been appropriate but additional biological information was needed. After conducting a status review for the flycatcher, the USFWS elevated it to candidate category 1 status on November 21, 1991 (USFWS 1991). A category 1 species is one for which the USFWS has substantial information to support a proposal to list, but publishing a proposal is precluded by other listing activity.

On January 25, 1992, a coalition of conservation organizations petitioned the USFWS under section 4 of the ESA, requesting listing of the flycatcher as an endangered species (Suckling et al. 1992). The USFWS found that the petition presented substantial information, and requested public comments and additional biological data on the prospective listing (USFWS 1992). After reviewing additional information, on July 23, 1993 the USFWS proposed to list the flycatcher as an endangered species, with 1,038 km (643 mi) of riparian habitats proposed for critical habitat designation (USFWS 1993). The USFWS again requested public comments and scientific information, and held six public hearings. After reviewing the additional information received, the USFWS designated the southwestern willow flycatcher as endangered, effective March 29, 1995 (USFWS 1995). Designation of critical habitat was deferred (see below).

F. Critical Habitat Designation History

When the USFWS listed the southwestern willow flycatcher as endangered, a decision was deferred regarding the 1,038 km (643 mi) of riparian habitats proposed as critical habitat (USFWS 1995). The USFWS determined it was necessary to consider additional comments, reconsider the prudence of designating critical habitat, and reconsider the boundaries of critical habitat. A second period for public comment was opened from February 17 to April 28, 1995. After considering the additional comments and scientific information received, on July 22, 1997 the USFWS finalized critical habitat designation for 964 km (599 mi) of riparian habitats (USFWS 1997a), with a correction made August 20, 1997 (USFWS 1997b). On May 11, 2001, the 10th Circuit Court of Appeals set aside the southwestern willow flycatcher critical habitat designation and instructed the USFWS to issue a new critical habitat designation in compliance with the Court's ruling. The USFWS is currently in the process of re-proposing critical habitat for the flycatcher. Unless otherwise instructed by the Court, the USFWS anticipates final designation in June, 2004. For a more detailed discussion of the physical and biological features of southwestern willow flycatcher habitat, see Appendix D.

II. BIOLOGY, ECOLOGY, AND STATUS

A. Taxonomy

The willow flycatcher is one of 11 flycatchers in the genus *Empidonax* (Order Passeriformes, Family Tyrannidae) breeding in North America. Although the *Empidonax* flycatchers are notoriously difficult to distinguish by sight in the wild, each has unique morphological features, vocalizations, habitats, behaviors and/or other traits that allow biologists to distinguish them.

The willow flycatcher was described by J.J. Audubon from a specimen taken along the Arkansas River in the early 1800s (Audubon 1831); he named it *Muscicapa traillii*. Since then, the species has undergone a series of name changes and species/subspecies designations (see Aldrich 1951, Browning 1993). Prior to 1973, the willow flycatcher and alder flycatcher (*E. alnorum*) were treated together as the Traill's flycatcher (*E. traillii*) (AOU 1957). Subsequent work established that they are two separate species (Stein 1958, 1963, Seutin and Simon 1988, Winker 1994), and the American Ornithologists' Union accepted that classification (AOU 1973). Some sources (AOU 1983, McCabe 1991) also treat *E. traillii* and *E. alnorum*, and all their subspecies, as a "superspecies," the "*traillii* complex." However, the two flycatchers are distinguishable by morphology (Aldrich 1951, Unitt 1987), song type, habitat use, structure and placement of nests (Aldrich 1953, Gorski 1969), eggs (Walkinshaw 1966), ecological separation (Barlow and McGillivray 1983), and genetics (Seutin and Simon 1988, Winker 1994, Paxton and Keim unpubl. data). The breeding range of the alder flycatcher generally lies north of the willow flycatcher's range.

The southwestern willow flycatcher is one of four subspecies of the willow flycatcher (Figure 1) currently recognized (Hubbard 1987, Unitt 1987), though Browning (1993) posits a fifth subspecies (*E. t. campestris*) in the central and midwestern U.S. The willow flycatcher subspecies are distinguished primarily by subtle differences in color and morphology, and by habitat use. The southwestern subspecies *E. t. extimus* was described by Phillips (1948), and its taxonomic status has been accepted by most authors (Aldrich 1951, Bailey and Niedrach 1965, Behle and Higgins 1959, Hubbard 1987, Phillips et al. 1964, Oberholser 1974, Monson and Phillips 1981, Unitt 1987, Schlorff 1990, Browning 1993, USFWS 1995). Recent research (Paxton 2000) concluded that *E. t. extimus* is genetically distinct from the other willow flycatcher subspecies.

The southwestern willow flycatcher is generally paler than other willow flycatcher subspecies, and also differs in morphology, e.g., wing formula, bill length, and wing:tail ratio (Unitt 1987 and 1997, Browning 1993). These differences require considerable experience, training, and reference study skins to distinguish, and are not reliable characteristics for field identification. Evidence also suggests song form differences among some willow flycatcher subspecies (Sedgwick 2001); these differences may serve as another parameter to distinguish the subspecies, although variations within subspecies may occur as well (Travis 1996, Sedgwick 1998).

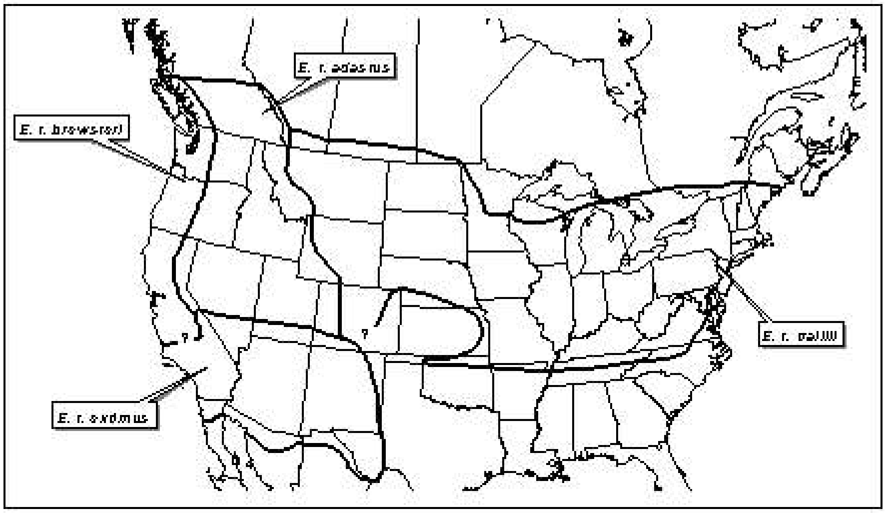

Figure 1. Breeding ranges of the subspecies of the willow flycatcher (*Empidonax traillii*).
From Sogge et al. (1997b), adapted from Unitt (1987), Browning (1993).

B. Range and Distribution

The historical breeding range of the southwestern willow flycatcher included southern California, southern Nevada, southern Utah, Arizona, New Mexico, western Texas, southwestern Colorado, and extreme northwestern Mexico (Figures 1 and 3[Fig. 3 follows page 68]; Hubbard 1987, Unitt 1987, Browning 1993). The flycatcher's current range is similar to the historical range, but the quantity of suitable habitat within that range is much reduced from historical levels. The flycatcher occurs from near sea level to over 2600 m (8500 ft), but is primarily found in lower elevation riparian habitats. Throughout its range, the flycatcher's distribution follows that of its riparian habitat; relatively small, isolated, widely dispersed locales in a vast arid region. Marshall (2000) found that 53% of southwestern willow flycatchers were in just 10 sites (breeding groups) rangewide, while the other 47% were distributed among 99 small sites of ten or fewer territories. In some parts of its northern range, questions of range boundaries between other willow flycatcher subspecies exist, including possible intergradations between subspecies. In California (see Figures 1 and 3), individuals of *E. t. extimus* and *E. t. brewsteri* are morphologically fairly distinct, even where their ranges are near one another (Unitt 1987). However, in southern Utah, southwestern Colorado, and perhaps northern New Mexico, there may be fairly broad clinal gradations between the southwestern willow flycatcher and the Great Basin/Rocky Mountain race *E. t. adastus* (Unitt 1987). Phillips et al. (1964)

suggested that *E. t. extimus* may be typical of lower elevations, noting that willow flycatchers from high elevations in eastern Arizona had some characteristics of *E. t. adastus*. Therefore in northern parts of the southwestern willow flycatcher's range, clinal gradations with *E. t. adastus* may exist with increasing elevation, as well as latitude. Recent genetic work by Paxton (2000) verified *extimus* genetic stock in south-central Colorado (i.e., San Luis Valley) and southwestern Utah (e.g., Virgin River). Overall, Paxton (2000) showed that the northern boundary for extimus was generally consistent with that proposed by Unitt (1987) and Browning (1993). This recovery plan adopts a range boundary that reflects these results. However, because of the absence of flycatchers in the lower to mid elevations of the Colorado Plateau in southern Utah and Southwestern Colorado, Paxton (2000) did not address potential sub-specific differences resulting from elevation or habitat differences and watershed boundaries. The Service recognizes that future data may result in refinements to the northern boundary. Records of probable breeding flycatchers in Mexico are few and are restricted to extreme northern Baja California del Norte and northern Sonora (Unitt 1987, Wilbur 1987). The flycatcher's wintering range includes southern Mexico, Central America, and probably South America (Stiles and Skutch 1989, Howell and Webb 1995, Ridgely and Gwynne 1989, Unitt 1997, Koronkiewicz et al. 1998, Unitt 1999). State-by-State summaries follow:

1. California

Historically, the southwestern willow flycatcher was common in all lower elevation riparian areas of the southern third of California (Wheelock 1912, Willett 1912 and 1933, Grinnell and Miller 1944), including the Los Angeles basin, the San Bernardino/Riverside area, and San Diego County (Unitt 1984, 1987). River systems where the flycatcher persists include the Colorado, Owens, Kern, Mojave, Santa Ana, Pilgrim Creek, Santa Margarita, San Luis Rey, San Diego, San Mateo Creek, San Timoteo Creek, Santa Clara, Santa Ynez, Sweetwater, San Dieguito, and Temecula Creek (Whitfield 1990, Holmgren and Collins 1995, Kus 1996, Kus and Beck 1998, Whitfield et al. 1998, McKernan and Braden 1999, L. Hays unpubl. data, Griffith and Griffith in press, W. Haas pers. comm., B. Kus pers. comm. and unpubl. data, McKernan unpubl. data).

2. Arizona

The historical range of the flycatcher in Arizona included portions of all major watersheds (H. Brown 1902 unpubl. data, Willard 1912, Swarth 1914, Phillips 1948, Unitt 1987). Contemporary investigations (post-1990) show the flycatcher persists, probably in much reduced numbers, along the Big Sandy, Bill Williams, Colorado, Gila, Hassayampa, Little Colorado, Salt, San Francisco, San Pedro, Santa Cruz, Santa Maria, Tonto Creek, and Verde river systems (Sferra et al. 1997, Sogge et al. 1997a, McKernan and Braden 1999, Paradzick et al. 1999, Tibbitts and Johnson 1999, Smith et al. 2002).

3. New Mexico

The historic breeding range of the flycatcher is considered to have been primarily from the Rio Grande Valley westward, including the Rio Grande, Chama, Zuni, San Francisco, and Gila watersheds (Bailey 1928, Ligon 1961, Hubbard 1987); breeding was unconfirmed in the San Juan and Pecos drainages (Hubbard 1987). Contemporary surveys documented that flycatchers persist in the Rio Grande, Chama, Zuni, San Francisco, and Gila watersheds and that small breeding populations also occur in the San Juan drainage and along Coyote Creek in the Canadian River drainage, but breeding remains unconfirmed in the Pecos watershed (Maynard 1995, Cooper 1996, Cooper 1997, Williams and Leal 1998, S. Williams, pers. comm.). The Gila Valley was identified by Hubbard (1987) as a stronghold for the taxon, and recent surveys have confirmed that area contains one of the largest known flycatcher populations (Skaggs 1996, Stoleson and Finch 1999). The subspecific identity (*E. t. extimus*. vs. *E. t. adastus*) of willow flycatchers in northern New Mexico has been problematical (Hubbard 1987, Unitt 1987, Maynard 1995, Travis 1996), but recent genetic research supports affiliation with *E.t. extimus* (Paxton 2000).

4. Texas

The eastern limit of the southwestern willow flycatcher's breeding range is considered to be in the Trans-Pecos region of western Texas (Unitt 1987), where presumably breeding flycatchers were reported from Fort Hancock on the Rio Grande (Phillips 1948), the Davis Mountains, including a reported nest with young in July 1890 (Oberholser 1974), Big Bend National Park (Wauer 1973, 1985), and possibly the Guadalupe Mountains (Phillips, pers. comm., cited in Unitt 1987). Current status in Texas is essentially unknown; no recent survey data are available.

5. Utah

The north-central limit of the flycatcher's breeding range is in southern Utah. Historically, the bird occurred in the following river systems: Colorado, Kanab Creek, San Juan (Behle et al. 1958, Behle and Higgins 1959, Behle 1985, Browning 1993), Virgin (Phillips 1948, Wauer and Carter 1965, Whitmore 1975), and perhaps Paria (BLM, unpubl. data). Behle and Higgins (1959) suggested that extensive habitat likely existed along the Colorado River and its tributaries in Glen Canyon. Contemporary investigations verified probable breeding flycatchers along the upper Virgin River, and Panguitch Creek (Langridge and Sogge 1998, Peterson et al. 1998, USFWS unpubl. data), but failed to locate breeders along the San Juan (Johnson and Sogge 1997, Johnson and O'Brien 1998). The subspecific identity (*E. t. extimus* vs. *E. t. adastus*) of willow flycatchers in high elevation/central Utah remains somewhat unresolved (Behle 1985, Unitt 1987, Browning 1993), and requires additional research.

6. Nevada

The historical status of the flycatcher at its range limit in southern Nevada is unclear; Unitt (1987) reported only three records, all before 1962. Contemporary investigations (post-1990) have verified breeding flycatchers on the Virgin River and Muddy River, the Amargosa River drainage at Ash Meadows NWR, Meadow Valley Wash, and the Pahranagat River drainage (McKernan and Braden 1999, Micone and Tomlinson 2000, USFWS unpubl. data).

7. Colorado

The historic and current breeding status of the southwestern willow flycatcher in Colorado is unclear (USFWS 1995). Hubbard (1987) believed the subspecies ranged into extreme southwestern Colorado, Browning (1993) was noncommittal, and Unitt (1987) tentatively used the New Mexico-Colorado border as the boundary between *E. t. extimus* and *E. t. adastus*. Several specimens taken in late summer have been identified as *E. t. extimus*, but nesting was not confirmed (Bailey and Niedrach 1965). Breeding willow flycatchers with genetic characteristics of the southwestern subspecies occur at Alamosa National Wildlife Refuge and McIntire Springs, but flycatchers from Beaver Creek and Clear Creek (Andrews and Righter 1992, Owen and Sogge 1997) did not have the southwestern subspecies genetic characteristics (Paxton 2000). There is much riparian habitat in southwestern Colorado that has not yet been surveyed for willow flycatchers; additional populations may be found with increased survey effort.

8. Mexico

The breeding status of the flycatcher in Mexico is unclear. Russell and Monson (1998) accepted no evidence that willow flycatchers ever nested in Sonora. However, several specimens from Sonora and Baja California del Norte are accepted as breeding evidence by others (Unitt 1987, Wilbur 1987, Browning 1993). In the more general treatments of field guides, where supporting evidence is not cited, the willow flycatcher is described as breeding in northern portions of Baja California del Norte and Sonora (Blake 1953, Peterson and Chalif 1973, Howell and Webb 1995). Based on the apparent historical abundance on the lower Colorado River near the U.S. - Mexico border before construction of dams, and current presence, it is likely that the flycatcher was present, perhaps abundant, in the Colorado River's delta in Mexico. Given the presence of flycatchers along the Rio Grande in southern New Mexico and the existence of riparian habitat along some drainages in northern Mexico, southwestern willow flycatchers may also breed in northern Chihuahua.

C. Habitat Characteristics

1. Overview and General Habitat Composition

The breeding habitat of the southwestern willow flycatcher is discussed in depth in Appendix D, and in Sogge and Marshall (2000). The flycatcher breeds in different types of dense riparian habitats, across a large elevational and geographic area. Although other willow flycatcher subspecies in cooler, less arid regions may breed more commonly in shrubby habitats away from water (McCabe 1991), the southwestern willow flycatcher usually breeds in patchy to dense riparian habitats along streams or other wetlands, near or adjacent to surface water or underlain by saturated soil. Common tree and shrub species comprising nesting habitat include willows (*Salix* spp.), seepwillow (aka mulefat; *Baccharis* spp.), boxelder (*Acer negundo*), stinging nettle (*Urtica* spp.), blackberry (*Rubus* spp.), cottonwood (*Populus* spp.), arrowweed (*Tessaria sericea*), tamarisk (aka saltcedar; *Tamarix ramosissima*), and Russian olive (*Eleagnus angustifolia*) (Grinnell and Miller 1944, Phillips et al. 1964, Hubbard 1987, Whitfield 1990, Brown and Trosset 1989, Brown 1991, Sogge et al. 1993, Muiznieks et al. 1994, Maynard 1995, Cooper 1996, Skaggs 1996, Cooper 1997, McKernan and Braden 1998, Stoleson and Finch 1999, Paradzick et al. 1999). Habitat characteristics such as plant species composition, size and shape of habitat patch, canopy structure, vegetation height, and vegetation density vary across the subspecies' range. However, general unifying characteristics of flycatcher habitat can be identified. Regardless of the plant species composition or height, occupied sites usually consist of dense vegetation in the patch interior, or an aggregate of dense patches interspersed with openings. In most cases this dense vegetation occurs within the first 3 - 4 m (10-13 ft) above ground. These dense patches are often interspersed with small openings, open water, or shorter/sparser vegetation, creating a mosaic that is not uniformly dense. In almost all cases, slow-moving or still surface water and/or saturated soil is present at or near breeding sites during wet or non-drought years.

Thickets of trees and shrubs used for nesting range in height from 2 to 30 m (6 to 98 ft). Lower-stature thickets (2-4 m or 6-13 ft) tend to be found at higher elevation sites, with tall stature habitats at middle and lower elevation riparian forests. Nest sites typically have dense foliage from the ground level up to approximately 4 m (13 ft) above ground, although dense foliage may exist only at the shrub level, or as a low dense canopy. Nest sites typically have a dense canopy, but nests may be placed in a tree at the edge of a habitat patch, with sparse canopy overhead. The diversity of nest site plant species may be low (e.g., monocultures of willow or tamarisk) or comparatively high. Nest site vegetation may be even- or uneven-aged, but is usually dense (Brown 1988, Whitfield 1990, Muiznieks et al. 1994, McCarthey et al. 1998, Sogge et al. 1997a, Stoleson and Finch 1999).

Historically, the southwestern willow flycatcher nested in native vegetation such as willows, buttonbush, boxelder, and *Baccharis*, sometimes with a scattered overstory of cottonwood (Grinnell and Miller 1944, Phillips 1948, Whitmore 1977, Unitt 1987). Following modern changes in riparian plant communities, the flycatcher still nests in native vegetation where available, but also nests in thickets dominated by the non-native tamarisk and Russian olive and in habitats where native and non-native trees and shrubs are present in essentially even mixtures (Hubbard 1987, Brown 1988, Sogge et al. 1993, Muiznieks et al. 1994, Maynard 1995, Sferra et al. 1997, Sogge et al. 1997a, Paradzick et al. 1999). The number of nests in different broad habitat types (e.g., dominated by native, exotic, and mixed native-exotic plant associations) is presented in Table 1.

Table 1 . Number of known southwestern willow flycatcher territories located within major vegetation/habitat types, by Recovery Unit. Data are from Sogge et al. 2002, based on last reported habitat and survey data for all sites where flycatchers were known to breed, 1993-2001. See Section IV.A. for definition of Recovery Units.

	Recovery Unit						
Vegetation Type	Basin & Mojave	Coastal California	Gila	Lower Colorado	Rio Grande	Upper Colorado	Total
Native (>90%)	63	109	188	37	68	3	468
Mixed native/exotic (>50% native)	3	49	77	56	46		231
Mixed exotic/native (>50% exotic)			108	50	3		161
Exotic (>90%)			77	2	11		90
Not reported	3	28	4	1			36
Total	69	186	454	146	128	3	986

<u>Habitats Dominated by Native Plants</u>

Occupied sites dominated by native plants vary from single-species, single-layer patches to multi-species, multi-layered strata with complex canopy and subcanopy structure. Site characteristics differ substantially with elevation. Low to mid-elevation sites range from single plant species to mixtures of native broadleaf trees and shrubs including willows, cottonwood, boxelder, ash (*Fraxinus* sp.), alder (*Alnus* sp.), blackberry, and nettle. Average canopy height can be as short as 4 m (13 ft) or as high as 30 m (98 ft). High-elevation nest sites dominated by native plants are more similar to each other than low elevation native sites. Most known high elevation (>1,900 m / 6,230 ft) breeding sites are comprised completely of native trees and shrubs, and are dominated by a single species of willow, such as coyote willow (*Salix exigua*) or Geyer's willow (*S. geyeriana*). However, Russian olive is a major habitat component at some high elevation breeding sites in New Mexico. Average canopy height is generally only 3 to 7 m (10-23 ft). Patch structure is characterized by a single vegetative layer with no distinct overstory or understory. There is usually dense branch and twig structure in the lower 2 m (6.5 ft), with high live foliage density from the ground to the canopy. Tree and shrub vegetation is often associated with sedges, rushes, nettles and other herbaceous wetland plants. These willow patches are usually found in mountain meadows, and are often associated with stretches of stream or river that include beaver dams and pooled water.

Habitats of Mixed Native and Exotic Plants

Southwestern willow flycatchers also breed in sites comprised of dense mixtures of native trees and shrubs mixed with exotic/introduced species such as tamarisk or Russian olive. The exotics are often primarily in the understory, but may be a component of overstory. At several sites, tamarisk provides a dense understory below an upper canopy of gallery willows or cottonwoods, forming a habitat that is structurally similar to the cottonwood-willow habitats in which flycatchers historically nested. A particular site may be dominated primarily by natives or exotics, or be a more-or-less equal mixture. The native and exotic components may be dispersed throughout the habitat or concentrated in distinct, separate clumps within a larger matrix. Generally, these habitats are found below 1,200 m (3,940 ft) elevation.

Habitats Dominated by Exotics Plants

Southwestern willow flycatchers also nest in some riparian habitats dominated by exotics, primarily tamarisk and Russian olive. Most such exotic habitats range below 1,200 m (3940 ft) elevation, and are nearly monotypic, dense stands of tamarisk or Russian olive that form a nearly continuous, closed canopy with no distinct overstory layer. Canopy height generally averages 5 to 10 m (16 - 33 ft), with canopy density uniformly high. The lower 2 m (6.5 ft) of vegetation is often comprised of dense, often dead, branches. However, live foliage density may be relatively low from 0 to 2 m (6.5 ft) above ground, but increases higher in the canopy. The flycatcher does not nest in all of the exotic species that can dominate riparian systems. For example, flycatchers rarely use giant reed (*Arundo donax*) and are not known to use tree of heaven (*Ailanthus altissima*).

Forty-seven percent of willow flycatcher territories occur in mixed native/exotic habitat (> 10% exotic) and twenty-five percent are at sites where tamarisk is dominant (Sogge et al. 2000). Flycatchers nest in tamarisk at many river sites, and in many cases, use tamarisk even if native willows are present (Table 2) (Sferra et al. 2000). Southwestern willow flycatchers nest in tamarisk at sites along the Colorado, Verde, Gila, San Pedro, Salt, Bill Williams, Santa Maria, and Big Sandy rivers in Arizona (McCarthey et al. 1998), Tonto Creek in Arizona (McCarthey et al. 1998), the Rio Grande and Gila rivers in New Mexico (Hubbard 1987, Maynard 1995, Cooper 1995, Williams, unpubl. data), and the San Dieguito, lower San Luis Rey, and Sweetwater rivers in California (Kus, unpubl. data), Meadow Valley Wash (Tomlinson, unpubl. data), and Virgin River in Nevada (McKernan and Braden 1999). Rangewide, 86% of nests were in tamarisk in mixed and exotic habitats. In Arizona, 93% of the 758 nests documented from 1993 - 1999 in mixed and exotic habitats were in tamarisk. This distribution is similar on an annual basis in Arizona, where in 1999, 92% of the 303 nests in mixed and exotic habitats were in tamarisk (Paradzick et al. 2000). In addition to the tamarisk, three other exotics have been used as nesting substrates. Two nests were documented in giant reed (Greaves, pers. comm.) in California, 26 nests were documented in Russian olive and one nest was documented in Siberian elm (*Ulmus pumila*) in New Mexico (Stoleson and Finch, unpubl. data).

Table 2. Relative abundance of southwestern willow flycatcher nests, by substrate for rangewide data compiled from 1993 - 1999, including some data from 2000 (Sferra et al. 2000). Percents are expressed in relation to total number of nests for each habitat type. Number of nests is shown in parentheses. Native habitats are those with < 10% cover of exotic plant species. Mixed and exotic habitats have >10% exotic plant species. Coast live oak and boxelder nests are not representative of distribution across the range: coast live oak nests only occur on the upper San Luis Rey in California and boxelder nests only occur in the Cliff-Gila area on the Gila River in New Mexico. Few tamarisk nests were found in native habitat.

	Percent (number of nests)	
Nest substrate	Native	Mixed and exotic
Tamarisk	-	86 (768)
Willow[1]	41 (459)	11 (103)
Coast live oak	10 (116)	0
Boxelder	33 (371)	0
Other[2]	15 (165)	3 (26)

[1] *Salix gooddingii, Salix exigua, Salix geyerana, Salix lasiolepis, Salix laevigata, Salix taxifolia.*

[2] Other nest substrates used in descending order of frequency: buttonbush *(Ceanothus occidentalis*), cottonwood (*Populus fremontii*), Russian olive (*Elaegnus angustifolia*), stinging nettle (*Urtica dioica*), alder (*Alnus rhombifolia, Alnus oblongifolia, Alnus tenuifolia*), velvet ash (*Fraxinus velutina*), poison hemlock (*Conium maculatum*), blackberry (*Rubus ursinus*), seep willow (*Baccharis salicifolia, Baccharis glutinosa*), canyon live oak (*Quercus chrysolepis*), rose *(Rosa californica, Rosa arizonica, Rosa multiflora*), sycamore (*Platinus wrightii*), giant reed (*Arundo donax*), false indigo (*Amorpha californica*), Pacific poison ivy (*Toxicodendron diversilobum*), grape (*Vitus arizonica*), Virginia creeper (*Parthenocissus quinquefolia*), Siberian elm (*Ulmus pumila*), walnut (*Juglans hindsii*).

Sferra et al. 2000 compiled the nesting success of 84% of the 2,008 nests documented primarily between 1993 - 1999, and some nests documented in 2000. Nest productivity in tamarisk-dominated sites is 23 -54%, which is similar to native willow-dominated sites (Table 3). Tamarisk nest success averaged 45% in New Mexico and 54% in Arizona, indicating that tamarisk nests are at least as successful as nests in other substrates.

However, because the physical and structural characteristics of tamarisk stands vary widely, not all have the same value as flycatcher breeding habitat. Among sites with tamarisk, suitable flycatcher breeding habitat usually occurs where the tamarisk is tall and dense, with surface water and/or wet soils present, and where it is intermixed with native riparian trees and shrubs. However, flycatchers breed in a few patches comprised of >90 % tamarisk, with dry soils and surface water >200 m away from some of their territories.

Tamarisk eradication can be detrimental to willow flycatchers in mixed and exotic habitats, especially in or near occupied habitat or where restoration is unlikely to be successful. Risks to the flycatcher increase if the tamarisk control projects are implemented in the absence of a plan to restore suitable native riparian plant species or if site conditions preclude the re-establishment of native plant species of equal or higher functional value. Threats also increase if the eradication projects are large-scale in nature, thus possibly setting the stage for large-scale habitat loss.

Table 3. Southwestern willow flycatcher nest success, by substrate, for data compiled from 1993 - 1999 in California, Arizona, and New Mexico, including some data from 2000 (Sferra et al. 2000). Nest success is calculated as the percent of nests fledging at least one flycatcher. Number of nests is in parentheses. Native habitats are those with < 10% cover of exotic plant species. Mixed and exotic habitats have > 10% cover of exotic plant species. Coast live oak and boxelder represent only two areas: the upper San Luis Rey in California and the Cliff-Gila area on the Gila River in New Mexico. Sample size is too small to calculate percent nest success for some categories, indicated by "-" notation. Data in mixed and exotic habitats in California have not yet been compiled.

	Percent nest success (number of nests)					
	California		Arizona		New Mexico	
Plant substrate	Native	Mixed and exotic	Native	Mixed and exotic	Native	Mixed and exotic
Tamarisk	0	N/A	0	54 (585)	-	45 (49)
Willow	47 (240)	N/A	36 (77)	39 (36)	42 (65)	23 (35)
Coast live oak	72 (116)	0	0	0	0	0
Boxelder	0	0	0	0	47 (289)	0
Other	55 (62)	N/A	44 (18)	-	53 (60)	-

2. Suitable, Potential, and Unsuitable Habitat

<u>Definitions.</u> The definition of the two commonly used terms - "currently suitable habitat" and "potentially suitable habitat " – are important for managers to understand for the recovery of the flycatcher. These terms encompass all the habitat components thought to influence reproductive success, including foraging habitat, micro-climate, vegetation density and distribution throughout the home range, presence of water, patch size, presence of other southwestern willow flycatchers, or other factors as they become identified.

Currently suitable habitat (hereafter "suitable habitat") is defined as a riparian area with all the components needed to provide conditions suitable for breeding flycatchers. These conditions are generally dense, mesic riparian shrub and tree communities 0.1 ha or greater in size within floodplains large enough to accommodate riparian patches at least 10 m wide (measured perpendicular to the channel); see Appendix D for more details. Currently, this definition of suitability is based solely on habitat characteristics, not on measures of flycatcher productivity or survival. Suitable habitat may be occupied or unoccupied; any habitat in which flycatchers are found breeding is, by definition, suitable. **Occupied suitable habitat** is that in which flycatchers are currently breeding or have established territories. **Unoccupied suitable habitat** appears to have physical, hydrological, and vegetation characteristics within the range of those found at occupied sites, but does not currently support breeding or territorial flycatchers. Some sites that appear suitable may be unoccupied because they may be missing an important habitat component not yet characterized. Other sites are currently suitable but unoccupied because the southwestern willow flycatcher population is currently small and spatially fragmented, and flycatchers have not yet colonized every patch where suitable habitat has developed.

Potentially suitable habitat (= "potential habitat") is defined as a riparian system that does not currently have all the components needed to provide conditions suitable for nesting flycatchers (as described above), but which could - if managed appropriately – develop these components over time. **Regenerating potential habitats** are those areas that are degraded or in early successional stages, but have the correct hydrological and ecological setting to be become, under appropriate management, suitable flycatcher habitat. **Restorable potential habitats** are those areas that could have the appropriate hydrological and ecological characteristics to develop into suitable habitat if not for one or more major stressors, and which may require active abatement of stressors in order to become suitable. Potential habitat occurs where the flood plain conditions, sediment characteristics, and hydrological setting provide potential for development of dense riparian vegetation. Stressors that may be preventing regenerating and restorable habitats from becoming suitable include, but are not limited to, de-watering from surface diversion or groundwater extraction, channelization, mowing, recreational activities, overgrazing by domestic livestock or native ungulates, exotic vegetation, and fire.

Unsuitable habitats are those riparian and upland areas which do not have the potential for developing into suitable habitat, even with extensive management. Examples of unsuitable habitat are found far outside of flood plain areas, along steep-walled and heavily bouldered canyons, at the bottom of very narrow canyons, and other areas where physical and hydrological conditions could not support the dense riparian shrub and tree vegetation used by breeding flycatchers even with all potential stressors removed.

Knowledge of the habitat components necessary for nesting flycatchers (Appendix D) will improve as additional studies are undertaken, allowing for more quantitative and possibly regionalized habitat descriptions in the future.

Specifying locations where nesting habitat is or could develop for flycatchers should not be confused with the overall management goal of rehabilitating and/or improving entire watersheds for southwestern willow flycatcher recovery. The health of riparian ecosystems and the development, maintenance, and regeneration of flycatcher nesting habitat depends on appropriate management of uplands, headwaters, and tributaries, as well as the main stem river reaches. All of these landscape components are inter-related. As a result, nesting habitat is only a small portion of the larger landscape that needs to be considered when developing management plans, recovery actions, biological assessments for section 7 consultations with the USFWS, or other documents defining management areas or goals for flycatcher recovery.

<u>The Importance of Unoccupied Suitable Habitat and Potentially Suitable Habitat</u>. Because riparian vegetation typically occurs in flood plain areas that are prone to periodic disturbance, suitable habitats will be ephemeral and their distribution dynamic in nature. Suitable habitat patches may become unsuitable through maturation or disturbance (though this may be only temporary, and patches may cycle back into suitability). Therefore, it is not realistic to assume that any given suitable habitat patch (occupied or unoccupied) will remain continually occupied and/or suitable over the long-term. Unoccupied suitable habitat will therefore play a vital role in the recovery of the flycatcher, because it will provide suitable areas for breeding flycatchers to: (a) colonize as the population expands (numerically and geographically), and (b) move to following loss or degradation of existing breeding sites. Indeed, many sites will likely pass through a stage of being suitable but unoccupied before they become occupied. Potential habitats that are not currently suitable will also be essential for flycatcher recovery, because they are the areas from which new suitable habitat develops as existing suitable sites are lost or degraded; in a dynamic riparian system, all suitable habitat starts as potential habitat. Furthermore, potential habitats are the areas where changes in management practices are most likely to create suitable habitat. Not only must suitable habitat always be present for long-term survival of the flycatcher, but additional acreage of suitable habitat must develop to achieve full recovery. Therefore, habitat management for recovery of the flycatcher must include developing and/or maintaining a matrix of riparian patches - some suitable and some potential - within a watershed so that sufficient suitable habitat will be available at any given time.

3. Patch Size and Shape

The riparian patches used by breeding flycatchers vary in size and shape. They may be relatively dense, linear, contiguous stands or irregularly-shaped mosaics of dense vegetation with open areas. Southwestern willow flycatchers nest in patches as small as 0.1 ha (0.25 ac) along the Rio Grande (Cooper 1997), and as large as 70 ha (175 ac) in the upper Gila River in New Mexico (Cooper 1997). Based on patch size values given in publications and agency reports (see Appendix D), mean size of flycatcher breeding patches is 8.5 ha (21.2 ac) (SE = 2.0 ha; range = 0.1 - 72 ha; 95% confidence interval for mean = 4.6 - 12.6; n = 63 patches). The majority of sites are toward the smaller end, as evidenced by a median patch size of 1.8 ha. Mean patch size of breeding sites supporting 10 or more flycatcher territories is 24.9 ha (62.2 ac) (SE = 5.7 ha; range = 1.4 - 72 ha; 95% confidence interval for mean = 12.9 - 37.1; n = 17 patches). Aggregations of occupied patches within a breeding site may create a riparian mosaic as large as 200 ha (494 ac) or more, such as at the Kern River (Whitfield 2002), Roosevelt Lake (Paradzick et al. 1999) and Lake Mead (McKernan 1997).

Flycatchers are generally not found nesting in confined floodplains where only a single narrow strip of riparian vegetation less than approximately 10 m (33 ft) wide develops, although they may use such vegetation if it extends out from larger patches, and during migration (Sogge and Tibbitts 1994, Sogge and Marshall 2000, Stoleson and Finch 2000z).

Flycatchers often cluster their territories into small portions of riparian sites (Whitfield and Enos 1996, Paxton et al. 1997, Sferra et al. 1997, Sogge et al. 1997b), and major portions of the site may be occupied irregularly or not at all. Most flycatcher breeding patches are larger than the sum total of the flycatcher territory sizes at that site. Flycatchers typically do not pack their territories into all available space within a habitat. Instead, territories are bordered by additional habitat that is not defended as a breeding territory, but may be important in attracting flycatchers to the site and/or in providing an environmental buffer (from wind or heat) and in providing post-nesting use and dispersal areas. Recent habitat modeling based on remote sensing and GIS data has found that breeding site occupancy at reservoir sites in Arizona is influenced by vegetation characteristics of habitat adjacent to the actual occupied portion of a breeding site (Arizona Game and Fish Dept, unpubl. data); therefore, unoccupied areas can be an important component of a breeding site. It is currently unknown how size and shape of riparian patches relate to factors such as flycatcher site selection and fidelity, reproductive success, predation, and brood parasitism.

4. Hydrological Conditions

In addition to dense riparian thickets, another characteristic common to most occupied southwestern willow flycatcher sites is that they are near lentic (quiet, slow-moving, swampy, or still) water. In many cases, flycatcher nest plants are rooted in or overhang standing water (Whitfield and Enos 1996, Sferra et al. 1997). Occupied sites are typically located along slow-moving stream reaches; at river backwaters; in swampy abandoned channels and oxbows; marshes; and at the margins of impounded water (e.g., beaver ponds, inflows of streams into reservoirs). Where flycatchers occur along moving streams, those streams tend to be of relatively low gradient, i.e., slow-moving with few (or widely spaced) riffles or other cataracts. The flycatcher's riparian habitats are dependent on hydrological events such as scouring floods, sediment deposition, periodic inundation, and groundwater recharge for them to become established, develop, be maintained, and ultimately to be recycled through disturbance.

5. Other Habitat Components

Other potentially important aspects of southwestern willow flycatcher habitat include landscape features (distribution and isolation of vegetation patches), physical features (micro-climate temperature and humidity) and biotic interactions (prey types and abundance, parasites, predators, interspecific competition). Population dynamics factors such as demography (i.e., birth and death rates, age-specific fecundity), distribution of breeding groups across the landscape, flycatcher dispersal patterns, migration routes, site fidelity, philopatry, and conspecific sociality also influence where flycatchers are found and what habitats they use. Most of these factors are poorly understood at this time, but may be critical to understanding current population dynamics and habitat use. Refer to Wiens (1985, 1989a, 1989b) for additional discussion of habitat selection and influences on bird species and communities.

6. Migration and Wintering Habitat

The migration routes used by southwestern willow flycatcher are not well documented. *Empidonax* flycatchers rarely sing during fall migration; therefore, distinguishing species is difficult. However, willow flycatchers (all subspecies) sing during spring migration. As a result, willow flycatcher use of riparian habitats along major drainages in the southwest has been documented (Sogge et al. 1997b, Yong and Finch 1997, Johnson and O'Brien 1998, McKernan and Braden 1999). Migrant southwestern willow flycatchers may occur in non-riparian habitats and/or be found in riparian habitats unsuitable for breeding. Such migration stopover areas, even though not used for breeding, may be critically important resources affecting productivity and survival.

The flycatcher winters in Mexico, Central America, and northern South America (Phillips 1948, Gorski 1969, McCabe 1991, Ridgely and Tudor 1994, Koronkiewicz et al. 1998, Unitt 1999). Popular literature on the birds of Mexico, Central, and South America describes willow flycatcher wintering habitat as humid to semi-arid, partially open areas such as woodland borders (Ridgely and Gwynne 1989, Stiles and Skutch 1989, Howell and Webb 1995). Second growth forest, brushy savanna edges, and scrubby fields and pastures are also used (Ridgely and Tudor 1994). In Panamá, Gorski (1969) found them in transitional and edge areas, often near a wetland. Similarly, in Costa Rica and Panamá, Koronkiewicz et al. (1998 and pers. comm) found willow flycatchers defending winter territories in areas with standing water, sluggish-moving streams with floating or emergent vegetation and adjacent seasonally inundated savanna, dense woody shrubs, patches or stringers of trees, and open grassy areas. They observed willow flycatchers most often along the edges of wetland areas, in dense woody shrubs bordering and extending into drier portions of the wetland, and in forest edge along open areas of the wetland. The most commonly used vegetation was patches of dense woody shrubs (*Mimosa* sp.) approximately 1-2 m (3-7 ft) tall, bordering and extending into wet areas. See Appendix E for detailed discussion of migration and wintering habitat and ecology.

D. Breeding Biology

The willow flycatcher (all subspecies) breeds across much of the conterminous United States and in portions of northern Mexico and extreme southern Canada (Figure 1). This section discusses the breeding-season ecology of the southwestern willow flycatcher. Relatively few ecological studies have been published on the southwestern subspecies, and much of what is known is presented in unpublished literature (e.g., technical reports). The following discussion uses ecological information from other subspecies where it is appropriate, and qualifies such information where it is extrapolated to the southwestern willow flycatcher.

1. Vocalizations

The willow flycatcher's primary song, "*fitz-bew*," distinguishes it from all other *Empidonax* flycatchers and other bird species (refer to Stein 1963 for a detailed discussion). This is the primary territorial song of male willow flycatchers. Singing bouts are usually comprised of a series of *fitz-bews*, sometimes interspersed with *britt* notes, lasting from less than a minute to over a half-hour. Males sing to advertise their territory to prospective mates and other nearby males. Female willow flycatchers also sing, although not as often as do males, and/or sometimes more quietly (Seutin 1987, Sedgwick and

Knopf 1992, Paxton et al. 1997, Sogge et al. 1997b, SWCA 2000, M. Whitfield unpubl. data). Migrant willow flycatchers often sing from tall song perches during spring migration, in much the way that territorial birds do (Johnson and Sogge 1997, Sogge et al. 1997b).

Male willow flycatchers sing most persistently early in the breeding season and early in each nesting cycle. Song rate declines as the season progresses, particularly once the male finds a mate and nesting efforts begin (Braden and McKernan 1998). Territorial flycatchers often begin singing well before dawn, and song rate is generally highest early in the morning. Short periods of pre-dawn singing often continue as late as July (Sogge et al. 1997b). In breeding groups with many territorial males, morning song rate may remain high throughout most of the breeding season. Unmated males and males with territories near other willow flycatchers tend to vocalize more than males in isolated territories (M. Whitfield, pers. comm.), which may make detection of isolated flycatchers more difficult.

Another common vocalization used by flycatchers is the "*whitt*" call, given by both sexes. *Whitts* are uttered during various activities, including foraging, perching, collecting nesting material, during interactions between flycatchers, as an alarm call, and on wintering grounds. *Whitt*s are often the most common vocalization used during mid- and late breeding season (Braden and McKernan 1998). Many other bird species have similar *whitt* calls, so unlike the *fitz-bew*, the *whitt* is not generally considered unique to willow flycatchers. Willow flycatchers also use an array of varied vocalizations, usually produced by paired adults interacting in close proximity to a nest and/or offspring. These include *wheeo*, *wheep*, *wheek-a-dee*, and *brrrt* phrases. See McCabe (1991) and Sedgwick (2000) for a detailed discussion of willow flycatcher vocalizations.

2. Breeding Chronology

A Neotropical migrant, southwestern willow flycatchers spend only three to four months on their breeding grounds. The remainder of the year is spent on migration and in wintering areas south of the United States. Figure 2 presents a generalized breeding chronology for the southwestern willow flycatcher, and is based on Unitt (1987), Brown (1988), Whitfield (1990), Skaggs (1996), Sogge (1995), Maynard (1995), Sferra et al. (1997), and Sogge et al. (1997b). Record or extreme dates for any stage of the breeding cycle may vary as much as a week from the dates presented. In addition, flycatchers breeding at higher elevation sites or more northerly areas usually begin breeding several weeks later than those in lower or southern areas.

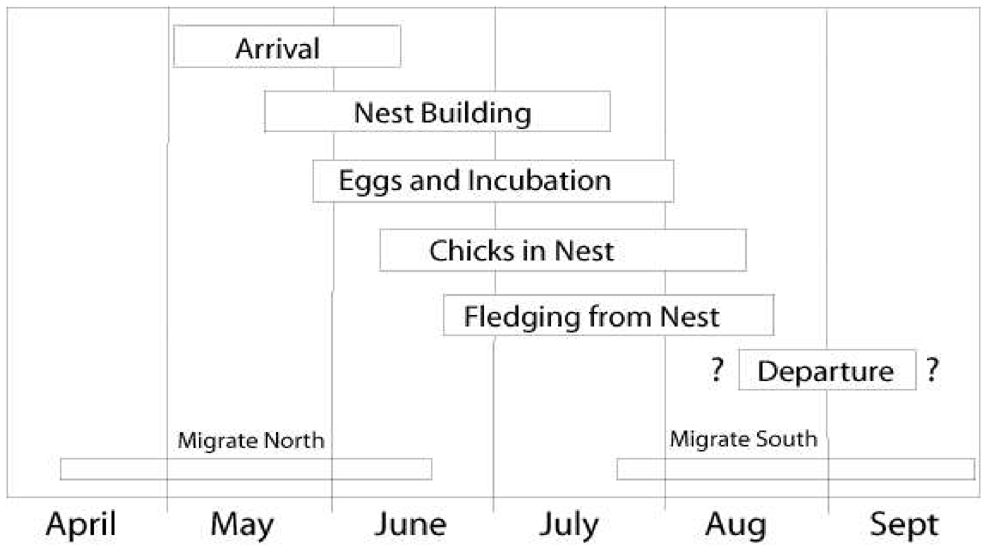

Figure 2. Generalized breeding chronology of the southwestern willow flycatcher (modified from Sogge et al. 1997a). Dates for a given stage may vary a week or more at a given site or during a given year.

Southwestern willow flycatchers typically arrive on breeding grounds between early May and early June, although a few individuals may establish territories in very late April (Willard 1912, Ligon 1961, Maynard 1995, Skaggs 1996, Sferra et al. 1997). Because arrival dates vary geographically and annually, northbound migrant willow flycatchers (of all subspecies) pass through areas where *E.t. extimus* have already begun nesting. Similarly, southbound migrants (of all subspecies) in late July and August may occur where southwestern willow flycatchers are still breeding (Unitt 1987). Therefore, it is only during a short period of the breeding season (approximately 15 June through 20 July) that one can assume that a willow flycatcher seen within *E.t. extimus* range is probably of that subspecies.

Relatively little is known regarding movements and ecology of adults and juveniles after they leave their breeding sites. Males that fail to attract or retain mates, and males or pairs that are subject to significant disturbance (such as repeated cowbird parasitism, predation, etc.) may leave territories by mid-July (Sogge 1995, Sogge et al. 1997b). Fledglings probably leave the breeding areas a week or two after adults, but few details are known.

3. Mating and Territoriality

Male flycatchers generally arrive first at a breeding site, and establish a territory by singing and interacting aggressively with other flycatchers. Willow flycatchers are strongly territorial, and will sing almost constantly when establishing territories. Females tend to arrive later (approximately a week or two). It is not known exactly what factors a female uses to select a territory, though it may be related to habitat quality or potential quality of the male. Second-year males arrive at about the same time as females (M. Whitfield, unpubl. data).

Males are usually monogamous, but polygyny rates of 5% - 20% have been documented (Whitfield and Enos 1996, Sferra et al. 1997, Paradzick et al. 2000, McKernan and Braden 2001). Polygynous males typically have two females in their territory. Genetic evidence shows that territorial males mate with females in other territories (i.e., engage in extra-pair copulations; Pearson 2002, E. Paxton unpubl. data). Data from color-banded populations (Whitfield 1990 and unpubl. data; Paxton et al. 1997, Kenwood and Paxton 2001) show that between-year mate fidelity is low, and that during a breeding season some flycatcher pairs break up and subsequently pair and breed with other individuals.

Southwestern willow flycatchers are strongly territorial. Flycatcher territories are often clumped together, rather than spread evenly throughout a habitat patch. This has led some authors to label willow flycatchers as "semi-colonial" (McCabe 1991), although they do not fit the strict definition of a colonial species and regularly breed at sites with only one or a few pairs (Sferra et al. 1997, Sogge et al. 1997a and 1997b, Paradzick et al. 1999). Territory size varies greatly, probably due to differences in population density, habitat quality, and nesting stage. Estimated breeding territory sizes generally range from approximately 0.1 ha to 2.3 ha (0.25-5.7 ac), with most in the range of approximately 0.2 - 0.5 ha (0.5-1.2 ac) (Sogge 1995, Whitfield and Enos 1996, Skaggs 1996, Sogge et al. 1997b). Territories of polygynous males are often larger than those of monogamous males. Whitfield (unpubl. data) observed instances of individual polygynous males using multiple singing perches several hundred meters (>600 ft) apart. Flycatchers may use a larger area than their initial territory after their young are fledged, and use non-riparian habitats adjacent to the breeding area. Even during the nesting stage, adult flycatchers sometimes fly outside of their territory, often through an adjacent flycatcher territory, to gather food for their nestlings.

4. Site Fidelity

Evidence gathered during multi-year studies of color-banded populations shows that although most southwestern willow flycatchers return to former breeding areas, flycatchers regularly move among sites within and between years (Netter et al. 1998, Kenwood and Paxton 2001, M. Whitfield unpubl. data). From 1997 through 2000, 66% to 78% of flycatchers known to have survived from one breeding season to the next returned to the same breeding site; conversely, 22% to 34% of returning birds moved to different sites (Luff et al. 2000). Both males and females move within and between sites, with males showing slightly greater site fidelity (Netter et al. 1998). Within-drainage movements are more common than between-drainage movements (Kenwood and Paxton 2001). Typical distances moved range from 2 to 30 km (1.2 - 18 mi); however, long-distance movements of up to 220 km have been observed on the lower Colorado River and Virgin River (McKernan and Braden 2001). In some cases, willow flycatchers are faced with situations that force movement, such as when catastrophic habitat loss occurs from fire or flood. Several such cases have been documented, with some of the resident willow flycatchers moving to remaining habitat within the breeding site, some moving to other sites 2 to 28 km (1.2 - 16.8 mi) away (Paxton et al. 1996, Owen and Sogge 1997), and others disappearing without being seen again.

5. Nests, Eggs, and Nestling Care

The flycatcher builds a small open cup nest, constructed of leaves, grass, fibers, feathers, and animal hair; coarser material is used in the nest base and body, and finer materials in the nest cup (Bent 1960). Nests are approximately 8 cm (3.15 in) high and 8 cm wide (outside dimensions), and have 2 to 15 cm (1-6 in) of loose material dangling from the bottom (or none, in tamarisk-dominated habitats). Females build the nest over a period of four to seven days, with little or no assistance from the male. Most nests are used only once, although females will often use some fibers and materials (particularly the lining) from the original nest when constructing a subsequent nest during the same season (McCabe 1991). Although uncommon, re-use of nests has been documented at several breeding sites in Arizona (Yard and Brown 1999, Arizona Game and Fish unpubl. data). Typical nest placement is in the fork of small-diameter (e.g., ≤1 cm or 0.4 in), vertical or nearly vertical branches. Occasionally, nests are placed in down-curving branches. Nest height varies considerably, from 0.5 m to 18 m (1.6 to 60 ft), and may be related to height of nest plant, overall canopy height, and/or the height of the vegetation strata that contain small twigs and live growth. Most typically, nests are relatively low, e.g., 2 to 7 m (6.5 to 23 ft) above ground.

Willow flycatcher eggs are buffy or light tan, with brown markings circling the blunt end. Eggs are approximately 18 mm long and 14 mm wide (0.45 x 0.35 in), and weigh about 1.6 g (0.05 oz) (McCabe 1991). Females typically lay one egg per day, until the nest contains 3 or 4 eggs. Incubation begins after the last egg is laid, and lasts 12 to 13 days. Most incubation is by the female, although male incubation is also known (Gorski 1969, H. Yard, B. Brown, and Arizona Game and Fish Department unpubl. data). Most eggs in a nest hatch within 48 hours of each other (McCabe 1991).

The female provides most of the initial care of the young. As demand for food increases with nestling growth, the male also brings food to the nest. Generally, only the female broods the young. Nest attendance decreases with nestling age, with females spending less than 10 percent of their time at the nest after nestling day 7 (Arizona Game and Fish Department unpubl. data). Nestlings fledge 12 to 15 days after hatching.

Fledglings stay close to the nest and each other for 3 to 5 days, and may repeatedly return to and leave the nest during this period (Spencer et al. 1996). Fledglings typically stay in the general nest area a minimum of 14 to 15 days after fledging, possibly much longer. Both parents feed the fledged young, though in some cases one parent may do all of the feeding (M. Whitfield unpubl. data). Dispersal distances and interactions with parents after this period are not well known.

6. Renesting

Second clutches within a single breeding season are uncommon if the first nest is successful. Most attempts at renesting occur if the young fledge from the first nest by late June or very early July. Renesting is regularly attempted if the first nest is lost or abandoned due to predation, parasitism, or disturbance; a female may attempt as many as four nests per season (Smith et al. 2002). Replacement nests are built in the same territory, and may be close to (even in the same plant) or far from (up to 20 m/65 ft) the previous nest (McCabe 1991, Sogge et al. 1997b). Clutch size decreases with each nest attempt (Holcomb 1974, McCabe 1991, Whitfield and Strong 1995). Some flycatchers may move hundreds of meters or even several kilometers to renest (Netter et al. 1998).

7. Post-Breeding Dispersal

Dispersal after the nesting cycle is poorly understood. Adults that are successful in raising young may remain at breeding sites through mid-August to early September. Pairs with unsuccessful first and/or second nests sometimes abandon their territories midway through the breeding season. Some of these birds are known to attempt renesting, either nearby or at another site, with movements of up to 30 km (18.6 mi) documented (Netter et al. 1998). Unpaired males may remain on territory through the early part of the breeding season but leave by mid-July (Sogge 1995, Sogge et al. 1997b).

8. Demography

Demography is the science of the interrelated life history factors that determine how populations grow, shrink, or change in other ways. Some basic understanding of the overall demography of a species is usually needed to interpret or estimate trends in any single parameter, such as population size, reproduction rates, or age class distributions. For example, to know that extremely high mortality of the young is normal for a species of tree helps explain why each adult may produce thousands of young annually. For imperiled species like the southwestern willow flycatcher, knowledge of demography often reveals that certain factors are of particular importance in conservation. For the flycatcher, many key demographic parameters are only beginning to be understood in detail. However, the current level of knowledge is sufficient to identify several parameters that should receive attention in recovery efforts. As our knowledge of demography increases, we will be better equipped to estimate and evaluate population trends. Key demographic factors for the flycatcher are discussed below, with comments regarding their relevance to recovery, and to evaluating and estimating population trends. This discussion draws heavily on Stoleson et al. (2000); see that publication for more information.

Age Classes

The importance of the relative proportions of birds of various ages (age class distribution) to population dynamics is not known for the flycatcher. Several observations are relevant to its significance as a demographic factor. Flycatchers breed the next spring after hatching, i.e., all flycatchers arriving on the breeding grounds are potential breeders, including those hatched the prior year (Paxton et al. 1997, Whitfield unpubl. data). Age may affect breeding success or productivity, though preliminary data from the Kern River showed no differences in the number of young fledged between yearling females and older females (Whitfield unpubl. data).

Sex Ratios

The ratio of males to females can have obvious importance in a population, as it determines what proportion is truly reproducing. However, with the flycatcher this is confused by known instances of polygyny, extra-pair copulation, and mate reshuffling (Paradzick et al. 1999, Netter et al. 1998, McKernan and Braden 2001, Pearson 2002). Unpaired males are present in the breeding season in some areas (Parker 1997, Sogge et al. 1997b, Paradzick et al. 1999, Whitfield unpubl. data).

Fecundity

Fecundity is the reproductive performance of an individual or population. For the southwestern willow flycatcher, fecundity is a product of probability of breeding, clutch size, hatching success, nesting success, and number of nesting attempts per season. Flycatcher fecundity is reduced, to varying degrees across its range, by factors such as nest predation and brood parasitism by the brown-headed cowbird. In some areas, probability of breeding may be diminished by skewed sex ratios (Stoleson et al. 2000). As is often the case with rare species, increasing fecundity of the flycatcher could be important to recovery. This might be accomplished through increasing habitat availability and quality, reducing brood parasitism, and if suitable techniques can be developed, decreasing rates of nest predation.

Longevity

Based on observations and recaptures of banded southwestern willow flycatchers, it is likely most live 1 to 3 years, with many living 4 years, and some individuals surviving 5 to at least 8 years (E. Paxton and M. Whitfield, unpubl. data). Sedgwick (2000) documented an *adastus* willow flycatcher surviving at least 11 years in the wild. Extensions of survivorship should increase populations by keeping individuals present in the population longer, and by gaining more reproductive years from those individuals. Increasing adult survivorship may be difficult, but possibilities include decreasing unnaturally high levels of predation, and improving the quality of breeding, migration, and wintering habitat.

Immigration and Emigration

Recent studies suggest immigration and emigration among flycatcher breeding sites may be fairly common. Using color-banded birds, movements among breeding sites have been documented, both within and between drainages, and within and between years (Langridge and Sogge 1997, Paxton et al. 1997, Netter et al. 1998). In east-central Arizona, Netter et al. (1999) reported that 13% of banded birds present in 1997 had moved to new sites in 1998. Distances moved range from 0.4 to 190 km (0.25 to 118 mi). Movements within drainages were most common, with a mean distance moved of 14 km (8.7 mi). Banding studies along the lower Colorado River and Virgin River drainages (McKernan and Braden 2001) have documented between-year adult movements of 13 - 100 km (8 - 62 miles); returning birds banded as nestlings moved 14 - 220 km (9 - 138 miles) from their natal sites. Between-year movements between drainages may be less common, but distances moved are considerable. Examples (from Netter et al. 1998): from the San Francisco River 40 km (25 mi) to the headwaters of the Little Colorado River; and to a site 90 km (56 mi) to the northeast; from the Verde River 190 km (118 mi) to the Gila River; from Tonto Creek 94 km (58 mi) to the Gila River.

E. Foraging Behavior and Diet

The willow flycatcher is an insectivore. It catches insects while flying, hovers to glean them from foliage, and occasionally captures insects on the ground. Flycatchers forage within and above the canopy, along the patch edge, in openings within the territory, above water, and glean from tall trees as well as herbaceous ground cover (Bent 1960, McCabe 1991, B. Valentine pers. comm., M. Whitfield pers. comm.). Willow flycatchers employ a “sit and wait” foraging tactic, with foraging bouts interspersed with longer periods of perching (Prescott and Middleton 1988). Southwestern willow flycatcher foraging rates are highest early and late in the day, and during the nestling period (SWCA 2001).

All North American *Empidonax* flycatchers appear to have generally similar diets during the breeding season, consisting of small to medium-sized insects (Beal 1912). The willow flycatcher is somewhat of a generalist. Wasps and bees (Hymenoptera) are common food items, as are flies (Diptera), beetles (Coleoptera), butterflies/moths and caterpillars (Lepidoptera), and spittlebugs (Homoptera) (Beal 1912, McCabe 1991). Plant foods such as small fruits have been reported (Beal 1912, Roberts 1932, Imhof 1962), but are not a significant food during the breeding season (McCabe 1991). Diet studies of adult southwestern willow flycatchers (Drost et al. 1997, DeLay et al. 2002) found a wide range of prey taken. Major prey items were small (flying ants) to large (dragonflies) flying insects, with Hymenoptera, Diptera and Hemiptera (true bugs) comprising half of the prey items. Willow flycatchers also took non-flying species, particularly Lepidoptera larvae. Plant material was again negligible.

F. Competitors

The extent to which competition affects southwestern willow flycatcher distribution and abundance is unknown. Resources for which competition might exist include nest sites and food. The flycatcher may experience competition from other species (interspecific), or from other willow flycatchers (intraspecific).

The greatest potential for interspecific competition might be expected from other *Empidonax* flycatchers, being closely related and similar in morphology and food habits. Where willow flycatchers (subspecies other than *extimus*) and other *Empidonax* flycatchers breed in the same habitats, they often maintain mutually exclusive territories (Frakes and Johnson 1982, McCabe 1991). However, Gorski (1969) concluded that “competition is almost lacking” between the closely related willow and alder (*E. alnorum*) flycatchers. In its breeding range, the southwestern willow flycatcher is often the only *Empidonax* flycatcher breeding in its nesting habitat. Competition also has not been demonstrated between the southwestern willow flycatcher and other flycatchers that commonly occur in or near to its habitat, e.g., the pacific-slope flycatcher (*E. difficilis*), ash-throated and brown-crested flycatchers (*Myiarchus cinerascens* and *M. tyrannulus*), black phoebe (*Sayornis nigricans*), and western wood-pewee (*Contopus sordidulus*). Other, less-related species are even less likely to be significant competitors, e.g., yellow warblers (*Dendroica petechia*) (McCabe 1991). Although willow flycatchers and other riparian species experience degrees of overlap in diet and nest site selection, interspecific territoriality is rarely observed, and many cases of overlapping territories are known.

As is often true, within-species (intraspecific) competition is likely the most intense. One resource for which intraspecific competition may exist is mates. Male willow flycatchers exhibit strong intraspecific territoriality. At many breeding sites, some males are polygynous (i.e., mate with more than one female in their territory) while others fail to secure mates (Stoleson et al. 1999, Smith et al. 2002). This implies that females may be limited at some sites, and that males compete for reproductive opportunities, with some (paired) being more successful than others (unpaired) . The ecological, evolutionary, and demographic effects of this competition are not well known.

G. Predation and Predators

Southwestern willow flycatchers are probably influenced by predation, but predation rates are within the typical range for open-cup nesting passerine birds (Newton 1998). However, for an endangered bird "normal" predation rates may exert disproportionately greater stresses on populations. Nest success may be particularly affected, and most of what is known about flycatcher predation involves nest predation. Predation can be the single largest cause of nest failure in some years (Whitfield and Enos 1996, Paradzick et al. 1999). In a New Mexico population, Stoleson and Finch (1999) attributed 37.3% of 110 nest failures to predation. Predation of southwestern willow flycatcher eggs and nestlings is documented for the common kingsnake (*Lampropeltis getulus*) (Paxton et al. 1997, McKernan and Braden 2001, Smith et al. 2002), gopher snake (*Pituophis melanoleucus affinis*) (Paradzick et al. 2000, McKernan and Braden 2001), Cooper's hawk (*Accipiter cooperii*) (Paxton et al. 1997), red-tailed hawk (*Buteo jamaicensis*) (Whitfield and Lynn 2000), great horned owl (*Bubo virginianus*) (Stoleson and Finch 1999), western screech owl (*Otus kennicottiii*) (Smith et al. 2002), yellow-breasted chat (*Icteria virens*) (Paradzick et al. 2000), and Argentine ants (*Linepithema humili*) (Famolaro 1998, B. Kus pers. comm.). Other potential predators of flycatcher nests include other snakes, lizards, chipmunks, weasels, racoons, ringtailed cats, foxes, and domestic cats (McCabe 1991, Sogge 1995, Langridge and Sogge 1997, Paxton et al. 1997, Sferra et al. 1997, McCarthey et al. 1998, Paradzick et al. 2000). Predatory birds such as jays, crows, ravens, hawks (especially accipiters), roadrunners, and owls may hunt in flycatcher habitat. Brown-headed cowbirds effectively function as predators if they remove flycatcher eggs during parasitism. Cowbirds are also known to kill nestlings of other songbirds (Sheppard 1996, Tate 1967, Beane and Alford 1990, Scott and McKinney 1994), and may act as predators on southwestern willow flycatcher chicks (M. Whitfield and AGFD unpubl. data). Although acts of nest predation by cowbirds have been documented on other species, available evidence indicates that cowbirds are not frequent predators of flycatcher nests; rates of nest predation have not declined in response to cowbird control (Whitfield et al. 1999, Whitfield 2000; Appendix F).

Predation of adults of most passerine birds is not often observed, and virtually no data of this kind of predation exists for the southwestern willow flycatcher. However, adult (and fledgling) flycatchers are vulnerable to predation by many of the animals discussed above, especially by predatory birds. Incubating females are particularly vulnerable, especially at night. Although no data are available, flycatchers are also likely to be exposed to predation during migration and on their tropical wintering grounds.

H. Disease and Parasites

1. Disease and Invertebrate Parasites

Although all wild birds are exposed to disease and various internal and external parasites, little is known of the role of disease and parasites on most species or populations. Disease and parasites may be significant factors in periods of environmental or physiological stress, during certain portions of a life cycle, or when introduced into a new or naive host (Karstad 1971, Atkinson and van Riper 1991, van Riper 1991). The willow flycatcher (various subspecies) is known to be a host to a variety of internal and external parasites. These include blood parasites such as *Haemoproteus*, *Leucocytozoon*, *Microfilaria*, *Tyrpanosoma* and *Plasmodium* (Bennett et al. 1982, C. van Riper and M. Sogge, unpubl. data); blow fly (*Protocalliphora* sp.) (Boland et al. 1989, Sabrosky et al. 1989, McCabe 1991, AGFD unpubl. data); and nasal mites (Pence 1975). Most bird species, including *Tyrannid* flycatchers, are susceptible to viral pox (Karstad 1971). Although these parasites likely occur in southwestern willow flycatchers, there is no information on what impact they have on infected birds or populations. McCabe (1991) identified mites *(Ornithonyssus sylviarum*) in 43% of flycatcher nests, and blowfly larvae in 32% of nests, but noted no significant negative effects from either. Conversely, Whitfield and Enos (1998) documented mortality of nestlings (southwestern willow flycatchers) due to severe mite infestation.

2. Cowbird Brood Parasitism

The southwestern willow flycatcher also experiences brood parasitism by the brown-headed cowbird (*Molothrus ater*) and cowbird impacts on some (but not all) populations are sufficiently large to warrant management efforts (See Appendix F). The cowbird lays its eggs in the nests of other species. The “host” species then incubate the cowbirds eggs and raise the young. Because cowbird eggs hatch after relatively short incubation and hatchlings develop quickly, they often outcompete the hosts’ own young for parental care. Cowbirds may also remove eggs and nestlings of host species from nests (or injure nestlings in nests), thereby acting as nest predators. Cowbirds can therefore have negative effects on reproductive success of flycatcher females and populations. Various factors have increased the range and numbers of the brown-headed cowbird, and potentially its impacts on hosts, over the pre-European condition, although these effects may have peaked several decades ago. Factors facilitating increased cowbird impacts include increased cowbird numbers through expansion of suburban and agricultural areas, and increases in cowbird access to riparian habitat via narrowed riparian zones and fragmentation. These issues are dealt with in depth in Appendix F.

Besides possibly contributing to the endangerment of the southwestern willow flycatcher and several other songbirds (e.g., least Bell’s vireo, golden-cheeked warbler, black-capped vireo), brood parasitism is a potential impediment to recovery. However, it is important to be aware that the presence of cowbird parasitism does not necessarily mean it is having critical or even significant effects on a given flycatcher population. Several factors influence the degree to which cowbird parasitism is a problem, including: parasitism rate; flycatcher response to parasitism (e.g., abandonment and renesting); and net reproductive success per female flycatcher. Once these factors are considered, the effect of parasitism is typically less than what seemed to be the case initially. See additional discussion below, in “Reasons for Decline and Current Threats” and Appendix F.

I. Status and Trends of Populations and Habitat

1. Current Flycatcher Populations

Developing a current population estimate is challenging. The population presents a moving target, both spatially and temporally. Because not all sites are re-surveyed in every year, the estimate generated here is a composite of known populations for different years at different sites. In each case, the most recent or more thorough year's data were used as the "current" population. This estimate is qualified by the knowledge that numbers of birds at a given site fluctuate from year to year, that inter-site dispersal takes place, and that some occupied sites have been destroyed or damaged in recent years, causing the former residents to relocate and forego breeding. Also, survey and monitoring effort has increased substantially from 1993 to the present, but varies among regions. Another confounding factor is the taxonomic identity of willow flycatchers at the edge of the range of the southwestern subspecies.

When the southwestern willow flycatcher was listed as endangered in 1995, approximately 350 territories were known to exist (Sogge et al. 2001). As of the 2001 breeding season, the minimum known number of southwestern willow flycatchers was 986 territories (Table 4). The numbers in Table 4 do not include flycatchers suspected to occur on some Tribal and private lands. Though much suitable habitat remains to be surveyed, the rate of discovery of new nesting pairs has recently leveled off (Sogge et al. 2001). A coarse estimate is that an additional 200 to 300 nesting pairs may remain undiscovered, yielding an estimated total population of 1,200 to 1,300 pairs/territories. Unitt (1987) estimated that the total flycatcher population may be 500 to 1000 pairs; thus, nearly a decade of intense survey efforts have found little more than slightly above the upper end of Unitt's estimate. The surveys of the 1990s have been valuable in developing a rangewide population estimate, but cannot identify a rangewide trend over that period. However, some local trends may be evident, as discussed below.

Table 4. Known numbers of southwestern willow flycatcher territories by State. Data are from Sogge et al. 2002, based on last reported survey data for all sites where flycatchers were known to breed, 1993-2001.

	State							
	Arizona[1]	California[1]	Colorado	Nevada	New Mexico	Utah	Texas	Total
Number of Territories	359	256	37	73	258	3	0	986

[1]Flycatchers on the lower Colorado River are all included in Arizona's total.

2. *Trends in Habitat and Flycatcher Distribution*

California

Unitt (1984, 1987) concluded the flycatcher was once fairly common in the Los Angeles basin, where habitat is virtually absent now. The South Fork of the Kern River is one of the few places where riparian habitat has increased substantially over the last 20 years. Approximately 250 ha of riparian habitat has regenerated along the South Fork Kern River since the early 1980s (Whitfield et al. 1999). However, despite an apparent abundance of suitable habitat and cowbird trapping, the flycatcher population on the South Fork Kern River has fluctuated from 38 territories in 1997 to 23 in 1999 (Whitfield et al. 1999). Downstream from the South Fork Kern River, willow flycatchers were common breeders in the extensive riparian habitat along the Kern River and Buena Vista Lake in the early 1900s (Linton 1908). Today, essentially all of the riparian habitat is gone and there are no recent reports of breeding willow flycatchers. However, it is uncertain whether the *E.t. extimus* subspecies bred there. Outside of the Kern River, the three largest flycatcher populations in California reside along the Owen's River from below Pleasant Valley Reservoir to Warm Springs Road, along the San Luis Rey River downstream of Lake Henshaw, and along the Santa Margarita River at Camp Pendleton. Limited willow flycatcher surveys have been conducted on the Owen's River in the early and mid 1990s, the most recent survey conducted in 2001 documented a minimum of 24 territories (Whitfield unpubl. data). Changes in land use along the San Luis Rey River, including the removal of grazing from Forest Service lands in the early 1990s, have improved the extent and quality of riparian habitat for southwestern willow flycatchers, which have increased from 12 territorial males in the late 1980s (Unitt 1987) to over 40 in 1999 (Kus et al. 1999, W. Haas, pers. comm.). In contrast, the flycatcher population at Camp Pendleton has remained fairly constant at under two dozen territories for the past two decades, despite the availability of additional apparently suitable habitat to support population expansion. The remaining flycatcher populations in southern California, most of which number fewer than five territories, occur at scattered sites along drainages that have changed little during the past 15 years.

Arizona

All of Arizona's major rivers and their tributaries where southwestern willow flycatchers were known to have bred have changed, often dramatically (Tellman et al. 1997). Rivers such as the Colorado, Gila, Santa Cruz, San Pedro, and Verde rivers have suffered extensive dewatering, and loss and fragmentation of riparian habitats. Consequently, many areas where the flycatcher was formerly locally abundant now support few or none. Following are just a few examples. The flycatcher was once abundant near the confluence of the Gila and Colorado rivers (T. Huels in litt., transcripts of H. Brown's field notes), but is now rare (McKernan and Braden 1999 and 2001, Paradzick et al. 1999 and 2000). Historically known along the Santa Cruz River near Tucson (Swarth 1914, Phillips 1948), flycatchers no longer breed there and suitable habitat is essentially lacking. The Verde Valley once hosted large amounts of dense, mesic riparian habitats in which flycatchers bred (E.A. Mearns historical field notes, Swarth 1914). Conversion to agriculture and phreatophyte control programs dramatically reduced riparian vegetation, and fewer than 10 flycatcher territories persist on the Verde River (Paradzick et al. 1999). Recently, newly developed habitat supporting a relatively large breeding population at the

Colorado River inflow to Lake Mead was inundated, and flycatchers no longer breed at that site (McKernan and Braden 1998, 1999, 2001). Two riparian areas continue to support substantial numbers of flycatchers. Over 150 flycatcher territories have been found along the lower San Pedro River and nearby portions of the Gila River (AGFD unpubl. data), where flycatchers have been known since the early 1900s (Willard 1912, Phillips 1948). Riparian habitat at the Tonto Creek and Salt River inflows to Roosevelt Lake hosts approximately 140 territories (Smith et al. 2002); these habitats probably developed only recently and are subject to inundation and possible destruction when reservoir levels are raised. The largest breeding population (21 territories) currently known along the lower Colorado River is found at Topock Marsh (McKernan and Braden 2002).

New Mexico

Loss of flycatcher populations and habitat likely has been most severe in the Rio Grande Valley, where the taxon may have been widespread and fairly common, including in the vicinities of Espanola and Las Cruces (Hubbard 1987), two areas where suitable habitat and flycatchers are no longer found; a remnant population found in upper Elephant Butte Reservoir in the early 1970s was lost to rising lake levels (Hubbard 1987). Along the San Francisco River, habitat degradation likely lead to the loss of breeding flycatchers in the vicinity of Glenwood. The large population along the Gila River reported by Egbert (1981) and Montgomery et al. (1985), and identified by Hubbard (1987) as a stronghold remains one of the largest known southwestern willow flycatcher population rangewide (Skaggs 1996, Stoleson and Finch 1999, Sogge et al. 2001).

Texas

In Trans-Pecos Texas, loss of suitable habitat and presumed breeding flycatcher populations almost certainly has been severe along the Rio Grande, especially the now-dry reach from below El Paso to the confluence with the Rio Conchos at Presidio. The last reported nesting in the region occurred in the Davis Mountains in 1890 (Oberholser 1974). In this century, there are few if any reports of occurrence between the dates 18 June and 21 July (Phillips 1948, Wauer 1973 and 1985, Oberholser 1974, Unitt 1987), implying breeding flycatchers are scarce or absent. However, no formal surveys have been conducted in recent years to determine presence or absence of breeding flycatcher populations or to evaluate potential flycatcher habitat.

Utah

Although Behle (1985) describes the willow flycatcher as a common summer resident statewide, there are few historical or current records in the southern portion of the State within the range of *E. t. extimus*. Historically, southern Utah's largest flycatcher populations may have been those along the Colorado River and its tributaries in Glen Canyon (Behle and Higgins 1959); these are now inundated by Lake Powell. The flycatcher also bred along the Virgin River in the St. George area (Behle et al. 1958), and along the San Juan River (Unitt 1987). Recent surveys have found the flycatcher absent as a breeding species on the Green and Colorado Rivers in the Canyonlands National Park area (M. Johnson unpubl.

data), on the San Juan River (west of the New Mexico border; Johnson and O'Brien 1998), and portions of the Manti-La Sal National Forest (Johnson 1998). Flycatchers have recently bred in small numbers along the Virgin River near St. George (Langridge and Sogge 1998, F. Howe unpubl. data), and single territories have been located at sites in the Panguitch Lake area (U.S. Forest Service unpubl. data) and within Bryce Canyon National Park (Schreier 1996).

Nevada

Southern Nevada is predominantly an arid region with few riparian areas, and nearly all rivers in the State empty into lakes that have no outlet or lose their waters by absorption and evaporation as they spread over valley floors (Linsdale 1936). Riparian habitat, and therefore breeding flycatchers, were probably found primarily along portions of major drainages such as the lower Colorado River, the Virgin River and its major tributaries, and areas where spring-fed riparian and wetland habitat flourished. Although some portions of the Virgin River retain substantial amounts of riparian vegetation, riparian habitats in most areas have been severely reduced and degraded, such that suitable flycatcher breeding habitat is even more rare than in the pre-settlement past. Unitt (1987) reported only three historical southwestern willow flycatcher breeding locations: Indian Springs, Corn Creek, and the Colorado River at the southern tip of the State. Recent surveys have discovered mostly small breeding populations along the Virgin River, Muddy River, Amargosa River, Meadow Valley Wash, and Pahranagat River drainages (McKernan and Braden 1998, 1999, 2001; Micone and Tomlinson 2000). Some of the flycatchers breeding at the Virgin River inflow to Lake Mead are subject to inundation by fluctuating lake levels (McKernan and Braden 1999 and 2001). At two breeding sites (Key Pittman Wildlife Management Area and Mesquite West), breeding habitat has recently become established and occupied (McKernan and Braden 2001, Gallagher et al. 2001).

Colorado

Southwestern Colorado hosts the headwaters of several major drainages, including the San Juan River and the Rio Grande, which flow through relatively broad valleys and once supported extensive riparian habitats. There are also many smaller streams which were once heavily wooded. However, much of the riparian habitat in these areas has been reduced and heavily impacted. Statewide, willow flycatchers were locally common (Bailey and Niedrach 1965), but it is difficult to reconstruct the historical distribution and abundance of *E. t. extimus*. Phillips (1948) makes no mention of flycatchers from the southwest portion of the State. Bailey and Niedrach (1965) describe two willow flycatchers collected in San Juan County, but these are not confirmed as breeders. Recent surveys suggest that willow flycatchers are very localized and uncommon within the probable range of *E. t. extimus* in southwestern Colorado. Within the range of *E. t. extimus*, breeding flycatchers have been confirmed only on tributaries to the San Juan (Williams Creek Reservoir, Los Pinos River, and Piano Creek) and at Alamosa National Wildlife Area and McIntire Springs, within the Rio Grande drainage in the San Luis Valley (Owen and Sogge 1997, Sogge et al. 2001). However, much riparian habitat remains unsurveyed, and additional breeding populations may be present. Recent genetics research (Paxton 2000) affirms that flycatchers in the San Luis Valley are affiliated with *E. t. extimus*, but uncertainties remain about the subspecies status of willow flycatchers elsewhere in extreme southwestern Colorado.

Mexico

As discussed above ("Range and Distribution"), it is possible the flycatcher was abundant on the delta of the Colorado River in Mexico prior to establishment of numerous dams upstream. Currently, surface water delivery to the delta is minimal or absent for long periods; habitat is much reduced and altered. Similarly, the flycatcher is likely to have occurred in northern Chihuahua along the Rio Grande, where habitat is now reduced and altered due to upstream dams. Historic record of breeding flycatchers on the Rio Grande at Fort Hancock, Texas, suggests occurrence in adjacent Chihuahua; the Rio Grande now is typically dry in that region.

J. Reasons for Listing and Current Threats

Section 4(a)(1) of the ESA lists five factors that must be considered when determining if a species should be designated as threatened or endangered. These factors are: A. The present or threatened destruction, modification, or curtailment of its habitat or range; B. Overutilization for commercial, recreational, scientific, or educational purposes; C. Disease or predation; D. The inadequacy of existing regulatory mechanisms; and E. Other natural or manmade factors affecting its continued existence. A species may be determined to be an endangered or threatened species due to one or more of the five factors. The southwestern willow flycatcher was determined to be endangered by numerous threats causing extensive loss of habitat (factor A), lack of adequate protective regulations (factor D; see Section III.), and other natural or manmade factors including brood parasitism by the brown-headed cowbird (factor E) (USFWS 1995).

The reasons for the decline of the southwestern willow flycatcher and current threats it faces are numerous, complex, and inter-related. The major factors are summarized below by categories, in approximate order of their significance. For additional discussions see USFWS (1995) and Marshall and Stoleson (2000). However, these factors vary in severity over the landscape and at any given locale, several are likely to be at work, with cumulative and synergistic effects. The most significant impact should be expected to vary from site to site. And because of their inter-relatedness, distinctions between different types of impacts are sometimes ambiguous or artificial. This is true even for divisions presented here, "Habitat Loss and Modification" and "Changes in Abundance of Other Species." For example, urban and agricultural development may cause both habitat degradation and changes in the abundance of cowbirds, domestic cats, and non-native vegetation. When assessing and addressing the impacts to any riparian ecosystem, the cumulative and inter-related impacts of all potential factors should be considered.

1. Habitat Loss and Modification

The primary cause of the flycatcher's decline is loss and modification of habitat. Its riparian nesting habitat tends to be uncommon, isolated, and widely dispersed. Historically, these habitats have always been dynamic and unstable in place and time, due to natural disturbance and regeneration events such as floods, fire, and drought. With increasing human populations and the related industrial, agricultural, and urban developments, these habitats have been modified, reduced, and destroyed by various mechanisms. Riparian ecosystems have declined from reductions in water flow, interruptions in natural hydrological events and cycles, physical modifications to streams, modification of native plant communities by invasion of exotic species, and direct removal of riparian vegetation. Wintering habitat has also been lost and modified for this and other Neotropical migratory birds (Finch 1991, Sherry and Holmes 1993). The major mechanisms resulting in loss and modification of habitat involve water management and land use practices, and are discussed below.

Dams and Reservoirs

Most of the major and many of the minor southwestern streams that likely supported southwestern willow flycatcher habitat are now dammed (Appendix D Table 2). Operation of dams modifies, reduces, destroys, or increases riparian habitats both downstream and upstream of the dam site. Below dams, natural hydrological cycles are modified. Maximum and minimum flow events both can be altered. Flood flows are reduced in size and frequency below many dams. Base flows can be increased or decreased depending on how the dam is operated. High flows are often reduced or shifted from that of the natural hydrograph below dams managed for downstream water supply. Daily water fluctuations can be very high below dams operated for hydroelectric power. The more or less annual cycle of base flow punctuated by short-duration floods is lost. In so doing, dams inhibit the natural cycles of flood-induced sediment deposition, floodplain hydration and flushing, and timing of seed dispersal necessary for establishment and maintenance of native riparian habitats. Lack of flooding also allows a buildup of debris, resulting in less substrate available for seed germination, and increasing the frequency of fires. Because of evapoconcentration, natural levels of salt and other minerals are often artificially elevated in downstream flow and in downstream alluvial soils. These changes in soil and water chemistry can affect plant community makeup (see below). Upstream of dam sites, riparian habitats are inundated by reservoirs, as beneath Lake Powell, where Behle and Higgins (1959) considered the flycatcher to be common. In some locales, this effect is partially mitigated by temporary development of riparian habitats at inflow deltas, where source streams enter the reservoirs. However, these situations tend to be vulnerable, often inundated or desiccated as reservoir management raises and lowers the water level, resulting in unstable flycatcher populations, such as at Elephant Butte Reservoir in New Mexico, Roosevelt Lake in Arizona, Lake Mead on the Colorado River, and Lake Isabella on the Kern River in California. Although large flycatcher populations do occupy reservoir habitat, they may not be as numerous or as persistent as those that occupied miles of pre-dammed rivers. For further discussion, see Appendices H and I.

Diversions and Groundwater Pumping

Surface water diversions and groundwater pumping for agricultural, industrial, and municipal uses are major factors in the deterioration of southwestern willow flycatcher habitats (Briggs 1996) (Appendix D Table 2). The principal effect of these activities is simple reduction of water in riparian ecosystems and associated subsurface water tables. Examples: (1) Of the Colorado River's approximate flow of 16 million acre-feet (maf) per year, human consumptive use accounts for almost 11 maf and reservoirs evaporate 1.5 maf, leaving little for riparian and aquatic ecosystems. Agriculture uses over two-thirds of the water diverted or pumped from the lower Colorado River basin, with at least 40% of this share used to grow livestock feed (Morrison et al. 1996); (2) Pacific River Institute's report on Colorado River Water, including statistics on magnitude of groundwater overdraft in AZ, NV, and CA, population and water consumption projections, and proportion of water used by agriculture; (3) CEC report's conclusion about the impacts of groundwater overdraft on the San Pedro Riparian National Conservation area; (4) Explanation of Arizona Department of Environmental Quality's declaration of groundwater mining in the Prescott Active Management Area and the potential ramifications on the Verde River. Chemistry, especially salinity, of water and soils may also be significantly affected by these activities (see Appendix I).

Channelization and Bank Stabilization

Southwestern riparian ecosystems have also been modified through physical manipulation of stream courses. Channelization, bank stabilization, levees, and other forms of flow controls are carried out chiefly for flood control. These engineering activities affect riparian systems by separating a stream from it's floodplain. These control structures prevent overbank flooding, reduce the extent of alluvial-influenced floodplain, reduce water tables adjacent to streams, increase stream velocity; increase the intensity of extreme floods, and generally reduce the volume and width of wooded riparian habitats (Szaro 1989, Poff et al. 1997, see also Appendices H and I).

Phreatophyte Control

In some areas riparian vegetation is removed from streams, canals, and irrigation ditches to increase watershed yield, remove impediments to streamflow, and limit water loss through evapotranspiration (Horton and Campbell 1974). Methods include mowing, cutting, root plowing, and application of herbicides. The results are that riparian habitat is eliminated or maintained at very early successional stages not suitable as breeding habitat for willow flycatchers (Taylor and Littlefield 1986). Clearing or mowing habitat can also result in establishment of exotic plants species, which can further reduce suitability.

Livestock Grazing

Overgrazing by domestic livestock has been a significant factor in the modification and loss of riparian habitats in the arid western United States (USDA Forest Service 1979, Rickard and Cushing 1982, Cannon and Knopf 1984, Klebenow and Oakleaf 1984, General Accounting Office 1988, Clary and Webster 1989, Schultz and Leininger 1990, Belsky et al. 1999). If not properly managed, livestock grazing can significantly alter plant community structure, species composition, relative abundance of species, and alter stream channel morphology. The primary mechanism of effect is by livestock feeding in and on riparian habitats. Overutilization of riparian vegetation by livestock also can reduce the overall density of vegetation, which is a primary attribute of southwestern willow flycatcher breeding habitat. Palatable broadleaf plants like willows and cottonwood saplings may also be preferred by livestock, as are grasses and forbs comprising the understory, depending on season and the availability of upland forage. Livestock may also physically contact and destroy nests. This impact is documented for nests of *E.t. brewsteri* in California (Stafford and Valentine 1985, Valentine et al. 1988). Southwestern willow flycatcher nests in low-stature habitats could be vulnerable to this impact, e.g., nests in *Salix geyeriana* at higher elevation near Greer, AZ. Livestock also physically degrade nesting habitat by trampling and seeking shade and by creating trails that nest predators and people (see Recreation subsection below) may use. Furthermore, improper livestock grazing in watershed uplands above riparian systems can cause bank destabilization, increased runoff, increased sedimentation, increased erosion, and reduced capacity of soils to hold water. Because the impact of herbivory can be highly variable both geographically and temporally, proper grazing management strategies must be developed locally. For further discussion, see Appendix G.

Recreation

In the warm, arid Southwest, recreation is often concentrated in riparian areas because of the shade, water, aesthetic values, and opportunities for fishing, boating, swimming, and other activities. As regional human populations grow, the magnitude and cumulative effects of these activities is considerable. Effects include: reduction in vegetation through trampling, clearing, woodcutting and prevention of seedling germination due to soil compaction; bank erosion; increased incidence of fire; promoting invasion by exotic plant species; promoting increases in predators and scavengers due to food scraps and garbage (ravens, jays, grackles, skunks, squirrels, domestic cats, etc.); promoting increases in brood-parasitic cowbirds; and noise disturbance. Recreational development also tends to promote an increased need for foot and vehicle access, roads, pavement, trails, boating, and structures which fragment habitat (i.e., verandas, picnic areas, etc.). Effects of these activities on southwestern willow flycatchers certainly vary with different situations. Reductions in density and diversity of bird communities, including willow flycatchers (*E. t. adastus*), has been associated with recreational activities (Aitchison 1977, Blakesley and Reese 1988, Szaro 1980, Taylor 1986, Riffell et al. 1996). For additional discussion see Appendix M.

Fire

Fire is an imminent threat to occupied and potential southwestern willow flycatcher breeding habitat. Although fires occurred to some extent in some of these habitats historically, many native riparian plants are neither fire-adapted nor fire-regenerated. Thus, fires in riparian habitats are typically catastrophic, causing immediate and drastic changes in riparian plant density and species composition. Busch (1995) documented that the current frequency and size of fires in riparian habitats on two regulated rivers (Colorado and Bill Williams) is greater than historical levels because reduced floods have allowed buildup of fuels, and because of the expansion and dominance of the highly-flammable tamarisk. Tamarisk and arrowweed (*Tessaria sericea*) recover more rapidly from fire than do cottonwood and willow. In recent years riparian wildfires destroyed occupied southwestern willow flycatcher sites on the Rio Grande in New Mexico, the San Pedro and Gila rivers in Arizona, and in the Escalante Wildlife Area in Colorado. For further discussion, see Appendix L.

Agricultural Development

The availability of relatively flat land, rich soils, high water tables, and irrigation water in southwestern river valleys has spawned wide-scale agricultural development. These areas formerly contained extensive riparian habitats. Agricultural development entails not only direct clearing of riparian vegetation, but also re-engineering floodplains (e.g., draining, protecting with levees), diverting water for irrigation, groundwater pumping, and applications of herbicides and pesticides, which may also affect the flycatcher and its habitat (Appendix D Table 2). For example, as recently as 1996, since the flycatcher's listing as endangered, up to 2 km (1.2 mi) of occupied flycatcher habitat was lost to agricultural development on the Santa Ynez River in California (USFWS in litt.). Agricultural development can also increase the likelihood or severity of cowbird parasitism, by creating foraging sites (e.g., short-grass fields, grain storage, livestock concentrations) in proximity to flycatcher nesting habitat (See Appendices E and F).

In many river reaches, the flood plain riparian habitat that is utilized by flycatchers is partly sustained by agricultural return flows (Appendix D Table 2). Natural functioning ecosystems would be more likely to sustain flycatcher populations over the long-term than artificial agricultural systems. With reductions in irrigated agriculture, additional water and land could be made available for restoration of flycatcher habitat. However, in the short-term, reductions in the agricultural return flows themselves can pose a threat to some flycatcher populations.

Strips of riparian vegetation that develop along drainage ditches or irrigation canals also potentially provide habitat for the flycatcher. Benefits are greatest when the vegetation is left undisturbed, as opposed to being periodically cleared, and where the riparian vegetation strips are dense, abundant, and relatively near natural flood plain habitat. However, riparian bird populations in small or temporary habitats may be population sinks, producing a net drain on the overall population; additional data are needed on source-sink dynamics of small and large flycatcher breeding sites.

Urbanization

Urban development results in many impacts to riparian ecosystems and southwestern willow flycatcher habitat. Urbanization in or next to flycatcher habitat provides the catalyst for a variety of related and inter-related direct and indirect effects which can cause loss and/or the inability to recover habitat.

At the broad perspective, urban development creates demands for domestic and industrial water use. These demands are satisfied by diverting water from streams and groundwater pumping, which de-water streams and aquifers. Municipal water management often involves constructing reservoirs, structures to control floods, and structures to control and alter stream courses and washes to protect floodplain development. These alter stream hydrology.

Urban development can ultimately begin the slow degradation of habitat by instigating further activities that remove natural river processes and/or adding other stresses to riparian areas. Urbanization provides the need for increased transportation systems that include bridges, roads, and vehicles detrimental to riparian habitat and riparian inhabitants. In recent years, placement of bridges have resulted in the loss of seven known flycatcher territories in New Mexico and Arizona, and the possible road-kill of a southwestern willow flycatcher in Arizona (Marshall and Stoleson 2000). Developments can also cause nearby private landowners that previously promoted conservation of their land to sell for development purposes. Also, as a result of dense riparian vegetation in proximity to development, some communities may choose to remove brush and/or other mid-story or sub-canopy vegetation to reduce or remove the risk of fire. Increased urbanization tends to promote a greater need for commercial development, which subsequently results in increased growth. Furthermore, urban development also increases the demand for recreational use of remaining riparian areas (see Recreation section above, and Appendix M).

Establishing housing developments near rivers promotes additional risks to the health of rivers, riparian habitat, and persistence of nesting flycatchers. Developments increase trash, bird feeders, and people, and as a result, the increased presence of predators such as cowbirds (see section 2., “Brood Parasitism,” below), house cats, and possibly a proliferation/concentration of other natural predators of flycatchers (i.e., great-tailed grackles, common ravens). Developers may remove habitat nearest the floodplain which provides sound and visual barriers, possible fledgling dispersal habitat, and plants which may provide food, sheltering, perching, and foraging for the flycatcher. Urban development can also produce pollutants to the environment through run-off, waste, and other chemicals. Urbanization can also increase the presence of non-native vegetation in the riparian area from the planting of grasses, shrubs, and trees that out-compete native plants.

Treated municipal wastewater presently sustains several of the riparian habitat patches upon which the flycatcher depends (Appendix D Table 2). At sites where the alluvial aquifer has not been severely depleted, discharge of treated water into the river channel has allowed for restoration or rehabilitation of large expanses of riparian vegetation. Concentrations of nutrients and other pollutants can be high in the effluent, but the presence of functional riparian ecosystems or constructed wetlands at the discharge site generally serves to improve the water quality.

Release of municipal effluent into a stream channel or alluvial aquifer does not automatically produce or sustain high quality riparian habitat. Regional planning efforts throughout the flycatcher's range can help to maximize the environmental benefits of reclaimed water. Hydrogeologic assessments can identify sites where shallow water tables and thus phreatophytic riparian vegetation are likely to develop; landscape studies can identify sites likely to have high wildlife habitat value by virtue of proximity and connectivity to existing riparian patches. Ecological input can delineate appropriate temporal and spatial patterns for the water release.

2. Changes in Abundance of Other Species

Exotic Species

Several exotic (non-native) plant species have become established in southwestern willow flycatcher riparian habitats, with varying effects on the bird. Tamarisk is widespread and often dominant in southwestern riparian ecosystems, often forming dense monotypic stands. Southwestern willow flycatchers do nest in some riparian habitats containing and even dominated by tamarisk (McKernan and Braden 1999, Paradzick et al. 2000), and available data suggest that flycatcher productivity and survivorship are similar between native and tamarisk habitats. However, native riparian plant communities may be of greater recovery value than tamarisk, because tamarisk in some settings facilitates a periodic fire regime, can be detrimental to native riparian plants in other ways (Busch and Smith 1993), and may in some cases be of lesser value to bird communities overall (Rosenberg et al. 1991). However, this does not diminish the value of maintaining currently suitable and occupied tamarisk habitat. Tamarisk can mimic many of the ecological functions of native riparian plant species (Stromberg 1998), and in many cases supports a riparian obligate bird community that would not occur in areas where habitat conditions can no longer support native riparian vegetation. This is significant, because where tamarisk is strongly dominant, replacement with native species may be difficult or impossible without changes in current hydrologic regimes. Unlike some native tree species, tamarisk also maintains the fine branching structure as it grows to maturity, which may make it attractive to nesting flycatchers for a longer period of time. Furthermore, tamarisk flowers throughout much of the summer, which may be important in attracting pollinating insects (a major component of flycatcher diet) throughout the flycatcher's breeding season.

Throughout the western U.S., large tracts of tamarisk are being cleared for purposes including water salvage, flood water conveyance, and/or wetland restoration. Such actions pose a threat to southwestern willow flycatchers when conducted in areas of suitable habitat (occupied or unoccupied) and when conducted in the absence of restoration plans to ensure replacement by vegetation of equal or higher functional value.

Russian olive is also well-established in southwestern riparian systems, and is present in some current flycatcher nest sites. The foliage of Russian olive is more broad-leaved than tamarisk, and so may be similar to willows in the ways it affects microsite conditions of temperature and humidity. Other exotic trees, such as Siberian elm (*Ulmus pumilis*) and tree of heaven occur in southwestern riparian ecosystems but do not appear to have value as nesting habitat for the flycatcher. Because their distributions are highly localized, their impacts on the flycatcher may be limited to very local, perhaps minor changes in riparian community composition. In California, giant reed (*Arundo donax*) is spreading rapidly, and forms dense monotypic stands unsuitable for willow flycatchers. Also, many exotic herbs are established in southwestern riparian ecosystems, including bermudagrass (*Cynodon dactylon*) and rabbitfoot grass (*Polypogon monspeliensis*). For further discussion, see Appendices G and J.

Brood Parasitism

As summarized above in "Disease and Parasites," brood parasitism negatively affects the flycatcher, by reducing reproductive performance. Parasitism typically results in reductions in number of flycatcher young fledged per female per year. Brown-headed cowbirds have probably occurred naturally in much of the flycatcher's range, for thousands of years (Lowther 1993). However, they likely increased in abundance with European settlement, and established in southern California only since 1900 (Rothstein 1994b, Appendix F). It is possible that cowbird abundance has peaked, and may be declining in recent decades (Sauer et al. 1997). At normal levels, parasitism is rarely an impact on host species at the population level. However, for a rare host, parasitism may be a significant impact on production of young at the population level, especially with the high predation rates flycatchers and other small passerines experience. When combined with negative influences of predation, habitat loss, and overall rarity, parasitism can be a significant contributor to population decline.

The effects and management of cowbird parasitism with respect to the flycatcher are complex. Cowbird parasitism levels vary widely across the flycatcher's range (Table 5). A given intensity of cowbird parasitism may or may not have significant influence on the trend of a given flycatcher population. Similarly, cowbird control may or may not result in significant, or even measurable benefits to a population. This is in part because cowbird parasitism acts in concert with many other negative influences on the flycatcher, some related and some not. These include habitat degradation, predation, size of flycatcher population, etc. In some cases a single impact like cowbird parasitism may not appear significant, but the additive (or synergistic) effects with other impacts may be very significant, even critical.

Table 5. Rates of parasitism by brown-headed cowbirds on the southwestern willow flycatcher at selected locations. (Adapted from Whitfield and Sogge 1999; no cowbird control at these sites for these years.)

Region	Years	# of Nests	Mean Annual Parasitism
South Fork Kern River, CA	1987, 1989-1992	163	66%
Mesquite, NV	1997	5	40%
Virgin River Delta, NV	1997	14	21%
Mormon Mesa, NV	1997	3	0%
Grand Canyon, AZ	1982-1986, 1992-1996	25	48%
White Mountains, AZ	1993-1996	36	19%
San Pedro River, AZ	1995-1996	61	3%
Roosevelt Lake, AZ	1995-1996	17	18%
Verde River, AZ	1996	13	46%
Gila River Valley, AZ	1995, 1997	49	18%
Other sites, NM	1995	10	40%

Cowbird management may prove to be an important tool in recovering the flycatcher, because it can be ameliorated more easily than other threats such as habitat loss or nest predation. But cowbird control actions such as trapping programs should not be viewed as a reflexive panacea. Because of local conditions, even intensive control may not result in increasing a flycatcher population. For example, on the Kern River, a flycatcher population has decreased from 34 pairs in 1993 to 23 in 1999, despite trapping having decreased parasitism from an average of 65% prior to trapping to an average of 22% with trapping (Whitfield et al. 1999). This does not mean that trapping is a wasted effort here; it may be preventing more serious declines. Evidently other influences are at work, which should also be addressed. Although effects of cowbird parasitism can be ameliorated with management, cowbird control has both benefits and downsides, some of which may be significant (see Appendix F), so cowbird control should be instituted only when impacts exceed certain levels. Given that parasitism rates of 20-30% have barely detectable effects on host recruitment because of renesting after desertion or predation of parasitized nests (see Appendix F), managers should in most cases consider cowbird control only when adequate data show that parasitism on a local population exceeds these rates for two or more years (see Appendix F). Trapping exerts strong selective pressures on local cowbird populations to develop resistance to trapping. Such resistance could reflect a true evolved behavior based on genetic variation or a learned tradition. Resistance could take the form of a lessened attraction to groups of cowbirds (as are used to attract birds to the decoy traps), a reluctance to enter traps, and an ability to escape from the decoy traps commonly used in cowbird control programs (see Appendix F, Section d: Potential Downsides or Negative Aspects of Cowbird Control).

3. Vulnerability of Small Populations

Demographic Effects

The total number of southwestern willow flycatchers is small, with an estimated 1100-1200 territories rangewide (see section II.I., "Current Population and Trends"). These territories are distributed in a large number of very small breeding groups, and only a small number of relatively large breeding groups. These isolated breeding groups are vulnerable to local extirpation from floods, fire, severe weather, disease, and shifts in birth/death rates and sex ratios. Marshall and Stoleson (2000) noted that "Even moderate variation in stochastic factors that might be sustained by larger populations can reduce a small population below a threshold level from which it cannot recover. The persistence of small populations depends in part on immigration from nearby populations, at least in some years (Stacey and Taper 1992). The small, isolated nature of current southwestern willow flycatcher populations exacerbates the risk of local extirpation by reducing the likelihood of immigration among populations." The vulnerability of the few relatively large populations makes the above threats particularly acute. In recent years, several of the few larger populations have been impacted by fire (San Pedro River) and inundation by impounded water (Lake Mead, Lake Isabella). Also, the flycatcher appears to be a quasi-colonial species (McCabe 1991). At its few large breeding sites, many territories are often packed into relatively small areas, with significant levels of polygyny, extra-pair copulation, and pair re-shuffling (Paxton et al. 1997, Netter et al. 1998, Paradzick et al. 1999). These may be significant factors in maintaining genetic interchange. The presence of a threshold "colony size" may be an important catalyst for successful breeding sites to function.

Genetic Effects

Because the flycatcher exists in small populations, there has been concern over potential low genetic variation within populations, and possible inbreeding (Marshall and Stoleson 2000). If low genetic variation did exist, it could result in reduced fecundity and survival, lowered resistance to parasites and disease, and/or physiological abnormalities (Allendorf and Leary 1986, Hartl 1988). However, recent research has found substantial genetic variation within and among flycatcher breeding groups, and within and between watersheds (Sogge et al. 1998, Busch et al. 2000). The flycatcher may also be threatened by low effective population size, which is an index of the actual numbers of individuals breeding in a population and the number of offspring they produce. A species' effective population size may be much smaller than the absolute population size because of uneven sex ratios, uneven breeding success among females, polygyny, and low population numbers which exacerbate these factors (Marshall and Stoleson 2000).

4. Migration and Winter Range Stresses

As a neotropical migrant, the flycatcher spends more time in migration and on the wintering grounds each year than it does on its North American breeding grounds (Sedgwick 2000). Migrant and wintering flycatchers face a number of known and potential threats. For example, migration is a period of high energy demands, and migrating individuals must find suitable "stopover" habitat at which to replenish energy reserves needed for the next step of migration flight (Finch et al. 2000). Insufficient stopover habitat, and destruction or degradation of existing habitat, could lead to increased mortality during migration, and/or prolonged migration resulting in late arrival to wintering or breeding sites (with reduced fitness upon arrival). Recent winter surveys in portions of Central America (Koronkiewicz et al. 1998, Koronkiewicz and Whitfield 1999, Lynn and Whitfield 2000) have found that willow flycatcher wintering habitat is often located in lowland areas that are subject to heavy agricultural uses, many of which negatively impact key habitat components at wintering sites. We do not know if winter habitat is currently limiting for willow flycatchers (nor exactly how much habitat is needed overall), but we do know that the amount of native lowland forest and wet areas (e.g., lagunas, esteros, etc.) - habitats in which flycatchers currently overwinter - has decreased dramatically over the last 100 years (Koronkiewicz et al. 1998). Furthermore, agri-chemicals and pesticides are still widely used in many regions through which flycatchers migrate, and in wintering sites (Koronkiewicz et al. 1998, Lynn and Whitfield 2000), thereby exposing flycatchers to potential environmental contaminants during much of the year.

III. CONSERVATION MEASURES

A. Regulatory Protection

1. Federal Laws Protecting the Southwestern Willow Flycatcher

Endangered Species Act

Listing under the ESA affords the southwestern willow flycatcher a number of protections, and also authorizes various conservation actions. Section 2 of the ESA directs all Federal agencies to seek to conserve endangered and threatened species, and to use their authorities in the furtherance of the purposes of the ESA. All agencies of the United States government are therefore authorized and obligated to proactively promote conservation and recovery of the southwestern willow flycatcher. Section 4 of the Act requires the Department of Interior and the Department of Commerce to develop and implement recovery plans for listed species. Section 7 reiterates the responsibility of all Federal agencies to proactively conserve and recover listed species, and requires all Federal agencies to consult with the USFWS on any actions they authorize, fund, permit, or carry out that may affect listed species or adversely modify critical habitat. Incidental "take" of a Federally listed species may be permitted through this consultation process. Section 9 provides protection for the southwestern willow flycatcher by prohibiting "take." "Take" is defined as "...to harass, harm, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct." Within the realm of "take," "harm" is further defined to include significant habitat modification or degradation that results in death or injury of the listed species, and significantly impairing essential behavior patterns, including breeding, feeding, or sheltering.

Section 10 of the ESA gives the authority to issue permits to non-Federal and private entities for "take," as long as such taking is incidental to, and not the purpose of, carrying out otherwise lawful activities. Often, these permits are issued for "habitat conservation plans" (HCP) developed under §10(a)(1)(B). Take permits issued for HCPs authorize incidental take, but not the underlying activities that result in take. This process ensures that the effects of the authorized incidental take will be adequately minimized and mitigated. Congress intended that the HCP process would be used to reduce conflicts between listed species and economic development activities. HCPs are used to develop creative partnerships between the public and private sectors in the interest of conserving listed species. In 1999, the USFWS issued a new policy under Section 10(a)(1)(A) of the ESA, for Safe Harbor Agreements (SHA) through enhancement of survival permits for listed species. The standard for an SHA is that the agreement must realize a "net conservation benefit" (i.e., by implementing the terms of one or more SHA, populations of a listed species will increase and/or their habitats will be improved). SHAs are temporary habitat protections with "take" allowed at sometime in the future back to an agreed upon baseline; if several SHAs were implemented simultaneously or sequentially, these efforts could assist in species' recovery.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (16 U.S.C. 701-711) was enacted in 1916 between the governments of the United States and Great Britain (representing Canada), subsequently Mexico in 1936, Japan in 1972, and the Union of Soviet Socialist Republics in 1976. The Migratory Bird Treaty Act expanded the definition of migratory birds to include virtually all birds found in the United States. It establishes provisions regulating take, possession, transport, and import of migratory birds, including nests and eggs.

Federal Land Policy and Management Act of 1976

The Federal Land Policy and Management Act of 1976 requires that ". . . the public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that . . . will preserve and protect certain public lands in their natural condition; (and) that will provide food and habitat for fish and wildlife . . ." Furthermore, it is the policy of the Bureau of Land Management "to manage habitat with emphasis on ecosystems to ensure self-sustaining populations and a natural abundance and diversity of wildlife, fish, and plant resources on public lands" (BLM manual 6500.06).

National Forest Management Act

The National Forest Management Act of 1976 directs that the National Forest System ". .where appropriate and to the extent practicable, will preserve and enhance the diversity of plant and animal communities." Additionally, sec. 219.12(g) requires the maintenance of viable populations of native vertebrates in national forests.

Clean Water Act

Congress passed the Federal Water Pollution Control Act Amendments of 1972 and the Clean Water Act (CWA) of 1977 to provide for the restoration and maintenance of the chemical, physical, and biological integrity of the nation's lakes, streams, and coastal waters. Primary authority for the implementation and enforcement of the CWA now rests with the U.S. Environmental Protection Agency (EPA) and to a lesser extent, the U.S. Army Corps of Engineers (COE). In addition to the measures authorized before 1972, the CWA implements a variety of programs, including: Federal effluent limitations and state water quality standards, permits for the discharge of pollutants and dredged and fill materials into navigable waters, and enforcement mechanisms.

Section 404 of the CWA is the principal Federal program that regulates activities affecting the integrity of wetlands. Section 404 prohibits the discharge of dredged or fill material in jurisdictional waters of the United States, unless permitted by COE under § 404 (a) (individual permits), 404 (e) (general permits), or unless the discharge is exempt from regulation as designated in § 404 (f).

There is controversy in administration of the COE's permit system and their responsibilities pursuant to the ESA. The limits of jurisdictional waters of the United States (the area covered under § 404) are determined by: 1) in the absence of adjacent wetlands, jurisdiction extends to the ordinary high water mark; or 2) when adjacent wetlands are present, jurisdiction extends beyond the ordinary high water mark to the limit of the adjacent wetlands; or 3) when the water of the United States consists only of wetlands, jurisdiction extends to the limit of the wetland. Riparian habitat in the Southwest is usually above the ordinary high water mark and often does not meet the definition of jurisdictional wetlands of the United States.

Section 402 of the CWA is the principal Federal program that regulates activities affecting water quality. One of the most significant features of the 1972 CWA is the creation of a national pollutant discharge elimination system (NPDES). Except as otherwise provided in the CWA, industrial sources and publicly owned treatment works may not discharge pollutants into navigable waters without a permit. The EPA may issue a permit for discharge upon condition that the discharge meets applicable requirements, which are outlined extensively in the CWA and which reflect, among other things, the need to meet Federal effluent limitations and state water quality standards.

2. State Laws Protecting the Southwestern Willow Flycatcher

Arizona

The State of Arizona is in the process of developing a list of "Wildlife of Special Concern in Arizona," which identifies species whose occurrence in Arizona is or may be in jeopardy, or those with known or perceived threats or population declines. The southwestern willow flycatcher is included in the most current (1996) draft of the list of "Wildlife of Special Concern in Arizona." This list will replace the previous list of "Threatened Native Wildlife in Arizona" (AGFD 1988) which categorized the willow flycatcher as "endangered." Both lists are informative and nonregulatory, serving mainly as policy guides for wildlife management. Under Arizona Revised Statutes, for a nongame passerine bird like the southwestern willow flycatcher, permits are required to take (R12-4-304), possess, sell, transport, import, and export carcasses (R12-4-305), and collect for scientific purposes (R12-4-418).

California

Three subspecies of willow flycatcher occur in California: the southwestern (*Empidonax traillii extimus*), the "little" willow flycatcher (*E.t. brewsteri*) and the Great Basin form (*E.t. adastus*). The State of California classifies willow flycatchers breeding within the state (all subspecies) as endangered (California Department of Fish and Game 1992). Under the California Endangered Species Act of 1984 (Fish and Game Code Sections 2050-216), the southwestern willow flycatcher therefore has the following protections: unless permitted by the California Department of Fish and Game (CDFG), a listed species shall not be imported into California or exported from California, and shall not be taken, possessed, purchased, or sold within California (Summary of Fish and Game Code Section 2080). Section 86 of the Fish and Game Code defines take as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill".

The following restrictions and regulations from the CDFG Code apply to a nongame passerine bird like the southwestern willow flycatcher: All birds occurring naturally in California that are not resident game birds, migratory game birds, or fully-protected birds are nongame birds. It is unlawful to take any nongame bird except as provided in the Fish and Game Code or in accordance with regulations of the Fish and Game Commission or in a mitigation plan for a mining operation approved by the CDFG (Fish and Game Code Section 3800). It is unlawful to take or possess any bird except as provided in the code or in regulations adopted by the commission pursuant to the Code (Summary of Section 2000). It also is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird (§3503). Further, it is unlawful to take or possess any migratory nongame bird designated in the Migratory Bird Treaty Act except as provided by rules and regulations adopted by the U.S. Secretary of the Interior (§3513).

The California Environmental Quality Act (CEQA [Public Resources Code Sections {PRC}] 21000-21178.1) and the regulations enacting it (California Code of Regulations [CCR] 15000-15387) are important tools for protecting biological resources in California. CEQA, which is similar to the National Environmental Policy Act (NEPA), has three primary purposes: 1) Minimizing impacts on the environment by identifying impacts and then applying mitigation measures; 2) Disclosing to decision makers and the public the potential impacts of a proposed action and associated mitigation measures; and 3) Disclosing the rationale behind decision makers' determinations to the public. With the exception of a few exempt actions, CEQA must be followed by all state and local public agencies for discretionary projects. Projects are defined as those actions carried out, funded, or permitted by the agencies.

CEQA is effected by completing documentation appropriate for the level of impact. Documentation ranges from a Negative Declaration for low-no impact projects to Environmental Impact Reports (EIR) for larger, more complex, or more impacting projects. Review and opportunity to comment by the public, and agencies other than the action agency, is mandatory. There is no enforcement agency for CEQA compliance; its intents are realized by the good-faith efforts of the decision-making agency, or through litigation. The California Department of Fish and Game is entitled, under certain circumstances involving noncompliance with CEQA, to replace another state or local public entity as lead agency.

The impacts of a project on biological resources are considered to be significant if the project has the potential to substantially reduce the habitat of fish and wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, and/or reduce the number or restrict the range of an endangered, rare or threatened species. Further, it directs that threats be viewed as both those posed directly by the project and those posed cumulatively by the project and other projects together. CEQA defines endangered, rare, or threatened species as those listed under the Federal and state Endangered Species Acts and also any other species that meet the definition under those acts, even if no listing action has been taken.

Decision-making agencies may deny projects which may cause a significant impact after mitigation, or for which the proponent is unwilling to accept mitigation conditions attached to the permit. On the other hand, if after applying feasible mitigation measures, the project still will result in significant impacts, the decision-making agency may still approve the action by adopting a “Statement of Overriding Considerations.” In this, the decision-making body must describe in writing the specific reasons (economic, legal, social, technological, or other benefits) which override the adverse environmental effects.

Colorado

The State of Colorado listed the southwestern willow flycatcher as endangered in May 1998. The flycatcher is therefore protected under Colorado Revised Statutes (C.R.S.) 33-2-105. Section 3 of this statute states that ". . it is unlawful for any person to take, possess, transport, export, process, sell or offer for sale, or ship and for any common or contract carrier to knowingly transport or receive for shipment any species or subspecies of wildlife appearing on the list of wildlife indigenous to this state determined to be endangered within the state pursuant to subsection (1) of this section." Section 4 contains identical language for taxa listed as threatened. Penalties for the take of state-listed endangered species are established in C.R.S. 33-6-109(3)(a). These penalties are ". .a fine of not less than two thousand dollars and not more than one hundred thousand dollars, or by imprisonment for not more than one year in the county jail, or by both such fine and such imprisonment, and an assessment of twenty points." The Colorado Division of Wildlife is also authorized to pursue civil action to recover the value of wildlife. C.R.S. 33-6-110(1)(a) establishes a minimum value of $1,000 for any endangered species. Colorado Wildlife Commission Regulation #1315 (a) provides that a ". . Scientific Collecting License may be issued for the purpose of marking or banding or temporary or permanent possession of wildlife specimens outside of established seasons."

Nevada

The southwestern willow flycatcher was proposed for re-classification from state Protected to Endangered status in the State of Nevada in 1997. As of 1999 the flycatcher has not been re-classified to state Endangered status. However, the flycatcher is currently a protected bird under the Nevada Administrative Code (NAC) §503.050. This protection means "...there is no open season and a person shall not capture or kill this wildlife or possess any part thereof, without first obtaining the appropriate license, permit, or written authorization from the Nevada Division of Wildlife." (NAC §503.090, §503.093). Penalties for violation include fines up to $500 and/or up to six months in prison (Nevada Revised Statute §501.385). There are no state habitat designations that govern land use practices or are analogous to the designation of critical habitat, under the ESA.

New Mexico

The State of New Mexico listed the southwestern willow flycatcher as Threatened (then called 'Group 2') in 1988 (NMDGF 1988), then re-classified the subspecies to Endangered status in 1996. The flycatcher is therefore protected under New Mexico's Wildlife Conservation Act (WCA) (17-2-37 to 17-2-46 NMSA 1978) of 1974. This protection means "except as otherwise provided in the WCA, it is unlawful for any person to take (including 'harass, hunt, capture or kill, or attempt to do so'), possess, transport, export, sell or offer for sale, or ship" the flycatcher in New Mexico. Penalties for violation include fines up to $1,000 or up to one year in prison. The WCA provides for no habitat designations analogous to the designation of critical habitat, and does not govern land use practices. The WCA provides for the issuance of permits for take, possession, transport, export or shipment for scientific, zoological or educational purposes, or for propagation in captivity.

Texas

The southwestern willow flycatcher is listed as an endangered species in Texas Parks and Wildlife Code (TPWC), §65.180. This designation affords the flycatcher the protections of TPWC §68.015, which prohibit capture, trapping, take, or killing, or attempting any of these acts. Also prohibited are possession, sale, distribution, or offering or advertising for sale any goods made from endangered fish or wildlife unless the goods were made from fish or wildlife that were lawfully born and raised in captivity for commercial purposes, or were made from fish or wildlife lawfully taken in another state. Also, TPWC §68.006 prohibits possession, taking, or transportation for zoological gardens or scientific purposes, and take or transportation from its natural habitat for propagation for commercial purposes. A permit for these activities may be issued under TPWC §43.022. Violation of the above provisions constitutes a TPWC Class B misdemeanor; multiple convictions constitute a Class A misdemeanor. The above provisions afford no protections for the habitat of state-listed endangered species.

Utah

The State of Utah lists the southwestern willow flycatcher as an endangered species on its Utah Sensitive Species List (Utah Division of Wildlife Resources 1998). This list, compiled pursuant to Policy Number W2NAT-1 (State Sensitive Species), is intended to stimulate management actions (e.g., conservation strategies) to benefit listed species. The list carries no regulatory authority. However, under Title 23, Wildlife Resources Code of Utah, the flycatcher may not be collected and possessed (R657-3-21), or imported and possessed (R657-3-32). The flycatcher may be transported live through Utah, and imported to a State or Federally regulated establishment (R657-3-37 and 38).

B. Actions to Offset Impacts, and Mitigation Efforts

The following are examples of some, but not all, actions to offset habitat impacts, and mitigation efforts directed at benefitting the flycatcher.

1. Marine Corps Base, Camp Pendleton, California

Annual cowbird trapping has been conducted since 1983 at Marine Corps Base, Camp Pendleton, California, in compliance with a Biological Opinion addressing impacts of Marine training operations on riparian habitat used by least Bell's vireos and southwestern willow flycatchers. In addition, annual surveys for flycatchers, and since 1999, nest monitoring, have been conducted, providing information on flycatcher population size, distribution, and productivity at the Base.

2. Prado Basin, California

In conjunction with efforts to conserve and recover the endangered least Bell’s vireo and southwestern willow flycatcher, species monitoring, cowbird trapping and habitat restoration and conservation efforts have been undertaken in the Prado Basin and contiguous reaches of the Santa Ana River since1996. Although the local management effort, funded largely by the Orange County Water District pursuant to several Biological Opinions, originally emphasized monitoring and management of the vireo, the conservation of the small breeding population of the flycatcher has been the top priority of the management team since the species was Federally listed as endangered. Given the past creation and present supervision of species management and habitat restoration endowments, management efforts will be sustained in perpetuity at current levels.

3. Lake Isabella, California

The construction of Isabella Dam on the Kern River (near Weldon, CA) and subsequent filling of the reservoir resulted in the development of a riparian woodland at the inflow of the South Fork of the Kern River. In 1997, the USFWS and COE convened a team of scientific experts to assist in resolution of issues relating to the operation of Isabella Reservoir and potential impacts to southwestern willow flycatchers that were breeding in dense willow habitat at the inflow area. The team determined that future reservoir operations were likely to continue impacting the flycatcher and its breeding habitat, and recommended the development and protection of an additional 1,000 ac of floodplain habitat (approximately 500 of which would be dense willow habitat) upstream in the Kern River Valley, continued cowbird trapping (to maximize local breeding productivity), and continued monitoring and research (del Nevo et al. 1998). To date, the COE has funded continued flycatcher monitoring and research, cowbird trapping, and efforts are still underway to identify and secure the needed floodplain habitat.

4. Clark County, Nevada, Habitat Conservation Plan

Clark County and its Desert Conservation Plan Implementation and Monitoring Committee is responsible for the implementation of the provisions of Section 10(a)(1)(B) Incidental Take permit, issued by the USFWS, pursuant to the ESA of 1973. Clark County administers the plan by assuming responsibility for the collection of mitigation fees, ensuring adherence to all compliance measures associated with the permit as well as overseeing implementation of the Plan. The Desert Conservation Plan is intended to promote a balance between economic stability and environmental integrity in Clark County, Nevada. Clark County is also responsible for the preparation of the Multiple Species Habitat Conservation Plan which, upon approval, will supercede the Desert Conservation Plan. The Plan will initially provide coverage for approximately 79 species and may include coverage for additional species as more information becomes available for these taxa over time, thereby assuring that clearly established conservation measures are not jeopardized alongside a vibrant local economy and the sustained appreciation of our natural resources.

5. Lower Colorado River Multi-Species Conservation Program

The objectives of the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) are to:
1) Conserve habitat and work toward the recovery of “included species” within the 100-year floodplain of the Lower Colorado River, pursuant to the ESA, and attempt to reduce the likelihood of additional species listings under the ESA;
2) Accommodate current water diversions and power production and optimize opportunities for future water and power

development, to the extent consistent with the law; and 3) provide the basis for take authorizations pursuant to the Federal ESA and California ESA. The LCR MSCP contains Federal project elements (U.S. Bureau of Reclamation (USBR) operations and maintenance) as well as State and private projects.

It is anticipated that the LCR MSCP will preserve existing habitat, create new riparian habitat, and restore damaged or degraded areas in order to provide habitat suitable for the southwestern willow flycatcher and yellow-billed cuckoo. To the extent practicable, these habitat areas will be managed as an integrated mosaic with wet sloughs and marshes designed to support the Yuma clapper rail and other marsh and aquatic wildlife. Conservation measures are being designed with the goal of distributing habitat for the southwestern willow flycatcher throughout the LCR MSCP planning area, to the extent consistent with the morphology of the river and floodplain, in order to maintain or establish connectivity.

The LCR MSCP will build on the ongoing implementation of the USFWS biological and conference opinion on LCR operations and maintenance, dated April 30, 1997, that directed Reclamation to implement Reasonable and Prudent Alternatives (RPAs) to: 1) protect approximately 1400 ac (565 ha) of currently unprotected occupied or potential southwestern willow flycatcher habitat through acquisition, easements, partnerships, and other means; 2) provide protective management for willow flycatchers and suitable habitat on the LCR through fire prevention planning, fencing, cowbird control, public education; 3) conduct five years of willow flycatcher research and monitoring on the LCR, and conduct other studies or projects that contribute to willow flycatcher conservation; 4) identify historical willow flycatcher habitat on the LCR that no longer exists and is unrestorable, and develop management recommendations for the MSCP to compensate for loss of habitat, through acquisition, easements; and 5) evaluate effectiveness of modified or removed channels on comparable river systems, assess how and where to modify or remove channels to restore riparian habitat on the LCR, and evaluate the success of different habitat restoration demonstration projects on the LCR (USFWS 1997c). Endangered Species Act coverage for USBR's LCR operations and maintenance was extended from April 30, 2002, to April 30, 2005. Some of the RPAs USBR was directed to do were completed (numbers 1, 4, and 5 described above). USBR will continue to conduct research, monitoring, and other conservation actions through 2005, or until the completion date of the LCR MSCP, whichever comes first.

6. Roosevelt Lake, Arizona

The USFWS biological opinion on the operation of the modified Roosevelt Dam, dated July 23, 1996, directed USBR to implement an RPA that would allow the use of the newly developed water conservation space within the reservoir. To partially fulfill requirements of the RPA, USBR was required to: 1) acquire occupied willow flycatcher habitat on the lower San Pedro River, now owned and managed by The Nature Conservancy as the San Pedro River Preserve; 2) establish a $1.25 million Management Fund to conduct management activities that benefit the willow flycatcher through habitat acquisition, fencing, restoration, cowbird trapping, and other projects; 3) create a Southwestern Willow Flycatcher Conservation Coordinator position to assist the USFWS in initiating recovery and conservation planning, and to implement activities required by the Biological Opinion; 4) implement a 10-year program of willow flycatcher research and monitoring at Roosevelt Lake and the lower San Pedro River; 5) implement a cowbird trapping program on the lower San Pedro River; and, 6) fund a variety of research and monitoring programs range-wide (USFWS 1996).

In addition to the above, the public is currently reviewing the Salt River Project's incidental take application, draft Environmental Impact Statement and draft Roosevelt Lake Habitat Conservation Plan (HCP) for the continued operation of the reservoir. The goals of the Roosevelt HCP are to "minimize and mitigate incidental take (due to continued operation of Roosevelt) of flycatchers, Yuma clapper rails, bald eagles, and cuckoos, to the maximum extent practicable, and to not appreciably reduce the likelihood of survival and recovery...in the wild." If the Roosevelt HCP is approved, the Salt River Project commits to implementing the following measures for the southwestern willow flycatcher in Gila and Maricopa counties, Arizona: (1) creating and managing riparian habitat at Roosevelt Lake; (2) acquiring and managing riparian habitat in several basins in central Arizona to provide a diversity of geographic locations; and, (3) focusing acquisition of riparian land in locations that birds are expected to occupy (i.e., in proximity to existing populations of flycatchers). This commitment will entail protection in perpetuity of a minimum of 1,500 acres of riparian habitat either on-site or near-site of Roosevelt reservoir, as well as 750 acres of riparian habitat management, water rights acquistion, and/or providing of benefits.

7. Sonoran Desert Multi-Species Conservation Plan

In Pima County, Arizona, the Sonoran Desert Conservation Plan's multi-species habitat conservation component includes the southwestern willow flycatcher as a "Priority Vulnerable Species." Recently identified in the Empire Cienega watershed in Pima County, it is anticipated that the Sonoran Desert Conservation Plan will preserve existing habitat, restore habitat, and manage lands consistent with conservation efforts for the flycatcher and up to 50 other species.

C. Conservation Efforts

1. Pro-Active Conservation Efforts Directed at the Flycatcher

A number of pro-active efforts, not driven by legal requirements, are being directed at conservation and recovery of the southwestern willow flycatcher. Several of these are discussed below, as examples of the range of beneficial programs that can be implemented.

Habitat Protection and Restoration

Kern River, California

The 456 ha (1127 ac) Kern River Preserve (KRP) was purchased in 1981 by The Nature Conservancy (TNC). The land had been operated as a cattle ranch since the mid-1800s. TNC removed cattle from the riparian areas shortly after they purchased the property in order to enhance the riparian habitat. However, some riparian areas are lightly to moderately grazed during the winter. The change in management resulted in the regeneration of at least 150 ha (370 ac) of riparian forest. In addition, TNC has planted over 125 ha (309 ac) of riparian habitat. In 1997, Audubon California took over management of the KRP and continues to manage the property for riparian values. One of California's largest populations of the southwestern willow flycatcher nests on the KRP.

Virgin River, Utah

Washington County, Utah, which is home to more than half of the Virgin River’s length, has ranked among the nation’s ten fastest-growing counties for the last four years. This growth in human community is facilitating detrimental uses of the Virgin River and its riparian resources. For example, a current proposal calls for a 60% reduction of the river’s winter flow in the last reach where two endangered fish maintain relatively healthy populations.

According to the Natural Heritage Programs in Utah, Arizona, and Nevada, the Virgin River Basin supports 32 species which are globally rare and of pressing conservation concern. The USFWS lists six of these species as endangered; two more are threatened and an additional 24 are being monitored. Many of these species rely on the Virgin River’s riparian habitat which occurs on only 1% of the entire Basin’s land base.

The Grand Canyon Trust has responded by launching a two-pronged effort: first, an extensive information gathering effort to prepare for reasonable discussions regarding management decisions, and second, an effort to regularly participate in key management processes which are determining the river’s future. The Trust’s vision is a healthy, accessible river with self-sustaining native plant and animal populations for the children of 2097 and beyond.

Gila River, New Mexico

In the Cliff-Gila Valley, The Nature Conservancy has initiated habitat enhancement on its lands, including reducing levees to allow controlled flooding and subsequent establishment of riparian vegetation for nesting flycatchers. Also in the same area, the Gila National Forest and the U-Bar Ranch have used the construction of artificial oxbows as a means to stabilize eroded banks while simultaneously creating wetland habitats of slack water surrounded by native riparian vegetation. These sites were constructed by digging down to the water table in linear troughs parallel to the Gila River course. The banks were then pole-planted with willows, cottonwoods, and sycamores. Southwestern willow flycatchers occupied the Gila Bird Area project on the Gila National Forest in 1997, within three years of its construction. Several pairs bred in the U-Bar project in 1999. Farther downstream, in the vicinity of the Lower Gila Box, the Bureau of Land Management has enhanced riparian patches by reducing or eliminating livestock grazing and by controlling off-road vehicles.

Monitoring and Research

Prior to approximately 1990, research regarding southwestern willow flycatchers was limited, consisting primarily of one regional and one State-based status and taxonomic review, and a handful of localized survey and breeding ecology efforts. Research was carried out by several independent researchers, in a few local areas, with little communication of data or regional data compilation. As the southwestern willow flycatcher drew increasing regulatory and management attention (starting with the proposed listing in 1991), survey, monitoring, and research efforts grew from minimal in 1992 to extensive by 1999. Since the early 1990s, statewide surveys have been initiated in Arizona, New Mexico, and Utah, generally as part of the Partners In Flight program. Standardized survey protocols were developed in 1994 and updated in 1997, and statewide survey data integration and reporting have been instituted in some States. In the mid-1990s, intensive breeding and migration ecology, demography, and habitat research was being conducted at several sites in Arizona, California, Nevada, and New Mexico. Range-wide population genetics work was also initiated at this time. Collaborative research is now being conducted throughout the flycatcher's range. Collectively, this body of inventory, monitoring, and research has provided sound quantitative data addressing key questions relative to the recovery and conservation of the southwestern willow flycatcher. Work has recently begun on the presence and potential impacts of environmental contaminants at selected flycatcher breeding sites in Arizona. Recent research has also investigated the status, distribution, habitat use and ecology of the willow flycatcher on its wintering grounds in Central America. Much of this valuable work is expected to continue into the future (given continued funding), and will yield valuable insights on flycatcher status, distribution, and ecology - with the overall goal of better designing, executing, and evaluating flycatcher conservation and management actions. As this occurs, it will be critical to continue local, statewide, and rangewide data synthesis and reporting, and the collaborative sharing of research needs, ideas, and information.

2. Other Efforts of Riparian Conservation That May Benefit the Flycatcher

Throughout the southwest, there are numerous private, local, State and regional efforts aimed at improving and/or reducing the degradation of riparian and wetland habitats. Specific examples include, but are not limited to: the Santa Clara River Enhancement and Management Plan; the Cascabel Community Conservation Plan; the San Pedro Riparian and Las Cienegas National Conservation Areas; the Verde River Management Plan; riparian habitat development downstream of the Nogales International Waste Water Treatment Plant; Las Vegas Wash wetlands restoration program; willow riparian restoration at Key Pittman Wildlife Management Area; San Juan Pueblo post-fire riparian restoration program; Santa Ana Pueblo riparian restoration project; Pueblo of Zuni riparian restoration program; restoration of instream flows on the Agua Fria below Lake Pleasant; water (effluent) releases into the Gila River below Phoenix; experimental releases of beaver on the San Pedro River; and, riparian fuels reduction research on the Rio Grande. These projects are at varying stages of development and implementation.

The USFWS applauds the agencies and groups involved in these and other efforts intended to increase the amount of, and improve the condition of, ecologically valuable riparian habitats. Similar projects are underway in virtually every flycatcher Recovery Unit (see Section IV.A.1.). While all such projects are welcome, it is important to recognize that not all of these efforts will directly benefit breeding southwestern willow flycatchers. The flycatcher breeds only in dense, mesic riparian patches - a subset of the types of riparian likely to be developed as a result of the above programs. It is quite possible, if not likely, that the basic objectives of many of these projects could be met without the development and maintenance of suitable flycatcher breeding habitat. Therefore, the USFWS encourages the groups responsible for these projects to work with flycatcher biologists to include, where possible, specific objectives and design criteria for development, enhancement, and protection of the types of habitats in which flycatchers breed. In this way, these myriad projects have the potential to contribute greatly to the recovery of the flycatcher.

D. Conservation of Listed, Proposed, Candidate, and Species of Special Concern

1. Listed Species Occupying The Same Ecosystem As The Flycatcher

A large number of species are listed as threatened or endangered, which inhabit the riparian and/or aquatic habitats to which the flycatcher also is tied (Table 6; also see http://endangered.fws.gov/wildlife.html#Species). This underscores that southwestern riparian and aquatic habitats, while supporting disproportionately high levels of biodiversity, have also been degraded at a landscape scale. The presence of so many threatened and endangered species within this broad ecosystem type does not mean that difficult decisions must be made of managing for one listed species rather than, or at the expense of, another. Rather, this situation illustrates that if riparian and aquatic ecosystems are restored to their natural, dynamic, heterogenous conditions, many imperiled species will benefit.

Table 6. Listed vertebrate species occupying the same ecosystems as the southwestern willow flycatcher. (E = Endangered, T = Threatened, P = Proposed, NA = Not Applicable, MX = Mexico)

Species/Status	Range, Habitat, Comments	Recovery Plan	Critical Habitat
Fox, San Joaquin kit (E) *Vulpes macrotis mutica*	Central CA: Various habitats, grassland and scrubland. May have benefitted from riparian habitats. Overlap with flycatcher hypothetical. Threats: habitat loss due to agricultural, industrial, urban development.	Yes	No
Jaguar (E) *Panthera onca*	AZ, NM, TX, MX: Various habitats; oak-pine woodlands in U.S., riverbottom jungle and thickets in tropics. May have benefitted from riparian habitats. Overlap with flycatcher hypothetical, possibly San Pedro and Santa Cruz rivers.	No	No
Jaguarundi, Sinaloan (E) *Herpailurus (=Felis) yagouaroundi tolteca*	TX, AZ(?): Tropical bottomland thickets. AZ reports unconfirmed. Overlap with flycatcher hypothetical, possibly San Pedro and Santa Cruz rivers.	Yes	No
Owl, Mexican spotted (T) *Strix occidentalis lucida*	UT, AZ, CO, NM, MX: Steep, wooded mountain slopes and rocky canyons, some wintering in lowland riparian woodlands. Threats: habitat loss - possibly including loss of wintering riparian habitat.	Yes	Yes
Pygmy-owl, cactus ferruginous (E) *Glaucidium brasilianum cactorum*	So. AZ: Riparian woodlands and desertscrub. Probably once sympatric along San Pedro, lower Gila, possibly Santa Cruz rivers. Threats: loss of riparian woodlands.	No	No (to be finalized in 2003)
Rails, light-footed clapper (E) *Rallus longirostris levipus* and Yuma clapper (E) *R. l. yumanensis*	CA, AZ, MX: Cattail-bulrush marshes. Local habitats dissimilar, but ranges likely include substantial flycatcher habitat. Threats: loss of habitat due to dewatering, channelization, loss of floods, contaminants.	Yes (Yuma)	No
Vireo, least Bell's (E) *Vireo bellii pusilis*	So. CA: Riparian thickets. Habitat similar to flycatcher's. Threats also similar: loss of habitat due to dewatering, loss of floods, channelization, cowbird parasitism.	Draft	Yes
Snake, giant garter (T) *Thamnophis gigas*	Central CA: Streams and sloughs, usually with mud bottoms. Threats: dewatering, agricultural conversion, urbanization.	No	No

Table 6, continued. Listed vertebrate species occupying the same ecosystems as the southwestern willow flycatcher . (E = Endangered, T = Threatened, P = Proposed)

Species/Status	Range, Habitat, Comments	Recovery Plan	Critical Habitat
Salamander, Sonoran tiger (E) *Ambystoma tigrinum stebbinsi*	AZ, MX: Ponds and marshes. Possibly once sympatric with flycatchers in San Pedro and upper Santa Cruz rivers. Threats: habitat alteration, climatic trends, isolation of small populations.	Yes	No
Salamander, California tiger (E) *Ambystoma californiense*	CA: Santa Barbara County lowland wetlands. Threats: severe degradation of breeding sites and associated uplands.	No	No
Toad, arroyo (E) *Bufo californicus*	CA, MX: Streams with shallow gravelly pools adjacent to sandy terraces. Sympatric with much of So. CA flycatcher populations. Threats: loss and degradation of riparian habitat, predation.	Yes	Yes
Leopard frog, Chiricahua (T) *Rana chiricahuensis*	AZ, NM, MX: Lowland cienegas, pools, livestock tanks, lakes, reservoirs, streams, most abundant in Gila and San Francisco drainages. Threats: habitat loss and predation by introduced predators.	No	No
Catfish, Yaqui (T) *Ictalurus pricei*	AZ, MX (Rio Yaqui drainage basin): In large rivers in areas of medium to slow current. Threats: habitat loss and non-native species.	Yes	Yes
Chub, Chihuahua (T) *Gila nigrescens*	NM, MX (Mimbres River NM): In deep pools bordered by undercut banks or with downed trees. Threats: riparian degradation	Yes	No
Chub, Pahranagat roundtail (E) *Gila robusta jordani*	NV: Pahranagat River drainage	Yes	No
Chub, humpback(E) *Gila cypha*	CA, AZ, UT, WY, CO: Strong, continuous water flow in the Colorado River between Nevada and Arizona, the Moapa and Virgin Rivers and the Pahranagat Valley. Threats: dewatering of rivers, flow control, migration and dispersal routes blocked by dams.	Yes	Yes
Chub, Virgin river (E) *Gila seminuda*	AZ, NV, UT: Pools and runs over sand and other sediment in the Virgin river. Threats: water diversion, exotic fish.	Yes	Yes
Chub, Owens tui (E) *Gila bicolor snyderi*	CA: Owens River system. Schools in weedy shallows of quiet waters. Threats: water diversion, exotic fish.	Yes	Yes

Table 6, continued. Listed vertebrate species occupying the same ecosystems as the southwestern willow flycatcher . (E = Endangered, T = Threatened, P = Proposed)

Species/Status	Range, Habitat, Comments	Recovery Plan	Critical Habitat
Chub, Sonora (T) *Gila ditaenia*	AZ, MX (Rio de la Concepcion drainage): In pools. Threats: habitat loss, dewatering of rivers.	Yes	Yes
Chub, Yaqui (E) *Gila purpurea*	AZ, MX: Rio Yaqui system and adjacent southeastern AZ. Sympatry with flycatchers questionable. Threats: riparian habitat degradation, possibly predation by exotic fish.	Yes	Yes
Dace, Ash Meadows speckled (E) *Rhinichthys osculus nevadensis*	NV: Amargosa River system. Flycatchers in area. Threats: exotic fish, earlier channelization and pumping.	Yes	Yes
Gambusia, Big Bend (E) *Gambusia gaigei*	TX: Springs in Big Bend National Park. Sympatry hypothetical. Threats: reduction in springflow	Yes	No
Minnow, loach (T) *Rhinichthys (=Tiaroga) cobitis*	AZ, NM, MX: Inhabits turbulent, rocky riffles of rivers and tributaries up to approximately 2200 m. Endemic to Gila River basin. Threats: modification of rivers, streams, and landscapes through dewatering &/or impoundment of streams, loss of natural flooding, livestock grazing, and non-native fishes.	Yes	Yes
Minnow, Rio Grande silvery (E) *Hybognathus amarus*	NM, TX, MX: Rio Grande. Sympatric with Rio Grande corridor flycatchers. Threats: Dewatering of river system, changes in flood regimes, and barriers(dams) to migration and dispersal.	Yes	No (to be finalized in 2003)
Pupfish, Ash Meadows Amargosa (E) *Cyprinodon nevadensis mionectes*	NV, Ash Meadows NWR and Amargosa River. Threats: exotic fish and dewatering.	Yes	Yes
Pupfish, Warm Springs (E) *Cyprinodon nevadensis pectoralis*	NV, Ash Meadows NWR. Threats: exotic fish and dewatering.	Yes	No
Pupfish, desert (E) *Cyprinodon macularius*	AZ, CA, MX:. Lower CO River system. Threats: dewatering.	Yes	Yes
Spikedace (T) *Meda fulgida*	AZ, NM: Gila and Verde river systems. Variable habitats, young at stream margins and adults in main channels, in clear, year-round streams. Formerly sympatric with much of flycatcher's central range; remaining spikedace occur with or near flycatchers on Verde and Gila Rivers, including Cliff-Gila area.	Yes	Yes

Table 6, continued. Listed vertebrate species occupying the same ecosystems as the southwestern willow flycatcher . (E = Endangered, T = Threatened, P = Proposed)

Species/Status	Range, Habitat, Comments	Recovery Plan	Critical Habitat
Moapa Dace (E) *Moapa coriacea*	Muddy River, NV: Spring pools, spring outflows, and the main stem. Threats: habitat degradation, exotic fish.	Yes	No
Spinedace, Little Colorado (T) *Lepidomeda vittata*	AZ: Headwaters of Little CO River. Sympatric with flycatchers. Threats: habitat degradation, exotic fish.	Yes	Yes
Topminnow, Gila & Yaqui (E) *Poeciliopsis occidentalis*	AZ, NM: Ephemeral flooded habitats in lowland Gila basin, stenothermal springs, and natural lentic habitats, primarily in shallow areas with aquatic vegetation and debris. Threats: loss of springs, river backwaters, and small stream habitat due to water impoundment and diversion, water pollution, introduction and spread of exotic predatory and competitive fish species.	Yes	No
Trout, Apache (=Arizona) (T) *Oncorhynchus (Salmo) apache*	AZ: Lakes and streams in White Mts	Yes	No
Trout, Gila (E) *Oncorhynchus (Salmo) gilae*	AZ, NM: Upper Gila River system	Yes	No
Chub, bonytail (E) *Gila elegans*	CA, AZ, NV, UT, CO, WY: Larger swiftwater channels of Colorado River system. Threats: changes in water temp, quality, availability, flood regimes; migration and dispersal routes blocked by dams.	Yes	Yes
Razorback sucker (E) *Xyrauchen texanus*	CA, AZ, NV, UT, CO, NM, WY, MX: CO and Gila River basins. Threats: changes in water temp, quality, availability, flood regimes; migration and dispersal routes blocked by dams.	Yes	Yes
Sucker, Santa Ana (T) *Catastomus santaanae*	CA: Los Angeles, San Gabriel, and Santa Ana rivers. Threats: water diversions, channelization, exotic fishes.	No	No
Pikeminnow (squawfish), Colorado (E) *Ptychocheilus lucius*	CA, AZ, NV, UT, CO, NM, WY, MX: CO River system except Salt and Verde rivers. Threats: changes in water temp, quality, availability, flood regimes; migration and dispersal routes blocked by dams.	Yes	Yes
Woundfin (E) *Plagopterus argentissimus*	AZ, NV, UT: Virgin River system, formerly in Gila system. Threats: water diversion, exotic fish.	Yes	Yes

2. Species of Special Concern Occupying The Same Ecosystem As The Flycatcher

A large number of riparian and aquatic species are listed by the States comprising the flycatchers breeding range as threatened, endangered, sensitive, or species of concern (For lists see AGFD 1988 and 1996, CDFG 1992, Colorado Revised Statutes 33-2-105, Nevada Administrative Code §503.050, NMDGF 1988, Texas Parks and Wildlife Code §65.180, UDWR 1998). These species are dependent on habitats that are similar to, and/or ecologically and hydrologically connected to the breeding and migration habitat of the flycatcher. Where they take the approach of restoring or mimicking natural hydrological processes, conservation efforts directed at the flycatcher or these species should be mutually beneficial.

IV. RECOVERY

A. Recovery Strategy

This section describes the approaches and strategies for recovering the southwestern willow flycatcher. These include the geographic approach in the following discussion, followed by the information and rationales used to identify recovery goals.

1. Recovery Units

The breeding range of the flycatcher encompasses all or portions of seven States. Habitat and breeding site characteristics, potential threats, management responsibilities and status, and recovery options vary widely among the breeding sites across this broad geographic area. Because of this broad geographic range and site variation, recovery is approached by dividing the flycatcher's range into six Recovery Units, which are further subdivided into Management Units. This provides a strategy to characterize flycatcher populations, structure recovery goals, and facilitate effective recovery actions that should closely parallel the physical, biological, and logistical realities on the ground. Further, using Recovery and Management Units assures that populations will be well distributed when recovery criteria are met.

Recovery Units are defined based on large watershed and hydrologic units. Advantages of this approach are: (1) there are clear relationships between watershed characteristics and the riparian habitats on which flycatchers depend; (2) current data show that flycatchers move among breeding sites within watersheds more often than between watersheds; (3) watershed boundaries are geographically based and thus can be clearly delineated; (4) standard watershed boundaries have been defined for other purposes (e.g., Hydrologic Unit Codes [HUCs]; Seaber et al. 1994) and can be readily applied within the flycatcher's range; (5) watershed-based management builds on recent trends for agencies to cooperatively approach recovery and general resource planning at ecosystem, watershed, and landscape levels.

The "Hydrologic Units" (Seaber et al. 1994) used in this process depict standardized boundaries of river basin units of the United States. They are widely accepted by Federal, regional, State, and local water resource agencies for use in planning and describing water use and related land use activities, and in geographically organizing hydrologic data. "Accounting Units" are the third of the four levels of classification of hydrologic units. Accounting Units may be a subdivision of an area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of streams forming a coastal drainage area. In this plan, Accounting Units were aggregated into Recovery Units, except where they are truncated by the northern subspecies boundary.

Recovery Unit boundaries were defined using the following decision process:

1. Wherever possible, Recovery Unit boundaries coincide with watershed boundaries to facilitate management of water and land resources, critical to flycatcher recovery, using watershed principles.

2. Most Recovery Unit boundaries were defined by watershed boundaries at the Accounting Unit level, as defined by USGS and Water Resource Council "Hydrologic Accounting Units."

3. In areas where an Accounting Unit boundary extended beyond the historic or currently known distribution of the flycatcher (e.g., along the northern and eastern edges of the subspecies' range), the subspecies' range (as derived from published and unpublished literature) defined the outer boundary. Approximate subspecies boundaries are represented by smoothed lines. Where subspecies boundaries are known, they are represented by the more detailed Accounting Unit boundaries.

4. In a few cases, flycatcher breeding sites were more closely related (from geographic, ecological, and management perspectives) to nearby sites in a neighboring Recovery or Management Unit than to other sites (typically quite distant) in their own Hydrologic Accounting Unit. In such cases, Recovery or Management Unit boundaries were altered. In one case, a breeding site along the lower Gila River near its confluence with the Colorado River was assigned to the Colorado River Recovery Unit, even though the site is physically located within the Gila Recovery Unit. This decision was made because the site was geographically close to other ecologically similar Colorado River sites, and very distant from all other Gila sites. In another case, a site in the upper Canadian River drainage in New Mexico, part of the Mississippi River system, was included with nearby Sangre de Cristo Mountains sites in the Rio Grande Recovery Unit.

2. Management Units

Within each Recovery Unit, Management Units were delineated following the same general decision process, but were based on watershed or major drainage boundaries at the HUC Cataloging Unit level. Cataloging Units are the fourth and smallest level in the hierarchy of hydrologic units. They may be a geographic area representing part or all of a surface drainage basin, a combination of drainage basins, or a distinct hydrologic feature. Most Management Units identified here are Cataloging Units. In some cases, a single (usually large) Cataloging Unit was divided into multiple Management Units, based on (a) local small-scale drainages, or (b) distinct geographic or man-made features (e.g., confluences, smaller watersheds, dams). In other cases, two Cataloging Units were combined to form one Management Unit: (a) based on the distribution and abundance of occupied flycatcher habitat; (b) where no flycatcher breeding sites exist in one of the Cataloging Units; and (c) where watershed divisions were indistinct. As with Recovery Units, the "outer" boundaries of some Management Units were defined by the flycatcher's range boundaries.

Using this approach, the Service defines six Recovery Units, each with four to seven Management Units (Tables 7 and 8, also Figures 4 through 11. Management actions (e.g., urban development, water withdrawal, grazing, mining) occurring within a particular Recovery Unit or Management Unit, or even outside the subspecies' range, may have an impact farther downstream within a nearby Unit. Managers must understand the watershed properties "upstream" in order to decide whether a particular action may have an impact elsewhere within the range of the subspecies. Conversely, managers throughout and "upstream" of the flycatcher's range must consider the downstream effects their actions may have, within an adjacent Recovery or Management Unit. This necessitates ecosystem and watershed management approaches to evaluating threats to, and developing recovery actions for, the flycatcher.

Table 7. Recovery Units and Management Units for the southwestern willow flycatcher. See also Figures 4 through 10.

Recovery Unit	Management Units
Coastal California	Santa Ynez, Santa Clara, Santa Ana, San Diego
Basin and Mojave	Owens, Kern, Amargosa, Mojave, Salton
Upper Colorado	San Juan, Powell
Lower Colorado	Little Colorado, Middle Colorado, Virgin, Pahranagat, Hoover - Parker, Bill Williams, Parker - Southerly International border
Gila	Upper Gila, San Francisco, Middle Gila/San Pedro, Santa Cruz, Roosevelt, Verde, Hassayampa/Agua Fria, Lower Gila
Rio Grande	San Luis Valley, Upper Rio Grande, Middle Rio Grande, Lower Rio Grande, Texas, Pecos

3. Recovery Unit Descriptions

Following are general descriptions of the location of each Recovery Unit, and selected characteristics of the known flycatcher breeding sites associated with each Unit. Data regarding the number and location of flycatcher territories, and their habitat and management characteristics, represent the best available information *at this time* (See also Figures 5-11and Tables 8-9). Because (a) no Recovery Unit has received 100% survey coverage, (b) flycatcher numbers vary annually at each site, and (c) other site characteristics change over time, the values reported below will change with each survey year and as new information becomes available.

Coastal California

This unit stretches along the coast of southern California from just north of Point Conception south to the Mexico border. There are 186 known flycatcher territories in this Recovery Unit (19% of the rangewide total), distributed along 15 relatively small watersheds, mostly in the southern third of the Recovery Unit. Most breeding sites are small (<5 territories); the largest populations are along the San Luis Rey, Santa Margarita, and Santa Ynez rivers. All territories occur in native or native-dominated habitats; over 60% are on government (Federal, State, and/or local) managed lands.

Basin and Mojave

This unit is comprised of a broad geographic area including the arid interior lands of southern California and a small portion of extreme southwestern Nevada. The 69 known flycatcher territories (7% of the rangewide total) are distributed among five widely-separated drainages. Almost all sites have <5 territories; the largest populations occur in the Kern and Owens river drainages. All territories are in native or native-dominated riparian habitats, and approximately 70% are on privately-owned lands.

Upper Colorado

This unit covers much of the Four-corners area of southwestern Colorado, southern Utah, northeastern Arizona, and northwestern New Mexico. The northern boundary of this unit is delineated by the northern range boundary of the flycatcher. Ecologically, this may be an area of intergradation between the southwestern willow flycatcher and the Great Basin form. Flycatchers are known to breed at only four sites in this unit, with only three flycatcher territories (<1% of the rangewide total) documented as of the most recent surveys. However, these low numbers of known flycatchers are probably a function of the relatively low survey effort in this unit, rather than an accurate reflection of the bird's numbers and distribution. Much willow habitat occurs along drainages throughout this Recovery Unit, and remains to be surveyed. All occupied sites occur in native (willow) habitats between 1,400 to 2,420 m elevation.

Lower Colorado River

This is a geographically large and ecologically diverse Recovery Unit, encompassing the Colorado River and its major tributaries, from Glen Canyon Dam downstream to the Mexico border. Despite its size, the unit includes only 146 known flycatcher territories (15% of the rangewide total), most of which occur away from the mainstem Colorado River. Most sites include <5 territories; the largest populations (most of which are <10 territories) are found on the Bill Williams, Virgin, and Pahranagat drainages. Approximately 69% of territories are found on government-managed lands, and 8% on

Tribal lands. Habitat characteristics range from purely native (including high-elevation and low-elevation willow) to exotic (primarily tamarisk) dominated stands.

Gila

This unit includes the Gila River watershed, from its headwaters in southwestern New Mexico downstream to near the confluence with the Colorado River. The 454 known flycatcher territories (46% of the rangewide total) are distributed primarily on the Gila and lower San Pedro rivers. Many sites are small (<5 territories), but sections of the upper Gila River and lower San Pedro River (including its confluence with the Gila River), and the inflows to Roosevelt Lake, support larger sites. Private lands host 50% of territories, including one of the largest known flycatcher populations, in the Cliff-Gila Valley, New Mexico. Approximately 50% of the territories are on government-managed lands. Although 58% of territories are in native-dominated habitats, flycatchers in this Recovery Unit make extensive use of exotic (77 territories) or exotic-dominated (108 territories) habitats (primarily tamarisk).

Rio Grande

This unit encompasses the Rio Grande watershed from its headwaters in southwestern Colorado downstream to the Pecos River confluence in southwestern Texas, although no flycatcher breeding sites are currently known along the Rio Grande in Texas. Also included is the Pecos River watershed in New Mexico and Texas (where no breeding sites are known) and one site on Coyote Creek, in the upper Canadian River watershed. The majority of the 128 territories (13% of the rangewide total) are found along the Rio Grande itself. Only three sites contain more than 5 territories. Most sites are in native-dominated habitats; exotic-dominated sites include primarily tamarisk or Russian olive. Of 56 nests that have been described in the middle and lower Rio Grande in New Mexico, 43 (77%) used tamarisk as the nest substrate. Government-managed lands account for 63% of the territories in this unit; Tribal lands support an additional 23%.

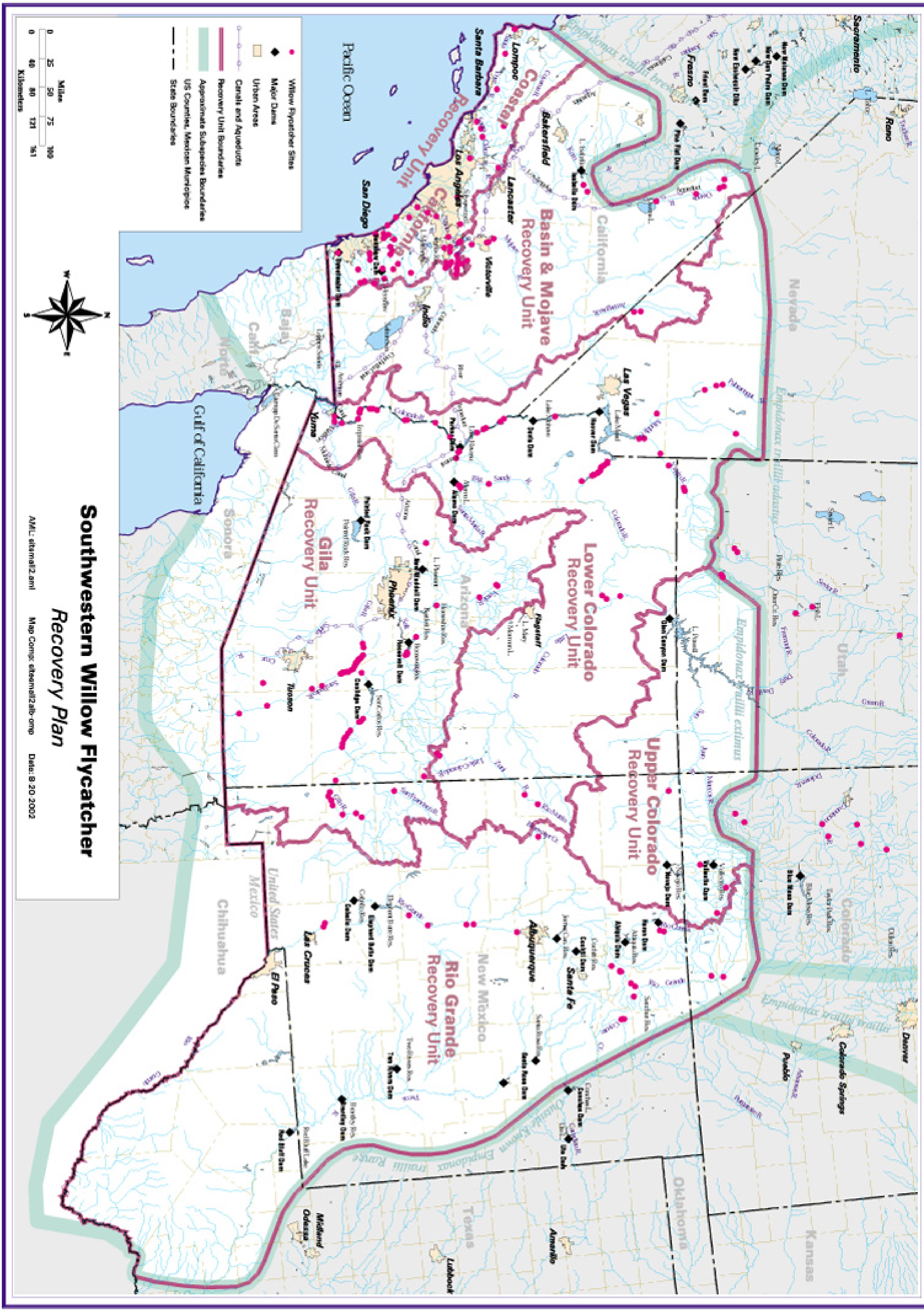

Figure 3. Breeding range of the southwestern willow flycatcher

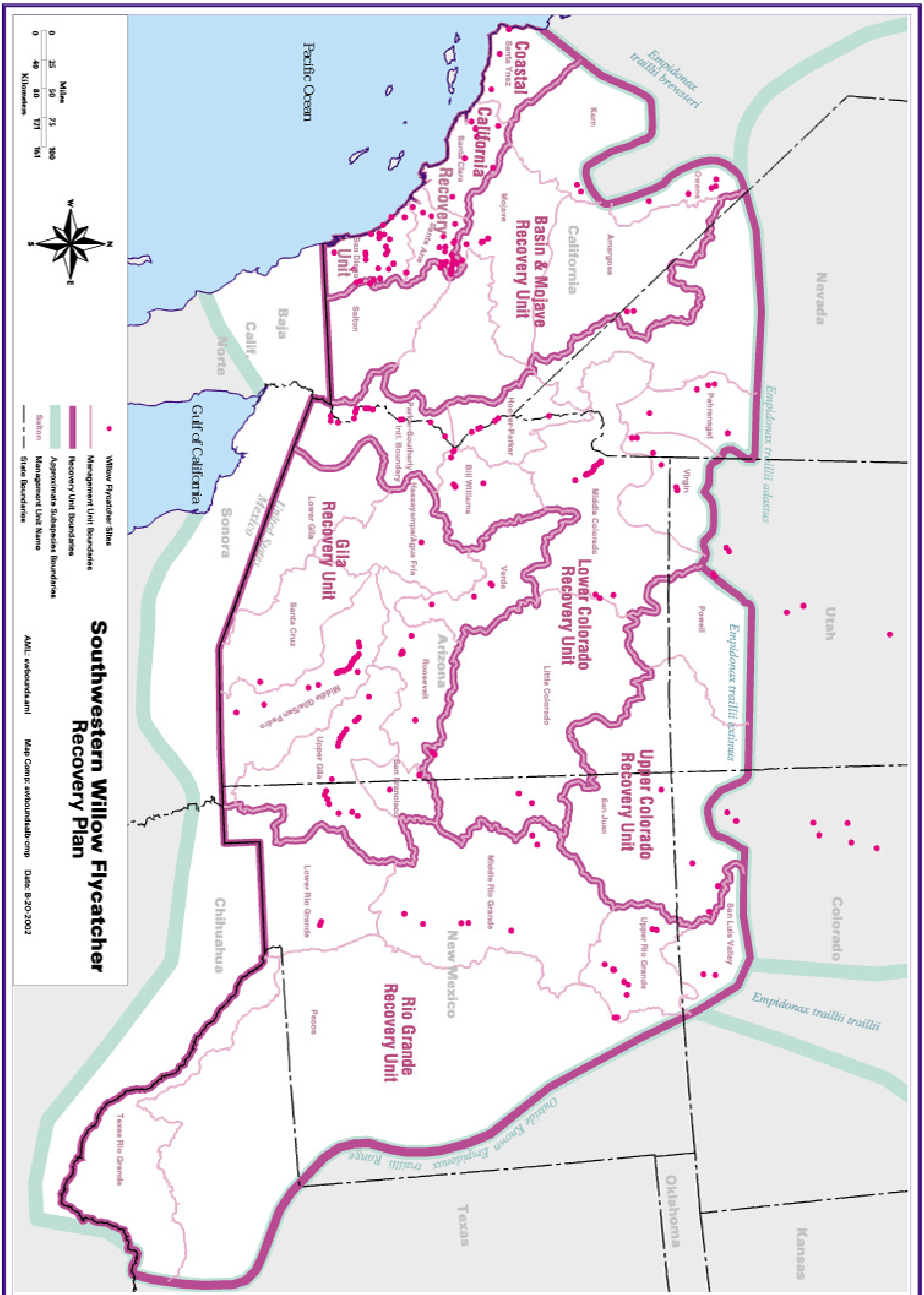

Figure 4. Recovery and Management Units for the southwestern willow flycatcher

Figure 5. Coastal California Recovery Unit

Figure 6. Basin & Mojave Recovery Unit

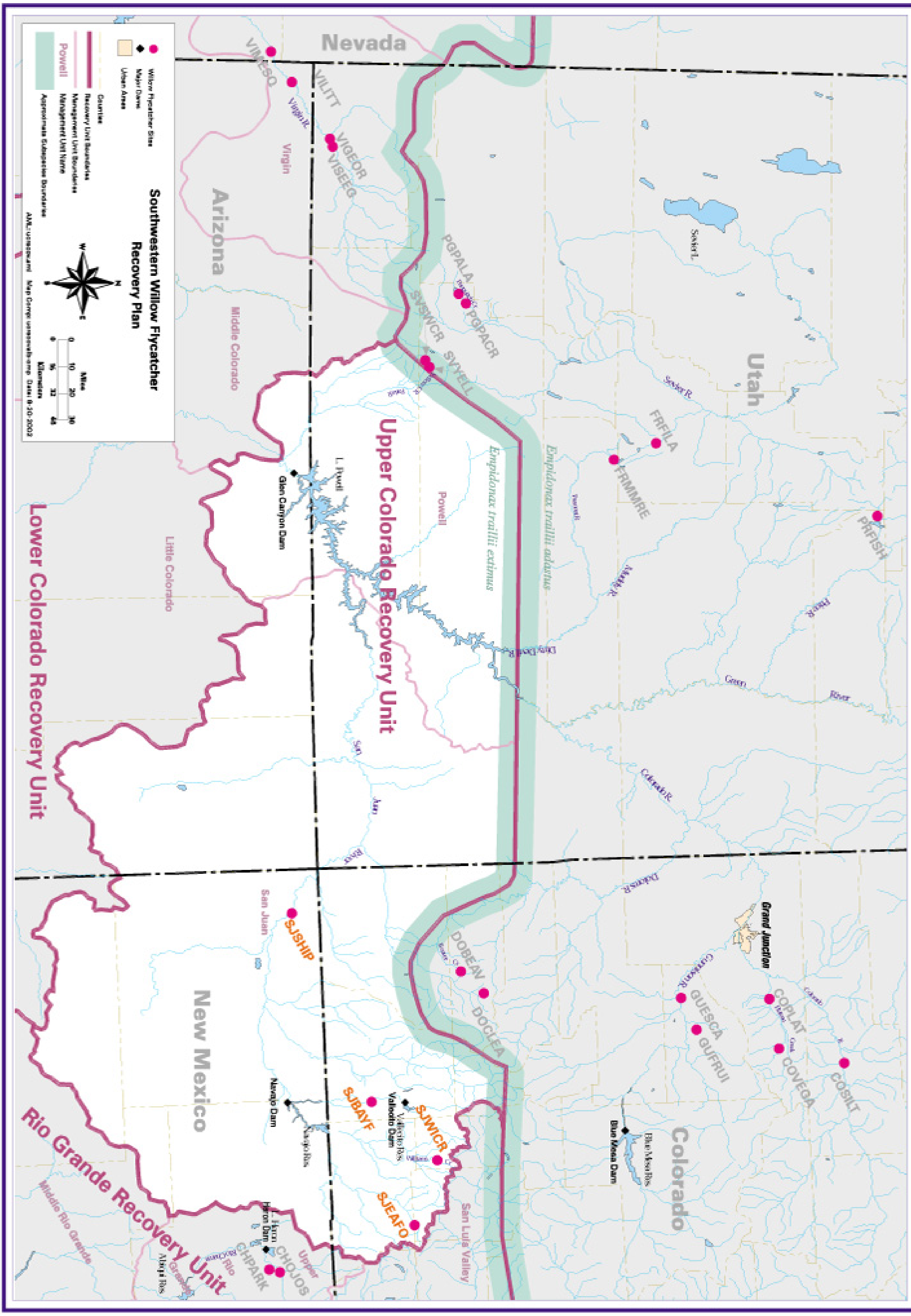

Figure 7. Upper Colorado Recovery Unit

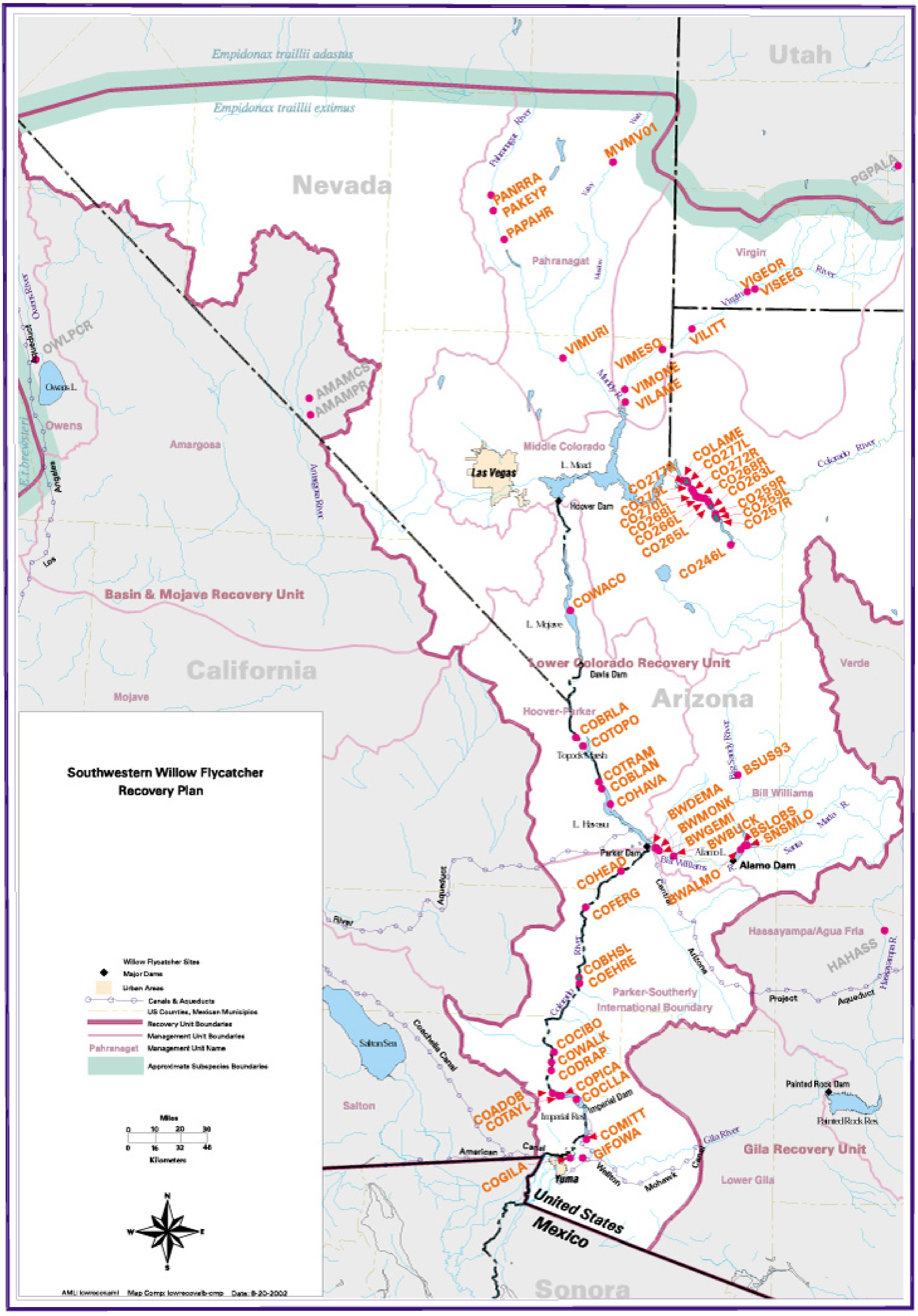

Figure 8. Lower Colorado Recovery Unit, western part

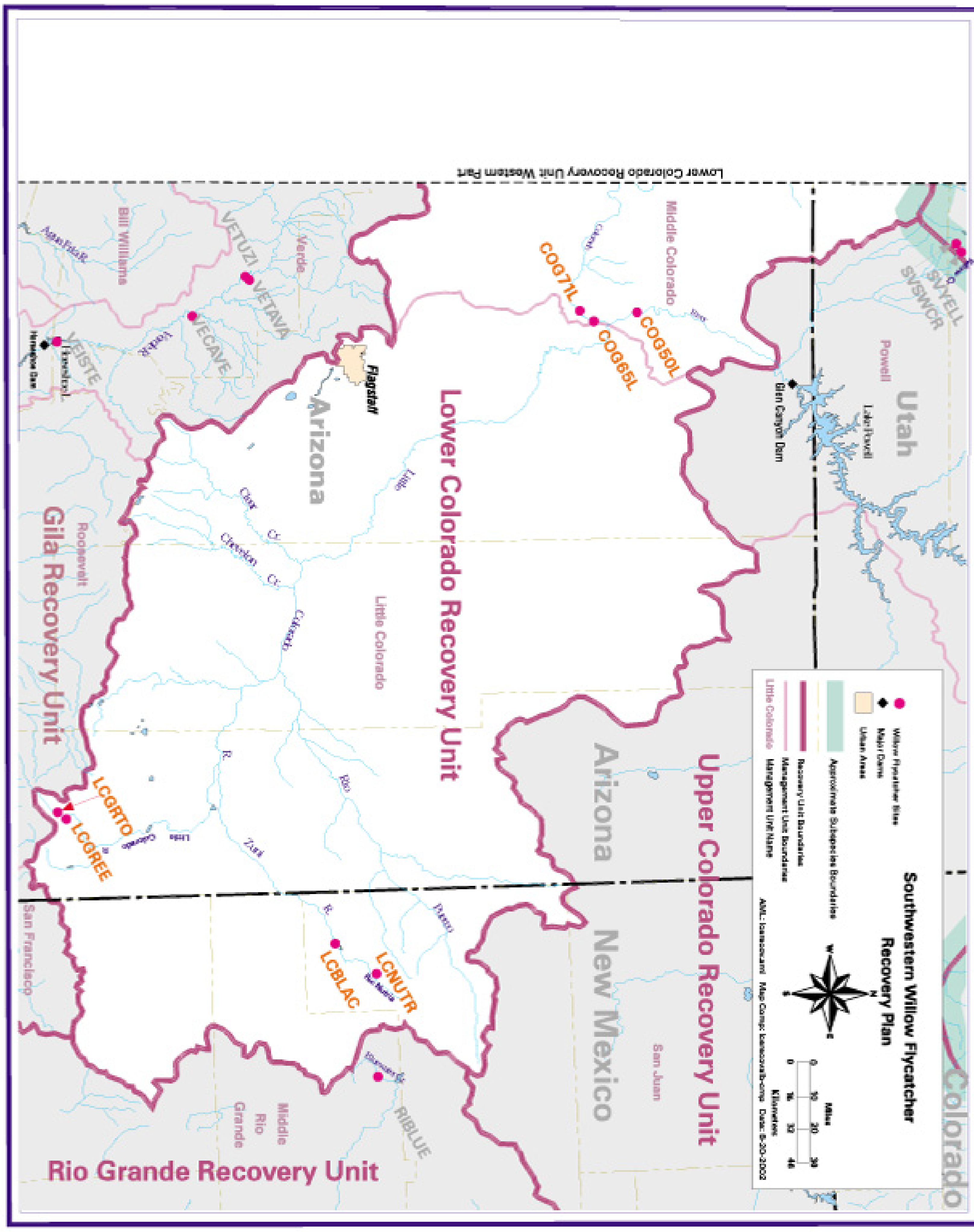

Figure 9. Lower Colorado Recovery Unit, eastern part

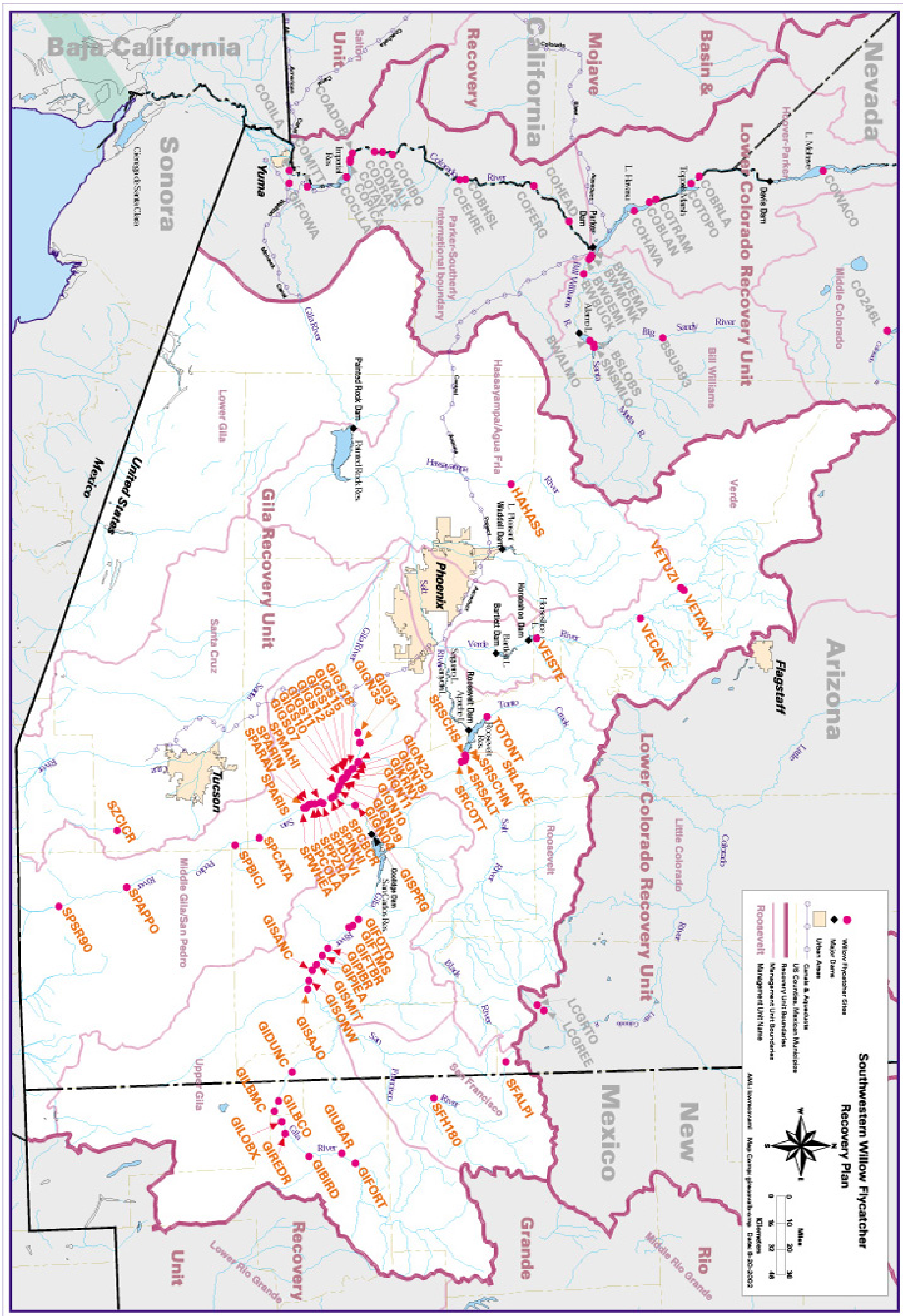

Figure 10. Gila Recovery Unit

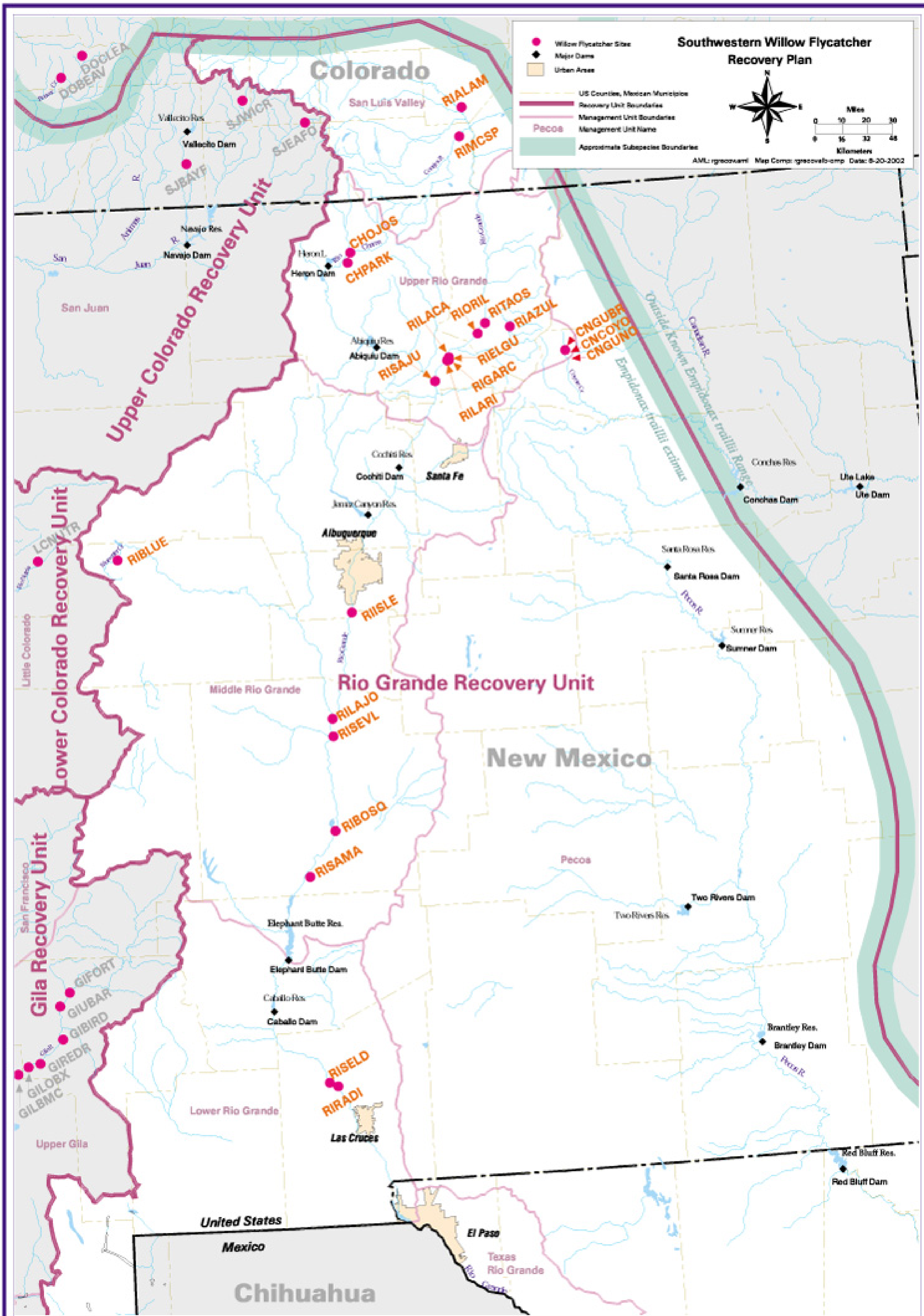

Figure 11. Rio Grande Recovery Unit

Table 8. Southwestern willow flycatcher site codes and names, by Recovery Unit. Site codes match those shown in figures 5 - 11.

Recovery Unit	Site Code	Site Name
Coastal California	AHMACA	Agua Hedionda - Macario Canyon
	LFLAFL	Las Flores Creek
	SACIEN	Santa Ana River - Cienega Seca
	SADAYC	Santa Ana River - Day Canyon
	SAJNKS	Santa Ana River - Jenk's Meadow
	SALACA	Santa Ana River - La Cadena to Waterman
	SAMILL	Santa Ana River - Mill Creek
	SAPRAD	Santa Ana River - Prado Basin
	SARTSN	Santa Ana River - Rattlesnake Creek
	SASNTI	Santa Ana River - San Timoteo Creek
	SASNCR	Santa Ana River - Sand Creek
	SAWACR	Santa Ana River - Waterman Creek
	SASTCR	Santa Ana River - Strawberry Creek
	SAMTNH	Santa Ana River - Mtn. Home Village
	SAOAGL	Santa Ana River - Oak Glen
	SAGRTH	Santa Ana River - Greenspot Thicket
	SAFOFA	Santa Ana River - Forest Falls
	SA38BC	Santa Ana River - SR 38 Bridge Cross
	SAMECR	Santa Ana River - Metcalf Creek
	SABANN	Santa Ana River - Banning Canyon
	SAVDCA	Santa Ana River - Van Dusen Canyon
	SADEER	Santa Ana River - Deer Creek
	SABEAR	Santa Ana River - Bear Creek
	SABAUT	San Jacinto River - Bautista Canyon
	SDSADI	San Dieguito River
	SDTICA	Santa Ysabel Creek - Tim's Canyon
	SDBATT	Santa Ysabel Creek- Battlefield
	SLCOUS	San Luis Rey River - Couser Canyon
	SLGUAJ	San Luis Rey River - Guajome Lake
	SLPILG	San Luis Rey River - Pilgrim Creek
	SLSLUP	San Luis Rey River - Upper
	SLAGTI	San Luis Rey River - Agua Tibia
	SLACCR	San Luis Rey River - Agua Caliente
	SLPALA	San Luis Rey River - Pala
	SLI5CO	San Luis Rey River - I5 to College
	SLCI15	San Luis Rey River - College to I15
	SMCAPE	Santa Margarita River - Camp Pendelton
	SMFALL	Santa Margarita River - Fallbrook Creek
	SGLALA	San Diego Creek - Laguna Lakes
	SDELCA	San Diego River - El Capitan
	SDWHPA	San Diego River - William Heise Park
	SOSMCR	San Mateo Creek
	STSAPA	Santa Clara River - Santa Paula
	STSATI	Santa Clara River - Saticoy
	STSFCR	Santa Clara River - San Francisquito Creek
	STUPPI	Santa Clara River - Upper Piru Creek
	STSOCA	Santa Clara River - Soledad Cyn
	STFILL	Santa Clara River - Fillmore Fish Hatchery
	SBSAGA	San Gabriel River
	SUCAGO	San Juan Creek - Canada Gobernadora
	SYBUEL	Santa Ynez River - Buellton

Table 8. Southwestern willow flycatcher site codes and names, by Recovery Unit. Site codes match those shown in figures 5 - 11.

Recovery Unit	Site Code	Site Name
Coastal California, cont.	SYGIBR	Santa Ynez River - Gibralter
	SYVAND	Santa Ynez River - Vandenberg AFB
	SWCUYA	Sweetwater Creek - Cuyamaca Lake
	SWSWRE	Sweetwater Creek - Sweetwater Reservoir
	TEAGUA	Temecula Creek - Aguanga
	TEOAKG	Temecula Creek - Oak Grove
Basin & Mojave	AMAMCS	Ash Meadows National Wildlife Refuge - Carson Slough
	AMAMPR	Ash Meadows National Wildlife Refuge - Point of Rocks
	MOLBRS	Holcomb Creek - Little Bear
	KECANE	Kern River - Canebrake Preserve
	KEKERN	Kern River - Kern River Preserve
	MOMOFR	Mojave River -Mojave Forks
	MOORGR	Mojave River - Oro Grande
	MOUPNA	Mojave River - Upper Narrows
	MOVICT	Mojave River - Victorville I-15
	OWBIGP	Owen's River - Big Pine
	OWCHBL	Owen's River - Chalk Bluff to 5 Bridges
	OWHWY6	Owen's River - Hwy 6
	OWLPCR	Owen's River - Lone Pine Creek
	OWPOLE	Owen's River - Poleta Road
	SESAFE	San Felipe Creek - San Felipe
Upper Colorado	SJSHIP	San Juan River - Shiprock
	SJWICR	San Juan River - Williams Creek Reservoir
	SJBAYF	San Juan River - Bayfield
	SJEAFO	San Juan River - East Fork (Piano Creek)
Lower Colorado	BSLOBS	Big Sandy River, Lower
	BSUS93	Big Sandy River - US 93
	BWALMO	Bill Williams River - Alamo Lake
	BWBUCK	Bill Williams River - Buckskin
	BWDEMA	Bill Williams River - Delta Marsh Edge
	BWGEMI	Bill Williams River - Gemini
	BWMONK	Bill Williams River - Monkey's Head
	COBHSL	Colorado River - Big Hole Slough
	COADOB	Colorado River - Adobe Lake
	COBLAN	Colorado River - Blankenship
	COBRLA	Colorado River - BR Lagoon
	COCIBO	Colorado River - Cibola Lake
	COCLLA	Colorado River - Clear Lake
	CODRAP	Colorado River - Draper Lake
	COEHRE	Colorado River - Ehrenberg
	COFERG	Colorado River - Ferguson Lake
	COGILA	Colorado River - Gila Confluence
	COHAVA	Colorado River - Lake Havasu - Neptune
	COHEAD	Colorado River - Headgate Dam
	COLAME	Colorado River - Lake Mead Delta
	COMITT	Colorado River - Mittry Lake
	COPICA	Colorado River - Picacho East (Is. Lk)
	COTAYL	Colorado River - Taylor Lake

Table 8. Southwestern willow flycatcher site codes and names, by Recovery Unit. Site codes match those shown in figures 5 - 11.

Recovery Unit	Site Code	Site Name
Lower Colorado, cont.	COTOPO	Colorado River - Topock Marsh
	COTRAM	Colorado River - Trampas Wash
	COWACO	Colorado River - Waterwheel Cove
	COWALK	Colorado River - Walker Lake
	COG50L	Colorado River - Grand Canyon RM 50-51 L
	COG65L	Colorado River - Grand Canyon RM 65.3 L
	COG71L	Colorado River - Grand Canyon RM 71 L
	CO246L	Colorado River - Grand Canyon RM 246 L
	CO257R	Colorado River - Grand Canyon RM 257.5 - 257.0 R
	CO259R	Colorado River - Grand Canyon RM 259 R
	CO259L	Colorado River - Grand Canyon RM 259.5 L
	CO263L	Colorado River - Grand Canyon RM 263-262
	CO265L	Colorado River - Grand Canyon RM 265-263L
	CO266L	Colorado River - Grand Canyon RM 266 L
	CO268R	Colorado River - Grand Canyon RM 268-264 R
	CO268L	Colorado River - Grand Canyon RM 268-265 L
	CO270L	Colorado River - Grand Canyon RM 270-268 L
	CO272R	Colorado River - Grand Canyon RM 272-268 R
	CO273L	Colorado River - Grand Canyon RM 273-270 L
	CO277L	Colorado River - Grand Canyon RM 277-273 L
	CO277R	Colorado River - Grand Canyon RM 277-274 R
	GIFOWA	Gila River - Fortuna Wash
	LCBLAC	Zuni/Black Rock
	LCNUTR	Zuni/Nutria Diversion Reservoir
	LCGREE	Little Colorado - Greer River Reservoir
	LCGRTO	Little Colorado - Greer Township
	MVMVO1	Meadow Valley Wash - Site 1
	PAKEYP	Key Pittman Wildlife Management Area
	PAPAHR	Pahranagat Lake National Wildlife Refuge
	PANRRA	Pahranagat River - North River Ranch
	SNSMLO	Santa Maria River, Lower
	VILAME	Virgin River Delta - Lake Mead
	VILITT	Virgin River - Littlefield
	VIGEOR	Virgin River - St. George
	VIMOME	Virgin River - Mormon Mesa
	VIMURI	Muddy River Delta - Overton Wildlife Area
	VISEEG	Virgin River - Seegmiller
Gila	GIBIRD	Gila River - Bird Area
	GIDUNC	Gila River - Duncan
	GIFORT	Gila River - Fort West Ditch
	GIFOTO	Gila River - Fort Thomas, Geronimo
	GIGN04	Gila River - GRN004
	GIGN09	Gila River - GRN009
	GIGN10	Gila River - GRN010
	GIGN11	Gila River - GRN011
	GIGN18	Gila River - GRN018
	GIGN20	Gila River - GRN020 (Kelvin Bridge)
	GIGN33	Gila River - GRN033
	GIGI31	Gila River - GRSN031
	GIGS07	Gila River - GRS007

Table 8. Southwestern willow flycatcher site codes and names, by Recovery Unit. Site codes match those shown in figures 5 - 11.

Recovery Unit	Site Code	Site Name
Gila, cont.	GIGS10	Gila River - GRS010
	GIGS11	Gila River - GRS011
	GIGS12	Gila River - GRS012
	GIGS13	Gila River - GRS013
	GIGS15	Gila River - GRS015
	GIGS18	Gila River - GRS018
	GIKRNY	Gila River - Kearny Sewage Ponds
	GILBCO	Gila River - Lower Box, Cottonwood
	GILOBX	Gila River - Lower Box
	GILBMC	Gila River - Lower Box; Main Canyon
	GIFTBR	Gila River - Fort Thomas Bridge
	GIFTMS	Gila River - Fort Thomas MS
	GIPIBR	Gila River - Pima Bridge
	GIPIEA	Gila River - Pima East
	GIREDR	Gila River - Redrock
	GISAJO	Gila River - San Jose
	GISANC	Gila River - Sanchez Road
	GISMIT	Gila River - Smithville Canal
	GISONW	Gila River - Solomon NW
	GISPRG	Gila River - Dripping Springs Wash
	GIUBAR	Gila River - U Bar Ranch
	HAHASS	Hassayampa River Preserve
	SFALPI	San Francisco Creek - Alpine Horse Pasture
	SFH180	San Fransisco River - Hwy 180
	SPAPPO	San Pedro River - Apache Powder Rd
	SPARAV	San Pedro River - Aravaipa Cr Confluence
	SPARIN	San Pedro River - Aravaipa Inflow North
	SPCBCR	San Pedro River - CB Crossing
	SPCOLA	San Pedro River - Cooks Lake
	SPDUVI	San Pedro River - Dudleyville Crossing
	SPINHI	San Pedro River - Indian Hills
	SPMAHI	San Pedro River - Malpais Hill
	SPPZRA	San Pedro River - PZ Ranch
	SPSR90	San Pedro River - SR 90
	SPWHEA	San Pedro River - Wheatfields
	SPARIS	San Pedro River - Aravaipa Inflow South
	SPBICI	San Pedro River - Bingham Cienega
	SPCATA	San Pedro River - Catalina Wash
	SZCICR	Santa Cruz River - Cienega Creek
	SRCOTT	Salt River - Cottonwood Acres I
	SRSALT	Salt River Inflow - Roosevelt Lake
	SRLAKE	Salt River Inflow - Roosevelt Lake; Lakeshore
	SRSCHN	Salt River - School House Point North
	SRSCHS	Salt River - School House Point South
	TOTONT	Tonto Creek Inflow - Roosevelt Lake
	VECAVE	Verde River - Camp Verde
	VEISTE	Verde River - Ister Flat
	VETAVA	Verde River - Tavasci Marsh
	VETUZI	Verde River - Tuzigoot Bridge

Table 8. Southwestern willow flycatcher site codes and names, by Recovery Unit. Site codes match those shown in figures 5 - 11.

Recovery Unit	Site Code	Site Name
Rio Grande	CHOJOS	Los Ojos Highway 95 Bridge
	CHPARK	Parkview Fish Hatch
	CNCOYO	Coyote Creek
	CNGUBR	Coyote Creek - Guadalupita Bridge
	CNGUNO	Coyote Creek - Guadalupita North
	RIALAM	Alamosa National Wildlife. Refuge
	RIAZUL	Tierra Azul (Rio Grande del Rancho)
	RIBLUE	Bluewater Creek
	RIBOSQ	Rio Grande - Bosque del Apache
	RIELGU	Rio Grande - Velarde-El Guique
	RIGARC	Rio Grande - Velarde-Garcia Acequia
	RIISLE	Rio Grande - Isleta
	RILACA	Rio Grande - Velarde-La Canova Acequia
	RILARI	Rio Grande - Velarde-La Rinconada
	RILAJO	Rio Grande - La Joya
	RIMCSP	McIntire Springs (Conejos River)
	RIORIL	Rio Grande - Orilla Verde
	RIRADI	Rio Grande - Radium Springs
	RISAJU	Rio Grande - San Juan Pueblo Bridge
	RISAMA	Rio Grande - San Marcial
	RISELD	Rio Grande - Selden Canyon
	RISEVL	Rio Grande - Sevilleta National Wildlife Refuge
	RITAOS	Rio Grande - Taos Junction Bridge
Outside currently known range of *E.t. extimus*		
	COPLAT	Colorado River - Plateau Creek
	COVEGA	Colorado River - Vega Reservoir
	COSILT	Colorado River - Silt
	DOBEAV	Dolores River - Beaver Creek
	DOCLEA	Dolores River - Clear Creek
	FRFILA	Fremont River - Fish Lake
	FRMMRE	Fremont River - Mill Meadow Reservoir
	GUESCA	Gunnison River - Escalante State Wildlife Area
	GUFRUI	Gunnison River - Fruit Growers Reservoir
	PGPACR	Panguitch Creek - Panguitch Creek
	PGPALA	Panguitch Creek - Panguitch Lake
	PRFISH	Price River - Fish Creek (above Scofield Reservoir)
	SVSWCR	Sevier River - Swamp Creek - Bryce Canyon National Park
	SVYELL	Sevier River - Yellow Creek - Bryce Canyon National Park

4. Population Viability Analysis

A population viability analysis (PVA), conducted to provide guidance for setting recovery objectives, was composed of two parts: a demographic analysis (Noon and Farnsworth 2000) and an incidence function analysis (Lamberson et al. 2000). Following is a brief summary of the most relevant PVA results.

Demographic analysis

The demographic analysis identifies the life history aspect (fecundity, juvenile survival, adult survival) that has the greatest effect on population growth. The model concluded that management focused on increasing fecundity (number of fledglings per female), followed closely by first year survival, will have the most influence on increasing the population (Noon and Farnsworth 2000). Analysis was based primarily on data from the Kern River in California (Whitfield unpubl. data, 1989–1999), with comparisons from some Arizona populations (Paxton et al. 1997, Netter et al. 1998). The demographic analysis was limited by the unavailability of long-term reproductive data at most sites, therefore results may not be applicable across the entire range of the bird.

Incidence Function Analysis

The incidence function analysis (Hanski 1994, Lamberson et al. 2000), which estimates population persistence over time within an existing network of occupied willow flycatcher sites, was based on data from 143 sites surveyed between 1994 - 1998 (USGS, unpubl. data). Separate models were developed for each of the six Recovery Units, assuming each may function as a metapopulation. A metapopulation is a group of spatially disjunct local willow flycatcher populations connected to each other by immigration and emigration. Results showed that the status of the southwestern willow flycatcher varies geographically. Metapopulations are most stable where many connected sites and/or large populations exist (Coastal California, Gila, Rio Grande Recovery Units). The model results predict greatest stability when sites can be established <15 km apart, each with 10 - 25 territories. Sites <15 km apart assures a high likelihood of connectivity. Once a threshold of about 25 territories/site is reached, the benefit of increasing the number of birds diminishes. Instead, metapopulation persistence (stability) is more likely to increase by adding more sites rather than adding more territories to existing sites. In addition to maximizing the colonization potential of sites within the metapopulations, this risk-spreading strategy reduces the likelihood that catastrophic events (e.g. fire, flood, disease) will negatively impact all sites.

In establishing population targets for recovery, the Technical Subgroup strove to identify a distribution and abundance of flycatchers that would minimize the distance between populations, connect isolated sites to other breeding populations, and increase population sizes to achieve metapopulation stability. The goal of the Recovery Plan is to assure long-term persistence of the species throughout its range, rather than maximize the number of birds or achieve historical pre-European settlement population levels.

Incidence Function Model Limitations

Although the incidence function model provided some insight into the current status of each metapopulation, it has some limitations. The main limitations are summarized below:

1) If the maximum number of territories detected in any one year between 1994 - 1998 does not truly represent each site in a dynamic colonization-extinction equilibrium, the model results will overestimate or underestimate occupancy rates. Equilibrium at many sites is unknown, because the number of territories varies annually.

2) Differences in how sites are designated can make a difference in model output. For example, what is considered a single large site in one drainage might be treated as several small sites at another. The model calculates greater enhancement potential (increase in population) for small sites near each other than for one large site of the same area and the same number of birds.

3) Insufficient survey effort or absent data may be responsible for low occupancy rates for some metapopulations (Basin and Mojave, Upper Colorado, Lower Colorado). Additional data have been collected at new and existing sites since the population viability analysis was conducted.

4) The incidence function analysis does not include catastrophic events. However, they were simulated in separate analyses by increasing and decreasing number of territories in all or a subset of sites within a metapopulation.

5) The model can underestimate the enhancement and colonization potential of a site because it assumes all sites are known and does not allow for colonization of new areas. New areas continue to be colonized or discovered.

6) It is unknown whether parameters derived from a subset of populations (Gila and Rio Grande Recovery Units) to calculate constants relating extinction and colonization probabilities to patch size and migration rates are applicable rangewide.

7) A rangewide analysis, pooling all data, was not conducted because of the absence of evidence that flycatchers belong to a single large metapopulation.

Therefore, the model should not be used to:

1) estimate the number of territories needed for population persistence. Instead, model recommendations for distance between sites and number of birds/site were used to develop the number of territories needed for recovery.

2) make predictions about persistence for more than five years into the future, especially if there are significant changes in pattern of site occupancy, site area, or costs to dispersal among sites.

3) predict extinction and recolonization rates of individual sites. Annual variation in number of territories/site, site inconsistencies in site designations, and inability of the model to allow for colonization of new sites limit the model's ability to predict site-specific events. Instead, model results were assessed at the metapopulation level.

5. Approach to Identifying Recovery Criteria

Within the Recovery Units and Management Units, the next issues to address are how many flycatchers are needed, and in what geographical distribution, to achieve recovery. The following text summarizes the USFWS' approach in determining recovery criteria (goals).

Rationale for Downlisting Criteria

The recovery criteria identified below and in Table 9 were developed based on information in published and unpublished sources including the population viability analysis (Lamberson et al. 2000, Noon and Farnsworth 2000), and the Technical Subgroup's collective knowledge and information relating to: distribution of current and potential flycatcher nesting areas; flycatcher dispersal and settlement patterns; and information on genetic variation and exchange.

The central points used in developing recovery criteria for downlisting were:

1. Territory is the unit of measure. Southwestern willow flycatchers are a territorial species, where males select and defend exclusive breeding territories in which they attempt to attract a mate and breed. Because it can be difficult to determine whether a particular male is paired with a female, the Service selected "territory" as the unit of measure for recovery goals (rather than "pairs"), recognizing that overall one territory generally equates to two flycatchers (one male and one female).

2. Populations should be distributed throughout the bird's range. Southwestern willow flycatcher populations should be geographically distributed throughout the bird's range in order to provide for sustainable metapopulations, minimize risk of simultaneous catastrophic loss, and avoid genetic isolation of breeding groups.

3. Populations should be distributed close enough to each other to allow for movement. Flycatcher populations should be spaced so that there is a likelihood of movement of individuals between populations, providing for genetic exchange and recolonization of other sites in the same and other Recovery Units. Therefore, breeding populations should be distributed among different Management Units within a Recovery Unit.

4. Large populations contribute most to metapopulation stability. Large populations (>10 territories), centrally located, contribute most to metapopulation stability, especially if other breeding populations are nearby. Such populations persist longer than small ones, and produce more dispersers emigrating to other populations or

colonizing new areas.

5. Smaller populations can contribute to metapopulation stability when arrayed in a matrix with high connectivity. Within a Management Unit or portion thereof, a matrix of smaller populations may provide as much or more stability than a single isolated population with the same number of territories because of the potential to disperse colonizers throughout the network of sites.

6. As the population of a site increases, the potential to disperse and colonize increases. As number of territories in a population increases, the potential to colonize nearby areas also increases, although in a non-linear fashion. Based on preliminary PVA data, the rate of increase in colonization potential (likelihood that birds will emigrate to new or existing sites) as population size increases is greatest between 4-10 territories, is less steep above 10 territories, and flattens out completely above 25 territories. Thus, numerically small increases in small populations may have a disproportionately large effect on colonization potential, and may be more beneficial than adding the same small number of territories to a large site, particularly when sites are close together. Therefore, 25 territories is used as a minimum recovery goal for each Management Unit. Where more than the minimum number (25) of territories is desired (because of habitat potential, isolation, and/or contribution to metapopulation stability), goals are set in multiples of 25. Spatial distribution within some of these Management Units is not specified, but it is likely that flycatchers will occupy more than one site within a Management Unit. Therefore, a Management Unit with a recovery goal of 25 territories could be distributed as one or several sites with varying distances between sites. Twenty-five territories distributed among several sites within close proximity to one another may function ecologically as one large site.

7. Increase/decrease in one population affects other populations. In functioning metapopulations, increases or decreases in one population may affect other populations. Thus, it is important to meet and maintain recovery objectives in each Recovery and Management Unit, each of which may influence adjacent units.

8. Some Recovery/Management Units have stable metapopulations; others do not. Some Recovery Units and/or Management Units currently have large and well distributed populations such that, with continued appropriate management, recovery goals for these units can be met and maintained. Other units require large increases in the number and distribution of breeding populations.

9. Maintaining/augmenting existing populations is a greater priority than allowing loss and replacement elsewhere. Maintaining and augmenting existing breeding populations is a faster, easier, and more reliable way to achieve and maintain population goals than to allow loss of existing populations with the hopes of replacement elsewhere. Thus, maintenance and protection of existing breeding populations is a priority.

10. Establishing habitat close to existing breeding sites increases the chance of colonization.

11. Additional survey effort is critically needed in some Management Units. Recent survey data are limited

or absent in some parts of the flycatcher's range, even regarding the presence of suitable flycatcher breeding habitat. Therefore, additional survey effort is most critically needed in Recovery Units and Management Units where recent survey efforts have been minimal or absent (e.g., portions of the Basin and Mojave, Upper Colorado, and Lower Colorado Recovery Units). These surveys will determine if flycatchers and/or breeding habitat are present, and to what degree they may be contributing to local populations and/or metapopulation stability.

In developing specific downlisting criteria, a methodology was sought that would produce an increase in the total number of individuals and of occupied sites sufficient to minimize the chances of extinction over the course of several centuries or more. Although there is a great deal of uncertainty in any assessment of population stability, there is general agreement among ecologists and conservation biologists that large populations are more secure than small ones. Just how large a population has to be to have a minimal chance of extinction over a long time period depends on many factors but those that have a size of 2,000 to 5,000 individuals are generally considered secure if their habitat is protected and obvious threats are removed (Haig et al. 1993, Pulliam and Dunning 1994, Lande 1995, Hanski et al. 1996, Wiens 1996). Populations in this size range are unlikely to be affected seriously, in the short-term at least (several thousand years), by random events such as genetic drift and demographic stochasticity (consecutive years with poor reproduction, heavily skewed sex ratios, etc.).

A population of 2,000 to 5,000 can still be devastated or even extinguished by catastrophic events, but for populations distributed over a large range, such as the flycatcher's, no single natural catastrophe or even several co-occurring natural catastrophes would likely cause the extinction of the entire taxon. Each flycatcher Recovery Unit occupies so large an area that catastrophes are unlikely to impact even all of the flycatchers within a unit. Nevertheless, catastrophes, whose effects are nearly impossible to model, could affect most individuals in Recovery Units where large proportions of territories are in the same Management Unit, river reach, or site.

Given these various uncertainties, the Technical Subgroup decided the best course was to determine goals for both the number of territories and the number of separate populations in each Recovery Unit. Rather than assume that a minimum overall population of X number of individuals is needed (based on conservation biology theory), the Technical Subgroup considered every Management Unit where flycatchers now occur, or could potentially occur given feasible management actions, and developed population targets (based on a minimum of, and multiples of, 25 territories). Population goals differed among some Management Units. Targets for Management Units centrally located within a particular Recovery Unit were sometimes higher than for less centrally located units. Goals were set higher for some Management Units with a greater potential for development or improvement of flycatcher habitat than for those with limited potential. If a Management Unit currently supports more than 25 territories, the goal for that unit was set *no lower than the current population level.* Thus, the recovery goals maintain *at least* the current number of territories in each Management Unit (and hence, each Recovery Unit).

It was assumed, a priori, that any substantial increase in overall flycatcher numbers projected by this method would result in a substantially decreased probability of extinction (given current data on persistence of flycatcher populations and current theory on metapopulations). With this method, the Technical Subgroup arrived at an overall target population of about 1,950 territories, which is an approximate doubling of the roughly 990 territories now documented to exist. These 1,950 territories infer a population size of about 3,900 individuals, assuming that most territories include monogamous pairs. Thus the current recovery goal of 1,950 territories is within the theoretical "secure range" of a population size of 2,000 to 5,000 individuals (approximately 1,000 to 2,500 territories).

B. Recovery Objectives and Criteria

1. Recovery Objectives

The overall recovery objective for the flycatcher is to attain a population level and an amount and distribution of habitat sufficient to provide for the long-term persistence of metapopulations, even in the face of local losses (e.g., extirpation). This requires that the threats that led to listing the flycatcher as an endangered species are ameliorated. The specific objectives are to recover the southwestern willow flycatcher to the point that it warrants reclassification to "threatened" status, and then further to the point where it is removed from the list of threatened and endangered species. The estimated date for downlisting is 2020. The estimated date for delisting is 2030.

2. Recovery Criteria

The recovery criteria (or goals) to achieve the above objectives are presented in the following discussion. These recovery criteria will be re-evaluated at least once every 5 years, and may be modified in the future in light of new scientific or technical information.

Reclassification: from Endangered to Threatened

There are two alternative sets of criteria that will allow for reclassifying the southwestern willow flycatcher from endangered to threatened. Neither set of criteria equate to achieving approximate historical, pre-European settlement population levels. Reclassification can occur if either set of criteria are met.

Criteria set A: Increase the total known population to a minimum of 1,950 territories (equating to approximately 3,900 individuals), geographically distributed to allow proper functioning as metapopulations, so that the flycatcher is no longer in danger of extinction. For reclassification to threatened status, these prescribed numbers and distributions must be reached *as a minimum, and maintained over a five year period*. Specific reclassification/downlisting criteria for each Recovery and Management Unit are presented in Table 9.

Each Management Unit must meet and hold *at least 80%* of its minimum population target, yet each Recovery Unit must at least meet its goal, as listed in Table 9. Therefore, if one Management Unit targeted for 50 territories reaches 40 territories, its shortage of 10 territories may be offset by a overage of 10 territories in another Management Unit *within that same Recovery Unit*. This flexibility is based on the fact the recovery goals specified for each Management Unit are estimations of the number needed, and that small departures from those specific goals are not biologically significant and therefore will not likely imperil the flycatcher- *as long as the overall Recovery Unit and rangewide goals are met.*

Criteria set B: Increase the total known population to a minimum of 1,500 territories (equating to approximately 3,000 individuals), geographically distributed among Management Units and Recovery Units, so that the flycatcher is no longer in danger of extinction. For reclassification to threatened status, these prescribed numbers and distributions must be reached *as a minimum, and maintained over a three year period*, and the habitats supporting these flycatchers must be protected from threats and loss.

Each Management Unit must meet and hold *at least 50%* of its minimum population target, and each Recovery Unit must meet at least 75% of its goal, listed in Table 9. For Recovery Units to attain 75% of their population goal, some Management Units within each Recovery Unit will need to exceed 50% of their goals. Similarly, in order to meet the rangewide goal of 1,500 territories, some Recovery Units will need to exceed 75% of their goals.

The habitats supporting these flycatchers must be provided sufficient protection from threats to assure maintenance of these habitats over time. Protection must be assured into the foreseeable future through development and implementation of conservation management agreements. Conservation management agreements may take many forms, including but not limited to the public land management planning process for Federal lands, habitat conservation plans (under Section 10 of the ESA), conservation easements, land acquisition agreements for private lands, and inter-governmental conservation agreements with Tribes. USFWS must be satisfied that the agreements provide adequate protection and/or enhancement of habitat.

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By providing two sets of criteria, the USFWS recognizes the need to allow flexibility in achieving and maintaining recovery goals, to accommodate management logistics, differing jurisdictions, natural stochastic events, and local variances in habitat quality and potential. Both criteria provide for substantial progress towards attaining a population level and an amount and distribution of habitat sufficient to provide for the long-term persistence of metapopulations. This flexibility is most effectively achieved at the Management Unit level. Therefore, numerical population goals for a particular Management Unit can be attained anywhere within that unit. This flexibility is intended to allow local managers to apply their knowledge to meet goals, possibly in areas the Service cannot identify and/or may not foresee. For example, local managers may know of areas that are logistically and/or biologically easier to recover than others. Managers should not focus recovery efforts only at the sites identified; for example, tributary stream reaches can and should be considered for recovery efforts. This is why the goals are generally specified only down to the Management Unit level. However, the Technical Subgroup highlighted some specific reaches where potential or suitable habitat exist, and/or where greater metapopulation stability can be achieved by establishing or enhancing populations in these areas (Table 10).

Note that, under either criteria set, any additional flycatchers above the minimum needed within a Recovery or Management Unit are not “excess”, and are deserving of (and require) the full protection afforded to all southwestern willow flycatchers until the flycatcher is delisted. Population levels above the minimum targets can provide for an important hedge against local catastrophic events, and are potential colonizers to other units.

Removal from the Federal Endangered Species List

The following criteria must be achieved to remove the southwestern willow flycatcher from the Federal list of threatened and endangered species:

1. Meet and maintain, at a minimum, the population levels and geographic distribution specified under reclassification to threatened criteria set A; increase the total known population to a minimum of 1,950 territories (equating to approximately 3,900 individuals), geographically distributed to allow proper functioning as metapopulations, as presented in Table 9.

2. Provide protection from threats and create/secure sufficient habitat to assure maintenance of these populations and/or habitats over time. The sites containing flycatcher breeding groups, in sufficient number and distribution to warrant downlisting, must be protected into the foreseeable future through development and implementation of conservation management agreements. Conservation management agreements may take many forms, including but not limited to the public land management planning process for Federal lands, habitat conservation plans (under Section 10 of the ESA), conservation easements, and land acquisition agreements for private lands, and inter-governmental conservation agreements with Tribes. The flycatcher may be considered for

delisting when (a) the USFWS has confirmed that the agreements have been created and executed in such a way as to achieve their role in flycatcher recovery, and (b) the individual agreements for all areas within all Management Units (public, private, and Tribal) that are critical to metapopulation stability (including suitable, unoccupied habitat) have demonstrated their effectiveness for a period of at least 5 years prior to delisting.

The current distribution of flycatcher breeding populations includes public, private, and Tribal lands in at least six of the seven States comprising its historical range. Given the dynamic nature of Southwestern riverine systems, where ecological processes vary both spatially and temporally, coupled with the complex nature of land management and ownership along river corridors, a recovery strategy that relies solely on public lands is impractical and improbable. To achieve and maintain recovery of this bird, it is likely that a network of conservation areas on Federal, State, Tribal, and other public and private lands will be necessary. To ensure that the population and habitat enhancement achieved for downlisting persist over the long-term, and to preclude the need for future re-listing of the flycatcher under the ESA, the management agreements must address the following:

1. Minimize the major stressors to the flycatcher and its habitat (including but not limited to floodplain and watershed management, groundwater and surface water management, and livestock management);

2. Ensure that natural ecological processes and/or active human manipulation needed to develop and maintain suitable habitat prevail in areas critical to achieving metapopulation stability; and,

3. The amount of suitable breeding habitat available within each Management Unit is at least double the amount required to support the target number of flycatchers described under reclassification to threatened criteria set A (page 78) and presented in Table 9.

It is important to recognize that most flycatcher breeding habitats are susceptible to future changes in site hydrology (natural or human-related), human impacts such as development or fire, and natural catastrophic events such as flood or drought. Furthermore, as the vegetation at sites matures, it can lose the structural characteristics that make it suitable for breeding flycatchers. These and other factors can destroy or degrade breeding sites, such that one cannot expect any given breeding site to remain suitable in perpetuity. Thus, the Service believes that long-term persistence of flycatcher populations cannot be assured by protecting only those habitats in which flycatchers currently breed. Rather, it is necessary to have additional suitable habitat available to which flycatchers, displaced by such habitat loss or change, can readily move.

The amount of additional habitat needed may vary in each Management Unit, based on local and regional factors that could affect the rate of occupied habitat loss and change. Until such time as these factors can be better quantified, the Service believes that conserving, within each Management Unit, double the amount of breeding habitat needed to support the target number of flycatchers assures that displaced flycatchers will have habitats in which to settle, given even a catastrophic level of local habitat loss. Based on a range-wide review of riparian patch sizes and southwestern willow flycatcher population sizes presented in published and unpublished literature (Appendix D), a patch has an average of 1.1 (± 0.1 SE) ha of dense, riparian vegetation for each flycatcher territory found within the patch. Therefore, delisting would require that twice this amount of breeding habitat (i.e., 2.2 ha) be protected for each flycatcher territory that is part of the recovery goal within a Management Unit. For example, a Management Unit with a recovery goal of 50 territories would need to assure the protection of 110 ha (50 territories x 1.1 ha for each territory x 2) of suitable habitat. This total amount of available and protected breeding habitat includes: (a) habitat occupied by flycatchers meeting the population target (50 territories), (b) flycatchers in excess of the population target, and (c) suitable but unoccupied habitat. The factor of 2.2 ha of breeding habitat per flycatcher territory can be modified based on more local data on patch sizes and population numbers. For example, if the average amount of dense, riparian vegetation per flycatcher territory were higher or lower for a given Management Unit, the amount of breeding habitat required, within that unit, to meet delisting criteria would change accordingly. Suitable habitat conditions at a site may be maintained over time through natural processes and/or active human manipulation.

Habitat objectives are incorporated in the delisting criteria because of the importance of providing replacement habitat for dispersing flycatchers after natural stochastic destruction of existing breeding habitat, and suitable habitat for future population growth. Essential to the survival and recovery of the flycatcher is a minimum size, distribution and spatial proximity of habitat patches that promotes metapopulation stability. The current size of occupied habitat patches is skewed heavily toward small patches and small population sizes (see Section II. C. 3; Patch Size and Shape); this situation inhibits recovery. Following the central points identified under the Rationale for Downlisting Criteria (above), recovery will be enhanced by increasing the number of larger populations and by having populations distributed close enough to increase the probability of successful immigration by dispersing flycatchers. For example, decreasing the proportion of small breeding groups can be achieved by striving for a minimum patch size that supports 10 or more territories. Available data indicate that current populations with 10 or more territories occupy patches with a mean size of 24.9 ha (61.5 acres) (see Section II. C. 3; Patch Size and Shape). Alternatively, along the lower San Pedro River and nearby Gila River confluence, smaller, occupied habitat patches with an average nearest-neighbor distance of approximately 1.5 km (USGS unpubl. data; Appendix D) show substantial between-patch movement by flycatchers (English et al. 1999, Luff et al. 2000) and function effectively as a single site. Thus, to promote recovery land managers and other conservation entities should strive to protect larger habitat patches (on the order of 25 ha) within management units and/or to minimize the distance between smaller occupied patches so that they function ecologically as a larger patch.

Measures To Minimize Take and Offset Impacts

To ensure achievement of recovery criteria, the following guidelines apply to designing projects, while minimizing impacts to the southwestern willow flycatcher.

1) Research, monitoring and survey projects should be used to evaluate the efficacy of measures intended to minimize or reduce impacts from project-related effects, but should not be used to offset actions that may result in loss, fragmentation, or modification of designated critical habitat, or areas not officially designated but that contain occupied habitat, or potential habitat.

2) Cowbird trapping should not be used to offset actions that may result in loss, fragmentation, or modification of designated critical habitat, occupied habitat, or potential habitat. Rather, cowbird control should be implemented at a site only after data collection shows that at least 20-30% of flycatcher nests are parasitized for two or more successive years as described in Section IV.E.; Narrative Outline for Recovery Actions.

3) All efforts should focus on preventing loss of flycatcher habitat. However, where occupied, unoccupied suitable, or unoccupied potential habitat is to be lost, modified, fragmented, or otherwise degraded, habitat should be replaced, permanently protected and managed within the same Management Unit. All efforts should strive to acquire, protect, restore and manage compensation habitat prior to project initiation. Recent research explores adequate replacement of both the land area and functional values of riparian and other wetland systems (National Research Council 2001, Wilson and Mitsch 1996, Briggs et al. 1994). Field data collected at flycatcher sites show that currently-suitable habitat patches on free flowing rivers occupy up to 20% of the floodplain in any given year and change in spatial location over time (Stromberg et al, 1997; Hatten and Paradzick, in review). Given the flycatcher's endangered status and typically small population sizes, there is a high degree of uncertainty as to whether flycatchers will colonize compensation habitat. There also is uncertainty regarding the comparability of ecological values between affected lands and compensation lands and regarding the long-term success of compensation lands. Given these uncertainties and the available data, specific analyses must be conducted on a project-by-project basis to determine the amount of compensation habitat required to approach no net loss. For instance, a relatively high compensation ratio may be required if the affected habitat has a higher than average population density; if the habitat has been occupied consecutively over the long-term; if the habitat contains a large population [>25 territories]; or if compensation lands are not proximate to affected habitat or metapopulation.

4) Permanent habitat loss, modification, or fragmentation resulting from agency actions should be offset with habitat that is permanently protected, including adequate funding to ensure the habitat is managed permanently for the protection of the flycatcher.

5) Habitat loss, modification, or fragmentation on Federal lands should not be offset with protection of Federal lands that would otherwise qualify for protection if the standards set forth in the Recovery Plan or other agency guidance were applied to those lands.

6) Areas slated for protection as a means of offsetting impacts should be identified using existing documents that have evaluated habitat conservation priorities rangewide (e.g., USBR 1999c); and should be conserved based on the following priorities: (1) occupied, unprotected habitat; (2) unoccupied, suitable habitat that is currently unprotected; (3) unprotected, potential habitat.

7) Modifying or converting occupied habitat dominated by exotic vegetation to habitat dominated by native vegetation does not constitute reduction or minimization of effects.

8) Occupied habitat is considered occupied year-round for project-related effects that degrade habitat quality.

Table 9. Recovery Criteria, by Recovery and Management Units: Minimum number of southwestern willow flycatcher territories needed to achieve reclassification to Threatened. Values for current number of known territories are based on the most recent available survey data for all breeding sites known to be occupied for at least one year between 1993 and 2001.

Recovery Unit	Management Unit	Current Number of Known Territories	Minimum Number of Territories for Reclassification
Coastal California	Santa Ynez	33	75
	Santa Clara	13	25
	Santa Ana	39	50
	San Diego	101	125
	Recovery Unit Total	**186**	**275**
Basin & Mojave	Owens	28	50
	Kern	23	75
	Amargosa	3	25
	Mojave	13	25
	Salton	2	25
	Recovery Unit Total	**69**	**200**
Upper Colorado	San Juan	3	25
	Powell	0	25
	Recovery Unit Total	**3**	**50**
Lower Colorado	Little Colorado	6	50
	Middle Colorado	16	25
	Virgin	40	100
	Pahranagat	34	50
	Hoover - Parker	15	50
	Bill Williams	32	100
	Parker - Southerly International Boundary	3	150
	Recovery Unit Total	**146**	**525**

Table 9, Continued. Recovery Criteria, by Recovery and Management Units: Minimum number of southwestern willow flycatcher territories needed to achieve reclassification to Threatened. Values for current number of known territories are based on the most recent available survey data for all breeding sites known to be occupied for at least one year between 1993 and 2001.

Recovery Unit	Management Unit	Current Number of Known Territories	Minimum Number of Territories for Reclassification
Gila	Upper Gila	187	325
	San Francisco	3	25
	Middle Gila/San Pedro	120	150
	Santa Cruz	1	25
	Roosevelt[1]	140	50
	Verde	3	50
	Hassayampa/Agua Fria	0	25
	Lower Gila	0	0
	Recovery Unit Total	**454**	**625**
Rio Grande	San Luis Valley	34	50
	Upper Rio Grande	37	75
	Middle Rio Grande	51	100
	Lower Rio Grande	6	25
	Texas	0	0
	Pecos	0	0
	Recovery Unit Total	**128**	**250**
	Rangewide Total	***986***	***1,950***

[1] This net reduction in the number of territories in the Roosevelt Management Area is based on the expected inundation of habitat resulting from increasing the surface elevation of Roosevelt Reservoir. The target for minimum number of territories will be re-evaluated after 5 years.

Table 10. Specific river reaches, within Management Units, where recovery efforts should be focused. Substantial recovery value exists in these areas of currently or potentially suitable habitat. Additional reaches may also contribute toward recovery goals.

Recovery Unit	Management Unit	Reach
Coastal California	Santa Ynez	Santa Ynez River from headwaters and tributaries to Pacific Ocean (CA)
	Santa Clara	Santa Clara River from Bouquet Canyon Road to Pacific Ocean (CA)
		Ventura River from Matilaja Hot Springs to Pacific Ocean (CA)
		Piru Creek from headwaters to Santa Clara River (CA)
		San Francisquito Creek from 3 miles upstream of Drinkwater Reservoir to Drinkwater Reservoir (CA)
		Soledad Canyon from Soledad Campground to Agua Dulce (CA)
		Big Tujunga Creek (CA)
		San Gabriel River from San Gabriel Reservoir to Santa Fe Flood Control Basin (CA)
	Santa Ana	Santa Ana River and its tributaries from headwaters on the San Bernardino National Forest to Prado Flood Control Basin Dam, including Waterman Creek, City Creek, Thurman Flats, Bautista Creek, and Day Canyon (CA)
		Mill Creek, San Bernardino National Forest (CA)
		Bear Creek and its tributaries to Santa Ana River, San Bernardino National Forest, including Van Dusen Canyon – Caribou Creek, Big Bear Lake, and Metcalf Creek (CA)
		San Timoteo Creek and its tributaries on the San Bernardino National Forest to Santa Ana River (CA)
		San Gorgonio Creek at Sawmill Canyon (part of Banning Canyon) (CA)
		San Diego Creek from Interstate Route 405 to Lake Forest Drive, including Laguna Lakes (CA)

Table 10. Specific river reaches, within Management Units, where recovery efforts should be focused. Substantial recovery value exists in these areas of currently or potentially suitable habitat. Additional reaches may also contribute toward recovery goals.

Recovery Unit	Management Unit	Reach
	San Diego	San Juan Creek Watershed, including Canada Gobernadora and Trabuco Creek (CA)
		San Mateo Creek from San Mateo Road crossing to Pacific Ocean (CA)
		San Onofre Creek from below Camp Horno to Pacific Ocean (CA)
		Las Flores Creek from Basilone Road to Pacific Ocean (CA)
		Fallbrook Creek from the Naval Weapons Station boundary to Santa Margarita River (CA)
		Santa Margarita River from confluence with DeLuz Creek to Pacific Ocean (CA)
		DeLuz Creek from De Luz Road to Santa Margarita River (CA)
		Temecula Creek from Oak Grove to Dripping Springs (CA)
		Pilgrim Creek from Vandegrift Road to confluence with San Luis Rey River (CA)
		San Luis Rey from Lake Henshaw Dam to Interstate Route 5, including Whelan Lake and Guajome Lake (CA)
		Agua Hediodonda from State Route 11 to Pacific Ocean (CA)
		San Diego River from 1 km north of Cedar Creek (32.999925 N, 116.3097 W, WGS 84) to El Capitan Reservoir (CA)
		San Dieguito River from Battlefield State Historic Park to Interstate Route 15 (CA)
		San Diego River from Magnolia Avenue to Mission Trails (CA)
		Sweetwater River from Rancho San Diego Golf course to Sweetwater Reservoir (CA)
		Tijuana River from Dairy Mart Road to Tijuana River Estuary (CA)

Table 10. Specific river reaches, within Management Units, where recovery efforts should be focused. Substantial recovery value exists in these areas of currently or potentially suitable habitat. Additional reaches may also contribute toward recovery goals.

Recovery Unit	Management Unit	Reach
Basin & Mojave	Owens	Owens River and tributaries from below Pleasant Valley Reservoir to Owens Lake (CA)
	Kern	South Fork Kern River from Canebrake Ecological Preserve to Rabbit Island and south to T26 S R34 E NE 1/4 Section 19 (CA)
	Amargosa	Ash Meadows National Wildlife Refuge (NV)
		Amargosa River from Spanish Trail Highway to T19N R7E N ½ Section 10 (CA)
	Mojave	Deep Creek from its headwaters to Mojave Forks Dam (CA)
		Mojave River from Spring Valley Lake to Bryman (CA)
		West Fork of the Mojave River from its headwaters to Mojave Forks Dam (CA)
	Salton	San Felipe Creek from San Felipe to Hwy 78 (CA)
Upper Colorado	San Juan	Los Pinos River from Vallecito Reservoir to LaBoca (CO)
		Animas River from Bodo State Wildlife Area to Colorado/New Mexico State line (CO)
		San Juan River from Malpais Arroyo one mile upstream to one mile downstream, near Shiprock (NM)
		San Juan River from two river miles upstream from State Route 262 bridge at Montezuma Creek (T41S R24E Section 3) to Chinle Creek (UT)
		East Fork of the San Juan River from Silver Creek to Treasure Creek (CO)
		San Juan River from West Fork confluence to Navajo River (CO)
	Powell	Tributaries to the Sevier River on the Markagunt Plateau (UT)
		Paria River from confluence with Cottonwood Wash (T41S R1W Section 20) to Highway 89 (T43S R1W Section 4) (UT)

Table 10. Specific river reaches, within Management Units, where recovery efforts should be focused. Substantial recovery value exists in these areas of currently or potentially suitable habitat. Additional reaches may also contribute toward recovery goals.

Recovery Unit	Management Unit	Reach
Lower Colorado	Little Colorado	Rio Nutria from Nutria Diversion Dam to confluence with Zuni River (NM)
		Zuni River from confluence with Nutria River (NM) to Arizona / New Mexico State line
		Nutrioso Creek from T7N R30E Section 9 north to Apache-Sitgreaves National Forest boundary (AZ)
		Little Colorado River from the diversion ditch at T8N R28E Section 16 upstream to Forest Road 113 on the West Fork (T7N R27E Section 33), upstream to Forest Road 113 on the East Fork (T6N R27E Section 10), and upstream to Joe Baca Draw on the South Fork (T8N R28E Section 34) (AZ)
		Little Colorado River from Springerville to St. Johns (AZ)
		Chevelon Creek from Gauging Station in T18N R27E Section 23 to confluence with Little Colorado River, including Chevelon Creek Wildlife Area (AZ)
	Middle Colorado	Colorado River from Spencer Canyon (river mile 246) to Lake Mead delta (AZ)
		Kanab Creek from one river mile north of confluence with Red Canyon (T42S R2W Section 5) (UT) to Colorado River (AZ)
	Virgin	Santa Clara River from Pine Valley to Virgin River (UT)
		North Fork of the Virgin River from Telephone Canyon in Zion National Park (T40S R10W Section 34) to East Fork of the Virgin River (T42S R10W Section 5) (UT)
		Virgin River from Rockville to Beaver Dam Wilderness Area (T43S R16W Section 29) (UT)
		Virgin River from Littlefield (AZ) to Lake Mead delta (NV)
	Pahranagat	Pahranagat River from Key Pittman Wildlife Management Area through Pahranagat National Wildlife Refuge to Maynard Lake (NV)
		Meadow Valley Wash from Caliente to Lincoln / Clark County line (NV)
		Muddy River from headwaters to Interstate Route 15 (NV)

Table 10. Specific river reaches, within Management Units, where recovery efforts should be focused. Substantial recovery value exists in these areas of currently or potentially suitable habitat. Additional reaches may also contribute toward recovery goals.

Recovery Unit	Management Unit	Reach
	Pahranagat (cont.)	Muddy River from Overton Wildlife Management Area to Lake Mead (NV)
	Hoover - Parker	Waterwheel, Pot, and Cottonwood Valley coves on Lake Mojave (AZ, CA)
		Colorado River in Havasu National Wildlife Refuge from river mile 245 to 213, including Topock Marsh (AZ, CA)
	Bill Williams	Big Sandy River from Wikieup to 4 miles south of U.S. Route 93 bridge (AZ)
		Big Sandy River from 5 miles north of the confluence with the Santa Maria River to Alamo Lake (AZ)
		Santa Maria River at Palmerita Ranch (AZ)
		Santa Maria River from Date Creek to Alamo Lake (AZ)
		Bill Williams River from Centennial Wash to confluence with Colorado River (AZ)
	Parker - Southerly International Border	Colorado River from Headgate Dam to Southerly International Border, including Cibola and Imperial National Wildlife Refuges, agricultural districts, and agricultural leases (AZ, CA)
		Confluence of Gila and Colorado rivers (AZ)
		Wellton-Mohawk Irrigation and Drainage District on Gila River (AZ)
Gila	Upper Gila	Eagle Creek from Honeymoon to the boundary of Apache-Sitgreaves National Forest and San Carlos Indian Reservation (AZ)
		Gila River from Mogollon Creek (NM) to Duncan (AZ)
		Gila river from Bonita Creek to Coolidge Dam (AZ)
	San Francisco	San Francisco River from junction of Forest Road 249 and U.S. Route 191 (AZ) to the confluence of Centerfire (NM)
		San Francisco River from Deep Creek (upstream from U.S. Route 180 bridge) to San Francisco Hot Springs (NM)

Table 10. Specific river reaches, within Management Units, where recovery efforts should be focused. Substantial recovery value exists in these areas of currently or potentially suitable habitat. Additional reaches may also contribute toward recovery goals.

Recovery Unit	Management Unit	Reach
	San Francisco (cont.)	San Francisco River from the Arizona / New Mexico border in T2S R32E to west boundary of Apache-Sitgreaves National Forest T3S R30E (AZ)
		Blue River from Dry Blue Creek to San Francisco River (AZ)
		Tularosa River from Apache Creek to San Francisco River (NM)
	Middle Gila / San Pedro	San Pedro River from international border to St. David (AZ)
		San Pedro River from The Narrows (near Pomerene) to Winkelman (AZ)
		Gila River from Winkelman to Kelvin Bridge (AZ)
	Santa Cruz	Santa Cruz River from Nogales Wastewater Treatment Plant to Chavez Siding Road (AZ)
		Cienega Creek from Empire Ranch to Pantano Road (AZ)
	Roosevelt	West Fork of Black River from West Fork Campground east to crossing at Forest Road 25
		West Fork of Black River near Thompson Ranch, T6N R27E Sections 25, 26, 36
		East Fork of Black River from Deer Creek to Buffalo Crossing
		Tonto Creek from Gisela to Roosevelt Lake (AZ)
		Roosevelt Lake (AZ)
		Salt River from State Route 88 to Roosevelt Lake (AZ)
	Verde	Verde River from Sycamore Canyon to confluence with Salt River (AZ)
	Hassayampa / Agua Fria	Hassayampa River from State Route 60 bridge in Wickenburg to San Domingo Wash (AZ)
		Gila River from Salt River to Gillespe Dam (AZ)
	Lower Gila	No reaches identified due to upstream diversions.

Table 10. Specific river reaches, within Management Units, where recovery efforts should be focused. Substantial recovery value exists in these areas of currently or potentially suitable habitat. Additional reaches may also contribute toward recovery goals.

Recovery Unit	Management Unit	Reach
Rio Grande	San Luis Valley	Rio Grande and tributaries within the San Luis Valley from Baxterville (CO) to the Colorado/New Mexico State line, including Alamosa National Wildlife Refuge
		Conejos River from Fox Creek to the Rio Grande (CO)
	Upper Rio Grande	Chama River from U.S. Routes 64/84 (bridge below town of Chama) to El Vado Reservoir (NM)
		Rio Grande from Taos Canyon (Taos Junction bridge on State Route 520) to Otowi Bridge (State Route 502) (NM)
		Rio Grande del Rancho from confluence of Sarco Canyon to confluence of Arroyo Miranda (NM)
		Coyote Creek in the vicinity of Coyote Creek State Park (NM)
	Middle Rio Grande	Rio Grande from Interstate Route 25 bridge at Exit 213 – 215 to Elephant Butte Dam (NM)
		Bluewater Creek from headwaters to Bluewater Dam (NM)
	Lower Rio Grande	Rio Grande from Elephant Butte Dam (NM) to New Mexico / Texas State line
	Texas	No reaches identified
	Pecos	No reaches identified

C. Recovery Implementation Oversight

Continuing Duties of the Recovery Team

During the formulation of the Recovery Plan, the Recovery Team consisted of a Technical Subgroup, six regional Implementation Subgroups, and a Tribal Working Group (see Section I. C., page 3). The Technical Subgroup compiled and reviewed scientific information, and developed recovery goals, strategies, and recommended actions. The Implementation Subgroups and the Tribal Working Group met with the Technical Subgroup, reviewed the draft Recovery Plan, and advised the Technical Subgroup as to the feasibility of recovery strategies and actions.

The recovery of the southwestern willow flycatcher will require continued active participation by the Technical Subgroup, Implementation Subgroups, and Tribal Working Group. Each of these groups will play a crucial role in the implementation of this Recovery Plan, as outlined below.

1. Implementation Subgroups. During development of the Recovery Plan, the role of the six Implementation Subgroups of the Southwestern Willow Flycatcher Recovery Team, as discussed in meetings and reiterated in the website-based comment forum hosted by the USFWS' Southwest Region, was to review the species data and recovery needs described by the Technical Subgroup, including the proposed implementation schedule and task priorities, and expand on the implementation schedule to determine alternative methods to accomplish the needed tasks while minimizing costs. Following completion of the Recovery Plan, the Implementation Subgroups will help determine which participants will implement recovery tasks, when, and with what resources, and will work with the USFWS to coordinate accomplishment of these tasks based on their priority. Previous and continuing participation of Implementation Subgroup members in activities of the Southwestern Willow Flycatcher Recovery Team, either in meetings or within the website comment forum, is covered by the recovery team exemption to the Federal Advisory Committee Act.

The Implementation Subgroups will be the focal points for the implementation of the Recovery Plan, and will take on an expanded and central role in flycatcher recovery. Ideally, each Implementation Subgroup will help plan, coordinate, and implement recovery actions within and among the Management Units within it's geographic area. Furthermore, the six Implementation Subgroups will communicate, and where possible coordinate, recovery actions rangewide. Representatives of the Implementation Subgroups will meet annually or biannually with the Technical Subgroup and/or the USFWS' southwestern willow flycatcher recovery coordinators (see below).

Specific functions of the Implementation Subgroups should include the following: (a) promote communication between various local interests within each Management and Recovery Unit; (b) work cooperatively to promote, plan, and initiate recovery actions; (c) provide data to help monitor Recovery Plan implementation within each Recovery Unit, and report problems, successes, and general recovery progress to the USFWS and the Technical Subgroup; and (d) recommend to the Technical Subgroup recovery plan revisions. The Implementation Subgroups will remain active as long as the recovery plan is in place.

2. Tribal Working Group. The responsibilities of the Tribal Working Group will be to: (a) provide the Technical Subgroup with recommendations regarding flycatcher recovery on Tribal lands; (b) facilitate actions (including the development of Memorandums of Agreement or Statements of Relationship with the USFWS) that will contribute to the recovery of the flycatcher; and (c) facilitate flycatcher surveys and monitoring on participating Tribal lands. A Tribal Liaison will participate in all Technical Subgroup meetings and functions. This position will remain active as long as the recovery plan is in place.

3. Technical Subgroup. The Technical Subgroup should continue to meet on an annual basis, in order to: (a) review new survey, monitoring, and research results; (b) monitor the progress of recovery actions; (c) address or clarify scientific or technical issues relating to flycatcher recovery; (d) provide guidance and interpretation to Implementation Subgroups regarding recovery actions and recommendations; and (e) oversee the adaptive management aspects of the plan, including revision of recovery actions and recommendations. Furthermore, the Technical Subgroup will take the lead in updating and revising the Recovery Plan, within 5 years of its adoption. The Technical Subgroup will remain active as long as the recovery plan is in place.

4. Southwestern Willow Flycatcher Recovery Coordinators. Because the recovery of the flycatcher is dependent upon goals and actions across a wide geographic area, across many political boundaries, and involving many different agencies and partners, a southwestern willow flycatcher recovery coordinator should be appointed by each of the three affected USFWS Regions, with lead coordination responsibilities remaining in the Southwest Region. These coordinators would: (a) provide technical assistance to agencies and land owners on such issues as project designs, land owner grant proposals, flycatcher management plan development, and Recovery Plan implementation; (b) promote communication among the various Recovery Units and agencies; (c) monitor range-wide Recovery Plan implementation, and report problems, successes, and general recovery progress to the USFWS and the Technical Subgroup; (d) help coordinate the meetings of the Implementation and Technical Subgroups; and (e) serve as advocates for flycatcher recovery and conservation issues. These positions will remain active as long as the Recovery Plan is in place. At the discretion of USFWS's Regional Directors, coordinators may be appointed and the most appropriate ways to coordinate recovery will be determined.

Centralized Southwestern Willow Flycatcher Information Repository

In order to track recovery progress, it will be important to collect, synthesize, and analyze annual survey and monitoring information from across the flycatcher's range. This is best done as a coordinated effort, by (a) requiring standardized reporting of all southwestern willow flycatcher survey efforts, and (b) managing these data in a centralized database in conjunction with Geographical Information Systems. Such a system has been maintained by the USGS and the BOR, based on information provided by State and Federal agencies, Tribes, and non-governmental organizations. This system should be continued, and updated annually, by the USGS, BOR and/or the USFWS Southwest Region's southwestern willow flycatcher recovery coordinator. Furthermore, annual recovery progress reports should be prepared and made readily available to all interested parties, including dissemination via the USFWS web site.

Adaptive Management

The recovery goals and recommended actions contained in the Recovery Plan are based on the best available scientific data that provide the foundation of our current understanding of southwestern willow flycatcher biology and riparian ecology. Over time, new information and understandings will emerge that will reinforce or revise what we currently know. Also, this Recovery Plan includes certain sections that encourage well-designed studies to answer important questions regarding the response of flycatchers and/or their habitats to various land use practices and regimes, as well as a section specifically identifying needed research (Section IV. F., page 130). It will be important to use adaptive management practices to assure that recovery goals and actions are consistent with these new data, and with any new or improved management tools. Adaptive management is dependent upon timely collection and reporting of information; this is especially true for monitoring data. The Technical Subgroup, Implementation Subgroups, Tribal Working Group, and recovery coordinators will work together to assure that the necessary information is collected, analyzed, and disseminated so that the value and effectiveness of recovery actions can be evaluated and, where needed, goals, actions, and techniques modified.

D. Stepdown Outline of Recovery Actions

The stepdown outline of actions needed to recover the southwestern willow flycatcher is presented below. Individual actions are discussed in the Narrative Outline (Section IV. E.) and in Appendices E through N.

1. Increase and improve currently suitable and potentially suitable habitat.

    1.1. Secure and enhance currently suitable and potentially suitable habitat on Federal lands, lands affected by federal actions, and cooperating non-Federal and Tribal lands.

        1.1.1. Develop management plans to reduce threats and promote processes that secure, restore, and enhance currently suitable and potentially suitable habitat.

        1.1.2. Manage physical elements and processes to reduce threats and promote processes that secure, restore, and enhance currently suitable and potentially suitable habitat.

            1.1.2.1. Restore the diversity of fluvial processes.

                1.1.2.1.1. Identify dams where modification of dam operating rules will benefit recovery of the flycatcher.

                1.1.2.1.2. Identify dams where modification of dam operations will benefit recovery of the flycatcher by taking advantage of system flexibility and water surpluses/flood flows.

                1.1.2.1.3. Determine feasibility of simulating the natural hydrograph to restore/enhance riparian systems.

                1.1.2.1.4. Determine feasibility of managing reservoir levels to establish and maintain lake fringe and inflow habitat.

                1.1.2.1.5. Determine feasibility of using surplus and/or flood flows to increase or add water to marsh areas between levees and on flood plains.

                1.1.2.1.6. Determine feasibility of keeping daily ramping rates and daily fluctuations for dam releases as gradual as possible to prevent bank erosion and loss of riparian vegetation, except when mimicking flood flows.

                1.1.2.1.7. Determine feasibility of augmenting sediment in sediment-depleted systems.

                1.1.2.1.8. Implement 1.1.2.1.3. – 1.1.2.1.7., where determined feasible.

                1.1.2.1.9. Monitor 1.1.2.1.3. – 1.1.2.1.7., and provide feedback to the Technical Subgroup.

            1.1.2.2. Restore adequate hydrogeomorphic elements to expand habitat, favor native over exotic plants, and reduce fire potential.

                1.1.2.2.1. Increase water available for recovery.

                    1.1.2.2.1.1. Increase efficiency of groundwater management to expand habitat, favor native over exotic plants, and reduce fire potential.

1.1.2.2.1.2. Use urban waste water outfall and rural irrigation delivery and tail waters for habitat restoration to expand habitat, favor native over exotic plants, and reduce fire potential.

1.1.2.2.1.3. Provide (reestablish) instream flows to expand habitat, favor native over exotic plants, and reduce fire potential.

1.1.2.2.2. Expand the active channel area that supports currently suitable and potentially suitable flycatcher habitat by increasing the width of levees and using available flows to mimic overbank flow.

1.1.2.2.3. Reactivate flood plains to expand native riparian forests.

1.1.2.2.4. Restore more natural channel geometry (width, depth, bank profiles) where the return of the natural hydrograph will be insufficient to improve habitat.

1.1.2.3. Manage fire to maintain and enhance habitat quality and quantity.

1.1.2.3.1. Develop fire risk and management plans.

1.1.2.3.2. Suppress fires.

1.1.2.3.3. Restore ground water, base flows, and flooding.

1.1.2.3.4. Reduce incidence of flammable exotics.

1.1.2.3.4.1. Manage/reduce exotic species that contribute to increased fire incidence.

1.1.2.3.4.2. Use water more efficiently and reduce fertilizer applications.

1.1.2.3.5. Reduce recreational fires.

1.1.3. Manage biotic elements and processes.

1.1.3.1. Restore biotic interactions, such as herbivory, within evolved tolerance ranges of the native riparian plant species.

1.1.3.1.1. Manage livestock grazing to restore desired processes and increase habitat quality and quantity.

1.1.3.1.1.1. If livestock grazing is a major stressor implement conservative livestock grazing guidelines. Implement general livestock grazing guidelines from Appendix G (see also Section IV. E.; Narrative Outline for Recovery Actions) in occupied, suitable, or potential habitat (potential habitats are riparian systems that have the appropriate hydrologic and ecologic setting to be suitable flycatcher habitat).

1.1.3.1.1.2. Determine appropriate use areas for grazing.

1.1. 3.1.1.3. Reconfigure grazing management units.

1.1.3.1.1.4. Improve documentation of grazing practices.

1.1.3.1.2. Manage wild ungulates.

1.1.3.1.3. Manage keystone species.

1.1.3.2. Manage exotic plant species.

1.1.3.2.1. Develop exotic species management plans.

1.1.3.2.2. Coordinate exotic species management efforts.

1.1.3.2.3. Restore ecosystem conditions that favor native plants.

1.1.3.2.3.1. Eliminate physical stresses, such as high salinity or reduced stream flows, that favor exotic plants.

1.1.3.2.3.2. Create or allow for a river hydrograph that restores the natural flood disturbance regime.

1.1.3.2.3.3. Restore ungulate herbivory to intensities and types under which native plant species are more competitive.

1.1.3.2.4. Retain native riparian vegetation in floodplains or channels.

1.1.3.2.5. Retain exotic species at sites dominated by native riparian vegetation.

1.1.3.2.5.1. At native dominated sites, retain tamarisk in occupied flycatcher habitat and, where appropriate, in suitable but unoccupied habitat, unless there is a trend for steady increase of tamarisk.

1.1.3.2.5.2. If needed, increase habitat quality within stands of exotic plants by implementing restorative actions such as seasonal flooding.

1.1.3.2.6. Remove exotics in occupied, suitable but unoccupied, and potentially suitable habitats dominated by exotics only if: 1) underlying causes for dominance of exotics have been addressed, 2) there is evidence that the exotic species will be replaced by vegetation of higher functional value, and 3) the action is part of an overall restoration plan.

1.1.3.2.6.1. In suitable and potential habitats where exotic species are to be removed through chemical or mechanical means, use a temporally staged approach to clear areas so some suitable or mature habitat remains throughout the restoration period for potential use by flycatchers.

1.1.3.2.6.2. Release habitat-targeted biocontrol agents only outside the occupied breeding range of the flycatcher.

1.1.3.3. Provide areas protected from recreation.

1.1.3.3.1. Reduce impacts from recreationists.

1.1.3.3.2. Confine camping areas.

1.1.3.3.3. Restore habitat impacted by recreation.

1.1.3.3.4. Place designated recreation shooting areas away from riparian areas.

1.1.3.3.5. Minimize attractants to scavengers, predators, and brown-headed cowbirds.

1.1.3.3.6. Provide on-site monitors where recreation conflicts exist.

1.2. Work with private landowners, State agencies, municipalities, and nongovernmental organizations to conserve and enhance habitat on non-Federal lands.

1.2.1. Evaluate and provide rangewide prioritization of non-Federal lands.

1.2.2. Achieve protection of occupied habitats.

1.2.3. Provide technical assistance to conserve and enhance occupied habitats on non-Federal lands.

1.2.4. Pursue joint ventures toward flycatcher conservation.

1.3. Work with Tribes to develop conservation plans and strategies to realize the potential for conservation and recovery on Tribal lands.

1.3.1. Work with Tribes to establish a regular system of surveys and monitoring, and train Tribal staff in the flycatcher survey protocol.

1.3.2. Determine protocols for information sharing.

1.3.3. Maintain an incumbent in the position of Tribal Liaison to the Technical Subgroup.

1.3.4. Provide technical assistance to Tribes that have flycatchers on their lands.

1.3.5. Support Tribal efforts to improve currently suitable and potentially suitable habitat.

1.3.6. Work with Tribes to determine the extent to which Tribal water rights might or might not be available to aid in conservation and recovery of the flycatcher.

1.3.7. Provide aid to Tribes for development of educational programs and opportunities that further flycatcher recovery.

2. Increase metapopulation stability.

2.1. Increase size, number, and distribution of populations and habitat within Recovery Units.

2.1.1. Conserve and manage all existing breeding sites.

2.1.2. Secure, maintain, and enhance largest populations.

2.1.3. Develop new habitat near extant populations.

2.1.3.1. Use existing habitat acquisition/conservation priorities.

2.1.4. Enhance connectivity to currently isolated occupied sites.

2.1.5. Facilitate establishment of new, large populations in areas where none exist, through habitat restoration.

2.1.6. Increase population sizes at small occupied sites.

3. Improve demographic parameters.

3.1. Increase reproductive success.

3.1.1. Manage brown-headed cowbird parasitism after collection of baseline data shows high rates of parasitism.

3.1.1.1. Increase the amount and quality of riparian habitat to increase habitat patch sizes and local flycatcher population sizes thereby minimizing levels and impacts of cowbird parasitism.

3.1.1.2. Develop cowbird management programs if warranted by baseline data on parasitism rates.

3.1.1.3. Implement cowbird management programs if warranted by baseline data on parasitism rates.

3.1.1.4. Pursue long-term landscape objectives for cowbird reduction.

3.1.2. Reduce direct impacts that topple or otherwise destroy nests.

3.1.3. Reconsider assessments of habitat quality or other threats if cowbird control and/or other measures increase reproductive output but not the number of breeding flycatchers.

4. Minimize threats to wintering and migration habitat.

    4.1. Identify, for purposes of protection, riparian habitats in the U.S. that provide essential migration and stopover habitat.

    4.2. Restore, protect, and expand riparian migration and stopover habitats in the U.S..

    4.3. Pursue international partnerships to identify migration and winter habitats and threats.

    4.4. Encourage programs that preserve habitats used by wintering and migrating flycatchers.

    4.5. Encourage programs that minimize threats to wintering and migrating flycatchers.

5. Survey and monitor.

    5.1. Facilitate and institute effective survey and monitoring programs.

        5.1.1. Adopt standardized protocols for surveying and monitoring.

        5.1.2. Institute appropriate monitoring of all reaches within management units.

        5.1.3. Integrate survey data at State and rangewide levels.

    5.2. Monitor effects of management and restoration practices.

        5.2.1. Review data to improve effectiveness of management and restoration practices.

    5.3. Survey to determine dispersal movements and colonization events.

    5.4. Expand survey efforts in wintering habitat.

6. Conduct research.

    6.1. Determine habitat characteristics that influence occupancy and reproductive success.

        6.1.1. Determine plant species / structure that determines occupancy and reproductive success.

        6.1.2. Determine habitat area needed for breeding birds.

        6.1.3. Determine effects of conspecifics on site occupancy and reproductive success.

        6.1.4. Determine use vs. availability of exotics in occupied sites.

        6.1.5. Determine long-term ecological productivity of native habitats vs. exotic habitats.

        6.1.6. Refine understanding of effects of physical microclimate on site occupancy and reproduction.

6.1.7. Determine influence of environmental toxins on breeding, survival, and prey base.

6.2. Investigate dam and reservoir management for maximizing downstream and delta habitat.

6.3. Investigate surface and groundwater management scenarios to determine thresholds for habitat suitability and to maximize habitat quality.

6.4. Investigate grazing systems, strategies, and intensities for riparian recovery and maintenance.

6.4.1. Investigate grazing systems, strategies, and intensities for riparian recovery and maintenance.

6.4.2. Investigate direct effects of livestock grazing on the flycatcher.

6.4.3. Investigate impacts of native ungulates on riparian recovery and maintenance.

6.5. Conduct research on cowbird parasitism and control.

6.5.1. Collect baseline data on cowbird parasitism.

6.5.2. Experimentally test the efficacy of cowbird trapping programs.

6.6. Determine the most successful techniques for creating or restoring suitable habitat to degraded or former riparian lands, such as abandoned agricultural fields in riparian corridors.

6.7. Refine methods for determining distribution and population status and trends.

6.7.1. Acquire demographic and dispersal information.

6.7.2. Conduct limiting factor analyses.

6.7.3. Explore new methods and data needs for population viability analyses.

6.7.4. Develop methodologies, which can be site specific if necessary, for determining year-to-year trends in population sizes at breeding sites.

6.7.5. Establish and refine protocols for addressing flycatcher distribution.

6.8. Determine present and historical distribution of the subspecies through genetic work.

6.9. Determine migration and wintering distribution, habitat, and threats.

6.9.1. Investigate migration ecology, habitat selection and use.

6.9.2. Investigate wintering distribution, status, ecology, and habitat selection.

6.9.3. Determine influence of environmental toxins on wintering flycatchers and their prey base.

6.10. Conduct research on means of increasing reproductive success by approaches other than, or in addition to, cowbird management, such as reducing losses of flycatcher eggs and nestlings to general nest predators.

6.11. Conduct research to determine why increases in reproductive success due to cowbird control or other measures may not lead to increases in numbers of breeding birds in populations experiencing improved reproductive success or in populations that could receive emigrants from such populations.

6.12. Investigate feasibility of reducing or eliminating habitat fire hazards.

6.12.1. Evaluate fuel reduction techniques in riparian habitats, especially tamarisk types.

6.12.2. Test modifying flammability for fuels to modify fire risks.

6.12.3. Test prescribed fire to achieve desired fire hazard reduction, habitat protection, and habitat improvement.

7. Provide public education and outreach.

7.1. Hold annual Implementation Subgroup meetings.

7.2. Maintain updated website.

7.3. Prepare brochures and make available to public.

7.3.1. Educate the public about landscaping with native plants.

7.3.2. Educate the public about recreational impacts, especially about fire hazards.

7.3.3. Educate the public that cowbird parasitism is a natural process but may require management efforts in some instances due to high levels or other stressors that have endangered flycatchers.

7.4. Post and maintain signs at some protected flycatcher breeding locations.

7.5. Conduct information exchange programs with foreign governments and publics.

7.6. Conduct symposia and workshops.

7.7. Continue survey training.

8. Assure implementation of laws, policies and agreements that benefit the flycatcher.

8.1. Fully implement §7(a)(1) of the ESA.

8.2. Fully implement all Biological Opinions resulting from ESA §7(a)(2) consultations.

8.3. Monitor, support, and evaluate compliance with laws, policies and agreements that provide conservation benefits.

8.3.1. Support compliance with ESA §7(a)(1) of the ESA.

8.3.2. Provide resource managers with training in conservation benefits.

8.3.3. Monitor compliance with ESA §7(a)(2) of the ESA.

8.3.4. Ensure consistency among ESA §7(a)(2) consultations.

8.3.5. Monitor compliance with existing Biological Opinions.

8.4. Integrate recovery efforts with those for other species.

8.5. Monitor compliance and effectiveness of agreements and other mechanisms used as delisting criteria.

8.6. Continue implementation of Secretarial Order 3206.

8.6.1. Effectively communicate with Tribes.

9. Track recovery progress.

9.1. Maintain collaborative structure of Recovery Team.

9.2. Annual review of survey and monitoring data.

9.3. Review and synthesis of current flycatcher research and other pertinent research.

9.4. Repeat Population Viability Analysis.

9.5. Develop recommendations for survey and monitoring strategies.

9.6. Update Recovery Plan every 5 years.

E. Narrative Outline for Recovery Actions

The southwestern willow flycatcher is endangered because of a variety of factors, the chief of which is loss and degradation of breeding habitat. Not only has extensive habitat loss severely reduced flycatcher populations, but it exacerbates other threats, such as cowbird parasitism and the demographic vulnerability inherent in a rare species that exists mainly in small, isolated populations. Recovery of the flycatcher will require preserving currently suitable and occupied habitat and substantially increasing the quantity of suitable nesting habitat. Loss and modification of flycatcher habitat has resulted from many negative influences. Recovery of this habitat would be most assured, and most quickly accomplished, by reversing all negative impacts rather than selective elimination or mitigation of just a few. But the negative impacts on riparian systems are formidable; they are the result of over 200 years' evolution of land-use practices, regional explosion in human population, physical re-engineering of whole river systems, and the complexities and restrictions of water-allocation law. Therefore the recovery actions outlined here attempt to steer a course through what is feasible, what is legal, and what will be effective. Because of the biological and logistical complexities of riparian habitat restoration, different locales and circumstances will require significantly different recovery approaches.

This outline categorizes recovery actions into nine types:

1. Increase and improve currently suitable and potentially suitable habitat.
2. Increase metapopulation stability.
3. Improve demographic parameters.
4. Minimize threats to wintering and migration habitat.
5. Survey and monitor.
6. Conduct research.
7. Provide public education and outreach.
8. Assure implementation of laws, policies, and agreements that benefit the flycatcher.
9. Track recovery progress.

1. Increase and improve currently suitable and potentially suitable habitat.

1.1. Secure and enhance currently suitable and potentially suitable habitat on Federal lands, lands affected by Federal actions, and cooperating non-Federal and Tribal lands. Secure and enhance all suitable and potential breeding habitat on Federal lands and/or on lands affected by Federal action, within the framework of recovery criteria identified in Section IV. B., above.

1.1.1. Develop management plans to reduce threats and promote processes that secure, restore, and enhance currently suitable and potentially suitable habitat. Recognizing that "an ounce of prevention is worth a pound of cure," management plans should focus on removing threats more than engineering elaborate cures, mitigation, or contrived restoration. Where feasible and effective, conserve and restore natural processes and elements by removing stressors or, secondarily, modify the stressors by naturalizing flow regimes, modifying grazing regimes, removing exotics, and/or removing barriers between channels and floodplains, to allow for natural recovery.

1.1.2. Manage physical elements and processes to reduce threats and promote processes that secure, restore, and enhance currently suitable and potentially suitable habitat. Reestablish physical integrity of rivers first, then proceed to biological integrity of flycatcher habitat. Physical integrity for rivers implies restoration and maintenance of their primary functions of water and sediment dynamics. The vegetation communities needed for flycatcher habitat require specific hydrologic and geomorphic conditions, primarily floods, sediments, and persistent water. Set reasonable restoration and maintenance targets for physical integrity, recognizing the restored system will be a combination of natural and artificial processes, designed to achieve or mimic pre-development conditions, although at a limited scale. Recognizing the amount of water presently available for habitat restoration and maintenance is far below the optimal amount, the primary objective is to use the least amount of water possible to restore a sustainable southwestern willow flycatcher population. See Appendices I and J for detailed discussions.

1.1.2.1. Restore the diversity of fluvial processes. Restore the natural diversity of fluvial processes such as movement of channels, deposition of alluvial sediments, and erosion of aggraded flood plains, that allow a diverse assemblage of native plants to establish.

1.1.2.1.1. Identify dams where modification of dam operating rules will benefit recovery of the flycatcher. Dam operations focus on direct economic goals, and treat rivers as water and power commodities, leaving little administrative space for endangered species and other broader objectives. Although legal and economic considerations limit operational flexibility, environmental restoration and maintenance are part of the operating strategies of many large, multi-purpose structures, and habitat considerations should be a part of decision-making for dam operating rules. Where feasible, dam operating rules should be changed to treat rivers as landscapes and ecosystems functioning in support of diverse species including the southwestern willow flycatcher. Include these broadened objectives in revisions of the laws of the river, as well as interstate water compacts and administrative rule decisions. Include endangered species recovery as one of the multiple objectives in dam operating rules. An example of Congressionally mandated changes to the Law of the River for the Colorado River is the 1992 Grand Canyon Protection Act which brought about changes in the operation of Glen Canyon Dam to benefit downstream environmental resources.

1.1.2.1.2. Identify dams where modification of dam operating rules will benefit recovery of the flycatcher by taking advantage of system flexibility and water surpluses / flood flows. Dam operations have greatly simplified downstream geomorphic systems, resulting in loss of the ecological complexity needed for flycatcher habitat. To restore the complexity of hydrodiversity and geodiversity which will lead to biodiversity, dam operations should allow occasionally complex flow regimes with a wide range of discharge levels, and flood or spike flows. In many years, this new regime would not necessarily result in increased water releases, but rather releases on a schedule different from the present. Where feasible, high or spike flows should be released in months that will most benefit native vegetation and native fishes, taking advantage of system flexibility and water surpluses / flood flows to create and maintain flycatcher habitat.

1.1.2.1.3. Determine feasibility of simulating the natural hydrograph to restore / enhance riparian systems. For those structures that have operating rules that include environmental values, use the same analytic techniques for assessing options to maintain flycatcher habitat that are used for other water resource objectives. Operate dams systematically to attempt to mimic natural river processes at least occasionally. Consider distributing flood storage capacity differentially between dams in various years so the intervening watercourses will occasionally experience floods while the system's flood protection integrity is maintained. Release flows for purposes that will better simulate natural hydrology and/or specifically to enhance riparian systems, e.g., release water for recharge purposes along with peak flows to enhance the flood-like processes between the dam and point of diversion.

1.1.2.1.4. Determine feasibility of managing reservoir levels to establish and maintain lake fringe and inflow habitat. Sequences of flood inflows, sediment deposition, and subsequent exposure of sediments often create extensive riparian habitat at reservoir inflows and margins. To the greatest extent feasible, reservoir levels should be managed to preserve this serendipitous "delta" habitat. Avoid desiccating drawdowns or extended, extreme inundation of these habitats. Because laws and regulations also control reservoir levels, this objective must be fit into existing operating rules and priorities, because it may conflict with water delivery or flood control responsibilities. The objective should be included in formal operating rules, however, and recognized as a benefit that dam operations provide.

1.1.2.1.5. Determine feasibility of using surplus and/or flood flows to increase or add water to marsh areas between levees and on flood plains. Additional flows above common allocations are of two types: 1) surplus flows that are formally declared as such and that are allocated to specific users, and 2) flood flows that represent spills or releases from storage and that are not allocated to specific users. Rather than conducting surpluses and/or flood flows through a system as quickly as possible, they should be used gradually, in part for habitat creation and maintenance. This should not conflict with other important uses of these flows such as hydrating downstream areas, e.g., hydrating the Colorado River delta in Mexico. Flood releases occur on an occasional basis which limits their usefulness, but they offer some opportunity for habitat maintenance which is not now fully exploited. Management of additional flows should be within a context of available habitat and suitable water chemistry. Pre-flood flow manipulations including lowering river banks, removing levees, and/or removing tamarisk may be necessary to achieve restoration at some sites.

1.1.2.1.6. Determine feasibility of keeping daily ramping rates and daily fluctuations for dam releases as gradual as possible to prevent bank erosion and loss of riparian vegetation, except when mimicking flood flows. Ramping rates, the rates at which releases are increased or decreased, should be kept as gradual as possible to prevent bank erosion and loss of riparian vegetation through mechanical processes at the margins of downstream channels.

1.1.2.1.7. Determine feasibility of augmenting sediment in sediment-depleted systems. Generally, dams trap sediments and release erosive clear-water discharges. As a result, downstream areas are both deprived of natural sediment input and stripped of what sediments remain. This process eliminates the native vegetation and habitats that were developed on the deposits, including flycatcher habitat. To help correct this trend, augment the sediment supply of river reaches downstream to replace the fine sediments artificially removed in upstream reservoirs, but insuring that sediments containing hazardous levels of heavy metals, pesticides, and herbicides are not re-mobilized, and that downstream fish habitats are not adversely affected. Sediment augmentation should be undertaken with due regard for downstream navigation and water quality values. Sediment augmentation in some cases may relieve sedimentation problems in reservoirs by piping dredged sediment past the dam to points downstream for reintroduction. Adaptive management approaches should be in place to make adjustments or stop sediment augmentation if adverse results appear. Dams in areas with low sediment inflows to reservoirs probably do not have sedimentation problems, and they also probably have had lesser effects on downstream sediment loads.

1.1.2.1.8. Implement 1.1.2.1.3. – 1.1.2.1.7., where determined feasible.

1.1.2.1.9. Monitor 1.1.2.1.3. – 1.1.2.1.7., and provide feedback to the Technical Subgroup.

1.1.2.2. Restore adequate hydrogeomorphic elements to expand habitat, favor native over exotic plants, and reduce fire potential. Restore the necessary elements such as shallow water tables, surface water flow, movement of sediments and nutrients, consistent with the natural flow regime. This will aid expansion of habitat, favor native over exotic plants, and reduce fire potential.

1.1.2.2.1. Increase water available for recovery. Many solutions for improving flycatcher habitat require increased availability of water in active channels or in near-channel areas. This issue is important throughout the flycatcher's range (e.g., lower Colorado River near Yuma, lower San Pedro River, Gila River below Coolidge Dam, Middle Rio Grande). Water purchases or other acquisition procedures, as well as other water management strategies, are likely to be required in a comprehensive recovery of the species. In some areas construction of new projects to provide water for both agriculture and development threaten the limited remaining flycatcher habitat. Because agricultural withdrawals from rivers and groundwater are much larger than any other economic sector, the agricultural community must be part of any long-term solution. Engage agricultural interests in all major watersheds in the range of the flycatcher to consult with agencies and other parties to take proactive measures to provide more water in rivers throughout the range of the flycatcher.

1.1.2.2.1.1. Increase efficiency of groundwater management to expand habitat, favor native over exotic plants, and reduce fire potential. Integrated, watershed-based approaches to water management may suffice to reverse some of the changes resulting from overdrafting ground water in some river reaches. All water users, whether municipal, agricultural, or industrial, need to work together and bear their share of water overdraft problems to achieve results. Approaches should focus on reducing withdrawals (e.g., xeriscaping, replacing high-water-use crops with high water-use-efficiency crops) and increasing recharge (e.g., recharge of aquifers with effluent). In cases of extreme dewatering, restoration of water tables may require importation of water from other basins.

1.1.2.2.1.2. Use urban waste water outfall and rural irrigation delivery and tail waters for habitat restoration to expand habitat, favor native over exotic plants, and reduce fire potential. These areas have the potential to support suitable flycatcher habitat (native willows) and often have open water surfaces. When using return flows to support or create flycatcher habitat, it may be necessary to periodically flush the soils to reduce the concentrations of salts below the levels that are toxic to willows. Success also will be enhanced if water level fluctuations do not exceed tolerance ranges of the plant species (see Appendix K). Restoration efforts in waste-water systems need to monitor water quality and contaminant levels to minimize risks.

1.1.2.2.1.3. Provide (reestablish) instream flows to expand habitat, favor native over exotic plants, and reduce fire potential. Maintain instream flow releases below dams at suitable levels to conserve or enhance instream values and public trust resources. For dams that are primarily flood control structures, release storage volumes to achieve both flood scouring processes and slower trickle flows over long periods to maximize groundwater recharge and maintain some surface flow downstream. Modify dam operations, diversions, and groundwater pumping to provide low level instream flows (enough merely to establish a wetted perimeter and a visible surface flow) during low flow periods downstream. Measure these flows at stream gages at the appropriate times to assure the water flows are of the magnitude and frequency intended to positively influence flycatcher habitat. Many gages do not provide resolution adequate for monitoring changes in base flows that are important for habitat. There is an ongoing effort in the Verde River basin to install additional gages to monitor changes to base flow. The sensitivity and sufficiency of the existing gage network should be considered, and modified to provide the necessary data for management decisions. In those river reaches downstream from diversion structures that desiccate the channels, procure water rights for delivery at desired times to hydrate flycatcher habitat.

1.1.2.2.2. Expand the active channel area that supports currently suitable and potentially suitable flycatcher habitat by increasing the width of levees and using available flows to mimic overbank flow. Reservoir storage and diversions have caused river channels and their associated landscapes to become drastically more narrow. Levees with narrow spaces between them have stabilized the restricted widths. As a result, the original natural riparian forest and potential flycatcher habitat have also shrunk, and become discontinuous. To correct this trend, increase the distance between levees. This will result in both increased flood conveyance potential and more space for dense riparian vegetation outside the low flow channel. Flood conveyance channels should be designed to provide adequate flood-flow capacity with a large portion of the width in riparian vegetation. For example, doubling the width of a channel dedicated to flood conveyance could free half the width from the necessity of channel clearing or dredging. If channel clearing must be done, schedule activities in such a way that riparian habitat is continuously available in the area, e.g., do not mow or grade entire flood control systems simultaneously. Sizing the channel width using the "meanderbelt" concept has potential for yielding both flood control and aquatic/riparian values. Discourage other land-uses, e.g., cultivated agriculture, within flood conveyance facilities when they are detrimental to riparian vegetation growth. Improve the along-channel connectivity of rivers by insuring continuous instream flows and allowing occasional minor floods with peak flows large enough to expand channel systems.

1.1.2.2.3. Reactivate flood plains to expand native riparian forests. Flood plains, oxbows on single-thread channels, and secondary channels on braided streams have become inactive due to flood suppression by dams, entrenchment, isolation by levees, and elimination of beaver, all of which have reduced or eliminated native riparian forests. To reverse this effect, permit overbank flows in selected locations to expand wetlands and riparian forests by larger releases from dams when excess water is available, or manage conveyance to include peak flows. Install gates in levees and temporarily (permanently where possible) breach selected levees to reactivate flood plains and abandoned channels behind the structures. Pump, syphon, or divert water to flood plains abandoned by channel entrenchment. Along some channels where the flood plain marshes can be maintained, construct additional levees around them, and install gates or valves to connect them through the main river levees to the channel to facilitate occasional diversions into them. Abandoned channels and oxbows can be excavated to remove sediment and can be reconnected to the main river channel through artificial channels with gates or valves to supply temporary flows.

1.1.2.2.4. Restore more natural channel geometry (width, depth, bank profiles) where the return of the natural hydrograph will be insufficient to improve habitat.

1.1.2..3. Manage fire to maintain and enhance habitat quality and quantity. See Appendix L (especially Table 2) for a complete discussion of fire issues and management.

1.1.2.3.1. Develop fire risk and management plans. Develop a fire plan for all current flycatcher breeding sites, and for sites where flycatcher-related riparian restoration is planned. A comprehensive fire evaluation and response plan should include these components: (1) Evaluation of the degree of fire threat for that particular site; (2) Identification of short-term preventative actions that will be taken to reduce the risk of fire; (3) Direction for quick response for fire suppression; (4) Post-fire remediation/restoration; (5) Identification of long-range efforts to reduce risk of fire; (6) Development of long-term monitoring of conditions in the riparian zone and watershed that maintain flood regimes and reduce fire susceptibility. This section of the fire plan should consider efforts such as monitoring regional water use patterns; water level trends in the regional and flood plain aquifers; fire-related recreational activities; and fuels loading (See Appendix L).

1.1.2.3.2. Suppress fires. Suppress fires in habitat and adjacent buffer zones. Fire suppression should make use of current, updated maps of occupied habitat and buffer zones that are part of each breeding site's fire plan.

1.1.2.3.3. Restore ground water, base flows, and flooding. Restoring water availability will reduce fire risks in several ways. Shallow ground water (i.e., no lower than 3 m below the flood plain surface for mature forests and within 0.5 to 1 m of the flood plain for younger forests measured during the peak water-demand periods) should restore or maintain native cottonwood-willow forests in non-water stressed, less flammable, condition. Shallow depth to ground water also will allow tamarisk stands to be more fire resistant than if water is deeper because they maintain higher internal water content. If a stream has become intermittent, perennial surface flows should be restored. In lieu of restoring the preferable option of natural hydrology, water in adequate amounts to raise plant water content and raise water tables could be supplied through flood irrigation, sprinklers, or agricultural tail water. To reduce fire size and frequency, allow floods sufficiently large to remove accumulated forest floor debris and moisten the surface soils and tree bases. Ideally, floods should be released in a fashion that mimics the natural flow regime.

1.1.2.3.4. Reduce incidence of flammable exotics.

1.1.2.3.4.1. Manage/reduce exotic species that contribute to increased fire incidence. Some exotic plant species (e.g., tamarisk, red brome) are more flammable than the native species they replace. Altered hydrology and livestock grazing are significant factors that can favor exotic plants. Following the livestock grazing guidelines in Appendix G should also favor natives over exotics. Where the consequences of fire are high due to fine fuel loads, livestock grazing might be used as a tool to reduce the risks, as long as such grazing follows the grazing guidelines detailed in Appendix G.

1.1.2.3.4.2. Use water more efficiently and reduce fertilizer applications. Manage flood plains and watersheds to keep salinity levels within the tolerance ranges of the native plant species. Some agricultural practices amplify the amount of salt and its delivery into rivers, which contributes to favorable conditions for exotic plants like tamarisk, which are more fire-tolerant and fire-prone than natives like willows. More efficient use of water and less reliance on fertilizers will help reduce salt loads.

1.1.2.3.5. Reduce recreational fires. Prohibit fires and fire-prone recreation uses in habitat and in large buffer strips surrounding habitat during high fire-risk periods. Manage the numbers and/or distribution of recreationists to concentrate them into locations where fire suppression efforts can be most effectively deployed. Some areas may need to be closed to recreational use during high-risk periods, such as 4th of July weekends or drought periods. Increase patrolling by enforcement personnel to enforce restrictions.

1.1.3. Manage biotic elements and processes.

1.1.3.1. Restore biotic interactions, such as herbivory, within evolved tolerance ranges of the native riparian plant species. Like flood-driven regeneration, herbivory of vegetation is a process with which riparian ecosystems and flycatchers have evolved. However, like hydrological processes, herbivory now is outside the realm of the natural historical norm due to reductions of some native species (beaver), intensive management of others (deer, elk), and introduction of non-natives (domestic livestock). As a result, riparian ecosystems have been altered in extent, composition, and fire potential. Please refer to Appendix G for discussion of domestic livestock.

1.1.3.1.1. Manage livestock grazing to restore desired processes and increase habitat quality and quantity.

1.1.3.1.1.1. If livestock grazing is a major stressor implement general livestock grazing guidelines from Appendix G in currently suitable or potentially suitable habitat (potentially suitable habitats are riparian systems that have the appropriate hydrological and ecological setting to be suitable flycatcher habitat). If a particular grazing system is not preventing the recovery of flycatcher habitat (e.g., regeneration of woody and herbaceous riparian vegetation), then that particular grazing system should be allowed to continue provided it is appropriately monitored and documented. Flexibility through adaptive management must be an integral component of the grazing system in order to continue to improve flycatcher habitat.

The following grazing recommendations, excerpted from Table 2 in Appendix G, should be interpreted as guidelines that must be applied according to site-specific conditions:

- During the **growing season** (of woody riparian vegetation), no livestock grazing in **taller stature** occupied flycatcher habitat (e.g., below 6,000 ft or 1,830 m) until research in comparable unoccupied habitats demonstrates no adverse impacts from grazing. If unoccupied habitat becomes occupied habitat, continue existing management (grazing should not exceed 35% of palatable, perennial grasses and grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use not to exceed 10%).

- During the **non-growing season** (of woody riparian vegetation) in **taller stature** occupied flycatcher habitat (e.g., below 6,000 ft or 1,830 m), there may be conservative grazing with average utilization not to exceed 35% (± 5%) of palatable, perennial grasses and grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use not to exceed 10%. Utilization of woody plants not to exceed an average of 40% (±10%) of current year's growth. Grazing must be accompanied by monitoring to ensure allowable use guidelines for vegetation are not exceeded. Livestock use of annual plants indicates overuse of grasses and grass-like plants.

- During the **growing season** (of woody riparian vegetation) in **low stature** occupied flycatcher habitat (e.g., 3-4 m monotypic shrubby willow at elevations > 6,000 ft or 1,830 m), no livestock grazing.

- During the **non-growing season** (of woody riparian vegetation) in **low stature** occupied flycatcher habitat (e.g., 3-4 m monotypic shrubby willow at elevations > 6,000 ft or 1,830 m), no livestock grazing.

- During the **growing season** (of woody riparian vegetation) in unoccupied but suitable flycatcher habitat in **taller stature** habitats (e.g., below 6,000 ft or 1,830 m), no grazing. However, a limited number of small-scale, well-designed experiments may be initiated in some areas, at the discretion of the USFWS, to determine levels of pre-breeding season grazing (not to exceed 35% (±5%) of palatable perennial grass or grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use not to exceed 10%) that do not adversely affect flycatcher habitat attributes.

- During the **non-growing season** (of woody riparian vegetation) in unoccupied but suitable flycatcher habitat in **taller stature** habitats (e.g., below 6,000 ft or 1,830 m), conservative grazing with average utilization not to exceed 35% (±5%) of palatable perennial grass or grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use not to exceed 10%. Utilization of current year's growth on woody species not to exceed 40% (±10%). Grazing must be accompanied by monitoring to ensure that guidelines for allowable use of vegetation are not exceeded.

- During the **growing season** (of woody riparian vegetation) in unoccupied but suitable flycatcher habitat in **low stature** habitat (e.g., 3-4 m monotypic shrubby willow at elevations >6,000 ft or 1,830 m), no livestock grazing.

- During the **non-growing season** (of woody riaprian vegetation) in unoccupied but suitable flycatcher habitat in **low stature** habitat (e.g., 3-4 m monotypic shrubby willow at elevations > 6,000 ft or 1,830 m), conservative grazing with average utilization not to exceed 35% (±5%) of palatable perennial grass or grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use not to exceed 10%. Utilization of current year's growth on woody species not to exceed 40% (±10%). Grazing must be accompanied by monitoring to ensure that guidelines for allowable use of vegetation are not exceeded.

- During the growing and non-growing season (of woody riparian vegetation) in restorable (or regenerating) habitat in tall and short stature flycatcher habitat, no grazing. However, provisional grazing in non-growing season (of woody riparian vegetation) is allowable in sites below 6,000 ft or 1,830 m if grazing is not a major stressor.

1.1.3.1.1.2. Determine appropriate use areas for grazing. Identify the most appropriate areas for permitting livestock grazing given the biodiversity concerns for the particular land management unit.

1.1. 3.1.1.3. Reconfigure grazing management units. Reconfigure grazing pasture boundaries and numbers of permitted livestock to reflect the true productivity of rangelands associated with important flycatcher recovery areas, and allow differential management of units of varying ecological sensitivity and significance. This reconfiguration should establish an adequate number of ungrazed areas at different elevations, habitat conditions, and geomorphic settings, to provide land management agencies and researchers with much-needed reference sites against which to compare the condition of grazed watersheds.

1.1.3.1.1.4. Improve documentation of grazing practices. Institute and/or improve record-keeping and documentation of grazing practices, retroactively where possible, so that the ecological effectiveness of various grazing practices can be monitored and scientifically evaluated.

1.1.3.1.2. Manage wild ungulates. Manage wild and feral ungulates to restore desired processes and increase habitat quality and quantity. Restore ungulate herbivory levels to those under which the native riparian species evolved, or at least under which the native plant species retain competitive dominance. Manage wild ungulates so that excessive utilization of herbaceous and woody vegetation does not occur and structure and composition of flycatcher habitat is maintained.

1.1.3.1.3. Manage keystone species. Manage keystone species such as beaver, within their historic ranges, to restore desired processes, increase habitat quality and quantity, reduce fire potential, and favor native over exotic plants. Beaver activity creates still waters by impoundment and aids sediment storage. Reintroduce or supplement populations where appropriate. Several issues must be considered before releasing beavers as a habitat restoration tool. The site should be assessed to ensure that there is an adequate food base of preferred foods, so that the natural successional dynamics are in place that will allow these plant species to regenerate over time. Otherwise, beaver activity can reduce habitat quality by reducing densities of wetland herbs and riparian trees and shrubs below replacement levels. The site should also be assessed to determine whether beaver were historically present. Finally, the effects on other locally rare or endangered fish or amphibians should be considered. For example, beaver activity could provide favorable conditions (especially perennial ponds) for unwanted species, such as the introduced bullfrog (*Rana catesbeiana*).

1.1.3.2. Manage exotic plant species. Manage exotic species as summarized below and as explained in more detail in Appendix H. To a large extent, abundance of exotic plants is a symptom of the ways riparian lands and waters have been managed. The solution requires a shift of emphasis, away from demonizing exotics and toward: (1) reducing the conditions that have allowed the exotics to be so successful, and (2) re-establishing a functional semblance of the conditions that allow native plants to thrive. It is unlikely that exotics can be completely driven out of southwestern riparian systems. But it is also unlikely that simply removing exotics (mechanically, chemically, or through biocontrol) will allow natives to thrive if conditions of hydrology, soil chemistry, grazing, and disturbance regime no longer favor them.

1.1.3.2.1. Develop exotics species management plans. Develop exotic species management plans as part of site restoration plans as detailed in Appendix H. The plans should consider the need for action (e.g., is the exotic species dominating the canopy layer or is it subdominant?), address the root causes for the dominance of the exotics, and assess the feasibility and need for passive vs. active restoration measures. Where possible, remove stressors, restore natural process, and patiently allow for natural recovery.

1.1.3.2.2. Coordinate exotics management efforts. Because the spread of exotics in riparian systems is a drainage-wide issue, effective management requires coordination among multiple landowners and users with diverse interests and management goals. In the absence of such coordination, management efforts are likely to fail as individual sites are reinvaded by exotics present elsewhere in the drainage.

1.1.3.2.3. Restore ecosystem conditions that favor native plants.

1.1.3.2.3.1. Eliminate physical stresses, such as high salinity or reduced stream flows, that favor exotic plants. Stresses such as dewatering and increased salinity favor a new assemblage of stress-tolerant exotic plant species. Tamarisks have high water-use efficiency, root deeply, and tolerate prolonged drought. Russian olive is drought tolerant at both the seedling and adult stages, relative to cottonwoods and willows. Tamarisks are adapted to salt levels that would stress or kill most native willows and Russian olive is more salt tolerant than many cottonwoods and willows.

To reduce drought stresses, reduce diversions and groundwater pumpage and otherwise increase instream flow and raise groundwater levels. If needed, remove aggraded sediments or excavate side channels to create cottonwood-willow seed beds that are within one meter of the ground water table. Reduce salt levels in floodplain soils by modifying agricultural practices and restoring periodic flushing flood flows.

1.1.3.2.3.2. Create or allow for a river hydrograph that restores the natural flood disturbance regime. Alteration of natural disturbance regimes or imposing new disturbances increases the chances that exotic plants will dominate a site. Some types of disturbance, e.g., soil disturbance from vehicles, livestock, and recreationists, have increased in riparian habitats. In contrast, flood disturbance has been reduced on many rivers. Natural flood regimes have been altered by dams, diversions, urbanization effects, and watershed degradation. As floods have decreased, fire disturbance has increased, which favors some exotics (e.g., tamarisk, giant reed) over natives. To counteract all these effects, restore flood regimes that are as close to natural as possible in timing, magnitude, and frequency; reduce livestock trampling and heavy recreational use; and reduce unnatural fire regimes by re-establishing natural floods where possible, or by intervention where this is not possible.

For below-dam reaches, release flood waters to coincide with the spring-season seed dispersal of cottonwoods and willows, creating conditions that favor these species. When restoring off-channel sites, release flows onto bare soil in a fashion that mimics the natural spring flood pulse. For above-dam reaches, time reservoir drawdowns to coincide with the early spring seed dispersal of cottonwoods and willows; this will favor establishment of the native species if moist bare soil is present.

1.1.3.2.3.3. Restore ungulate herbivory to intensities and types under which the native riparian species are more competitive. Domestic livestock grazing has altered vegetation composition throughout the Southwest by favoring unpalatable or grazing-tolerant plant species, many of which are exotic. Among the riparian plant species that appear to increase under grazing are exotic bermuda grass, annual brome grasses, tamarisks and Russian olive, and native seep-willow. Livestock grazing should be managed so as to eliminate browsing on young, palatable riparian shrubs and trees (such as willows), consistent with the general livestock grazing guidelines provided in Appendix G.

1.1.3.2.4. Retain native riparian vegetation in flood plains and channels. Clearing channels for water salvage or increased flood water conveyance, plowing flood plain fields, and channel-narrowing caused by flow-regulation have all provided large-scale opportunities for establishment of exotics. Eliminating projects involving clearing of native riparian vegetation will help to ensure that the desired native species persist in the watershed.

1.1.3.2.5. Retain exotic species at sites dominated by native riparian vegetation.

1.1.3.2.5.1. At native dominated sites, retain tamarisk in occupied flycatcher habitat and, where appropriate, in suitable but unoccupied habitat, unless there is a trend for steady increase of tamarisk. Removing tamarisk and other species from occupied sites may harm the flycatchers, as may removing tamarisk from suitable unoccupied sites. For example, clearing the tamarisk understory from mixed stands of native and exotic trees and shrubs may reduce habitat quality. If habitat assessment reveals sustained increase in tamarisk abundance, conduct an evaluation of underlying causes and pursue restoration following the guidelines in Appendix H.

1.1.3.2.5.2. If needed, increase habitat quality within stands of exotic

plants by implementing restorative actions such as seasonal flooding. Seasonal inundation of tamarisk stands, for example, may improve habitat quality by improving the thermal environment or increasing the insect food base.

1.1.3.2.6. Remove exotics in occupied, suitable but unoccupied, and potentially suitable habitats dominated by exotics only if: 1) underlying causes for dominance of exotics have been addressed, 2) there is evidence that the exotic species will be replaced by vegetation of higher functional value, and 3) the action is part of an overall restoration plan. Before implementing control of exotic plants, correct the underlying causes for their dominance, such as changed flood regime, lowered groundwater level, or increased soil salinity. There are risks to the flycatcher if stands of exotic plants (such as tamarisk stands) are not replaced by plant species of equal or higher value, or if the stands lose quality (for example, by losing foliage density).

When clearing patches of undesirable exotics using fire, earth- and vegetation-moving equipment, or approved herbicides, make sure that the site conditions and timing of clearing are favorable for the establishment of the desired native species. If there is a high probability that replacement vegetation (e.g., younger stands of the same exotic, or facultative riparian species such as quailbrush, *Atriplex lentiformis*), will have lower habitat quality that the initial vegetation, then do not remove the exotic.

If exotic clearing is planned in areas near occupied territories, make sure that the areas targeted for clearing do not have any endangered species nest sites, and areas are at least 100m away from the closest nest site. This buffer zone should be enlarged if the method of clearing (e.g. herbicide drift, fire spread) is one that could have impacts well beyond the application area. Clearing activities (e.g. earthmoving) should be timed to avoid the breeding season of the flycatcher and other sensitive species (i.e., late March-September).

1.1.3.2.6.1. In suitable but unoccupied and potentially suitable habitats where exotic species are to be removed through chemical or mechanical means, use a temporally staged approach to clear areas so some mature habitat remains throughout the restoration period for potential use by flycatchers. This staggered approach will create a mosaic of different aged successional stands. In addition, it will allow the benefits of an adaptive management approach to be realized: if the restoration effort fails, one will be able to learn from the mistakes and prevent failure on a grand scale.

1.1.3.2.6.2. Release habitat-targeted biocontrol agents only outside the occupied breeding range of the flycatcher. The U.S. Department of Agriculture (APHIS) has received approval for release of three biocontrol insects designed to reduce the abundance of tamarisk. However, in recognition of the functional role that tamarisk provides to flycatchers, the release was approved only for areas at least 200 miles from their occupied breeding range. This criteria should be adhered to for these approved biocontrol insects and similar criteria should be applied should new such biocontrol insects be submitted for approval.

1.1.3.3. Provide areas protected from recreation. Keep trails, campsites, and heavily used day use areas away from areas to be developed or maintained for flycatchers. Ensure protected areas are large enough to encompass breeding, foraging, and post-fledgling habitat. Direct vehicles, boating, swimming, tubing, and fishing away from occupied suitable habitat, especially during the breeding season, where impacts are likely to negatively impact habitat or flycatcher behavior. Where potentially suitable habitat has been identified as future flycatcher habitat, these incompatible recreation activities should be minimized to allow habitat to develop.

1.1.3.3.1. Reduce impacts from recreationists. Manage recreation by instituting recreation user control. Recreation control involves altering visitor behavior to minimize impacts, and ranges from complete restriction to some acceptable level of use. Recreation user control can be accomplished in a number of ways, including requiring permits, collecting user fees, limiting number of visitors, constraining visitor access or activities, instituting zoning or periodic closures, limiting the frequency and duration of use, providing visual barriers, and reducing motorboat impacts. See Appendix M for detailed discussion of recreation impacts.

1.1.3.3.2. Confine camping areas. Evaluate whether confining camping to a small concentrated number of campsites is less detrimental to wildlife and habitat than dispersal over a wide area. Institute fire bans when danger is high or where habitat is vulnerable. If campfires are authorized, confine them to fire boxes. Limit or prohibit fuelwood collecting in riparian areas.

1.1.3.3.3. Restore habitat impacted by recreation. Where needed, post signs that explain the importance of habitat restoration, fence habitat, and/or temporarily close trails and use areas.

1.1.3.3.4. Place designated recreation shooting areas away from riparian areas. Designated shooting areas used for target practice should be located away from riparian areas to minimize physical destruction of habitat and noise disturbance, and lead contamination.

1.1.3.3.5. Minimize attractants to scavengers, predators, and brown-headed cowbirds. Where recreation users congregate, provide adequate waste facilities (covered trash receptacles, restrooms) and regular collection service. Place horse stables away from the riparian area. Avoid use of bird seed feeders containing seeds preferred by cowbirds.

1.1.3.3.6. Provide on-site monitors where recreation conflicts exist. Where recreation conflicts exist and total closure is not practical, provide on-site monitors to educate users and control use.

1.2. Work with private landowners, State agencies, nongovernmental organizations, and municipalities to conserve and enhance habitat on non-Federal lands. Work toward conserving occupied, suitable but unoccupied, and potential flycatcher habitat on non-Federal lands.

1.2.1. Evaluate and provide rangewide prioritization of non-Federal lands. Evaluate and provide rangewide prioritization of non-Federal lands considered critical for conservation and recovery of the flycatcher, in cooperation with landowners (see USBR 1999c).

1.2.2. Achieve protection of occupied habitats. Achieve protection of occupied habitats through Habitat Conservation Plans, Safe Harbor Agreements, partnerships, cooperative agreements, conservation easements, or acquisition of sites from willing landowners.

1.2.3. Provide technical assistance to conserve and enhance occupied habitats on non-Federal lands. Make technical assistance and, where possible funding, available to non-Federal owners of occupied habitats, to conserve and enhance habitat.

1.2.4. Pursue joint ventures toward flycatcher conservation. Pursue joint ventures toward flycatcher conservation. For example, in 1999, the USFWS initiated its Sonoran Desert Joint Venture Program. This is a binational program with the primary goal of developing and maintaining a broad range of avian conservation efforts (e.g., research, habitat preservation and restoration, and education) throughout the Sonoran desert in the United States and Mexico. A priority project will be to initiate flycatcher surveys in the riparian habitats of Sonora, Mexico.

1.3. Work with Tribes to develop conservation plans and strategies to realize the considerable potential for conservation and recovery on Tribal lands. Develop partnerships between Tribes and Federal, State, and private agencies.

1.3.1. Work with Tribes to establish a regular system of surveys and monitoring, and train Tribal staff in the flycatcher survey protocol. Assist in securing funding, as available, to implement the survey and monitoring system, or assist Tribes with grant solicitation or grant writing to agencies that fund or manage watershed/wetland or riparian restoration initiatives.

1.3.2. Determine protocols for information sharing. All Tribes have serious concerns about what will happen with any information that is gathered concerning the location and numbers of endangered species, habitat, or water quantities. Protocols for information sharing must be collaboratively developed and agreed upon between Federal agencies and individual Tribes participating in flycatcher survey and recovery efforts.

1.3.3. Maintain an incumbent in the position of Tribal Liaison to the Technical Subgroup. The Tribal Liaison is necessary to effectively promote flycatcher survey and recovery efforts on Tribal lands. Support Tribal efforts to do surveys for flycatchers and monitor occupied sites. Provide technical assistance and funding as available.

1.3.4. Provide technical assistance to Tribes that have flycatchers on their lands. Assist Tribes in developing watershed management plans, securing funding, and grant solicitation or grant writing to agencies that fund or manage watershed/wetland or riparian restoration initiatives.

1.3.5. Support Tribal efforts to improve currently suitable and potentially suitable habitat. Assist in securing fencing, off-site livestock drinkers, scientific and technical assistance in developing fire plans, post-fire restoration plans, cowbird management plans, and habitat monitoring programs.

1.3.6. Work with Tribes to determine the extent to which Tribal water rights might or might not be available to aid in conservation and recovery of the flycatcher. In all but a few instances in the Southwest, Indian water rights are senior to those of nearly all other users. Proposing changes in water use requires thorough evaluation of Tribal water rights and water resources. Federal agencies should consult with Tribes to determine the extent to which Tribal water rights are available, or not, to aid flycatcher recovery efforts.

1.3.7. Provide aid to Tribes for development of educational programs and opportunities that further flycatcher recovery.

2. Increase metapopulation stability.

2.1. Increase size, number, and distribution of populations and habitat within Recovery Units.

2.1.1. Conserve and manage all existing breeding sites. Conservation of all existing breeding sites and occupied habitats is crucial to recovery.

2.1.2. Secure, maintain, and enhance largest populations. Conservation and enhancement of the largest local flycatcher populations, now and as the species recovers, are key elements of recovering the bird. These local populations will serve as source populations, providing emigrating individuals to colonize new habitat as it develops. Sites that have 10 or more nesting pairs, and/or are near other suitable habitats or smaller populations, are capable of serving this recovery function. Current sites that are of particular importance are:

Rio Grande in the San Marcial area (NM);

Gila River in the Cliff-Gila Valley (NM);

Gila River from Bonita Creek to San Carlos Reservoir and from Winkleman to Ashurst-Hayden Dam (AZ);

San Pedro River from Aravaipa Creek to Gila Confluence (AZ);

Roosevelt Lake, Tonto Creek and Salt River Inflows (AZ);

Colorado River at Topock Marsh (CA);

Alamo Lake, Brown's Crossing (headwaters of Bill Williams River), and lower Santa Maria River (AZ);

South Fork of the Kern River (CA);

Upper San Luis Rey River (CA);

Santa Ynez River (CA);

Santa Margarita River on Camp Pendleton (CA); and

Alamosa National Wildlife Refuge (CO).

2.1.3. Develop new habitat near extant populations. Using the habitat restoration techniques described above, increase the extent, distribution, and quality of habitat close (≤15 km) to extant populations. This will increase the stability of local metapopulations by providing new habitat that will serve dual functions: (1) replacement habitat in the event of destruction of some habitat in the current population, and (2) new habitat for colonization, which once occupied will enhance connectivity between sites.

2.1.3.1. Use existing habitat acquisition/conservation priorities. Use existing evaluations and priorities for acquiring, securing, and/or enhancing riparian habitat, whether for mitigation or pro-active conservation. The Bureau of Reclamation (USBR 1999c) has completed a range-wide assessment of flycatcher habitat for acquisition and conservation priorities.

2.1.4. Enhance connectivity to currently isolated occupied sites. Using the habitat restoration techniques described above, increase habitat near to and between currently isolated sites. This will create "stepping stones" of habitat to enhance connectivity as well as provide replacement habitat and colonization habitat.

2.1.5. Facilitate establishment of new, large populations in areas where none exist. Through habitat restoration, establish new populations of large size (≥25 territories) in areas where few or no flycatchers exist, but where there is a potential for habitat and establishing a population will increase metapopulation stability. This is particularly important in areas lacking such core populations, e.g., the lower Colorado River.

2.1.6. Increase population sizes at small occupied sites. Using the habitat restoration techniques described above, increase the number of breeding pairs at small sites (especially those with 10 or fewer territories) to improve stability and colonization potential.

3. Improve demographic parameters.

3.1. Increase reproductive success. A fundamental need for expanding flycatcher populations toward recovery are increases, locally and rangewide, in reproductive success. Increasing reproductive success will generate the increased numbers of new breeding birds needed to colonize restored habitats. Several stressors are at work that reduce reproductive success below adequate levels; these stressors must be relieved. Increasing the availability of suitable habitat, also fundamental to recovery, will remain unfulfilled without the new breeding birds to fill it.

3.1.1. Manage brown-headed cowbird parasitism after collection of baseline data show high rates of parasitism. Cowbird parasitism impacts flycatchers to varying degrees across the range of the bird. Local site situations, and management approaches, will differ because of many factors including habitat quality, flycatcher population size, and relative severity of other stressors on the flycatcher. For a complete discussion of cowbird effects and management, see Appendix F.

3.1.1.1. Increase the amount and quality of riparian habitat to increase habitat patch sizes and local flycatcher population sizes thereby minimizing levels and impacts of cowbird

parasitism. Enhancing habitat is likely to reduce the impact of cowbird parasitism, in several ways. Increased amounts of high quality habitat and increased patch sizes of such habitat will allow for larger flycatcher breeding populations. These larger populations are likely to experience reduced levels of cowbird parasitism by dispersing cowbird eggs over a larger number of nests. Larger populations are also less likely to suffer from stochastic demographic effects of parasitism such as total reproductive failure of all breeders. Also, due to their relatively larger amounts of interior habitat, large patches of riparian woodland are likely to further reduce cowbird parasitism and nest predation, both of which tend to be concentrated along habitat edges.

3.1.1.2. Develop cowbird management programs if warranted by baseline data on parasitism rates. Develop cowbird trapping programs that include the following elements: (1) a program of periodic reviews, every 3-5 years, by scientists who are not involved in the trapping program but who will assess its benefits to flycatcher breeding populations; (2) a statement of goals that define conditions that will end the trapping program (including local flycatcher population targets and delisting the bird); (3) a nest monitoring program for at least two years after trapping ceases to determine whether parasitism rates exceed acceptable levels; (4) assurance that funds will be available if cowbird trapping needs to be reinstated.

3.1.1.3. Implement cowbird management programs if warranted by baseline data on parasitism rates. Cowbird trapping should be instituted only after baseline data show that parasitism on a local population exceeds 20% - 30% for two or more successive years. See Appendix F for full discussion of important elements of trapping programs.

3.1.1.4. Pursue long-term landscape objectives for cowbird reduction. A long-term management objective should be to reduce cowbird numbers at landscape levels by reducing anthropogenic influences that provide foraging opportunities for them. These influences include bird feeders and other anthropogenic food sources such as livestock pastures. There should be no single distance over which livestock must be excluded from flycatcher populations, because the effectiveness of livestock exclusion depends on the availability of other food sources for cowbirds in the local landscape. In some landscapes there are so many potential food sources for cowbirds that the only limits on livestock should be exclusion from riparian habitat to protect the habitat itself.

3.1.2. Reduce direct impacts that topple or otherwise destroy nests. Reduce potential direct impacts on nests, by implementing grazing guidelines (see above and Appendix G) and measures to reduce recreation impacts (see above and Appendix M).

3.1.3. Reconsider assessments of habitat quality or other threats if cowbird control and/or other measures increase reproductive output but not the number of breeding flycatchers. Reconsider assessments of habitat quality or other threats if increases in flycatcher reproductive success due to cowbird control or other measures do not lead to increases in numbers of breeding birds in populations experiencing improved reproductive success or in populations that could receive emigrants from such populations.

4. Minimize threats to wintering and migration habitat. At this time, it is not possible to target management actions specifically for the endangered southwestern willow flycatcher subspecies, because the timing and areas of migration and wintering overlap for all subspecies. However, actions that benefit any one subspecies (or the species as a whole) are likely to benefit *E.t. extimus*.

4.1. Identify, for purposes of protection, riparian habitats in the U.S. that provide essential migration and stopover habitat. For a migrating flycatcher, almost any riparian vegetation is preferable to rip-rap banks, agricultural fields, or urban development. The presence of water can influence local insect abundance, a critical energy resource. Therefore, keeping water present in or adjacent to riparian habitats is desirable.

4.2. Restore, protect, and expand riparian migration and stopover habitats in the U.S. Expanding riparian habitats, and restoring those that are heavily damaged, will increase the distribution and amount of food (energy) resources available to migrating flycatchers. Pursue all opportunities for creating or restoring riparian vegetation, especially along portions of major river systems where riparian vegetation is rare or lacking. Prevent or minimize loss and degradation of existing riparian habitats. Protection should be afforded to a wide variety of habitats, not only those with the characteristics of flycatcher breeding sites. The presence of water can influence local insect abundance, and thus potential prey base and energy resources. Therefore, riparian restoration or creation projects should include the goal of maintaining water in or adjacent to these riparian habitats.

4.3. Pursue international partnerships to identify migration and winter habitats and threats. Almost nothing is known regarding migration patterns and stopover habitats, especially south of the U.S. border. Also, there is more information needed on winter status and distribution for much of the flycatcher's winter range, especially in northern South America. The USFWS, USGS, USFS, USBR, and State Game and Fish (SGF) agencies should pursue and support international partnerships that facilitate gathering this important information. Such partnerships may be governmental, private, or combinations of both. Much of the needed work could be conducted by local biologists in cooperation with experts from the U.S..

4.4. Encourage programs that preserve habitats used by wintering and migrating flycatchers. Once migration and winter habitats are identified, Federal agencies (including Agency for International Development) should work with other countries and existing private international conservation groups to develop programs to protect these habitats. Such programs could involve the functional equivalents of conservation easements and agreements, land purchases, government agency policy directives, and/or similar programs. Successful programs will involve close cooperation between partners, and should incorporate extensive public outreach and education.

4.5. Encourage programs that minimize threats to wintering and migrating flycatchers. Migrating and wintering flycatchers face potential threats such as exposure to pesticides and other agrochemicals. This is especially true in parts of Central and South America, where many potent and injurious chemicals banned in the U.S. are still in widespread use. Federal agencies should work with other countries and existing private international conservation groups to develop and implement programs to alleviate or minimize these threats. Such programs could involve the functional equivalents of conservation easements and agreements, government agency policy directives, and/or similar programs. Successful programs will involve effective partnerships, and should incorporate extensive public outreach and education.

5. Survey and Monitor.

5.1. Facilitate and institute effective survey and monitoring programs.

5.1.1. Adopt standardized protocols for surveying and monitoring. Adopt standardized, rangewide protocols for surveying and monitoring to achieve rangewide comparable measures of occupancy, reproductive performance, and cowbird parasitism. These standardized protocols should also standardize and institutionalize annual reporting of data to appropriate State or Federal agencies, or other central data repository. Identify monitoring approach for downlisting: How often? What scale? What intensity (sampling, total census, etc.).

5.1.2. Institute appropriate monitoring of all reaches within management units.

5.1.3. Integrate survey data at State and rangewide levels. All survey and monitoring data should be reported annually and integrated at State and regional levels. This will allow annual monitoring of flycatcher status, particularly with respect to numerical recovery goals.

5.2. Monitor effects of management and restoration practices.

5.2.1. Review data for adaptive management purposes to improve effectiveness of management and restoration practices. The implementation and effectiveness of management and restoration practices should be monitored. Monitoring reports should be submitted to the USFWS to allow future practices to be modified and improved as warranted.

5.3. Survey to determine dispersal movements and colonization events. Suitable but unoccupied habitat should be surveyed to document dispersal movements, colonization events, and progression of habitat suitability.

5.4. Expand survey efforts in wintering habitat. With the consent of appropriate international authorities, perform surveys for wintering flycatchers in Central and South America. Provide technical and, where possible, financial support for local investigators to perform surveys.

6. Conduct Research.

6.1. Determine habitat characteristics that influence occupancy and reproductive success. Determine at local and landscape scales those habitat characteristics that influence occupancy of habitat by flycatchers, and reproductive success.

6.1.1. Determine plant species/structure that determines occupancy and reproductive success. The floristic characteristics of breeding habitat that contribute beneficially to site occupancy and reproductive success should be better defined. Characteristics requiring further definition include plant species composition and associations, structure, age classes, and patch size/configuration. These investigations should be done at both the patch and landscape scales using remote sensing and GIS technology.

6.1.2. Determine habitat area needed for breeding birds. The amount of habitat area needed for long-term conservation along dynamic ecosystems, as well as on managed, regulated rivers, should take into account the rate of riparian habitat succession, loss, and regeneration in different parts of the flycatcher's range; plant species composition; frequency of catastrophic events such as flood, fire, and drought; and factors identified in 6.1.1. above. These investigations should be done at both the patch and landscape scales using remote sensing and GIS technology.

6.1.3. Determine effects of conspecifics on site occupancy and reproductive success. The flycatcher is sometimes described as quasi-colonial, in that breeding pairs tend to occur in clusters. This tendency may affect annual occupancy of a habitat patch, and also reproductive success, due to effects on defense against (or attraction of) cowbirds and/or predators, opportunities for polygyny and re-pairing, etc. The presence of other willow flycatcher subspecies in *E. t. extimus* breeding habitat early in the breeding season may affect these phenomenon. These phenomena should be better understood, because of their potential effect on the fundamental demographic factors of site colonization, site occupancy, and reproductive success.

6.1.4. Determine use vs. availability of exotics in occupied sites. The use of exotic plant associations by flycatchers should be compared with availability of exotic associations, to better define any preferences and/or avoidances.

6.1.5. Determine long-term ecological productivity of native habitats vs. exotic habitats. The relative effects on long-term flycatcher productivity of native habitats (e.g., willows, boxelder) versus exotics (e.g., tamarisk, Russian olive) and various mixed associations, should be determined.

6.1.6. Refine understanding of effects of physical microclimate on site occupancy and reproduction. Physical parameters of nest sites such as the temperature, humidity, and insolation of the habitat interior may significantly affect site occupancy and reproductive success. These parameters may substantially differ in habitats dominated by native vs. exotic plant associations. The significance of these parameters should be better defined.

6.1.7. Determine influence of environmental toxins on breeding, survival, and prey base. Environmental toxins are a potential impact on breeding flycatchers. The possible scope and influence of this factor should be determined, by blood/tissue sampling, soil and water analysis, and by conducting information surveys to determine what agents are being used in any given area.

6.2. Investigate dam and reservoir management for maximizing downstream and delta habitat. Research is needed to identify management opportunities for operating dams and reservoirs to maximize habitat downstream, and at river inflow delta areas. This research should not only identify ways to maximize habitat, but also ways to anticipate and manage the inevitable setbacks imposed by prolonged drought and large/extended precipitation events.

6.3. Investigate surface and groundwater management scenarios to determine thresholds for habitat suitability and to maximize habitat quality. Research is needed to identify management opportunities for managing surface and groundwater to maximize habitat. This research should not only identify ways to maximize habitat, but also ways to anticipate and manage the inevitable setbacks imposed by prolonged drought.

6.4. Investigate grazing systems, strategies, and intensities for riparian recovery and maintenance.

6.4.1. Investigate grazing systems, strategies, and intensities for riparian recovery and maintenance. Research on the effects and uses of livestock grazing on riparian ecosystem health and recovery should be increased and refined. It is imperative that such research include comparison of control versus treatment areas, better documentation of grazing intensities and systems, previous land uses, and other potentially complicating factors. Federal land management agencies should work with State universities, private colleges, and research institutions to fund and facilitate research that better defines the ecological and hydrological effects and sustainability of livestock grazing in southwestern riparian ecosystems.

6.4.2. Investigate direct effects of livestock grazing on the flycatcher. The direct effects of livestock grazing, such as physically damaging nests or nest trees, should be further investigated.

6.4.3 Investigate impacts of native ungulates on riparian recovery and maintenance.

6.5. Conduct research on cowbird parasitism and control.

6.5.1. Collect baseline data on cowbird parasitism. Before cowbird control is initiated at a site, collect at least two years of baseline data to determine whether cowbird control is warranted. See Appendix F for guidelines.

6.5.2. Experimentally test the efficacy of cowbird trapping programs. Trapping efforts should be designed in part as experiments that can determine whether cowbird trapping benefits flycatcher populations, by reducing declines or allowing increases in numbers. See Appendix F for guidelines for these experiments.

6.6. Determine the most successful techniques for creating or restoring suitable habitat to degraded or former riparian lands, such as abandoned agricultural fields in riparian corridors.

6.7. Refine methods for determining distribution and population status and trends.

6.7.1. Acquire demographic and dispersal information. Acquire data on demographics and dispersal, through color banding.

6.7.2. Conduct limiting factor analyses. Conduct analyses to identify factors that may be limiting population stability, including contaminants, predators, patch size, and habitat effects on reproductive success.

6.7.3. Explore new methods and data needs for population viability analyses. As data on the flycatcher accumulate and the science of population viability analysis evolves, managers should evaluate which methods are most appropriate for the flycatcher, and assure that the necessary data are being collected.

6.7.4. Develop methodologies, which can be site specific if necessary, for determining year-to-year trends in population sizes at breeding sites. As various management strategies are applied at sites over periods of several years or more, it will be essential to accurately determine whether targeted populations respond in a favorable manner with increased population sizes. Methodologies developed to achieve this goal will have to control for survey intensity and frequency, amount of area surveyed, development of additional habitat (if the management action of interest is not dealing with the generation of new habitat) and year-to-year within site movements of flycatchers. To achieve success in this regard, methodologies need not result in complete counts of local populations but should generate reliable yearly indicators of the population size at a particular site.

6.7.5. Establish and refine protocols for addressing flycatcher distribution. To accurately determine changes in distribution and status, methodologies should be developed to monitor sites with suitable habitat but lacking flycatchers, so as to establish data on absence and on years when the sites become occupied.

6.8. Determine present and historical distribution of the subspecies through genetic work. The taxonomic status and distribution of the willow flycatcher subspecies should continue to be refined, through genetic research.

6.9. Determine migration and wintering distribution, habitat, and threats.

6.9.1. Investigate migration ecology, habitat selection and use. Although recent work has shed some light on migration timing and habitat use within some major southwestern rivers, little is known about migration, especially south of the U.S. border. Migration routes and stopover habitats/areas should be determined. This will require continued banding on the breeding grounds, in combination with netting/banding during migration periods, in all potential migration regions and habitats. Because most of the distance flycatchers travel during migration is outside of the U.S., research should focus on the types, locations, and extent of habitats used in those areas. This could identify geographic areas of habitats of particular concern, and allow development of specific management actions. Additional research is also needed to document important migratory behaviors, pathways, and survival in the U.S., including the relative value of different riparian habitats.

6.9.2. Investigate wintering distribution, status, ecology, and habitat selection. Recent work has provided valuable information on flycatcher wintering distribution, status, and ecology. However, these data are limited to Mexico, Costa Rica, El Salvador, and Panama, and do not include a substantial part of the willow flycatcher's winter range. Knowledge of winter distribution, habitat use, survival, and threats is needed for other areas. Additional research on winter survival, site fidelity, habitat selection, and habitat quality are also needed to properly assess habitat characteristics, quality, and availability. Remote sensing and GIS technologies should be used to determine landscape-level habitat distribution and availability.

6.9.3. Determine influence of environmental toxins on wintering flycatchers and their prey base. As in the breeding range, environmental toxins are a potential impact on the wintering grounds. The possible scope and influence of this factor should be determined, by blood/tissue sampling and by conducting information surveys to determine what agents are being used in any given area.

6.10. Conduct research on means of increasing reproductive success by approaches other than, or in addition to, cowbird management. Evaluate feasibility and effectiveness of reproductive manipulations such as reducing losses of flycatcher eggs and nestlings to general nest predators.

6.11. Conduct research to determine why increases in reproductive success due to cowbird control, or other measures, may not lead to increases in numbers of breeding birds. Determine for populations experiencing reproductive success and for populations that could receive emigrants from such populations, why numbers of breeding birds do not increase.

6.12. Investigate feasibility of reducing or eliminating habitat fire hazards. Without impacting flycatcher habitat, investigate methods for reducing or eliminating flammability of riparian habitat, e.g., reducing ignition sources. There has been little, if any, experimentation with fuel reduction in riparian habitats, especially tamarisk, and there are no standard guidelines on how best to accomplish this. Experimental riparian fuel reduction and flammability modification should be tested, conducted only in unoccupied habitats until the success and ramifications are better understood. Efficacy of these actions as a fire management tool, and effects on flycatcher habitat, should be tested in a scientific, controlled fashion.

6.12.1. Evaluate fuel reduction techniques in riparian habitats, especially tamarisk types. There has been little, if any, experimentation with fuel reduction in riparian habitats, especially tamarisk, and there are no standard guidelines on how best to accomplish this.

6.12.2. Test modifying flammability for fuels to modify fire risks. Evaluate whether managing for high water content in tamarisk by providing shallow depth to ground water allows tamarisk stands to be more fire resistant than if water is deeper.

6.12.3. Test the ability of prescribed fires to achieve desired fire hazard reduction, habitat protection, and habitat improvement. To better manage the controlled burns in tamarisk stands, one may wish to limit efforts to the rainy season, inundate the stand before burning, or reduce the fuel loads mechanically before burning.

7. Provide public education and outreach.

7.1. Hold annual Implementation Subgroup meetings. Convene annual meetings to report progress, review data, evaluate ongoing actions, and to plan and coordinate future work.

7.2. Maintain updated website. Maintain updated flycatcher website to disseminate new information on the flycatcher, current and developing habitat restoration technologies, problem-solving forums relating to implementing recovery actions, and other information relevant to flycatcher recovery.

7.3. Prepare brochures and make available to public.

7.3.1. Educate public about landscaping with native plants. Educate agencies and public about the benefits of landscaping and revegetating with native plants, and discourage use of exotics.

7.3.2. Educate public about other recreational impacts, especially fire hazards. Develop brochures, signs, and other interpretive materials to educate river and riparian recreationists about the ecological roles of fires and floods, and the potential dangers of accidental fires. In the long-term, this should help to reduce accidental fires and garner public support for the implementation of ecological restoration approaches. Inform maintenance and utility workers about the importance of protecting habitat. Educate equestrians about the value of overhanging branches to nesting birds and encourage them to avoid trimming overhanging branches.

7.3.3. Educate public about cowbird control. Inform public about cowbird ecology, impacts on other bird species, and approaches to cowbird control (See Appendix F). Inform the public of factors that enhance cowbird abundance, and measures that can be taken to reduce their abundance.

7.4. Post and maintain signs at some protected flycatcher breeding locations. At flycatcher breeding locations that are exposed to substantial levels of public use, signs should be posted and maintained that inform the public about necessary protective measures, and the overall ecological and economic goals and benefits of riparian restoration.

7.5. Conduct information exchange programs with foreign governments and publics. Inform the foreign governments and public about the flycatcher, the importance of migration stopover and winter habitats, and the threats the flycatcher faces during these periods. Work with local biologists, government officials, and private landowners to identify specific actions that can be undertaken, at particular sites, that will benefit wintering and migrating flycatchers.

7.6. Conduct symposia and workshops. As information accumulates regarding flycatcher ecology, restoration ecology and techniques, and ancillary issues of riparian and aquatic recovery, it will be important to share information in the interactive forum of symposia and workshops. These should be organized and sponsored by State and Federal agencies, and target private stakeholders, academic, independent researchers, and government regulatory and resource biologists.

7.7. Continue survey training. Survey training provided by State wildlife agencies, the USFWS, and/or Partners In Flight programs should be continued. These training sessions are crucial for assuring consistency in survey methods and minimizing disturbance of flycatchers. Training sessions also serve as important information-sharing meetings. While written survey protocols largely achieve the goals of standardizing surveys, annual survey training allows valuable opportunities for clarifying questions, exploring issues, and sharing accumulated experiences in an interactive setting.

8. Assure implementation of laws, policies and agreements that benefit the flycatcher.

8.1. Fully implement §7(a)(1) of the ESA. Section 7(a)(1) of the ESA requires all Federal agencies to use their authorities to further the conservation of the flycatcher and all other listed species. Federal agencies should meet this obligation to promote recovery of the flycatcher proactively, not simply as an outcome of consultation under ESA §7(a)(2).

8.2. Fully implement all Biological Opinions resulting from ESA §7(a)(2) consultations. Federal agencies can accomplish significant recovery efforts by fully implementing all Reasonable and Prudent Measures, Alternatives, and Conservation Recommendations resulting from consultation with the USFWS under the authority of ESA §7(a)(2). For example, the Lower Colorado River Biological Opinion obligates significant habitat acquisition that will substantially promote flycatcher recovery.

8.3. Monitor, support, and evaluate compliance with laws, policies and agreements that provide conservation benefits to the flycatcher.

8.3.1. Support compliance with ESA §7(a)(1) of the ESA. Section 7(a)(1) requires Federal agencies to use their authorities to further the conservation of the southwestern willow flycatcher and all other listed species.

8.3.2. Provide resource managers with training in conservation benefits. Provide resource managers with training in the ecological and economic benefits of riparian protection and enhancement, for species and resources other than the flycatcher.

8.3.3. Monitor compliance with ESA §7(a)(2) of the ESA. Section 7(a)(2) requires Federal agencies to consult with the Service to ensure that they are not undertaking, funding, permitting, or authorizing actions likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat.

8.3.4. Ensure consistency among ESA §7(a)(2) consultations. Consultations and resultant Biological Opinions should use consistent approaches, criteria, and data with regard to environmental baselines, effects of actions, take, jeopardy/non-jeopardy thresholds, incidental take allowed, reasonable and prudent measures, and conservation recommendations.

8.3.5. Monitor compliance with existing Biological Opinions. All Federal agencies should assure compliance with Biological Opinions, including reporting implementation of conservation recommendations and reasonable and prudent measures and alternatives. Determining the actual effects of Federal actions, to compare with the anticipated effects, will provide an important feedback loop to continually refine conservation and recovery measures.

8.4. Integrate recovery efforts with those for other species. Planning flycatcher recovery is directly related to planning for other endangered riparian birds, native fishes, reptiles, amphibians, invertebrates, and plants because they all are dependent on the same hydrologic, geomorphic, and vegetation systems. Decisions that affect one species will inevitably affect all of them, yet recovery planning and implementation efforts are not formally connected. Therefore, formally connect planning and decision making for flycatcher recovery with the recovery of other imperiled aquatic and riparian species, e.g., Rio Grande silvery minnow, woundfin, Virgin River chub, Moapa dace, Pahranagat roundtail chub, and others (see Table 6). Determine likely interaction effects of implementing a plan for one species on the others. Integrate management into State and regional Partners In Flight Bird Conservation Plans.

8.5. Monitor compliance and effectiveness of agreements and other mechanisms used as delisting criteria.

8.6. Continue implementation of Secretarial Order 3206.

8.6.1. Effectively communicate with Tribes. Appropriate agencies should meet annually with Tribes to report progress on conservation measures, review data, plan future efforts, and coordinate joint activities.

9. Track recovery progress.

9.1. Maintain collaborative structure of Recovery Team. Maintain a Recovery Team structure that retains the Technical and Implementation Subgroups, and the Tribal Working Group. Appoint a USFWS southwestern willow flycatcher recovery coordinator in each USFWS region, with lead coordination through USFWS Region 2.

9.2. Annual review of survey and monitoring data. The Technical Subgroup and recovery coordinators should have access to, acquire, and review all annual survey and monitoring data; these data should be shared with the Implementation Subgroups and Tribal Working Group. Data and interpretations provided by compiling entities (e.g., State wildlife agencies, Partners In Flight programs) should be reviewed and included in an annually updated comprehensive assessment of the population status of the flycatcher.

9.3. Review and synthesis of current flycatcher research and other pertinent research. The Technical Subgroup and recovery coordinators should keep aware of current research on the flycatcher and other pertinent research (e.g., restoration ecology), to maintain a comprehensive synthesis of the current body of knowledge relevant to flycatcher recovery. New research data should be shared with the Implementation Subgroups and Tribal Working Group.

9.4. Repeat Population Viability Analysis. After adequate new monitoring data have accumulated, repeat a Population Viability Analysis to re-examine the flycatcher's status and conservation priorities.

9.5. Develop recommendations for survey and monitoring strategies. The Technical Subgroup and recovery coordinators should, with the assistance of State wildlife agencies and Partners In Flight groups, periodically review survey and monitoring strategies and methods to evaluate their efficacy in maintaining an effective view of the flycatcher's status. Methodologies and strategies should be revised as appropriate, and this information communicated to the Implementation Subgroups and Tribal Working Group.

9.6. Update Recovery Plan every 5 years. Modify this recovery plan in response to management, monitoring, and research data, at 5-year intervals.

F. Minimization of Threats to the Southwestern Willow Flycatcher Through Implementation of Recovery Actions

A species may be determined to be an endangered or threatened species due to one or more of the five factors described in Section 4(a)(1) of the ESA. The final rule listing the southwestern willow flycatcher evaluated threats to the species in terms of three listing factors (USFWS 1995). The three listing factors included: the present or threatened destruction, modification, or curtailment of the flycatcher's habitat or range; the inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting the flycatcher's continued existence. At the time of listing, the USFWS was unaware of threats resulting from overutilization for commercial, recreational, scientific, or educational purposes. The USFWS was also unaware of any disease that constitutes a significant threat to the flycatcher, but did recognize that predation of southwestern willow flycatchers may constitute a significant threat that may be increasing with habitat fragmentation. Implementation of the recovery actions described in Section IV. D. and E. above would minimize these threats as follows:

Listing Factor 1: The present or threatened destruction, modification, or curtailment of its habitat or range. Loss and modification of southwestern riparian habitats have occurred from urban and agricultural development, water diversion and impoundment, channelization, livestock grazing, off-road vehicle and other recreational uses, and hydrological changes resulting from these and other land uses (USFWS 1995). The final rule also recognizes invasion by the exotic tamarisk as another likely factor in the loss and modification of southwestern willow flycatcher habitat. Recommended recovery actions that would minimize these threats are: 1. Increase and improve currently suitable and potentially suitable habitat; 1.1. Secure and enhance currently suitable and potentially suitable habitat on Federal lands, lands affected by Federal actions, and cooperating non-Federal and Tribal lands; 1.1.1. Develop management plans to reduce threats and promote processes that secure, restore, and enhance currently suitable and potentially suitable habitat; 1.1.2. Manage physical elements and processes to reduce threats and promote processes that secure, restore, and enhance currently suitable and potentially suitable habitat; 1.1.2.1. Restore the diversity of fluvial processes; 1.1.2.1.1. Identify dams where modification of dam operating rules will benefit recovery of the flycatcher; 1.1.2.1.2. Identify dams where modification of dam operations will benefit recovery of the flycatcher by taking advantage of system flexibility and water surpluses/flood flows; 1.1.2.1.3. Determine feasibility of simulating the natural hydrograph to restore/enhance riparian systems; 1.1.2.1.4. Determine feasibility of managing reservoir levels to establish and maintain lake fringe and inflow habitat; 1.1.2.1.5. Determine feasibility of using surplus and/or flood flows to increase or add water to marsh areas between levees and on flood plains; 1.1.2.1.6. Determine feasibility of keeping daily ramping rates and daily fluctuations for dam releases as gradual as possible to prevent bank erosion and loss of riparian vegetation, except when mimicking flood flows; 1.1.2.1.7. Determine feasibility of augmenting sediment in sediment-depleted systems; 1.1.2.1.8. Implement 1.1.2.1.3. – 1.1.2.1.7., where determined feasible; 1.1.2.1.9. Monitor 1.1.2.1.3. – 1.1.2.1.7., and provide feedback to the Technical Subgroup; 1.1.2.2.

Restore adequate hydrogeomorphic elements to expand habitat, favor native over exotic plants, and reduce fire potential; 1.1.2.2.1. Increase water available for recovery; 1.1.2.2.1.1. Increase efficiency of groundwater management to expand habitat, favor native over exotic plants, and reduce fire potential; 1.1.2.2.1.2. Use urban waste water outfall and rural irrigation delivery and tail waters for habitat restoration to expand habitat, favor native over exotic plants, and reduce fire potential; 1.1.2.2.1.3. Provide (reestablish) instream flows to expand habitat, favor native over exotic plants, and reduce fire potential; 1.1.2.2.2. Expand the active channel area that supports currently suitable and potentially suitable flycatcher habitat by increasing the width of levees and using available flows to mimic overbank flow; 1.1.2.2.3. Reactivate flood plains to expand native riparian forests; 1.1.2.2.4. Restore more natural channel geometry (width, depth, bank profiles) where the return of the natural hydrograph will be insufficient to improve habitat; 1.1.2.3. Manage fire to maintain and enhance habitat quality and quantity; 1.1.2.3.1. Develop fire risk and management plans; 1.1.2.3.2. Suppress fires; 1.1.2.3.3. Restore ground water, base flows, and flooding; 1.1.2.3.4. Reduce incidence of flammable exotics; 1.1.2.3.4.1. Manage/reduce exotic species that contribute to increased fire incidence; 1.1.2.3.4.2. Use water more efficiently and reduce fertilizer applications; 1.1.2.3.5. Reduce recreational fires; 1.1.3. Manage biotic elements and processes; 1.1.3.1. Restore biotic interactions, such as herbivory, within evolved tolerance ranges of the native riparian plant species; 1.1.3.1.1. Manage livestock grazing to restore desired processes and increase habitat quality and quantity; 1.1.3.1.1.1. If livestock grazing is a major stressor implement conservative livestock grazing guidelines. Implement general livestock grazing guidelines from Appendix G (see also Section IV. F.; Narrative Outline for Recovery Actions) in occupied, suitable, or restorable habitat (restorable habitats are riparian systems that have the appropriate hydrologic and ecologic setting to be suitable flycatcher habitat); 1.1.3.1.1.2. Determine appropriate use areas for grazing; 1.1. 3.1.1.3. Reconfigure grazing management units; 1.1.3.1.1.4. Improve documentation of grazing practices; 1.1.3.1.2. Manage wild ungulates; 1.1.3.1.3. Manage keystone species; 1.1.3.2. Manage exotic plant species; 1.1.3.2.1. Develop exotic species management plans; 1.1.3.2.2. Coordinate exotic species management efforts; 1.1.3.2.3. Restore ecosystem conditions that favor native plants; 1.1.3.2.3.1. Eliminate physical stresses, such as high salinity or reduced stream flows, that favor exotic plants; 1.1.3.2.3.2. Create or allow for a river hydrograph that restores the natural flood disturbance regime; 1.1.3.2.3.3. Restore ungulate herbivory to intensities and types under which native plant species are more competitive; 1.1.3.2.4. Retain native riparian vegetation in floodplains or channels; 1.1.3.2.5. Retain exotic species at sites dominated by native riparian vegetation.; 1.1.3.2.5.1. At native dominated sites, retain tamarisk in occupied flycatcher habitat and, where appropriate, in suitable but unoccupied habitat, unless there is a trend for steady increase of tamarisk; 1.1.3.2.5.2. If needed, increase habitat quality within stands of exotic plants by implementing restorative actions such as seasonal flooding; 1.1.3.2.6. Remove exotics in occupied, suitable but unoccupied, and potentially suitable habitats dominated by exotics only if: 1) underlying causes for dominance of exotics have been addressed, 2) there is evidence that the exotic species will be replaced by vegetation of higher functional value, and 3) the action is part of an overall restoration plan; 1.1.3.2.6.1. In suitable and potential habitats where exotic species are to be removed through chemical or mechanical means, use a temporally staged approach to clear areas so some mature habitat remains throughout the restoration period for potential use by flycatchers; 1.1.3.2.6.2. Release habitat-targeted biocontrol agents only outside the breeding range of the flycatcher; 1.1.3.3. Provide areas protected from recreation; 1.1.3.3.1. Reduce impacts from recreationists; 1.1.3.3.2. Confine camping areas; 1.1.3.3.3. Restore habitat impacted by recreation; 1.1.3.3.4. Place designated recreation shooting areas away from riparian areas; 1.1.3.3.5. Minimize attractants to scavengers, predators, and brown-headed cowbirds; 1.1.3.3.6. Provide on-site monitors where recreation conflicts exist; 1.2. Work with private landowners, State agencies, municipalities, and nongovernmental organizations to conserve and enhance habitat on non-Federal lands; 1.2.1. Evaluate and provide rangewide prioritization of non-Federal lands; 1.2.2. Achieve protection of occupied habitats; 1.2.3. Provide technical assistance to conserve and enhance occupied habitats on non-Federal lands; 1.2.4. Pursue joint ventures toward flycatcher conservation; 1.3. Work with Tribes to develop conservation plans and strategies to realize the considerable potential for conservation and recovery on Tribal lands; 1.3.1. Work with Tribes to establish a regular system of surveys and monitoring, and train Tribal staff in the flycatcher survey protocol; 1.3.2. Determine protocols for information sharing; 1.3.3. Maintain an incumbent in the position of Tribal Liaison to the Technical Subgroup; 1.3.4. Provide technical assistance to Tribes that have flycatchers on their lands; 1.3.5. Support Tribal efforts to improve currently suitable and potentially suitable habitat; 1.3.6. Work with Tribes to determine the extent to which Tribal water rights might or might not be available to aid in conservation and recovery of the flycatcher; 1.3.7. Provide aid in developing educational programs and opportunities that further flycatcher recovery; 2. Increase metapopulation stability; 2.1. Increase size, number, and distribution of populations and habitat within Recovery Units; 2.1.1. Conserve and manage all existing breeding sites; 2.1.2. Secure, maintain, and enhance largest populations; 2.1.3. Develop new habitat near extant populations; 2.1.3.1. Use existing habitat acquisition/conservation priorities; 2.1.4. Enhance connectivity to currently isolated occupied sites; 2.1.5. Facilitate establishment of new, large populations in areas where none exist, through habitat restoration; 2.1.6. Increase population sizes at small occupied sites; 4.1. Identify, for purposes of protection, riparian habitats in the U.S. that provide essential migration and stopover habitat; 4.2. Restore, protect, and expand riparian migration and stopover habitats in the U.S.; 4.3. Pursue international partnerships to identify migration and winter habitats and threats; 4.4. Encourage programs that preserve habitats used by wintering and migrating flycatchers; 4.5. Encourage programs that minimize threats to wintering and migrating flycatchers. 5.4. Expand survey efforts in wintering habitat; 6.1. Determine habitat characteristics that influence occupancy and reproductive success; 6.1.1. Determine plant species / structure that determines occupancy and reproductive success; 6.1.2. Determine habitat area needed for breeding birds; 6.1.3. Determine effects of conspecifics on site occupancy and reproductive success; 6.1.4. Determine use vs. availability of exotics in occupied sites; 6.1.5. Determine long-term ecological productivity of native habitats vs. exotic habitats; 6.1.6. Refine understanding of effects of physical microclimate on site occupancy and reproduction; 6.2. Investigate dam and reservoir management for maximizing downstream and delta habitat; 6.3. Investigate surface and groundwater management scenarios to determine thresholds for habitat suitability and to maximize habitat quality; 6.4. Investigate grazing systems, strategies, and intensities for riparian recovery and maintenance; 6.4.1. Investigate grazing systems, strategies, and intensities for riparian recovery and maintenance; 6.4.2. Investigate direct effects of livestock grazing on the flycatcher; 6.4.3 Investigate impacts of native ungulates on riparian recovery and maintenance; 6.6. Determine the most successful techniques for creating or restoring suitable habitat to degraded or former riparian lands, such as abandoned agricultural fields in riparian corridors; 6.9.

Determine migration and wintering distribution, habitat, and threats; 6.9.1. Investigate migration ecology, habitat selection and use; 6.9.2. Investigate wintering distribution, status, ecology , and habitat selection; 6.12. Investigate feasibility of reducing or eliminating habitat fire hazards; 6.12.1. Evaluate fuel reduction techniques in riparian habitats, especially tamarisk types; 6.12.2. Test modifying flammability for fuels to modify fire risks; 6.12.3. Test prescribed fire to achieve desired fire hazard reduction, habitat protection, and habitat improvement; 7.3.1. Educate the public about landscaping with native plants; 7.3.2. Educate the public about recreational impacts, especially about fire hazards; and 7.4. Post and maintain signs at some protected flycatcher breeding locations.

Listing Factor 2: Overutilization for commercial, recreational, scientific, or educational purposes. The USFWS is unaware of threats resulting from overutilization.

Listing Factor 3: Disease or predation. The USFWS is unaware of any disease that constitutes a significant threat to the southwestern willow flycatcher. However, predation may constitute a significant threat and may be increasing with habitat fragmentation. This threat is addressed by recovery actions 1.1.3.3.5. Minimize attractants to scavengers, predators, and brown-headed cowbirds; and 6.10. Conduct research on means of increasing reproductive success by approaches other than, or in addition to, cowbird management, such as reducing losses of flycatcher eggs and nestlings to general nest predators.

Listing Factor 4: The inadequacy of existing regulatory mechanisms. Prior to listing, the Migratory Bird Treaty Act (MBTA) (16 U.S.C. § 703-712) was the only Federal protection provided for the southwestern willow flycatcher. Unlike the ESA, there are no provisions in the MBTA preventing habitat destruction unless direct mortality or destruction of active nests occurs. State listings of the flycatcher in New Mexico and Arizona do not convey habitat protection or protection of individuals beyond existing regulations on capture, handling, transportation, and take of native wildlife. In California, the California Endangered Species Act (CESA) prohibits unpermitted possession, purchase, sale, or take of listed species, but the CESA definition of take does not include harm, which under the ESA can include destruction of habitat that actually kills or injures wildlife by significantly impairing essential behavioral patterns (although CESA requires consultation between the CDFG and other State agencies to ensure that activities of State agencies will not jeopardize the continued existence of State-listed species). As a consequence, the USFWS determined additional protections under the ESA to be necessary. Threats associated with the inadequacy of existing regulatory mechanisms are addressed by the following recommended recovery actions: 4. Minimize threats to wintering and migration habitat; 4.1. Identify, for purposes of protection, riparian habitats in the U.S. that provide essential migration and stopover habitat; 4.2. Restore, protect, and expand riparian migration and stopover habitats in the U.S; 4.3. Pursue international partnerships to identify migration and winter habitats and threats; 4.4. Encourage programs that preserve habitats used by wintering and migrating flycatchers; 4.5.

Encourage programs that minimize threats to wintering and migrating flycatchers; 7.5. Conduct information exchange programs with foreign governments and publics; 8. Assure implementation of laws, policies and agreements that benefit the flycatcher; 8.1. Fully implement §7(a)(1) of the ESA; 8.2. Fully implement all Biological Opinions resulting from ESA §7(a)(2) consultations; 8.3. Monitor, support, and evaluate compliance with laws, policies and agreements that provide conservation benefits; 8.3.1. Support compliance with ESA §7(a)(1) of the ESA; 8.3.3. Monitor compliance with ESA §7(a)(2) of the ESA; 8.3.4. Ensure consistency among ESA §7(a)(2) consultations; 8.3.5. Monitor compliance with existing Biological Opinions; 8.5. Monitor compliance and effectiveness of agreements and other mechanisms used as delisting criteria; 8.6. Continue implementation of Secretarial Order 3206; and 8.6.1. Effectively communicate with Tribes.

Listing Factor 5: Other natural or manmade factors affecting its continued existence. The final rule recognizes threats associated with the susceptibility of small, isolated populations, threats from brood parasitism by the brown-headed cowbird, and potential threats from pesticides as a result of the flycatcher's preference for floodplain areas that are now largely agricultural. Recommended recovery actions that address these threats include: 2. Increase metapopulation stability; 2.1. Increase size, number, and distribution of populations and habitat within Recovery Units; 2.1.1. Conserve and protect all existing breeding sites; 2.1.2. Secure, maintain, and enhance largest populations; 2.1.3. Develop new habitat near extant populations; 2.1.3.1. Use existing habitat acquisition/conservation priorities; 2.1.4. Enhance connectivity to currently isolated occupied sites; 2.1.5. Facilitate establishment of new, large populations in areas where none exist, through habitat restoration; 2.1.6. Increase population sizes at small occupied sites; 3.1.1.1. Increase the amount and quality of riparian habitat to increase habitat patch sizes and local flycatcher population sizes thereby minimizing levels and impacts of cowbird parasitism; 3. Improve demographic parameters; 3.1. Increase reproductive success; 3.1.1. Manage brown-headed cowbird parasitism after collection of baseline data shows high rates of parasitism; 3.1.1.1. Increase the amount and quality of riparian habitat to increase habitat patch sizes and local flycatcher population sizes thereby minimizing levels and impacts of cowbird parasitism; 3.1.1.2. Develop cowbird management programs if warranted by baseline data on parasitism rates; 3.1.1.3. Implement cowbird management programs if warranted by baseline data on parasitism rates; 3.1.1.4. Pursue long-term landscape objectives for cowbird reduction; 3.1.2. Reduce direct impacts that topple or otherwise destroy nests; 3.1.3. Reconsider assessments of habitat quality or other threats if cowbird control measures do not increase numbers of breeding flycatchers; 6.1.7. Determine influence of environmental toxins on breeding, survival, and prey base; 6.5. Conduct research on cowbird parasitism and control; 6.5.1. Collect baseline data on cowbird parasitism; 6.5.2. Experimentally test the efficacy of cowbird trapping programs; 6.9.3. Determine influence of environmental toxins on wintering flycatchers and their prey base; 6.11. Conduct research to determine why increases in reproductive success due to cowbird control or other measures may not lead to increases in numbers of breeding birds in populations experiencing improved reproductive success or in populations that could receive emigrants from such populations; and 7.3.3. Educate the public that cowbird parasitism is a natural process but may require management efforts in some instances due to high levels or other stressors that have endangered flycatchers.

V. Implementation Schedule

The following Implementation Schedule outlines actions and costs for the southwestern willow flycatcher recovery program. It is a guide for meeting the objectives elaborated throughout Section IVof this Recovery Plan. This schedule indicates action numbers, priorities, descriptions, duration, potential partners, and estimated costs. These actions, when accomplished, should bring about the recovery of the southwestern willow flycatcher. The costs estimated are intended to assist in planning. The time estimated to reclassification as threatened is 20 years, with removal from the Federal endangered species list possible in 30 years. Primary emphasis is placed on estimating costs for the first 5 years because the USFWS intends to re-evaluate this Recovery Plan, and amend as necessary, in 5 years. This Recovery Plan does not obligate any involved agency and/or partner to expend the estimated funds. Although cooperation and collaboration with private landowners is an important tenant of this Recovery Plan, private landowners are also not obligated to expend any funds. In some instances, it it not possible to estimate costs until related actions have been completed.

Action Priority

Priority actions for recovering the southwestern willow flycatcher are based on the following ranking system: actions with a value of 1 are necessary to prevent extinction or irreversible decline in the species in the foreseeable future; actions with a value of 2 are necessary to prevent a significant decline in species population/habitat quality, or some other significant negative impact, short of extinction; and actions with a value of 3 include all other actions necessary to meet recovery objectives.

Commonly used abbreviations in the Implementation Schedule are noted below. Refer to Appendix B for a complete list of acronyms and abbreviations.

FTE Full Time Equivalent. Estimated at GS-11 salary and benefits ($61,000) in Phoenix, Arizona.
FY Fiscal Year. FY01 refers to the first year, subsequent to approval of the Recovery Plan, in which implementation of recovery actions begin.
MU Management Unit, as designated in the Recovery Plan.
RU Recovery Unit, as designated in the Recovery Plan.
TBD To be determined.

Shaded boxes represent years when no action (or funds) is expected to be taken.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
1	1.1.1	Develop management plans to reduce threats and promote processes that secure, restore, and enhance currently suitable and potentially suitable habitat.	5 yrs.	AFA	600	120	120	120	120	120			20% of MUs complete 1 plan each year until 100%. At $20,000 per management plan/year, $20,000 x 6 MUs = $120,000/year.
2	1.1.2.1.1	Identify dams where modification of dam operating rules will benefit recovery of the flycatcher.	2 yrs.	USBR, COE, FERC	1100	550	550						6 RUs x 1.5 FTEs/RU = 9 FTEs. 9 FTEs @ $61,000/year = $549,000/year.
2	1.1.2.1.2	Identify dams where modification of dam operations will benefit recovery of the flycatcher by taking advantage of system flexibility and water surpluses/flood flows.	2 yrs.	USBR, COE, FERC	0	0	0						Same funds as 1.1.2.1.1.
3	1.1.2.1.3	Determine feasibility of simulating the natural hydrograph to restore/enhance riparian systems.	3 yrs.	USBR, COE, DOE, GCAMWG	1650			550	550	550			6 RUs x 1.5 FTEs/RU = 9 FTEs. 9 FTEs @ $61,000/year = $549,000/year. Feasibility studies to be conducted for those areas identified in 1.1.2.1.1-1.1.2.1.2.

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Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	1.1.2.1.4	Determine feasibility of managing reservoir levels to establish and maintain lake fringe and inflow habitat.	3 yrs.	USBR, COE	0			0	0	0			Same funds as 1.1.2.1.3. Feasibility studies to be conducted for those areas identified in 1.1.2.1.1-1.1.2.1.2.
3	1.1.2.1.5	Determine feasibility of using surplus and/or flood flows to increase or add water to marsh areas between levees and on flood flows.	3 yrs.	USBR, COE, MRGCD, MSCP	0			0	0	0			Same funds as 1.1.2.1.3. Feasibility studies to be conducted for those areas identified in 1.1.2.1.1-1.1.2.1.2.
2	1.1.2.1.6	Determine feasibility of keeping daily ramping rates and daily fluctuations for dam releases as gradual as possible to prevent bank erosion and loss of riparian vegetation, except when mimicking flood flows.	3 yrs.	USBR, COE, GCAMWG	0			0	0	0			Same funds as 1.1.2.1.3. Feasibility studies to be conducted for those areas identified in 1.1.2.1.1-1.1.2.1.2.
3	1.1.2.1.7	Determine feasibility of augmenting sediment in sediment-depleted systems.	3 yrs.	USBR, COE, MRGCD, MSCP, GCAMWG	0			0	0	0			Same funds as 1.1.2.1.3. Feasibility studies to be conducted for those areas identified in 1.1.2.1.1-1.1.2.1.2.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	1.1.2.1.8	Implement 1.1.2.1.3-1.1.2.1.7, where feasible.	6-30 yrs.	USBR, COE	TBD						TBD	TBD	Costs dependent on feasibility findings.
2	1.1.2.1.9	Monitor 1.1.2.1.3-1.1.2.1.7, and provide feedback to the Technical Subgroup.	6-30 yrs.	USBR, COE	TBD						TBD	TBD	Costs dependent on feasibility findings.
1*	1.1.2.2.1.1	Increase efficiency of groundwater management to expand habitat, favor native over exotic plants, and reduce fire potential.	30 yrs.	IRR, MRGCD, ADWR, ABQ	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Critical areas need to be identified and strategies agreed upon.
2	1.1.2.2.1.2	Use urban waste water outfall and rural irrigation delivery and tail waters for habitat restoration to expand habitat, favor native over exotic plants, and reduce fire potential.	30 yrs.	MRGCD, IRR, MWD, ABQ, PHX, LSV, SND	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Water districts to identify opportunities for implementation and determine associated costs.
2	1.1.2.2.1.3	Provide (reestablish) instream flows to expand habitat, favor native over exotic plants, and reduce fire potential.	6-30 yrs.	USBR, COE, ADWR, MWD, MRGDC, ABQ, PHX, LSV, SND, IRR	TBD						TBD	TBD	Cost should be coordinated with 1.1.2.1.3-1.1.2.1.7.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	1.1.2.2.2	Expand the active channel area that supports currently suitable and potentially suitable flycatcher habitat by increasing the width of levees and using available flows to mimic overbank flow.	6-30 yrs.	USBR, COE	TBD						TBD	TBD	Costs should be coordinated with 1.1.2.1.3-1.1.2.1.7.
2	1.1.2.2.3	Reactivate flood plains to expand native riparian forests.	6-30 yrs.	USBR, COE, MSCP, MRGCD	TBD						TBD	TBD	Costs should be coordinated with 1.1.2.1.3-1.1.2.1.7.
3	1.1.2.2.4	Restore more natural channel geometry (width, depth, bank profiles) where the return of the natural hydrograph will be insufficient to improve habitat.	6-30 yrs.	USBR, COE	TBD						TBD	TBD	
2	1.1.2.3.1	Develop fire risk and management plans.	5 yrs.	BLM, FS, FWS, DOD, USBR	600	120	120	120	120	120			Same formula as 1.1.1.
2	1.1.2.3.2	Suppress fires.	30 yrs.	BLM, FS, FWS, DOD, USBR	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Sites to be prioritized in management plans in 1.1.2.3.1.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
1	1.1.2.3.3	Restore ground water, base flows, and flooding.	6-30 yrs.	USBR, COE MWD, MRGCD, ADWR, IRR	TBD						TBD	TBD	Identify opportunities from implementing 1.1.1.
3	1.1.2.3.4.1	Manage/reduce exotic species that contribute to increased fire incidence.	6-30 yrs.	BLM, FS, USBR, FWS, DOD, NRCS	TBD						TBD	TBD	Identify opportunities from implementing 1.1.1.
3	1.1.2.3.4.2	Use water more efficiently and reduce fertilizer applications.	30 yrs.	NRCS, FWS, BLM	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Opportunities based on local conditions.
3	1.1.2.3.5	Reduce recreational fires.	5 yrs.	USBR, BLM, FS, FWS	1200	240	240	240	240	240			4 agencies x 6 RU x $10,000/year = $240,000/year.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	1.1.3.1.1.1	If livestock grazing is a major stressor implement conservative livestock grazing guidelines. Implement general livestock grazing guidelines from Appendix G (see also Section E. Narrative Outline for Recovery Actions) in occupied, suitable, or restorable habitat (restorable habitats are riparian systems that have the appropriate hydrologic and ecologic setting to be suitable flycatcher habitat.)	5 yrs.	BLM, FS	7320	1464	1464	1464	1464	1464			Reevaluate with 5 year revision of plan. 24 FTEs @ $61,000/year = $1,464,000/year. (Assuming 12 FTEs per agency.)
2	1.1.3.1.1.2	Determine appropriate use areas for grazing.	5 yrs.	BLM, FS, FWS, SGF	0	0	0	0	0	0			Same funds as 1.1.3.1.1.1.
2	1.1.3.1.1.3	Reconfigure grazing management units.	5 yrs.	BLM, FS	0	0	0	0	0	0			Same funds as 1.1.3.1.1.1.
3	1.1.3.1.1.4	Improve documentation of grazing practices.	5 yrs.	BLM, FS	0	0	0	0	0	0			Same funds as 1.1.3.1.1.1.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
3	1.1.3.1.2	Manage wild ungulates.	30 yrs.	BLM, FS, FWS, SGF	0	0	0	0	0	0	0	0	Can be accomplished through existing and ongoing program activities; no new funds needed.
3	1.1.3.1.3	Manage keystone species.	30 yrs.	BLM, FS, FWS, SGF	0	0	0	0	0	0	0	0	Can be accomplished through existing and ongoing program activities; no new funds needed.
2	1.1.3.2.1	Develop exotic species management plans.	5 yrs.	USBR, COE, BLM, FS, FWS, DOD, NRCS, SGF, SAG, MRGCD	600	120	120	120	120	120			20% of MUs complete 1 plan each year until 100%. At $20,000 per management plan/year, $20,000 x 6 MUs/year = $120,000/year.
3	1.1.3.2.2	Coordinate exotic species management efforts.	5 yrs.	USBR, BLM, FS, FWS, DOD, NRCS, SGF, SAG, MSCP, MRGCD	1830	366	366	366	366	366			6 RUs x 1 FTE /RU @ $61,000/year x 5 yrs = $366,000/year.
2	1.1.3.2.3.1	Eliminate physical stresses, such as high salinity or reduced stream flows, that favor exotic plants.	30 yrs.	USBR, COE, FWS, SGF	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Opportunities identified in 1.1.3.2.1.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	1.1.3.2.3.2	Create or allow for a river hydrograph that restores the natural flood disturbance regime.	30 yrs.	USBR, COE	732	366	366	TBD	TBD	TBD	TBD	TBD	To identify appropriate areas, 6 RU x 1 FTE/RU @ $61,000 = $366,000/year. FY03-30 funds dependent on feasibility findings in FY01-02.
2	1.1.3.2.3.3	Restore ungulate herbivory to intensities and types under which native plant species are more competitive.	30 yrs.	BLM, FS, FWS, SGF	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Coordinate with 1.1.3.1.2.
1	1.1.3.2.4	Retain native riparian vegetation in floodplains or channels.	20 yrs.	BLM, FS, FWS, USBR, SGF, SAG	1,800	600	600	600	TBD	TBD	TBD		$100,000 for each RU (6) for 3 years to retain native riparian vegetation where immediately threatened. Prioritize with plans in 1.1.1 for longer-term management.
2	1.1.3.2.5.1	At native dominated sites, retain tamarisk in occupied flycatcher habitat and, where appropriate, in suitable but unoccupied habitat, unless there is a trend for steady increase of tamarisk.	20 yrs.	BLM, FS, FWS, USBR, NRCS, SGF, SAG	TBD	TBD	TBD	TBD	TBD	TBD	TBD		Coordinate with 1.1.2.3.3.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s) FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
2	1.1.3.2.5.2	If needed, increase habitat quality within stands of exotic plants by implementing restorative actions such as seasonal flooding.	30 yrs.	USBR, COE	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Coordinate with 1.1.2.3.3.
3	1.1.3.2.6.1	In suitable and potential habitats where exotic species are to be removed through chemical or mechanical means, use a temporally staged approach to clear areas so some mature habitat remains throughout the restoration period for potential use by flycatchers.	30 yrs.	NRCS, BLM, FS, FWS, SAG	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	Depends on planned site-specific management actions.
2	1.1.3.2.6.2	Release habitat-targeted biocontrol agents only outside the occupied breeding range for the flycatcher.	30 yrs.	USDA, USGS, FWS	0	0	0	0	0	0	0	0	Costs not accrued within range of flycatcher.

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Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
3	1.1.3.3.1	Reduce impacts from recreationists.	5 yrs.	BLM, FS, NPS, SPK	7320	1464	1464	1464	1464	1464			4 agencies x 6 RU = 24 FTEs @ $61,000/year = $1,464,000/year. Reassess at 5 yr. revision.
3	1.1.3.3.2	Confine camping areas.	5 yrs.	BLM, FS, NPS, SPK	0	0	0	0	0	0			Same funds as 1.1.3.3.1.
3	1.1.3.3.3	Restore habitat impacted by recreation.	5 yrs.	BLM, FS, NPS, SPK	0	0	0	0	0	0			Same funds as 1.1.3.3.1.
3	1.1.3.3.4	Place designated recreation shooting areas away from riparian areas.	5 yrs.	BLM, FS, FWS, SGF	0	0	0	0	0	0			Same funds as 1.1.3.3.1.
3	1.1.3.3.5	Minimize attractants to scavengers, predators, and brown-headed cowbirds.	5 yrs.	BLM, FS, NRCS, SPK, SGF, SAG	0	0	0	0	0	0			Same funds as 1.1.3.3.1.
3	1.1.3.3.6	Provide on-site monitors where recreation conflicts exist.	5 yrs.	BLM, FS, FWS, NPS, SGF, SPK	0	0	0	0	0	0			Same funds as 1.1.3.3.1.
2	1.2.1	Evaluate and provide rangewide prioritization of non-Federal lands.	Complete	USBR, BLM, FS, FWS, NRCS, SGF	0								

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
1	1.2.2	Achieve protection of occupied habitats.	30 yrs.	FWS, FS, BLM, NRCS	24315	1430	1430	1430	1430	1430	715 / year	644 / year	Approximately half of currently known territories occur on federal lands and are already protected. Assume that half (975)of total number of territories needed to delist the species (1950) need protection. Based on the Recovery Plan, each territory = 1.1 ha. Cost of protection of 1 territory is estimated at $2,600/ha. Years 1-5: 500 territories x 1.1ha x $2600/ha. Years 6-20: 250 territories x 1.1ha x $2600/ha. Years 21-30: 225 territories x 1.1ha x $2,600/ha.
2	1.2.3	Provide technical assistance to conserve and enhance occupied habitats on non-Federal lands.	30 yrs.	DOI, USDA	29280	976	976	976	976	976	976 / yr	976 / yr	32 MU x 0.5 FTE/year = $976,000/year.
2	1.2.4	Pursue joint ventures toward flycatcher conservation.	5 yrs.	FWS	250	50	50	50	50	50			For projects along U.S. - Mexico border.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
2	1.3.1	Work with tribes to establish a regular system of surveys and monitoring, and train tribal staff in the flycatcher survey protocol.	10 yrs.	DOI	100	10	10	10	10	10	10 /yr thru FY10		4 (Phoenix, Albuquerque, Southern California, Utah) regional workshops through BIA area offices, at $2500 / workshop + travel costs per year.
3	1.3.2	Determine protocols for information sharing.	5 yrs.	DOI	305	61	61	61	61	61			4 BIA area offices (as above) x 0.25 FTEs/office @ $61,000/FTE.
2	1.3.3	Maintain an incumbent in the position of Tribal Liaison to the Technical Subgroup.	30 yrs.	FWS	30	1	1	1	1	1	1/yr	1/yr	Travel costs.
2	1.3.4	Provide technical assistance to tribes that have flycatchers on their lands.	5 yrs.	FWS, BIA, USBR	1220	244	244	244	244	244			1 FTE @ $61,000/year x 4 BIA area offices.
2	1.3.5	Support tribal efforts to improve currently suitable and potentially suitable habitat.	5 yrs.	FWS, BIA, USBR	0	0	0	0	0	0			Same funds as 1.3.4.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
3	1.3.6	Work with tribes to determine the extent to which tribal water rights might or might not be available to aid in conservation and recovery of the flycatcher.	5 yrs.	FWS, BIA, USBR	0	0	0	0	0	0			Same funds as 1.3.4.
3	1.3.7	Provide aid in developing educational programs and opportunities that further flycatcher recovery.	5 yrs.	FWS, BIA	0	0	0	0	0	0			Same funds as 1.3.4.
1	2.1.1	Conserve and manage all existing breeding sites.	30 yrs.	AFA, SGF, SPK, SAG	0	0	0	0	0	0	0	0	Same funds as 1.2.2.
1	2.1.2	Secure, maintain, and enhance largest populations.	5 yrs.	AFA, SGF, SPK, SAG	600	120	120	120	120	120			See narrative outline 2.1.2 for list of 12 largest populations. $10,000/year x 12 populations = $120,000/year
2	2.1.3.1	Use existing habitat acquisition / conservation priorities.	30 yrs.	USBR, BLM, FS, FWS, DOD, NRCS	0	0	0	0	0	0	0	0	No additional funds necessary.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	2.1.4	Enhance connectivity to currently isolated occupied sites.	5 yrs.	USBR, BLM, FS, FWS, DOD, NRCS, SGF	15750			3150	3150	3150	3150 FY06 - 07		6 RU x 7 agencies x $75,000/year = $2,100,000/year.
2	2.1.5	Facilitate establishment of new, large populations in areas where none exist, through habitat restoration.	3-5 yrs.	USBR, BLM, FS, FWS, DOD, NRCS, SGF, MSCP, MRGCD	515			172	172	172			Assume 1 new site of at least 10 territories in each RU. 1 territory = 1.1 ha. Costs of $2,600 per territory. 6 RU x 10 territories x 1.1 ha x $2,600 = $172,000/year.
2	2.1.6	Increase population sizes at small occupied sites.	5 yrs.	USBR, BLM, FS, FWS, DOD, NRCS, SGF, MSCP, MRGCD	7545	1509	1509	1509	1509	1509			Based on Recovery Plan, approximately 223 sites currently exist, minus 12 large populations; assume that 25% of small sites will be increased by 10 territories at 1.1 ha/territory @$2600/territory. (25%) (211) x 11 ha x $2600 = $1,509,000

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	3.1.1.1	Increase the amount and quality of riparian habitat to increase habitat patch sizes and local flycatcher population sizes thereby minimizing levels and impacts of cowbird parasitism.	5 yrs.	USBR, BLM, FS, FWS, DOD, NRCS, SGF, MRGCD, MSCP	0	0	0	0	0	0			Coordinate with 2.1.4 - 2.1.6.
2	3.1.1.2	Develop cowbird management programs if warranted by baseline data on parasitism rates.	3-5 yrs.	USBR, BLM, FS, FWS, DOD, NRCS, SGF, MRGCD, MSCP	0			0	0	0			See FY 01-02 baseline data collection, action 6.5.1. Coordinate funds with 3.1.1.3.
2	3.1.1.3	Implement cowbird management programs if warranted by baseline data on parasitism rates.	3-10 yrs.	USBR, BLM, FS, FWS, DOD, NRCS, SGF, MRGCD, MSCP	3120			390	390	390	390 / year until FY10		$65,000/year per 5-trap site x 6 RU for 7 years.
3	3.1.1.4	Pursue long-term landscape objectives for cowbird reduction.	30 yrs.	BLM, FS, FWS, DOD, MRGCD, MSCP, NRCS, SGF	0	0	0	0	0	0	0	0	Coordinate with 2.1.4 - 2.1.6 and 3.1.1.2 - 3.1.1.3.
2	3.1.2	Reduce direct impacts that topple or otherwise destroy nests.	30 yrs.	BLM, FS, FWS	0	0	0	0	0	0	0	0	Coordinate with 1.1.3.1.1.1 and 1.1.3.3.1.

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Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
3	3.1.3	Reconsider assessment of habitat quality or other threats if cowbird control measures do not increase numbers of breeding flycatchers.	10 yrs.	USGS, FWS, BLM, FS	TBD	TBD	TBD	TBD	TBD	TBD	TBD		Based on results from 3.1.1.3.
2	4.1	Identify, for purposes of protection, riparian habitats in the U.S. to provide migration and stopover habitat.	5 yrs.	USBR, COE, BLM, FS, FWS, DOD, SGF, SPK, IRR	750	150	150	150	150	150			Estimated funds for studies to complement ongoing research in each RU.
2	4.2	Restore, protect, and expand riparian migration and stopover habitats in the U.S.	4-30 yrs.	USBR, COE, BLM, FS, FWS, DOD, SGF, SPK	TBD				TBD	TBD	TBD	TBD	Based on 4.1. Prioritze areas to protect.
2	4.3	Pursue international partnerships to identify migration and winter habitats and threats.	1-5 yrs.	FWS, USGS, USBR, SGF	125	25	25	25	25	25			Re-evaluate with 5-year Recovery Plan revision.
2	4.4	Encourage programs that preserve habitats used by wintering and migrating flycatchers.	5 yrs.	FWS, USGS	125	25	25	25	25	25			Re-evaluate with 5-year Recovery Plan revision.

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Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	4.5	Encourage programs that minimize threats to wintering and migrating flycatchers.	5 yrs.	FWS, USGS	125	25	25	25	25	25			Re-evaluate with 5-year Recovery Plan revision.
2	5.1.1	Adopt standardized protocols for surveying and monitoring.	1 yr.	FWS, SGF	15					15			Re-evaluate with 5-year Recovery Plan revision.
2	5.1.2	Institute appropriate monitoring of all reaches within management units.	5 yrs.	FWS, USBR, BLM, FS, DOD, SGF, USGS	3500	700	700	700	700	700			Extrapolated from 2000-2001 statistics from BLM, FS.
2	5.1.3	Integrate survey data at state and rangewide levels.	5 yrs.	FWS, USGS, SGF	125	25	25	25	25	25			
2	5.2.1	Review data to improve effectiveness of management and restoration practices.	5 yrs.	FWS, USGS, SGF	50	10	10	10	10	10			Funds for several team meetings per year.
3	5.3	Survey to determine dispersal movements and colonization events.	5 yrs.	USGS, FWS, USBR, BLM, FS, SGF	0	0	0	0	0	0			Same funds as 5.1.2.
3	5.4	Expand survey efforts in wintering habitat.	5 yrs.	USGS, FWS	500	100	100	100	100	100			Extrapolated from current USGS survey efforts in wintering habitat.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s) FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
3	6.1.1	Determine plant species / structure that determines occupancy and reproductive success.	5 yrs.	USGS, SGF, FS, BLM	500	100	100	100	100	100			
3	6.1.2	Determine habitat area needed for breeding birds.	3 yrs.	USGS, FWS, SGF	1098			366	366	366			6 RU x 1 FTE/RU @ $61,000 = $366,000
3	6.1.3	Determine effects of conspecifics on site occupancy and reproductive success.	3 yrs.	USGS, FWS, SGF	225			75	75	75			Estimated costs for two studies within the range.
3	6.1.4	Determine use vs. availability of exotics in occupied sites.	3 yrs.	USGS, SGF, USBR, BLM, FS, FWS	150	50	50	50					Estimated costs for one study within the range.
3	6.1.5	Determine long-term ecological productivity of native habitats vs. exotic habitats.	5 yrs.	USGS, SGF, FWS	1000	200	200	200	200	200			Estimated costs for one study within the range.
3	6.1.6	Refine understanding of effects of physical microclimate on site occupancy and reproduction.	3 yrs.	USGS, SGF, FWS	180			60	60	60			Estimated costs for one study within the range.

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						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
3	6.1.7	Determine influence of environmental toxins on breeding, survival, and prey base.	3 yrs.	FWS, USGS	225	75	75	75					Estimated costs for one study within the range.
2	6.2	Investigate dam and reservoir management scenarios to determine thresholds for habitat suitability and to maximize habitat quality.	30 yrs.	USGS, FWS, USBR, COE, GCAMWG, MSCP	0	0	0	0	0	0	0	0	Coordinate funds with feasibility studies in actions 1.1.2.1.3 - 1.1.2.1.7.
2	6.3	Investigate surface and groundwater management scenarios to determine thresholds for habitat suitability and to maximize habitat quality.	3 yrs.	FWS, USGS, USBR, SGF	0	0	0	0					Same funds as 1.1.2.2.1.1.
2	6.4.1	Investigate grazing systems, strategies, and intensities for riparian recovery and maintenance.	5 yrs.	BLM, FS, FWS	0	0	0	0	0	0			Same funds as 1.1.3.1.1.1.
3	6.4.2	Investigate direct effects of livestock grazing on the flycatcher.	5 yrs.	BLM, FS, FWS	0	0	0	0	0	0			Same funds as 1.1.3.1.1.1.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
3	6.4.3	Investigate impacts of native ungulates on riparian recovery and maintenance.	3 yrs.	SGF, BLM, FS, FWS,	150			50	50	50			Estimated funds for one study within the range.
2	6.5.1	Collect baseline data on cowbird parasitism.	2 yrs.	USGS, SGF, USBR, BLM, FS, FWS	300	150	150						See 3.1.1.2.
3	6.5.2	Experimentally test the efficacy of cowbird trapping programs.	7 yrs.	USGS	0			0	0	0	0 thru FY10		Coordinate funds with programs from 3.1.1.3.
2	6.6	Determine the most successful techniques for creating or restoring suitable habitat to degraded or former riparian lands, such as abandoned agricultural fields in riparian corridors.	10 yrs.	USGS, USDA, MSCP, MRGCD, IRR	1720	172	172	172	172	172	172 / yr. FY 06-10		Based on efforts to create 11ha of suitable habitat in each RU each year for 10 years. 11ha x 2,600$ x 6RUs = $172,000
2	6.7.1	Acquire demographic and dispersal information.	5 yrs.	USGS, SGF, USBR, BLM, FS, FWS	750	150	150	150	150	150			Complement ongoing surveys rangewide.
2	6.7.2	Conduct limiting factor analyses.	5 yrs.	USGS, SGF, FWS	250	50	50	50	50	50			Estimated costs for one study within the range.

V. Implementation Schedule

Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							Comments
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
3	6.7.3	Explore new methods and data needs for population viability analyses.	5 yrs.	USGS, FWS	0	0	0	0	0	0			Coordinate funds with 5.1.3 and 5.2.1.
3	6.7.4	Develop methodologies, which can be site specific if necessary, for determining year-to-year trends in population sizes at breeding sites.	3 yrs.	USGS, SGF, FWS	300	100	100	100					Complement ongoing surveys rangewide.
3	6.7.5	Establish and refine protocols for addressing flycatcher distribution.	3 yrs.	USGS, SGF, FWS	450	150	150	150					Complement ongoing studies rangewide.
3	6.8	Determine present and historical distribution of the subspecies through genetic work.	3 yrs.	USGS	150	50	50	50					Estimated costs for one study within the range.
3	6.9.1	Investigate migration ecology, habitat selection and use.	5 yrs.	USGS	375	75	75	75	75	75			Continue ongoing work.
3	6.9.2	Investigate wintering distribution, status, ecology, and habitat selection.	5 yrs.	USGS	375	75	75	75	75	75			Continue ongoing work.

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Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s) FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
3	6.9.3	Determine influence of environmental toxins on wintering flycatchers and their prey base.	3 yrs.	USGS, FWS	225			75	75	75			Estimated costs for one study.
3	6.10	Conduct research on means of increasing reproductive success by approaches other than, or in addition to, cowbird management, such as reducing losses of flycatcher eggs and nestlings to general nest predators.	5 yrs.	USGS, FWS	250	50	50	50	50	50			Estimated costs for one study within the range to complement an ongoing nest monitoring study.
3	6.11	Conduct research to determine why increases in reproductive success due to cowbird control or other measures may not lead to increases in numbers of breeding birds in populations experiencing improved reproductive success or in populations that could receive emigrants from such populations.	5 yrs.	USGS	250	50	50	50	50	50			Estimated costs for one study within the range to complement an ongoing nest monitoring study.

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Priority #	Action #	Action Description	Duration	Minimum List of Potential Partners	Total Estimated Costs	Costs ($1000s)							
						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
3	6.12.1	Evaluate fuel reduction techniques in riparian habitat, especially tamarisk types.	3 yrs.	BLM, FS, FWS, DOD, SGF, USGS	450			150	150	150			Estimated costs for one assessment within the range to complement ongoing fuel reduction activities.
3	6.12.2	Test modifying flammability for fuels to modify fire risks.	5 yrs.	BLM, USGS, FWS, FS, DOD	250	50	50	50	50	50			
3	6.12.3	Test prescribed fire to achieve desired fire hazard reduction, habitat protection, and habitat improvement.	20 yrs.	BLM, FS, FWS, DOD, SGF, USGS	3,000	600	600	600	600	600	TBD		1 study ($100,000) in each RU (6). Reevaluate with Recovery Plan revision.
3	7.1	Hold annual Implementation Subgroup meetings.	5 yrs.	RTTS, ISGs	0	0	0	0	0	0			Same duration and funds as 9.1.
3	7.2	Maintain updated website.	Ongoing	FWS, USGS	25	5	5	5	5	5	TBD	TBD	Repeat 5 year time cycle as needed, based on plan revisions.
3	7.3.1	Educate the public about landscaping with native plants.	5 yrs.	USDA, DOI, SGF	0	0	0	0	0	0			Revise public education focal themes based on plan revision. Same funds as 1.1.3.2.
3	7.3.2	Educate the public about recreational impacts, especially about fire hazards.	5 yrs.	USDA, DOI, SGF	0	0	0	0	0	0			Revise public education focal themes based on plan revision. Same funds as 1.1.2.3.5.

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						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	Comments
3	7.3.3	Educate the public that cowbird parasitism is a natural process but may require management efforts in some instances due to high levels or other stressors that have endangered flycatchers.	5 yrs.	USDA, DOI, SGF	TBD*	TBD	TBD	TBD	TBD	TBD			*Could include brochures/printed materials, information sessions, presentations for recreationists (e.g., campfire talks)
3	7.4	Post and maintain signs at some protected flycatcher breeding locations.	5 yrs.	BLM, FS, NPS, FWS, SGF, SPK	0	0	0	0	0	0			Coordinate funds with 1.1.3.3.1.
3	7.5	Conduct information exchange programs with foreign governments and publics.	Ongoing	USGS, FWS	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
3	7.6	Conduct symposia and workshops.	1 workshop every 10 yrs.	USGS, FWS	75						25 in FY10	25 in FY20 and FY30	
2	7.7	Continue survey training.	5 yrs.	FWS, SGF, USGS	125	25	25	25	25	25			
1	8.1	Fully implement 7(a)(1) of the ESA.	Ongoing	AFA	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	

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						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
1	8.2	Fully implement all Biological Opinions resulting from ESA 7(a)(2) consultations.	Ongoing	AFA	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
2	8.3.1	Support compliance with ESA 7(a)(1)	Ongoing	AFA	915	183	183	183	183	183	TBD	TBD	1FTE @ $61,000 x 3 FWS Regions = $183,000. Estimated for five year periods, to be revised and continued as needed.
3	8.3.2	Provide resource managers with training in conservation benefits.	Ongoing	AFA, SGF, SPK	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	
2	8.3.3	Monitor compliance with ESA 7(a)(2).	Ongoing	AFA	0	0	0	0	0	0	0	0	Same funds as 8.3.1
2	8.3.4	Ensure consistency among ESA 7(a)(2) consultations.	Ongoing	FWS	0	0	0	0	0	0	0	0	Same funds as 8.3.1.
2	8.3.5	Monitor compliance with existing Biological Opinions.	Ongoing	AFA	0	0	0	0	0	0	0	0	Same funds as 8.3.1.
2	8.4	Integrate recovery efforts with those for other species.	Ongoing	RTTS, ISGs	0	0	0	0	0	0	0	0	Same funds as 9.1.

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						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	8.5	Monitor compliance and effectiveness of agreements and other mechanisms used as delisting criteria.	20 yrs.	FWS	275						25 in FY20	25 per year	Action would begin at downlisting; downlisting is estimated to occur in 20 years.
2	8.6.1	Effectively communicate with Tribes.	5 yrs.	AFA	0	0	0	0	0	0			Can be accomplished through existing and ongoing program activities; no new $ needed.
3	9.1	Maintain collaborative structure of Recovery Team.	Ongoing	FWS, RTTS, ISGs	120	20	20	20	20	40			$20,000 each year; $40,000 in fifth year to revise plan. Repeat as necessary.
2	9.2	Annual review of survey and monitoring data.	1-5 yrs.	RTTS	0	0	0	0	0	0			Same funds as 9.1.
2	9.3	Review and synthesis of current flycatcher research and other pertinent research.	1-5 yrs.	USGS, FWS, SGF	50	10	10	10	10	10			
3	9.4	Repeat Population Viability Analysis.	4th, 5th years	FWS, USGS	120				20	100			
2	9.5	Develop recommendations for survey and monitoring strategies.	5 yrs.	USGS, FWS, SGF	0	0	0	0	0	0			Coodinate funds with 9.1 - 9.3.

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						FY 01	FY 02	FY 03	FY 04	FY 05	FY 06-20	FY 21-30	
2	9.6	Update Recovery Plan every 5 years.		FWS, RTTS, ISGs	40					40			

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VII. APPENDICES

Appendix A:
Implementation Subgroup Members

The following have participated in Implementation Subgroup meetings and/or in the Southwestern Willow Flycatcher Implementation Subgroup Comment Forum at http://ifw2es.fws.gov/swwf

Organization / Affiliation	**Contact**	**Primary Recovery Unit Affiliation(s)**
Arizona Cattle Growers	C. B. 'Doc' Lane	Gila, Lower Colorado River
Arizona Game and Fish Dept.	Dan Groebner	Gila
Arizona Game and Fish Dept.	Tracy McCarthey	Gila, Lower Colorado River
Arizona Game and Fish Dept.	William E. Werner	Lower Colorado River
Arizona Power Authority	Thomas A. Hine	Lower Colorado River
Arizona Met. Water Users Assoc.	V.C. Danos	Gila
Arizona Met. Water Users Assoc.	Kathy Ferris	Gila
Arizona State University	Jonathan Snyder	Gila
Arizona State University	Julie Stromberg	*All*
Arizona State University	Will Graf	*All*
Arizona Wildlife Federation	Randy Bonney	Gila, Lower Colorado River
Audubon	Bernard Foy	Rio Grande
Audubon	David Henderson	Rio Grande
Audubon	Reed Tollefson	Basin and Mojave
Audubon	Tom Jervis	Rio Grande
Budd-Falen Law Offices	Karen Budd-Falen	Gila
California Cattlemen's Assoc.	Patrick Blacklock	Basin and Mojave, Coastal California
California Dept. Fish and Game	Bob Allen	Basin and Mojave
California Dept. Fish and Game	Nancy G. Andrew	Lower Colorado River
California Dept. Fish and Game	Brad Valentine	*All*
California Dept. Fish and Game	Chris Hayes	Lower Colorado River
California Dept. Fish and Game	John Gustafson	Basin and Mojave, Coastal California

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
California Dept. Fish and Game	Scott Clemons	Coastal California
California Dept. Fish and Game	David Mayer	Coastal California
California State University	Helen Bombay	Basin and Mohave
City of Albuquerque	Ondrea Linderoth-Hummel	Rio Grande
City of Albuquerque (PWD)	Susan Kelly	Rio Grande
City of Chandler	Doug Toy	Gila
City of Chandler	Cynthia Haglin	Gila
City of Mesa	Colette Moore	Gila
City of Peoria	Erik Dial	Gila
City of Phoenix	Tom Buschatzke	Gila
City of Phoenix	Jim Callahan	Gila
City of Phoenix	Bill Chase	Gila
City of Tucson	Dennis Rule	Gila
Clark County Conservation Dist.	John Hunt	Lower Colorado River
Clark County Env. Planning	Cynthia J. Truelove	Lower Colorado River
Coalition of AZ/NM Counties	Howard Hutchinson	Gila
Cocopah Tribe	John Swenson	Lower Colorado River
Colorado Dept. Water Resources	Mike Sullivan	Rio Grande, Upper Colorado River
Colorado River Board California	Christopher S. Harris	Lower Colorado River
Colorado River Board California	Fred Worthley	Lower Colorado River
Colorado River Comm. Nevada	Phillip Lehr	Lower Colorado River
Colorado River Indian Tribes	Michael Scott Francis	Lower Colorado River
Dairy Producers of New Mexico	Sharon Lombardi	Gila, Rio Grande
Defenders of Wildlife	John Fritschie	Lower Colorado River
Eagle Environmental, Inc.	Dale Stahlecker	Rio Grande

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
EcoPlan Associates, Inc.	Bill Davis	Lower Colorado River
EcoPlan Associates, Inc.	George A. Ruffner	Lower Colorado River
Elephant Butte Irrigation Dist.	Gary Esslinger	Rio Grande
Environmental Consulting	Jim Greaves	Coastal California
Forest Guardians	John Horning	Gila, Rio Grande
Fort Huachuca Military	H. Sheridan Stone	Gila
Fort Mojave Tribe	John Algots	Lower Colorado River
Fort West Ditch Association	Linda Stailey	Gila
Gila Hotsprings Ranch	David and Becky Campbell	Gila
Hatch and Parent	Susan F. Petrovich	Coastal California
Hopi Tribe	Charles R. Mahkewa	Lower Colorado River
Hualapai Tribe	Kerry Christensen	Lower Colorado River
Imperial Irrigation District	Michel Remington	Lower Colorado River
ISDA	Robert S. Lynch	Gila, Lower Colorado River
Kern County Farm Bureau	Loron Hodge	Basin and Mojave
Kern County Planning Dept.		Basin and Mojave
Lincoln County Public Lands	Shelley Wadsworth	Lower Colorado River
Los Alamos National Laboratory	David Keller	Rio Grande
Metropolitan Water District	Marty Meisler	Lower Colorado River
Middle Rio Grande Cons. Dist.	Sterling Grogan	Rio Grande
Middle Rio Grande Cons. Dist.	Yasmeen Najmi	Rio Grande
National Park Service	Curtis Deuser	Lower Colorado River
National Park Service	Kent Turner	Lower Colorado River
National Park Service	Ross D. Haley	Lower Colorado River
National Park Service	Tim Tibbitts	*All*

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
Nature Conservancy	Jim Moore	Lower Colorado River
Nature Conservancy	Patrick McCarthy	Gila
Nature Conservancy	Peter L. Warren	Lower Colorado River
Nature Conservancy	Rob Marshall	*All*
Nevada Department of Wildlife	Cris Tomlinson	Lower Colorado River
Nevada Department of Wildlife	Jon Sjoberg	Lower Colorado River
New Mexico Cattle Growers	Caren Cowan	Gila, Rio Grande
New Mexico Dept. Agriculture	Bill Moore	Rio Grande
New Mexico Dept. Agriculture	George Douds	Rio Grande
New Mexico Dept. Game & Fish	Chuck Hayes	Gila, Rio Grande
New Mexico Dept. Game & Fish	Sartor O. Williams	*All*
New Mexico Farm Bureau	Joel Alderete	Gila, Rio Grande
NM Interstate Stream Comm.	John Whipple	Gila, Rio Grande
NM Interstate Stream Comm.	Rhea Graham	Rio Grande
NM Interstate Stream Comm.	Rolf Schmidt-Petersen	Rio Grande
New Mexico State Government	Cecilia Abeyta	Rio Grande
New Mexico State University	Jerry Holechek	*All*
New Mexico State University	Jon Boren	*All*
New Mexico State University	Terrell Baker	Gila, Rio Grande
Northern Pueblo Agency (BIA)	Norman Jojola	Rio Grande, Lower Colorado River
NRCD - Redington	Johnny Lavin	Gila
NRCD - Verde	John Parsons	Gila
NRCD - Winkelman	Jean Schwennesen	Gila
NRCS - High Desert	Jim Neveu	Lower Colorado River
NRCS	Dave Seery	Rio Grande

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
Ogden Environmental	Kristie Klose	Lower Colorado River
Palo Verde Irrigation District	Gerry Davisson	Lower Colorado River
Parsons Engineering Sci., Inc.	David Connally	Rio Grande
People for the USA	Shauna Johnson	Upper & Lower Colorado River
Phelps Dodge Corporation	Dawn Meidinger	Gila
Phelps Dodge Corporation	Ty Bays	Gila
Private Consultant	Helen Yard	Gila, Lower Colorado River
Production Credit Assoc. NM	Jimmie C. Hall	Gila, Rio Grande
Pueblo of Zuni	Steven Albert	*All*
Ranching Industry	Bruce Hafenfeld	Basin and Mojave
Ranching Industry	David Ogilvie	Gila
Ranching Industry	Joe A. Romero	Rio Grande
Ranching Industry	Kenneth Zimmerman	Basin and Mojave
Ranching Industry	Walt Anderson	Gila
Rio Grande Compact Comm.	Jack Hammond	Rio Grande
Salmon, Lewis, & Weldon	Lisa McKnight	Gila
Salt River Pima-Maricopa Tribe	Morris Pankgana	Gila
Salt River Pima-Maricopa Tribe	Steve Parker	Gila
Salt River Project	Charlie Ester	Gila
Salt River Project	Craig Sommers	Gila
San Carlos Apache Tribe	Matt Hopkins, Jr.	Gila
San Diego County Water Auth.	Larry Purcell	Lower Colorado River
San Juan Pueblo	Charles Lujan	Rio Grande
Santa Ana Pueblo	Les Ramirez	Rio Grande
Santa Ana Pueblo	Todd Caplan	Rio Grande

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
Southern Nevada Water Auth.	Janet Monaco	Lower Colorado River
Southern Nevada Water Auth.	Zane Marshall	Lower Colorado River
Southern Sierra Research Center	Mary Whitfield	*All*
Southern Ute Tribe	Adam Red	Upper Colorado River
Southern Ute Tribe	Terry Stroh	Upper Colorado River
Southwest Center	Noah Greenwald	Gila
Southwest Rivers	Rick Johnson	Lower Colorado River
SWCA	Bryan Brown	Gila
SWCA	C. Michelle Brown	Rio Grande
SWCA	G. Scott Mills	Gila
Sweetwater Authority	Peter Famolaro	Coastal California
University of Arizona	Larry Sullivan	Gila
Univ. California Santa Barbara	Chris Farmer	Coastal California
Univ. California Santa Barbara	Mark Holmgren	Coastal California
Univ. California Santa Barbara	Stephen Rothstein	*All*
University of New Mexico	Adrian Oglesby	Rio Grande
University of New Mexico	Kris Johnson	Rio Grande
U.S. Army Corps of Engineers	William R. DeRagon	Rio Grande
U.S. Army Corps of Engineers	Roy Proffitt	Basin and Mojave
U.S. Bureau of Indian Affairs	Amy Heuslein	Gila, Lower Colorado
U.S. Bureau of Indian Affairs	Joseph Jojola	Rio Grande, Upper Colorado
U.S. Bureau Land Management	Barney Wegener	Rio Grande
U.S. Bureau Land Management	Bill Grossi	Lower Colorado River
U.S. Bureau Land Management	Bob Welch	Rio Grande
U.S. Bureau Land Management	Dave Smith	Lower Colorado River

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
U.S. Bureau Land Management	Elroy Masters	Lower Colorado River
U.S. Bureau Land Management	Hilary Donoghue Countess	Rio Grande
U.S. Bureau Land Management	James Jeffery Chynoweth	Upper Colorado River
U.S. Bureau Land Management	Jim Silva	Rio Grande
U.S. Bureau Land Management	John Andes	Lower Colorado River
U.S. Bureau Land Management	Michael Herder	Gila
U.S. Bureau Land Management	Pamela Herrera	Rio Grande
U.S. Bureau Land Management	Paul Sawyer	Rio Grande
U.S. Bureau Land Management	Rebecca Peck	Rio Grande
U.S. Bureau Land Management	Robert Douglas	Upper Colorado River
U.S. Bureau Land Management	Roger Taylor	Gila
U.S. Bureau Land Management	Sam DesGeorges	Rio Grande
U.S. Bureau Land Management	Sid Slone	Lower Colorado River
U.S. Bureau Land Management	Ted Cordery	Gila
U.S. Bureau Land Management	Wesley K. Anderson	Rio Grande
U.S. Bureau Land Management	William Merhege	Rio Grande
U.S. Bureau of Reclamation	Art Coykendall	Rio Grande
U.S. Bureau of Reclamation	Barbara Raulston	Lower Colorado River
U.S. Bureau of Reclamation	Christine D. Karas	Upper Colorado River
U.S. Bureau of Reclamation	Darrell Ahlers	Upper Colorado River, Rio Grande
U.S. Bureau of Reclamation	Diane Laush	Gila
U.S. Bureau of Reclamation	Hector Garcia	Rio Grande
U.S. Bureau of Reclamation	Anne Janik	Rio Grande
U.S. Bureau of Reclamation	Jane Harkins	Lower Colorado River
U.S. Bureau of Reclamation	John Swett	Lower Colorado River

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
U.S. Bureau of Reclamation	Karen A. Blakney	Upper Colorado River
U.S. Bureau of Reclamation	Karen E. Barnett	Upper Colorado River
U.S. Bureau of Reclamation	Larry White	Upper Colorado River, Rio Grande
U.S. Bureau of Reclamation	Laura Herbranson	Lower Colorado River
U.S. Bureau of Reclamation	Mike Walker	Lower Colorado River
U.S. Bureau of Reclamation	Sarah L. Wynn	Upper Colorado River
U.S. Bureau of Reclamation	Susan Sferra	*All*
U.S. Bureau of Reclamation	Tom Shrader	Lower Colorado River
USDA - APHIS	Julie Gould	Gila
USDA - ARS	Jack DeLoach	Gila, Rio Grande
USDA - ARS	James Tracy	Rio Grande
U.S. Department of Energy	Tom Smigel	Lower Colorado River
USDA Forest Service	Ben Kuykendall	Rio Grande
USDA Forest Service	Bill Brown	Coastal California
USDA Forest Service	Chris Schultz	Rio Grande
USDA Forest Service	Bobbi Barrera	Rio Grande
USDA Forest Service	Craig woods	Gila
USDA Forest Service	Eddie Alford	Gila
USDA Forest Service	Jerry Monzingo	Gila, Rio Grande
USDA Forest Service	Kirsten Winter	Coastal California
USDA Forest Service	Corey Ferguson	Coastal California
USDA Forest Service	Larry Allen	Gila
USDA Forest Service	Maeton C. Freel	Basin and Mojave
USDA Forest Service	Mike Ross	Gila
USDA Forest Service	Paul Boucher	Gila

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
USDA Forest Service	Ralph Pope	Gila
USDA Forest Service	Ronald L. Rodriguez	Upper Colorado River
USDA Forest Service	Rosemary A. Stefani	Coastal California
USDA Forest Service	Steve Loe	Coastal California
USDA Forest Service	Steven Anderson	Basin and Mojave
USDA Forest Service	Teresa Ritter	Basin and Mojave
USDA Forest Service	Tom Bonomo	Gila
USDA Forest Service	Wally Murphy	Gila, Rio Grande
USDA Forest Service - RMRS	Brian Kent	Upper Colorado River, Rio Grande
USDA Forest Service - RMRS	Deborah M. Finch	*All*
USDA Forest Service - RMRS	Scott Stoleson	Gila
U.S. Fish and Wildlife Service	Al Pfister	Upper & Lower Colorado River
U.S. Fish and Wildlife Service	April Fletcher	Rio Grande
U.S. Fish and Wildlife Service	Bruce Palmer	Gila
U.S. Fish and Wildlife Service	Bryan Arroyo	Rio Grande
U.S. Fish and Wildlife Service	Carol Torrez	Gila, Rio Grande
U.S. Fish and Wildlife Service	Cindy Schulz	Rio Grande, Lower Colorado River
U.S. Fish and Wildlife Service	Dave Krueper	Gila
U.S. Fish and Wildlife Service	David Pereksta	Coastal California, Basin and Mojave
U.S. Fish and Wildlife Service	Diana Whittington	Upper Colorado River
U.S. Fish and Wildlife Service	Doug Duncan	Gila
U.S. Fish and Wildlife Service	Elizabeth Lucas	Coastal California
U.S. Fish and Wildlife Service	John Martin	Coastal California
U.S. Fish and Wildlife Service	Greg Beatty	Gila, Lower Colorado River

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
U.S. Fish and Wildlife Service	Ina Pisani	Coastal California, Basin and Mojave
U.S. Fish and Wildlife Service	Ivana Noell	Coastal California, Basin and Mojave
U.S. Fish and Wildlife Service	Jackie Ferrier	Lower Colorado River
U.S. Fish and Wildlife Service	Janet Bair	Lower Colorado River
U.S. Fish and Wildlife Service	Jeff Whitney	Rio Grande
U.S. Fish and Wildlife Service	Jeri Kay Krueger	Lower Colorado River
U.S. Fish and Wildlife Service	John Martin	Coastal California
U.S. Fish and Wildlife Service	John P. Taylor	Rio Grande
U.S. Fish and Wildlife Service	John Stephenson	Coastal California
U.S. Fish and Wildlife Service	Kelly J. Goocher	Coastal California
U.S. Fish and Wildlife Service	Kenneth Sanchez	Basin and Mojave
U.S. Fish and Wildlife Service	Kevin Sloan	Lower Colorado River
U.S. Fish and Wildlife Service	Laura Romin	Upper Colorado River
U.S. Fish and Wildlife Service	Loren Hays	Coastal California, Basin and Mojave
U.S. Fish and Wildlife Service	Mary Jo Stegman	Gila
U.S. Fish and Wildlife Service	Patricia Zenone	Gila, Rio Grande
U.S. Fish and Wildlife Service	Paul Tashjian	Rio Grande
U.S. Fish and Wildlife Service	Ron Garcia	Rio Grande
U.S. Fish and Wildlife Service	Sam Spiller	Lower Colorado River
U.S. Fish and Wildlife Service	Sarah Rinkevich	Rio Grande
U.S. Fish and Wildlife Service	Steve Silcox	Gila, Rio Grande
U.S. Fish and Wildlife Service	Terry Ireland	Upper Colorado River, Rio Grande
U.S. Fish and Wildlife Service	Theresa Davidson	Gila, Rio Grande
U.S. Fish and Wildlife Service	Kelly Stone	Rio Grande

Organization / Affiliation	Contact	Primary Recovery Unit Affiliation(s)
U.S. Geological Survey	Barabara Kus	*All*
U.S. Geological Survey	Jim Sedgewick	Upper Colorado River
U.S. Geological Survey	Mark Sogge	*All*
U.S. Geological Survey	Thomas J. Koronkiewicz	*Winter Range Studies*
USMC Camp Pendleton	William Berry	Coastal California
USMC Camp Pendleton	Deborah Bieber	Coastal California
Utah Division of Wildlife Cons.	Frank P. Howe	Upper Colorado River
Virgin River Land Preservation	Lori Rose	Lower Colorado River
Virginia Tech University	Sylvia L. Schmidt	Basin and Mohave
WAPA	John Holt	Lower Colorado River
Washington County Commission	Alan D. Gardner	Upper and Lower Colorado River
Washington County Water Conservation District	Morgan Jensen	Upper and Lower Colorado River
Water Consult	Tom Pitts	Rio Grande
Western New Mexico University	Rolland Shook	Gila
Yavapai County	Chip Davis	Gila
Yavapai County	Dean Lewis	Gila

Appendix B.
List of Acronyms and Abbreviations Used In This Recovery Plan

ABQ	City of Albuquerque
ac	Acre(s)
ADWR	Arizona Department of Water Resources
AFA	all Federal agencies
AGFD	Arizona Game and Fish Department
aka	Also known as
AOU	American Ornithologists' Union
BLM	Bureau of Land Management
BIA	Bureau of Indian Affairs
CDFG	California Department of Fish and Game
CDW	Colorado Division of Wildlife
COE	U.S. Army Corps of Engineers
CPFS	Colorado Plateau Field Station
CSU	Colorado State University
CWA	Clean Water Act
DOD	U.S. Department of Defense
DOI	Department of the Interior
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FS	U.S. Forest Service
FWS	U.S. Fish and Wildlife Service
ft	Foot/feet
g	Gram(s)
GCAMWG	Glen Canyon Adaptive Management Workgroup
ha	Hectare(s)
IRR	irrigation districts
ISGs	Implementation Subgroups
km	Kilometer(s)
LSV	City of Las Vegas
m	Meter(s)
maf	Million acre-feet
mi	Mile(s)
MRGCD	Middle Rio Grande Conservancy District
MSCP	Multi-Species Conservation Program (Lower Colorado River)
mm	Millimeter(s)
MWD	Metropolitan Water District
NCEAS	National Center for Ecological Analysis and Synthesis
NDW	Nevada Division of Wildlife
NMDGF	New Mexico Dept. of Game and Fish
NMOS	New Mexico Ornithological Society
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge (USFWS)
oz	Ounce(s)
PHX	City of Phoenix
RTTS	Recovery Team Technical Subgroup
SAG	State Agriculture
SDNHM	San Diego Natural History Museum
SGF	State Game and Fish Agencies
SND	City of San Diego
SPK	State Parks
SWCA	Steven W. Carothers & Associates
SWCBD	Southwest Center for Biological Diversity
TBD	To Be Determined
TNC	The Nature Conservancy
TPWD	Texas Parks and Wildlife Department
TUC	City of Tucson
UDWR	Utah Division of Wildlife Resources
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service, or "Service"
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
USMC	U.S. Marine Corps
WAPA	Western Area Power Administration

Appendix C.
Glossary

Alluvial: Composed of soil and sand deposited by flowing water.

Biocontrol agents: Organisms that are released into an ecosystem for the purpose of reducing the abundance of, or eliminating, a pest species. They often are imported from the pest organism's geographic region of origin. Often, biocontrol agents are insects.

Bioproductivity: In ecosystems, the rate of production of new biomass.

Biotic: Living; usually applied to the biological aspects of an organism's environment.

Browse: **n.** Leaves, twigs, and young shoots of trees or shrubs that animals feed on; **v.** feeding on the leaves, twigs, and young shoots of trees or shrubs. That is, woody plants as forage. This use is as opposed to graze, used in this report to refer to leaves and stems of non-woody plants (grasses & forbs) that animals feed on, or feeding on non-woody plants.

Carrying capacity: The maximum number of a given species of animal that a habitat can support without damage to soil and vegetation resources.

Colonization potential: Likelihood that birds will emigrate to other sites.

Controlled burns or prescribed burns: Fires set by humans within a delimited area under a discrete set of environmental and staffing conditions to achieve certain management goals such as ecosystem restoration, forage production, or wildfire prevention.

Demographic analysis: Identifies the life history aspect or parameter (fecundity, juvenile survival, adult survival) that has the greatest effect on population growth.

Demography: The science of the interrelated life history factors that determine how populations grow, shrink, or change in other ways.

Deterministic model: Model in which the life history aspects or parameters (fecundity, juvenile survival, adult survival) remain constant over time.

Dewater: Reduce the rate or volume of stream flow, and/or lower the water table in the flood plain aquifer.

Disturbance: Any discrete event, usually of short duration and great intensity, that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment

Diversity or biodiversity: The total variety of life and its processes. Includes the variety represented by all species, the different genes within each species, and the variety of different habitats and ecosystems in which these species exist.

Ecosystem functions: Processes that control the products and rates of change of the ecosystem (e.g. soil erosion, water discharge, succession) or that are intrinsic to the perpetuation of the ecosystem (such as cycling of nutrients or balanced rates of soil production and erosion).

Exotic species: A non-native species introduced into a new ecosystem as a result of human intervention. If that species establishes self-sustaining populations, it is then considered a naturalized exotic.

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Extirpated: Locally extinct.

Fecundity: Number of young fledged per female.

Fire regime: The spatial and temporal patterns of a fire within a given biotic community type, including intensity (temperature or amount of combustible fuels consumed), duration (burn time), size (amount of land area burned) and distribution (patchiness), timing (season of occurrence), and frequency (number of years elapsed between fires).

Flood regime: The magnitude, timing, duration, and frequency of flooding that are characteristic of streams in a particular ecoregion.

Flow regime: The magnitude, timing, duration, and frequency of surface flows (including low flows and flood flows) that are characteristic of a particular stream type in a particular ecoregion.

Fluvial: Pertaining to or formed by a river.

Fluvial geomorphology: River processes and forms related to earth materials and surfaces, particularly the sediment that is eroded, transported, and deposited by channel flow in streams and rivers.

Fuel load: Amount of flammable plant biomass in an area

Geomorphology: The study of the physical features of the Earth's surface and their relationship to its geological structures.

Habitat: A place where a species normally lives, often described in terms of physical features (such as topography) and in biological features (such as plant species composition).

Habitat complexity: The extent to which an area provides habitat for multiple species, by providing a variety of physical features and biological associations.

Herbaceous: A seed plant whose stem withers away to the ground after each season's growth, as distinguished from woody plants - i.e., grasses and forbs.

Herbivores: Animals that feed on plants .

Hydrograph: The stage, flow, velocity, and other properties of water with respect to time.

Hydrography: The science of measuring, describing, mapping, and explaining the distribution of surface water.

Hydrologic: Pertaining to the distribution, circulation, and properties of the Earth's waters.

Hydrology: The study of physical and chemical processes related to water in the environment, including precipitation, surface runoff, channel flow, and groundwater.

Hydrophytic vegetation: Plants living in water or wet ground.

Incidence function: Estimates metapopulation persistence within an existing network of occupied habitat patches.

Invasive species: A species that has become particularly abundant in an ecosystem as a result of human activities in the ecosystem. Invasive species can be native or exotic to the area.

Keystone species: A species that through its activities or interactions with other species plays a critical role in determining community structure.

Late Quaternary: Generally, the more recent times of the geologic period following the Tertiary in the Cenozoic Era and comprising all of the Holocene and some of the Pleistocene epochs. Generally, the last 1,000,000 years.

Lentic: Quiet, slow-moving, swampy, or still water.

Meanderbelt: That portion of the active flood plain which is subject to occupation occasionally by the migrating, meandering channel of the main stream.

Mesic: Moderately moist.

Metapopulation: Group of spatially disjunct local willow flycatcher populations connected to each other by immigration and emigration.

Mitigation: Measures to prevent, reduce, or correct the net adverse consequences of particular activities.

Monitoring: (Grazing Activities) The practice of tracking the utilization rates and overall effects of grazing over time, through repeated collection of data. Food plants are examined and measured to determine what percentage has been eaten, trampled, or lost to other causes. Other plants in the area (e.g., willows and other woody species) are examined, and observations are recorded regarding trampling or other damage. Records are maintained of livestock stocking rates (number of cattle per unit of area per unit of time), and all changes are recorded. Significant climatological events are noted (e.g., hard freezes, heavy rains, floods, droughts, high temperatures).

Monotypic: In reference to flycatcher habitat, a condition in which the woody vegetation is strongly dominated by one species, or several very similar species, mostly in similar growth forms and size/ages.

Mycorrhizae: A mutualistic and close association between fungi and plant roots which facilitates the uptake of minerals by plants.

Natal areas: Birth areas.

Parameter: Population statistics such as fecundity, juvenile survival rate, or adult survival rate.

Passerines: Technically, members of the Order Passerines. Commonly referred to as "perching birds", and accounting for approximately 60% of all bird species.

Phreatophyte: A deep-rooted perennial plant that derives its water from a more or less permanent subsurface water supply, and is thus not dependent on annual rainfall for survival.

Pleistocene: The first epoch of the Quaternary Period in the Cenozoic Era, ranging from 1,800,000 to 10,000 years before present.

Population sink: A population in which the birth rate is below that required to maintain a stable population size.

Population viability analysis: A process of estimating the probability that a population of a specified size will persist over time.

Productivity or bioproductivity: In ecosystems, the rate of production of new biomass.

Rhizomes: Underground, lateral stems that allow a plant species to spread vegetatively.

River regulation: Modification of the flow regime of a river by humans, through the use of engineered structures including dams, diversion structures, and levees.

Salinity: The amount of salts dissolved in a given volume or weight of water.

Selective pressure: A force acting on populations that results in differential reproduction and contribution of genes to future generations.

Site: A variably delimited geographic location, the limits of which may include elements of habitat, land ownership, and practicality. A site may be delimited by habitat, that is, an entire patch of riparian vegetation, or it may be a subdivision of a riparian patch delimited by land ownership and/or the ability to survey effectively. A "site" may encompass a discrete breeding location, or several.

Stochastic events: Random events such as fire, disease, flood, and drought.

Stressor: From an ecosystem perspective, any factor that causes an ecosystem to decline in biodiversity, bioproductivity, or resilience.

Stubble height: Residual vegetation, or the amount of vegetation that remains after grazing animals have used an area. A 3-inch stubble height is a direct measurement indicating that a forage plant is clipped off or broken at 3 inches above the ground.

Suitable habitat: Riparian stands that appear to have all the components necessary for flycatchers to establish territories and/or nest. Occupied habitat is, by definition, suitable. Some suitable habitat may be unoccupied for any of a multitude of reasons.

Transpiration: The movement of water through plants from the roots to the atmosphere via the vascular system.

Utilization: The proportion of current year's forage that is consumed or destroyed by grazing animals. Overall utilization is comprised of both the portion eaten by livestock (harvest efficiency) and the portion lost to trampling, insects, or other causes. In general, these two categories are of equivalent value. Therefore, a 40% utilization rate means that of the current year's growth, 20% was eaten by livestock, 20% was lost to trampling or other causes, and 60% remains.

Vegetation composition: The make-up of a plant community, in terms of the different types of plant species present.

Watershed: A region drained by a river or river system.

Xeric: Dry or desert-like.

Appendix D.

Southwestern Willow Flycatcher Habitat[1]

A. Introduction

The distribution and abundance of a species across a landscape depends in part on the distribution and abundance of suitable habitat. If basic resource needs such as food, water, and other biological and physical features are not present, then that species is excluded from the area. Scarcity of suitable habitat is often the primary reason for the status of most rare and endangered species. An understanding of an endangered species' habitat is crucial to effective management, conservation and recovery.

The southwestern willow flycatcher (*Empidonax traillii extimus*) breeds in relatively dense riparian habitats in all or parts of seven southwestern states, from near sea level to over 2000 m (6100 ft). Although other willow flycatcher subspecies that occur in cooler, less arid regions may breed in shrubby habitats away from water (McCabe 1991), *E.t. extimus* breeds only in dense riparian vegetation near surface water or saturated soil. Other habitat characteristics such as dominant plant species, size and shape of habitat patch, canopy structure, vegetation height, and vegetation density vary widely among sites. This document presents an overview of southwestern willow flycatcher breeding habitat, with an emphasis on gross vegetation characteristics. There have been few quantitative studies of flycatcher habitat (but see Whitfield and Strong 1995, Whitfield and Enos 1996, Spencer et al. 1996, McKernan and Braden 1999, Stoleson and Finch 1999, Uyehara and Whitfield 2000, McKernan and Braden 2001). Therefore, this document focuses on qualitative information on plant species composition and structure. Although many of the details of vegetation characteristics differ among breeding sites, this document describes those elements or attributes that are shared by most.

B. What Is "Habitat"?

Birds and bird communities have played a major role in the development of the concept of habitat, yet specific definitions of the term habitat are often vague and/or differ from one another (Block and Brennan 1993). However, a common theme among different definitions and terms is that "habitat" includes the physical and biological environmental attributes that influence the presence or absence of a bird species (Morrison et al. 1992). Habitat involves many components in addition to composition and structure of vegetation. The distribution and abundance of species are influenced by environmental features (climate, food, extent of habitat), predation, competition, parasitism, disease, disturbance, past history and even random chance (Wiens 1989b). Research is usually focused on those habitat components

[1]This document is adapted from Sogge and Marshall 2000. (See Literature Cited)

that are most easily or reliably quantified and/or considered most likely to influence the bird community. No single study can address all of the factors that may influence bird species presence in an ecosystem.

Many factors affect how a species selects habitat, and these factors do not act equally for all species or even for all populations of a single species (Wiens 1989a, 1989b). A species' morphological and physiological traits allow it to exploit certain resources and therefore, certain habitats (Morrison et al. 1992). Life-history or behavioral traits such as foraging and mating strategies are also factors that influence a species' habitat selection (Hansen and Urban 1992). Proximate factors such as song perches, nest sites, and the structure and composition of the vegetation determine whether a bird settles in a habitat. These are part of a habitat selection "template" (Wiens 1989a) that results from both an individual's genetic makeup and information learned. Ultimately, the suitability of a particular habitat is reflected by reproductive success and survivorship. Mere occupancy of a habitat does not confirm the habitat is optimal, only that it meets the (perhaps minimal) selection template for those individuals breeding there. There has yet to be developed a comprehensive habitat model for the southwestern willow flycatcher that enables one to determine which breeding habitats, or parts of a single breeding patch, are better than others based on vegetation characteristics alone.

C. Breeding Habitat

Breeding habitats of the southwestern willow flycatcher vary across its range, in structure and species makeup of vegetation, characteristics of water associated with the site, elevation, and other factors. However, the accumulating knowledge of flycatcher breeding sites reveals important areas of similarity. These constitute the basic concept of what is suitable breeding habitat. These areas of similarity, or habitat features, are each discussed below, with examples from the field. First, it is helpful to state them in general terms to create a basic understanding of what is habitat.

The southwestern willow flycatcher breeds in riparian habitats along rivers, streams, or other wetlands, where relatively dense growths of trees and shrubs are established, near or adjacent to surface water or underlain by saturated soil. Throughout the range of the flycatcher, these riparian habitats tend to be rare, widely separated, small and/or linear locales, separated by vast expanses of arid lands. Common tree and shrub species comprising nesting habitat include willows (*Salix* sp.), boxelder (*Acer negundo*), tamarisk (aka saltcedar, *Tamarix ramosissima*), and Russian olive (*Eleagnus angustifolia*) (Grinnell and Miller 1944, Phillips 1948, Phillips et al. 1964, Whitmore 1977, Hubbard 1987, Unitt 1987, Whitfield 1990, Brown and Trosset 1989, Brown 1991, Sogge et al. 1993, Muiznieks et al. 1994, Maynard 1995, Stoleson and Finch 1999, Paradzick et al. 1999, Uyehara and Whitfield 2000, McKernan and Braden 2001).

Habitat characteristics such as plant species composition, size and shape of habitat patch, canopy structure, vegetation height, and vegetation density vary across the subspecies' range. However, regardless of the plant species composition or height, occupied sites usually consist of dense vegetation in the patch interior, or an aggregate of dense patches interspersed with openings. In most cases this dense vegetation occurs within the first 3 - 4 m (10-13 ft) above ground. These dense patches are often interspersed with small openings, open water or marsh, or shorter/sparser vegetation, creating a mosaic that is not uniformly dense.

Southwestern willow flycatchers nest in thickets of trees and shrubs ranging in height from 2 m to 30 m (6 to 98 ft). Lower-stature thickets (2-4 m or 6-13 ft tall) tend to be found at higher elevation sites, with tall stature habitats at middle and lower elevation riparian forests. Nest sites typically have dense foliage at least from the ground level up to approximately 4 m (13 ft) above ground, although dense foliage may exist only at the shrub level, or as a low dense canopy. Nest sites typically have a dense canopy. Canopy density at nest sites include the following values: 74% on the Kern River, CA (Uyehara and Whitfield 2000 and pers. comm.), less than 50% to 100% (but generally 75%-90%) on the lower Colorado River (McKernan and Braden 1999), 89% to 93% in AZ (Spencer et al. 1996), and 84% on the Gila River, NM (Stoleson and Finch 1999). The diversity of nest site plant species may be low (e.g., monocultures of willow or tamarisk) or comparatively high. Nest site vegetation may be even) or uneven)aged, but is usually dense (Brown 1988, Whitfield 1990, Muiznieks et al. 1994, McCarthey et al. 1998, Sogge et al. 1997a, Stoleson and Finch 1999, McKernan and Braden 2001). On the Gila River, NM, Stoleson et al. (1998) found differences between occupied and unoccupied habitats that were near one another and were generally similar. Occupied sites had greater foliage density, greater canopy cover, and greater numbers of trees than unoccupied sites. Unoccupied sites had fewer shrubs and saplings, more open canopies, and greater variability in these characteristics. Historically, the southwestern willow flycatcher probably nested primarily in willows, buttonbush (*Cephalanthus occidentalis*), and seepwillow *(Baccharis* sp.*)*, sometimes with a scattered overstory of cottonwood (*Populus* sp.) (Grinnell and Miller 1944, Phillips 1948, Whitmore 1977, Unitt 1987). Following modern changes in riparian plant communities, the flycatcher still nests in native vegetation where available, but also nests in thickets dominated by tamarisk and Russian olive (Hubbard 1987, Brown 1988, Sogge et al. 1993, Muiznieks et al. 1994, Maynard 1995, Sferra et al. 1997, Sogge et al. 1997a, McKernan and Braden 1999).

Nesting willow flycatchers of all subspecies generally prefer areas with surface water nearby (Bent 1960, Stafford and Valentine 1985, Harris et al. 1987), but *E. t. extimus* almost always nests near surface water or saturated soil (Phillips et al. 1964, Muiznieks et al. 1994). At some nest sites surface water may be present early in the breeding season but only damp soil is present by late June or early July (Muiznieks et al. 1994, M. Whitfield, Kern River Research Center, in litt.)1993, J. and J. Griffith, Griffith Wildlife Biology, in litt.)1993). At some breeding sites, water may be present in most years but absent in others, especially during drought periods or if reservoir levels recede (see Section 7 below). Ultimately, a water table close enough to the surface to support riparian vegetation is necessary. In some cases a site may dry out, but riparian vegetation and nesting flycatchers may persist for a short time (one or two breeding seasons) before they are eventually lost.

1. General Vegetation Composition And Structure

Southwestern willow flycatcher breeding habitat can be broadly described based on plant species composition and habitat structure. These two habitat characteristics are the common denominators most conspicuous to human perception, but are not the only important components. However, they have proven useful in describing known breeding sites, evaluating suitable survey habitat, and in predicting where breeding flycatchers may be found.

The following habitat descriptions are organized into three broad habitat types - those dominated by native vegetation, by exotic vegetation, and those with mixed native and exotic plants. These broad habitat descriptors reflect the fact that southwestern willow flycatchers now inhabit riparian habitats dominated by both native and non-native plant species. Tamarisk and Russian olive are used as nesting substrates. In some cases, flycatchers are breeding in locations where these species form the dominant canopy species or occur in nearly monotypic stands. Table 1 presents data on flycatcher habitat use from throughout this subspecies' range. Data on the most conspicuous plant species were collected in conjunction with population data at 221 sites across the bird's range (Table 1), and demonstrate the widespread use of riparian habitats comprised of both native and exotic trees and shrubs. A breeding site was considered "dominated" by either native or exotic plants if they comprised an estimated ≥60% of vegetation volume of shrubs and small trees. Table 1 does not reflect an analysis of flycatcher selection of either native- or exotic-dominated communities in relation to the availability of these habitats across the landscape.

Table1. The number of known southwestern willow flycatcher territories located within major vegetation/habitat types, by state. Data are from Sogge et al. 2002, based on last reported habitat and survey data for all sites where flycatchers were known to breed, 1993-2001.

	State						
Vegetation Type	AZ	CA	CO	NM	NV	UT	Total
Native (>90%)	33	172	37	194	32	0	468
Mixed native/exotic (>50 native)	102	52	0	50	27	0	231
Mixed exotic/native (>50% exotic)	140	1	0	3	14	3	161
Exotic (>90%)	79	0	0	11	0	0	90
Unreported	5	31	0	0	0	0	36
Total	359	256	48	258	73	3	986

[1]see Appendix Q for full list of data sources.

Narrative descriptions of the general vegetation types used throughout the southwestern willow flycatcher's range are provided below. These vegetation descriptions focus on the dominant tree and shrub components. The habitat types described below include a continuum of plant species composition (from nearly monotypic to mixed species) and vegetation structure (from simple, single stratum patches to complex, multiple strata patches). Because pictures are often much more effective than verbal descriptions at conveying the general nature of a riparian patch, we include one or more photographs of each type of occupied breeding habitat (See Appendix). The intent of the descriptions and photographs is to provide a basic understanding of the types of habitat occupied by the flycatcher, not to create a standardized definition or classification. All known breeding sites are not described or illustrated, so every potential variant is not shown. However, the sites presented capture most of the known range of patch floristics, structure and size.

2. Native Vegetation Dominated

Approximately half of southwestern willow flycatcher territories are in patches dominated by native trees and shrubs, especially willows (*Salix* spp.). The floristic and gross structural variation of occupied native-dominated habitats is quite broad. Occupied sites vary from monotypic, single strata patches to multi-species, multi-layered strata with complex canopy and subcanopy structure. Overall, sites differ substantially with elevation, and are treated separately below.

Low to Mid-Elevation Native Sites

General characteristics: These sites range from single plant species to mixtures of native broadleaf trees and shrubs including (but not limited to) Goodding's *(Salix gooddingii*) or other willow species, cottonwood, boxelder, ash (*Fraxinus* spp.), alder (*Alnus* spp.), and buttonbush. Average canopy height can be as short as 4 m (13 ft) or as high as 30 m (98 ft). Gross patch structure is generally characterized by individual trees of different size classes, often forming a distinct overstory of cottonwood, willow or other broadleaf tree with recognizable subcanopy layers and a dense understory of mixed species. However, although some descriptions of flycatcher breeding habitat emphasize these multi-species, canopied associations, flycatchers also breed at sites with tall (>5 m/16 ft) monotypic willow. Exotic or introduced trees and shrubs may be a rare component at these sites, particularly in the understory. In an unusual site along the upper San Luis Rey River in San Diego County, CA, willow flycatchers breed in a streamside area dominated by live oak (*Quercus agrifolia*), where willows once predominated but were reduced by a phreatophyte control program several decades ago and are now regenerating (W. Haas, pers. comm.).

Examples

South Fork of the Kern River at Lake Isabella, Kern County, CA., elevation 780 m (2558 ft) (see Whitfield and Enos 1996, Whitfield 2002). This is one of the largest tracts of native-dominated flycatcher habitat in the Southwest (Figure 1). The site includes roughly 500 ha (1235 ac) of riparian woodland dominated by a dense overstory of red willow (*Salix laevigata*) and Gooding's willow, interspersed with open areas often dominated by nettle (*Urtica dioica*) and mule fat (*Baccharis salicifolia*), cattails (*Typha* spp.) and tules (*Scirpus* spp.). Canopy height is typically from 8 to 12 m (26-39 ft). This site has numerous river channels, sloughs, and marshes that provide surface water and saturated soils across a relatively broad floodplain throughout most of the breeding season (Figure 2).

Santa Ynez River, Santa Barbara County, CA., (see Holmgren and Collins 1995). Willow flycatchers breed at several areas along the perennial Santa Ynez River between Buellton (elevation approximately 150 m or 490 ft) and the ocean. These species-rich riparian sites (Figure 3) are comprised of red willow, black cottonwood (*Populus trichocarpa*) and box elder with dense, shrubby thickets of willows (*Salix lasiolepis* and *S. exigua*), mulefat, poison oak (*Toxicodendron diversilobum*) and blackberry (*Rubus spp.*).

San Pedro River, Pinal County, AZ., elevation 600 m (see Spencer et al. 1996, McCarthey et al. 1998, Smith et al. 2002). Several flycatcher breeding sites along this riparian system are dominated primarily by Fremont cottonwood *(P. fremontii*) and Goodding's willow (Figure 4). Understory is comprised of younger trees of these same species, with tamarisk (*Tamarix ramosissima*) as a minor component in some areas. Overstory canopy height averages 15 to 20 m (49-65 ft). Open water, marshes and seeps (including cattail and bulrush), and saturated soil are present in the immediate vicinity.

Gila River, Grant County, NM., elevation 1,480 m (4854 ft) (see Skaggs 1996, Cooper 1997, Stoleson and Finch 1999). One of the largest known population of breeding southwestern willow flycatchers is found in a series of narrow riparian patches distributed over a 13 km (8 mi) stretch of the Gila River. Flycatchers breed in two distinct structural types; riparian scrub and riparian forest. Riparian scrub (Figure 5) is dominated by 4 to 10 m (13-33 ft) tall shrubby willows and seepwillow (*Baccharis glutinosa*) that grow along the river bank or in old flood channels. These shrub strips are sometimes less than 10 m (33 ft) wide and rarely more than 20 m (66 ft). Riparian forest patches (Figure 6) were 100 to 200 m wide (328-650 ft), and dominated by trees such as Fremont cottonwood, Goodding's willow, Arizona sycamore (*Plantanus wrightii*) and boxelder. Understory includes young trees of the same species. Canopy height generally ranges between 20 and 30 m (33-98 ft). Much of this forest vegetation is sustained by water from the river and small, unlined water diversions that function much like a dendritic stream system. To the extent that more specifically quantified data on vegetation structure have been developed, that information comes from this population. Skaggs (1996) found that 90% of territories occurred in Mixed Broadleaf Riparian Forest (Brown et al. 1979), which locally were expressed as "...dense, multi-layered canopies." Greatest foliage density was at heights of 3-13m (10-42 ft), and canopy cover (>2 m height) averaged 95%. In both Mixed Broadleaf Riparian Forest and Mixed Narrowleaf Riparian Scrub, Skaggs found approximately 600 stems/ha of dominant trees. Herbaceous groundcover and understory were not quantified. In comparing nest sites and unused sites in the Cliff-Gila Valley, Stoleson and Finch (1999) found that nest sites were significantly higher in average canopy cover, foliage density at 3-10 m, patchiness, and number of tree stems per unit area. Nest sites were significantly lower in average ground cover, average canopy height, and total basal area of woody stems. Ground cover is probably lower at nest sites because of the high degree of canopy closure or, as at the Kern River, due to standing water.

<u>*High-Elevation Native Sites*</u>

General characteristics: As a group, these sites are more similar than low elevation native sites. Most high elevation (≥1900 m or 6232 ft) breeding sites are comprised completely of native trees and shrubs, and are dominated by a single species of willow, such as coyote willow (*Salix exigua*) or Geyer's willow (*S. geyeriana*). However, Russian olive is a major habitat component at some high elevation breeding sites in New Mexico. Average canopy height is generally only 3 to 7 m (10-23 ft). Gross patch structure is characterized by a single vegetative layer with no distinct overstory or understory. There is usually very dense branch and twig structure in lower 2 m (6.5 ft), with high live foliage density from the ground to the canopy. Tree and shrub vegetation is often associated with sedges, rushes, nettles and other herbaceous wetland plants. These willow patches are usually found in mountain meadows, and are often associated with stretches of stream or river that include many beaver dams and pooled water.

Examples

Little Colorado River near Greer, Apache County, AZ., elevation 2530 m (8298 ft) (see Spencer et al. 1996, Langridge and Sogge 1997, McCarthey et al. 1998). This 14 ha (34.5 ac) site is a mosaic of dense, shrubby Geyer's willow (Figure 7), dense herbaceous ground cover, and open water. The river and associated beaver ponds create marshes, wet meadows and saturated soil conditions. Average willow canopy height is 4 to 6 m (13-20 ft). The willow matrix is a combination of clumps and thin strips 3 to 5 m (10-16 ft) wide. The shrubby vegetation is structurally composed of a single layer of live vegetation, with dense branch and twig structure and high live foliage density from ground level to canopy. Habitat surrounding the broad valley is primarily ponderosa pine (*Pinus ponderosa*) and scattered houses and cabins.

Alamosa National Wildlife Refuge, Alamosa County, CO., elevation 2,290 m (8000 ft) (see Owen and Sogge 1997). This site includes a series of mostly small habitat patches distributed along several kilometers of the upper Rio Grande. The river is narrow, and winds through the generally flat landscape. The shrubby vegetation (Figure 8) is dense, almost monotypic willow, with small amounts of cottonwood present in a few patches. Shrub height is typically 3-4 m high, with some larger emergent cottonwoods at some, but not all, patches.

3. Exotic Vegetation Dominated

Exotic plant species such as tamarisk and Russian olive were not introduced or widespread in southwestern riparian systems until approximately 100 years ago. Thus, southwestern willow flycatchers evolved in and until fairly recently (from an evolutionary perspective) bred exclusively within thickets of native riparian vegetation. However, as the widespread loss and modification of native riparian habitats progresses, the flycatcher is found breeding in some exotic-dominated habitats. From the standpoint of flycatcher productivity and survivorship, the suitability of exotic-dominated sites is not known. Flycatcher productivity in at least some exotic-dominated sites is lower than in some native-dominated habitats (Sferra et al. 1997, Sogge et al. 1997a), but higher at other locations (McKernan and Braden 1999). However, other factors such as small riparian patch size may have greater effects on productivity at those sites.

Southwestern willow flycatchers do not nest in all exotic species that have invaded and sometimes dominate riparian systems. For example, flycatchers do not use tree of heaven (*Ailanthus altissima*). Even in the widespread tamarisk, flycatchers tend to use only two discreet forms - low stature tamarisk found in the understory of a native cottonwood-willow gallery forest or the tall (6 - 10 m or 19-33 ft) mature stands of tamarisk that have a high percentage of canopy closure.

Most exotic habitats range below 1,200 m (3,940 ft) elevation. As a group, they show almost as much variability as do low elevation native-dominated sites. Most exotic sites are nearly monotypic, dense stands of exotics such as tamarisk or Russian olive that form a nearly continuous, closed canopy (with no distinct overstory layer). Canopy height generally averages 5 to 10 m (16 - 33 ft), with canopy density uniformly high. The lower 2 m (6.5 ft) of vegetation is often very difficult to penetrate due to dense branches. However, live foliage density may be relatively low from 0 to 2 m (6.5 ft) above ground, but increases higher in the canopy.

Examples

Roosevelt Lake, Gila County, AZ., elevation 640 m (2100 ft) (Sferra et al. 1997, McCarthey et al. 1998, Smith et al. 2002). Two of the largest known southwestern willow flycatcher populations in Arizona breed in large, contiguous stands of dense, mature tamarisk at the Tonto Creek and Salt River inflows to Roosevelt Lake (Figures 9 and 10). Along the Salt River inflow, flycatchers breed in several patches of essentially monotypic saltcedar (as well as in more native-dominated patches nearby). Tamarisk-dominated patches at the Tonto Creek site include a few scattered, large cottonwood trees that emerge above the tamarisk canopy, which averages 8 to 12 m (26 - 40 ft) in height. Within the patches, there are numerous small openings in the canopy and understory. As is often the case in such mature tamarisk stands, there is little live foliage below a height of 3 to 4 m (10-14 ft) within the interior of the patch (although live foliage may be continuous and thick at the outer edges of the patch), and virtually no herbaceous ground cover. However, numerous dead branches and twigs provide for dense structure in the lower 2 to 3 m (6-10 ft) strata (Figure 11). In normal or wet precipitation years, surface water is adjacent to or within the tamarisk patches.

Colorado River in Grand Canyon, Coconino County, AZ., elevation 850 m (2788 ft) (see Sogge et al. 1997). The willow flycatcher breeding sites along the Colorado River in the Grand Canyon (Figure 12) are very small (0.6 to 0.9 ha), dense patches of mature tamarisk, bordered on the upslope side by acacia (*Acacia greggii*) and along the river's edge by a thin band of sandbar willow (*Salix exigua*). Tamarisk canopy height averages 8 to 12 m (26-40 ft). Live foliage is dense and continuous along the edge of the patch, but within the patch interior does not begin until 2 to 4 m (10-14 ft) above ground. A dense layer of dead branches and twigs provides for a thick understory below the live vegetation. These sites have almost no herbaceous understory due to a dense layer of fallen tamarisk branches and leaf litter. All patches are no further than 5 m (16.4 ft) from the river's edge.

4. Mixed Native and Exotic Habitats

General characteristics: Many southwestern willow flycatcher breeding sites are comprised of dense mixtures of native broadleaf trees and shrubs (such as those listed above) mixed with exotic/introduced species such as tamarisk or Russian olive. The exotics are often primarily in the understory, but may be a component of overstory. At several sites, tamarisk provides a dense understory below an upper canopy of gallery cottonwoods, forming a habitat that is structurally similar to the cottonwood-willow habitats in which flycatchers historically nested. A particular site may be dominated primarily by natives or exotics, or be a more-or-less equal mixture. The native and exotic components may be dispersed throughout the habitat or concentrated in distinct, separate clumps within a larger matrix. Sites almost always include or are bordered by open water, cienegas, seeps, marshes, and/or agricultural runoff channels. However, during drought years surface water at some sites may be gone early in the breeding season. Generally, these habitats are found below 1,200 m (3940 ft) elevation.

Examples

Rio Grande at San Juan Pueblo, Rio Arriba County, NM., elevation 1,716 m (5,630 ft)) (see Maynard 1995, Cooper 1997). In this locale, southwestern willow flycatchers breed in a habitat that includes a scattered overstory of cottonwood, with subcanopies and understories comprised of Russian olive and coyote willow. The Russian olive averages 8 to 12 m (26-40 ft) in height, and the willows 3.5 to 6 m (12-20 ft). River channels, diversion ditches, old river oxbows, and associated marshy areas are present within and adjacent to the site (Figure 13).

San Pedro River, Pinal County, AZ., elevation 600 m (1968 ft) (see Spencer et al. 1996, McCarthey et al. 1998). Parts of the extensive riparian tracts of the lower San Pedro River are dominated by cottonwood and willow, but include substantial amounts of dense tamarisk. In some cases, the tamarisk occurs as a dense understory amidst a cottonwood, willow, ash or boxelder overstory (Figure 14), while in others it borders the edge of the native vegetation (Figure 15). Overall canopy height ranges from 10 to 18 m (33-59 ft).

Verde River at Camp Verde, Yavapai County, AZ., elevation 940 m (3,083 ft) (see SWCA 2001). Southwestern willow flycatchers breed here in a mixture of willow, cottonwood, and tamarisk habitat (Figure 16). Most of the territories are found in a cluster of dense mature tamarisk 6 to 8 m (19.5-26 ft) tall that is bordered by narrow bands of young willow, which in turn is surrounded on one side by a large (>50 ha) stand of mature cottonwoods and willows (15-20 m tall) with little understory. Although the patch itself is located on a sandy terrace approximately 4 m (13 ft) above typical summer river level, the Verde River flows along the eastern edge of the patch and a small intermittently flowing irrigation ditch provides water to a small pond adjacent to the tamarisk and willows. Patches of herbaceous ground cover are scattered throughout the site, but are absent under the tamarisk canopy.

Virgin River, Washington County, UT., elevation 1,100 m (3,608 ft) (USFWS unpubl. data). Along one portion of Virgin River riparian corridor near St. George, flycatchers breed in a mixture of dense willow, Russian olive and tamarisk near an emergent marsh (Figure 17). The native trees form a tall overstory 10-12 m (33-40 ft) high, which is bordered by a shorter (10-12 m or 33-40 ft) band of tamarisk, and a strip of 4 to 8 m (13-26 ft) tall willow. The stretch of occupied habitat is approximately 60 m (197 ft) wide and 100 m (328 ft) long, and is located in an old meander channel through which the river no longer flows. In normal and wet years return channels and river flows seasonally inundate the base of the vegetation.

5. Standard BioticVegetation Classifications And Descriptions

In addition to the above habitat descriptions, existing systematic classification systems for biotic and vegetative communities are also helpful to generally categorize southwestern willow flycatcher habitats. The system developed by Brown et al. (1979) as supplemented by Brown (1982) is widely used and provides valuable habitat descriptions. Flycatcher habitats can be placed into the broad biomes and series noted below. Because of local variations in relative abundance of plant species, individual sites will vary in community/ series, association and subassociation (see Brown 1982 for discussion). Below is a listing of several major biotic communities, with subordinate classifications, and examples of known flycatcher habitat areas (Numerical identifiers follow Brown et al. 1979; all in Nearctic Realm).

Lower Elevation Habitats

224 Tropical-Subtropical Swamp, Riparian, and Oasis Forests

224.5 Sonoran Riparian and Oasis Forests

224.53 Cottonwood-Willow Series (historical lower Colorado River, San Pedro River AZ)

234 Tropical-Subtropical Swamp and Riparian Scrub

234.7 Sonoran Deciduous Swamp and Riparian Scrub

234.72 Saltcedar Disclimax Series (current lower Colorado River)

223 Warm Temperate Swamp and Riparian Forests

232.2 Interior Southwestern Riparian Deciduous Forest and Woodland series

223.21 Cottonwood-Willow series

223.22 Mixed Broadleaf series (Gila River, Gila-Cliff Valley, NM)

223.3 Californian Riparian Deciduous Forest and Woodland

223.31 Cottonwood-Willow Series (Kern, Santa Margarita and Santa Ynez Rivers, CA)

223.32 Mixed Broadleaf Series (San Luis Rey River CA)

233 Warm Temperate Swamp and Riparian Scrub

233.2 Interior Southwestern Swamp and Riparian Scrub

233.21 Mixed Narrowleaf Series (Gila-Cliff Valley, NM)

233.22 Saltcedar Disclimax Series (Roosevelt Lake AZ, Grand Canyon AZ)

233.221 *Tamarix chinensis* -Mixed Deciduous association (Verde and San Pedro Rivers AZ)

Upper Elevation Habitats

231 Arctic-Boreal Swampscrubs

231.6 Rocky Mountain Alpine and Subalpine Swamp and Riparian Scrub series (Greer, Alpine, AZ)

232 or the Cold Temperate Swamp and Riparian Scrubs biome

or 232.2 Plains and Great Basin Swamp and Riparian Scrub series

232.3 Rocky Mountain Riparian Scrub (Beaver Creek, CO)

222 Cold Temperate Swamp and Riparian Forests

222.3 Rocky Mountain Riparian Forest (Beaver Creek, CO)

Several sites described in the preceding discussion lie at middle elevations, and have Russian olive as a major habitat component, with varying amounts of tamarisk and/or native trees and shrubs also present. Examples include: the Rio Grande River at San Juan Pueblo, (elevation 1,716 m / 5,630 ft); the Virgin River, UT (elevation 1,100 m /3608 ft). While these sites do not neatly fit into the current categories of Brown et al. (1979), they could most appropriately be characterized as being related to the 233.22 Saltcedar Disclimax Series, *Tamarix chinensis* -Mixed Deciduous association.

6. Patch Size and Shape

The riparian patches used by breeding flycatchers vary in size and shape. They may be relatively dense, linear, contiguous stands or irregularly-shaped mosaics of dense vegetation with open areas. Southwestern willow flycatchers nest in patches as small as 0.1 ha (0.25 ac) along the Rio Grande (Cooper 1997), and as large as 70 ha (175 ac) in the upper Gila River in New Mexico (Cooper 1997).

To summarize characteristics of breeding patch size, we extracted information on patch size values from the following sources: Maynard 1994, Sogge 1995, Cooper 1996, Cooper 1997, Sogge et al. 1997a, Ahlers and White 1998, Paradzick et al. 1999, Johnson and Smith 2000, Paradzick et al. 2000, Ahlers and White 2001, Gallagher et al. 2001, SWCA 2001, Arizona Game and Fish Department unpublished data, and USGS unpublished data. Mean reported size of flycatcher breeding patches was 8.6 ha (21.2 ac) (SE = 2.0 ha; range = 0.1 - 72 ha; 95% confidence interval for mean = 4.6 - 12.6; n = 63 patches). The majority of sites were toward the smaller end, as evidenced by a median patch size of 1.8 ha. Mean patch size of breeding sites supporting 10 or more flycatcher territories was 24.9 ha (62.2 ac) (SE = 5.7 ha; range = 1.4 - 72 ha; 95% confidence interval for mean = 12.9 - 37.1; n = 17 patches). Aggregations of occupied patches within a breeding site may create a riparian mosaic as large as 200 ha (494 ac) or more, such as at the Kern River (Whitfield 2002), Roosevelt Lake (Paradzick et al. 1999) and Lake Mead (McKernan 1997). Based on the number of flycatcher territories reported in each patch, it required an average of 1.1 ha (2.7 ac) (SE = 0.1 ha; range = 0.01 - 4.75; 95% confidence interval for mean = 0.8 - 1.3; n = 63 patches) of dense riparian habitat for each territory in the patch. Because breeding patches include areas that are not actively defended as territories, this does NOT equate to an average territory size.

In some cases where a series of flycatcher breeding sites occur as closely distributed but non-contiguous patches of riparian vegetation, individuals show strong fidelity to that stretch of river but move readily among patches - between and within years. This movement and mixing of individuals occurs to such a degree that the entire reach of river appears to function as a single patch. An example of this is found along the lower San Pedro River and nearby Gila River confluence (English et al. 1999, Luff et al. 2000); here, the occupied habitat patches have an average nearest-neighbor distance of approximately 1.5 km (1 mile) (SD = 1.1 km, Range = 0.03 - 3.9; USGS unpublished data).

Flycatchers often cluster their territories into small portions of riparian sites (Whitfield and Enos 1996, Paxton et al. 1997, Sferra et al. 1997, Sogge et al. 1997b), and major portions of the site may be occupied irregularly or not at all. Recent habitat modeling based on remote sensing and GIS data has found that breeding site occupancy at reservoir sites in Arizona is influenced by vegetation characteristics of habitat adjacent to the actual occupied portion of a breeding site (Arizona Game and Fish Dept, unpublished data), therefore, unoccupied areas can be an important component of a breeding site. It is currently unknown how size and shape of riparian patches relate to factors such as flycatcher site selection and fidelity, reproductive success, predation, and brood parasitism.

Flycatchers are generally not found nesting in confined floodplains where only a single narrow strip of riparian vegetation less than approximately 10 m (33 ft) wide develops, although they may use such vegetation if it extends out from larger patches, and during migration (Sogge and Tibbitts 1994, Sogge and Marshall 2000, Stoleson and Finch 2000z).

7. Presence of Water and Hydrological Conditions

In addition to dense riparian thickets, another characteristic common to the vast majority of flycatcher nesting sites is that they are associated with lentic water (quiet, slow-moving, swampy, or still) or saturated soil. Occupied sites are often located in situations such as along slow-moving stream reaches, at stream backwaters, in swampy abandoned oxbows/ marshes/cienegas, and at the margins of impounded water, including the inflows of streams into reservoirs. Where flycatchers occur along moving streams, those streams tend to be of relatively low slope (or gradient), i.e., slow-moving with few (or widely spaced) riffles or other cataracts. The apparent association between southwestern willow flycatcher habitat and quiet water likely represents the relationship between the requirements of the bird for certain vegetation characteristics and patch size/shape, and the hydrological conditions that allow those conditions to develop. Lentic water conditions may also be important in influencing the insect prey base of the flycatcher.

Flycatcher habitat becomes established because of water flow conditions that result from the following factors (not in order of importance): seasonality/duration, gradient, width of flow, depth of flow, hydraulic roughness, sediment particle sizes for bed and banks, suspended sediment load, channel cross sectional morphology, longitudinal morphology (pool and riffle, rapids, step pools), vegetation in the channel, channel sinuosity, and channel pattern (single thread, braided, compound). It is not possible to define “suitable” or “potential” flycatcher habitat with specific values or configurations for just one or several of these factors (e.g., gradient or channel pattern), because all these factors are related to one other. The range and variety of flow conditions that will establish and maintain flycatcher habitat can arise in free flowing streams differing substantially in these factors. Also, flow conditions that will establish and maintain flycatcher habitat can be achieved in regulated streams, depending on scale of operation and the interaction of the primary physical controls. Still, very generally flycatcher habitat tends to occur along streams of relatively low gradient. However, the low gradient may exist only at the habitat patch itself, on streams that are generally steeper when viewed on the large scale (e.g., percent gradient over miles or kilometers). For example, obstructions such as logjams, beaver dams, or debris deposits from tributaries may partially dam streams, creating relatively quiet, lentic pools upstream.

By definition, the riparian vegetation that constitutes southwestern willow flycatcher breeding habitat requires substantial water. Further, hydrological events such as scouring floods, sediment deposition, periodic inundation, and groundwater recharge are important for the flycatcher’s riparian habitats to become established, develop, and be recycled through disturbance. It is critical to keep in mind that in the southwest, hydrological conditions at a site can vary remarkably within a season and between years. At some locations, particularly during drier years, water or saturated soil is only present early in the breeding season (i.e., May and part of June). At other sites, vegetation may be immersed in standing water during a wet year, but be hundreds of meters from surface water in dry years. This is particularly true of reservoir sites such as the Kern River at Lake Isabella, Tonto Creek and Salt River at Roosevelt Lake, and the Rio Grande near Elephant Butte Reservoir. Human-related factors such as river channel modifications (e.g., by creation of pilot channels) or altered subsurface flows (e.g., from agricultural runoff) can temporarily or permanently dry a site. Similarly, where a river channel has changed naturally (Sferra et al. 1997), there may be a total absence of water or visibly saturated soil for several years. In such cases, the riparian vegetation and any flycatchers breeding within it may persist for several years. However, we do not know how long such sites will continue to support riparian vegetation and/or remain occupied by breeding flycatchers.

In the geographical setting of the southwest, most streams descend from the higher elevations of their upper watersheds at relatively high slope or gradient. Drainages descend toward the lowlands through valleys and canyons where streamflow is in a single-thread channel, confined by steep banks, steep upland slopes, and/or canyon walls. Under these conditions even floodwaters do not spread far laterally from the banks, but rise vertically between the confining slopes or canyon walls. Flood-scour zones often are present at the stream margins, where riparian vegetation is absent or frequently removed. The zone of frequently-wetted land adjacent to the stream is relatively narrow, because the land rises steeply from the level of typical base streamflow (Figure 18). Also, high-gradient streams possess high erosive energy. Soil and sediment comprising streambanks is often coarse, cobbly, bouldery, or even bedrock. Such soil/sediment types are rarely associated with the wet, dense vegetation of willow flycatcher habitat. Under all the above conditions, riparian vegetation is seldom dense enough to provide flycatcher breeding habitat. Riparian vegetation is often present in much narrower configurations, usually a relatively narrow, linear growth with inadequate width to constitute willow flycatcher habitat.

In contrast, streams of lower gradient and/or more open valleys have a greater tendency to support potential willow flycatcher habitat patches. As streams reach the lowlands, their gradients typically flatten out. Simultaneously, the surrounding terrain often opens up into broader floodplains. Under such conditions streams meander back and forth, higher flow events spread shallowly across the floodplain, backwaters develop, and abandoned channels from previous stream alignments persist, often with moist conditions and riparian vegetation. The permanently-wetted perimeter of the stream (by either surface or subsurface water) is much more extensive and wider. The sediments of a lower floodplain are capable of retaining much more subsurface water, being deeper, finer, and extending farther laterally from the active stream channel. Riparian plant communities that are wider, more extensive, and more dense are able to develop. Conditions like these lower floodplains also develop where streams enter impoundments, either natural (e.g., beaver ponds) or human-made (reservoirs). Low-gradient stream conditions may also occur high in watersheds, as in the marshy mountain meadows supporting flycatchers in the headwaters of the Little Colorado River near Greer, Arizona.

In summary, suitable southwestern willow flycatcher habitat is less likely to occur in steep, confined streams as are found in narrow canyons. Flycatcher habitat is more likely to develop, and in more extensive patches, along lower gradient streams with wider floodplains. However, exceptions to this generality indicate that relatively steep, confined streams can also support significant flycatcher habitats. The San Luis Rey River in California supports a substantial flycatcher population, and stands out among flycatcher habitats as having a relatively high gradient and being confined in a fairly narrow, steep-sided valley. The San Luis Rey may not be an eccentric exception to typical flycatcher habitat settings, but instead an indication of the true range of potential habitat. Although stream gradient (and even vegetation) seem unusual there, the many other factors of hydrology and vegetation characteristics allow flycatchers to thrive. Finally, it is important to note that even a steep, confined canyon or mountain stream may present local conditions where just a portion of an acre or hectare of flycatcher habitat may develop. Such sites are important individually, and in aggregate. Flycatchers are known to occupy very small, isolated habitat patches, and may occur in fairly high densities within those patches.

Recovering and conserving such sites may be an important contribution to recovering the flycatcher.

8. Other Habitat Components

Other potentially important aspects of southwestern willow flycatcher habitat include distribution and isolation of vegetation patches, prey types and abundance, parasites, predators, environmental factors (e.g., temperature, humidity), and interspecific competition (see Breeding Season Biology chapter of the Recovery Plan for additional information regarding some of these factors). Population dynamics factors such as demography (i.e. birth and death rates, age-specific fecundity), distribution of breeding groups across the landscape, flycatcher dispersal patterns, migration routes, site fidelity, philopatry, and conspecific sociality also influence where flycatchers are found and what habitats they use. Most of these factors are poorly understood at this time, but may be critical to understanding current population dynamics and habitat use. Refer to Wiens (1985, 1989a, 1989b) for additional discussion of habitat selection and influences on bird species and communities.

9. What Is Not Willow Flycatcher Breeding Habitat

Cottonwood-willow gallery forests that are devoid of an understory and that appear park-like do not provide breeding habitat for southwestern willow flycatchers. Similarly, isolated, linear riparian patches less than approximately 10 m (33 ft) wide do not provide breeding habitat. However, mosaics made up of aggregations of these small, linear riparian "stringers"may be used by breeding flycatchers, particularly at high elevations. Short stature (< 4 m or <13 ft) tamarisk stands as well as sparse stands of tamarisk characterized by a scattering of trees of any height also do not provide breeding habitat for flycatchers. Finally, riparian mesquite woodlands ("bosques') do not provide willow flycatcher breeding habitat, although they may be adjacent to (typically upland) nesting habitat (See Figures 18 - 20). At Ash Meadows National Wildlife Refuge, a unique exception is found where flycatchers nest in a tamarisk-mesquite association.

10. Potential Habitat

Loss of habitat is one of the primary causes for the endangered status of the southwestern willow flycatcher. As a result, a fundamental question to be addressed in recovering the bird is "where can suitable breeding habitat be re-established?" Suitable habitats arise from areas of potentially suitable habitat.

Potentially suitable habitat (hereafter "potential habitat") is defined as a riparian system that does not currently have all the components needed to provide conditions suitable for nesting flycatchers (as described above), but which could - if managed effectively - develop these components over time. **Regenerating potential habitats** are those areas that are degraded or in early successional stages, but have the correct hydrological and ecological setting to be become, under appropriate management, suitable flycatcher habitat. **Restorable potential habitats** are those areas that could have the appropriate hydrological and ecological characteristics to develop into suitable habitat if not for one or more key stressors, and which may require active abatement of stressors in order to become suitable. Potential habitat occurs where the flood plain conditions, sediment characteristics, and hydrological setting provide potential for development of dense riparian vegetation. Stressors that may be preventing regenerating and restorable habitats from becoming suitable include, but are not limited to, de-watering from surface diversion or groundwater extraction, channelization, mowing, recreational activities, over-grazing by domestic livestock or native ungulates, exotic vegetation, and fire.

11. Unsuitable Habitat

Unsuitable habitats are those riparian and upland areas which do not have the potential for developing into suitable habitat, even with extensive management. Examples of unsuitable habitat are found far outside of flood plain areas, along steep walled and heavily bouldered canyons, at the bottom of very narrow canyons, and other areas where physical and hydrological conditions could not support the dense riparian shrub and tree vegetation used by breeding flycatchers even with all potential stressors removed.

12. The Importance of Unoccupied Suitable Habitat and Potentially Suitable Habitat.

Because riparian vegetation typically occurs in flood plain areas that are prone to periodic disturbance, suitable habitats will be ephemeral and their distribution dynamic in nature. Suitable habitat patches may become unsuitable through maturation or disturbance (though this may be only temporary, and patches may cycle back into suitability). Therefore, it is not realistic to assume that any given suitable habitat patch (occupied or unoccupied) will remain continually occupied and/or suitable over the long term. Unoccupied suitable habitat will therefore play a vital role in the recovery of the flycatcher, because they will provide suitable areas for breeding flycatchers to: (a) colonize as the population expands (numerically and geographically), and (b) move to following loss or degradation of existing breeding sites. Indeed, many sites will likely pass through a stage of being suitable but unoccupied before they become occupied. Potential habitats that are not currently suitable will also be essential for flycatcher recovery, because they are the areas from which new suitable habitat develops as existing suitable sites are lost or degraded; in a dynamic riparian system, all suitable habitat starts as potential habitat. Furthermore, potential habitats are the areas where changes in management practices are most likely to suitable habitat. Therefore, habitat management for recovery of the flycatcher must include developing and/or maintaining a matrix of riparian patches - some suitable and some potential - within a watershed so that sufficient suitable habitat will available at any given time.

13. Sources of Water Sustaining Breeding Sites

Although some flycatcher breeding sites are along lakes, streams, or rivers that are relatively unimpacted by human activities, most of the riparian vegetation patches in which the flycatcher breeds are supported by various types of supplemental water including agricultural and urban runoff, treated water outflow, irrigation or diversion ditches, reservoirs, and dam outflows (Table 2). Although the waters provided to these habitats might be considered “artificial”, they are often essential for maintaining the habitat in a suitable condition for breeding flycatchers. However, reliance on such water sources for riparian vegetation persistence may be problematic because the availability of the water (in quantity, timing, and quality) is often subject to dramatic change based on human use patterns; there is little guarantee that the water will be available over the long-term.

Table 2. Southwestern willow flycatcher sites dependent on supplemental water to sustain the habitat. Supplemental water type is indicated by an "X" if known and a "?" if uncertain. Sites listed would likely deteriorate in quality if supplemental water supply was terminated. Natural riparian systems where these sites occur may have supported southwestern willow flycatchers prior to disturbance, although they may have been distributed differently. In some cases, even though sites are supported by supplemental water, greater damage may be simultaneously occurring by other activities in the area (e.g., overdrafting).

Management Unit	Site Code	Agricultural / urban runoff	Sewage treatment facility or effluent outflow[1]	Irrigation or diversion canal[2]	Reservoir / dam[3]	Regulated flows[4]
Kern	KEKERN			X	X	
Mojave	MOUPNA		?			
Santa Ynez	SYVAND		X		X	
	SYBUEL	X				
	SYGIBR				X	
Santa Clara	STSATI	X			X	
Santa Ana	SAPRAD	X	X		X	
	SASNTI		X			
San Diego	SOSMCR	X	X			
	SMFALL				X	
	SMCAPE		X			
	LFAFL		X			
	SLPILG		X			
	SLGUAJ	X				
	SLSUP					X
	SLCOUS	X				
	SDSADI	?				?
	SDBATT	?				?
	SDTICA	?				?
	AHMACA	X				
	SOLALA	X				
	SUCAGO					X
Upper San Juan	SJWICR		X			
Little Colorado	LCNUTR			X		
Middle Colorado	COGC50L					X
	COG65L					X
	COG71L					X
	CO246L					X
	CO259R					X
	CO265L					X
	CO266L					X
	CO268R					X
	CO268L					X
	CO270L					X

Table 2, Continued. Southwestern willow flycatcher sites dependent on supplemental water to sustain the habitat. Supplemental water type is indicated by an "X" if known and a "?" if uncertain. Sites listed would likely deteriorate in quality if supplemental water supply was terminated. Natural riparian systems where these sites occur may have supported southwestern willow flycatchers prior to disturbance, although they may have been distributed differently. In some cases, even though sites are supported by supplemental water, greater damage may be simultaneously occurring by other activities in the area (e.g., overdrafting).

Management Unit	Site Code	Agricultural / urban runoff	Sewage treatment facility or effluent outflow[1]	Irrigation or diversion canal[2]	Reservoir / dam[3]	Regulated flows[4]
	CO272R					X
	CO273L					X
	COMEAD				X	X
Virgin	VIMESQ	X				
	VILAME				X	
	VIGEOR		X			
	VILITT	X				
Pahranagat	NLKEYP			X		
	PANRRA	X				
	PAPAHR				X	
Hoover-Parker	COBLAN					X
	COBRLA					?
	COHAVA				X	X
	COTOPO					X
	COTRAM					X
	COWACO				X	X
Bill Williams	BSLOBS				X	
	BWALMO				X	
	BWBUCK					X
	BWDEMA				X	X
	BWGEMI					X
	BWMONK					X
	SNSMLO				X	
Parker-Mexico	COADOB					X
	COCIBO					X
	COCLLA					X
	CODRAP					X
	COEHRE					X
	COFERG				X	X
	COGILA					X
	COMITT					X
	COPICA					X

Table 2, Continued. Southwestern willow flycatcher sites dependent on supplemental water to sustain the habitat. Supplemental water type is indicated by an "X" if known and a "?" if uncertain. Sites listed would likely deteriorate in quality if supplemental water supply was terminated. Natural riparian systems where these sites occur may have supported southwestern willow flycatchers prior to disturbance, although they may have been distributed differently. In some cases, even though sites are supported by supplemental water, greater damage may be simultaneously occurring by other activities in the area (e.g., overdrafting).

Management Unit	Site Code	Agricultural / urban runoff	Sewage treatment facility or effluent outflow[1]	Irrigation or diversion canal[2]	Reservoir / dam[3]	Regulated flows[4]
	COTAYL					X
	COWALK					X
Upper Gila	GIFORT			X		
	GIUBAR			X		
Mid Gila / San Pedro	GIKRNY		X			
	GIPIEA	X				
	SPINHI	X				
	SRCOTT				X	
	SRSALT				X	
	SRSCHN				X	
	SRSCHS				X	
	TOTONT					
Verde	VECAVE			X		
	VEISTE				X	
	VETAVA		X	X		
San Luis Valley	RIALAM			X		
	RIMSCP			X		
Upper Rio Grande	CHPARK			X		
	CNGUNO			X		
	RILACA				X	
	RILARI	X				
	RIGARC			X		
	RISAJU	X		X		
Middle Rio Grande	RIBOSQ			X		
	RISAMA			X	X	

[1]Pond, treated or untreated effluent. [2]Channel edge, overflow, outflow, and/or seepage.

[3]Backed up water, reservoir edge. [4]Including pumped or piped in water.

D. Migration and Wintering Habitat

The migration routes used by southwestern willow flycatcher are not well documented. *Empidonax* flycatchers rarely sing during fall migration, so that means of distinguishing species is not available. However, willow flycatchers (all subspecies) sing during spring migration. As a result, willow flycatcher use of riparian habitats along major drainages in the southwest has been documented (Sogge et al. 1997b, Johnson and O'Brien 1998, McKernan and Braden 2001). Migrant willow flycatchers may occur in non-riparian habitats and/or be found in riparian habitats that are unsuitable for breeding. Such migration stopover areas, even though not used for breeding, may be critically important resources affecting local and regional flycatcher productivity and survival.

Although little is known specifically about southwestern willow flycatcher wintering habitats, recent wintering ground surveys allow a general description of the habitats used by *Empidonax traillii* in general. Willow flycatchers can be distinguished from other *Empidona*x flycatchers on wintering grounds by the subtle distinguishing field marks, and because on wintering grounds they do emit characteristic calls, occasionally including the territorial "fitz-bew" song (Gorski 1969, Koronkiewicz et al. 1998). Unitt (1997) found no evidence that the various willow flycatcher subspecies are separated geographically on the wintering grounds. And although distinguishing the flycatcher subspecies in the field is not possible (except by in-hand examination by experts), wintering habitats occupied by any willow flycatchers are therefore likely to be representative of the southwestern subspecies. The flycatcher winters in Mexico and Central America, where they are known to sing and defend winter territories, and northern South America (Phillips 1948, Gorski 1969, McCabe 1991, Koronkiewicz et al. 1998, Unitt 1999). Popular literature on the birds of Mexico, Central, and South America describes willow flycatcher wintering habitat as humid to semi-arid, partially open areas such as woodland borders (Stiles and Skutch 1989, Howell and Webb 1995, Ridgely and Gwynne 1989). Second growth forest, brushy savanna edges, and scrubby fields with hedges as at plantations are also used. Looking specifically for wintering willow flycatchers in Panamá, Gorski (1969) found them in transitional and edge areas, often with a wetland (river, wet field) nearby. Similarly, in Costa Rica and Panamá, Koronkiewicz et al. (1998) and Koronkiewicz and Whitfield (1999) found willow flycatchers in lagunas and intermittent freshwater wetlands, muddy seeps, seasonally inundated savanna/pasture and sluggish rivers, meandering waterways and oxbows. They only found willow flycatchers in areas that consisted of these four main elements: 1) Standing or slow-moving water and wetland flora; 2) Patches of dense woody shrubs; 3) Patches and/or stringers of trees; 4) Open to semi-open areas. The most commonly used vegetation used was patches of dense woody shrubs (*Mimosa* sp. and *Cassia* sp.) approximately 1-2 m (3-7 ft) tall, bordering and extending into wet areas. In early 1999, a southwestern willow flycatcher banded on breeding grounds in southern Nevada was recaptured on wintering grounds in the Guanacaste region of northwestern Costa Rica (Koronkiewicz pers. comm). Wintering range and habitat requirements are areas of much-needed research for the southwestern willow flycatcher. See Appendix E for more detailed information.

14. Summary and Conclusion

Southwestern willow flycatchers breed in substantially different types of riparian habitat across a large elevational and geographical area. Breeding patch size, configuration, and plant species composition can vary dramatically across the subspecies' range. However, certain patterns emerge and are present at most sites. Regardless of the plant species composition or height, occupied sites always have dense vegetation in the patch interior. In most cases this dense vegetation occurs within the first 3 - 4 m (10-13 ft) above ground. Canopy cover is usually very high - typically 80% or greater. These dense patches are often interspersed with small openings, open water, or shorter/sparser vegetation, creating a mosaic that is not uniformly dense. Nesting habitat patches will tend not to be very narrow, as single rows of trees bordering a small stream. In almost all cases, slow-moving or still surface water and/or saturated soil will be present at or near breeding sites during wet or normal precipitation years. The ultimate measure of habitat suitability is not simply whether or not a site is occupied. Suitable habitats are those in which, with other significant stresses absent (e.g., cowbird parasitism), flycatcher reproductive success and survivorship results in a stable or growing population. Without long term data showing which sites have stable or growing populations, we cannot determine which habitats are suitable or optimal for breeding southwestern willow flycatchers. Some occupied habitats may be acting as population sources, while others may be functioning as population sinks (Pulliam 1988).

Unfortunately, a habitat model or template that specifically describes flycatcher breeding habitat is not available at this time. Our understanding of what is "suitable" is confounded by several observations. Even very experienced flycatcher researchers have seen what they consider to be suitable habitat go unoccupied. Specifically, at the Kern River, Whitfield (pers. comm.) notes that many individuals are not resighted as yearlings, but are resighted in later years as older breeders. This suggests that some yearling birds, although they are reproductively mature, exist as non-breeding "floaters." This would seem to be due to a shortage of breeding habitat; however, the experienced impression of researchers is that substantial amounts of "suitable" but unoccupied habitat are available. These observations likely suggest that there are subtleties of habitat suitability that researchers have not yet discerned. Even that likelihood is confused by the effects of the species' rarity, and slight tendency to be a semi-colonial nester.

E. Literature Cited

Please see Recovery Plan Section VI.

Figure 1. Breeding site at South Fork of Kern River, CA. Note canopy height and breadth of floodplain at this cottonwood-willow dominated site.

Figure 2. Breeding site at South Fork of Kern River, CA. Note the dense tangle of willow understory and small openings directly above surface water.

Figure 3. Breeding site at Santa Ynez River, CA. Note proximity to surface water, and the structural complexity and density of native broadleaf species.

Figure 4. Breeding site on the San Pedro River, AZ. Note the emergent plants bordering dense willows and buttonbrush. Water is present throughout site.

Figure 5. Breeding site on Gila River, NM. Note mosaic of riparian stringers, proximity to surface water. Exposed banks remnant of past grazing.

Figure 6. Breeding site on Gila River, NM. Note openings within dense cottonwood and boxelder vegetation, and presence of water in channel.

Figure 7. Breeding site on the Little Colorado River, AZ. Note dense shrubby high-elevation willows and surface water.

Figure 8. Breeding site at Alamosa, CO. Note dense structure and short stature. This patch is adjacent to the upper Rio Grande.

Figure 9. Breeding site on Tonto Creek at Roosevelt Lake, AZ. Note dense, tall, monotypic tamarisk with openings in patch interior. No water present when photo taken.

Figure 10. Breeding site on the Salt River at Roosevelt Lake, AZ. Note dense, tall, monotypic tamarisk with mosaic of openings in patch interior.

Figure 11. Breeding site at Topock Marsh, AZ. Note dense, structure in lower 3-4 m within this tamarisk stand.

Figure 12. Breeding site on the Colorado River in the Grand Canyon, AZ. Note dense, tall, monotypic tamarisk adjacent to backwater.

Figure 13. Breeding site on the Rio Grande, NM. This dense, Russia olive dominated patch is bordered by marsh and a slough channel along the Rio Grande.

Figure 14. Breeding site on the Verde River, AZ. Note dense, tall tamarisk interspersed with and surrounded by willows and cottonwoods.

Figure 15. Breeding site on San Pedro River, AZ. Note the height, density and openings in this mixed native-exotic site. Surface water is present but not visible in foreground.

Figure 16. Breeding site at Tonto Creek, Roosevelt Lake, AZ. Note tall cottonwoods and willows interspersed with tamarisk, and the patch interior openings.

Figure 17. Breeding site on Virgin River, UT. The dense native-exotic vegetation is bordered by slough channel. Foreground is 2-3 m above terrain in which trees are rooted.

Figure 18. Example of native riparian habitat (in Grand Canyon, AZ) not suitable for Willow Flycatcher breeding. Habitat too narrow and short stature.

Figure 19. Example of native riparian habitat (in CO) that is not suitable for Willow Flycatcher breeding. Park-like gallery forest is devoid of dense understory.

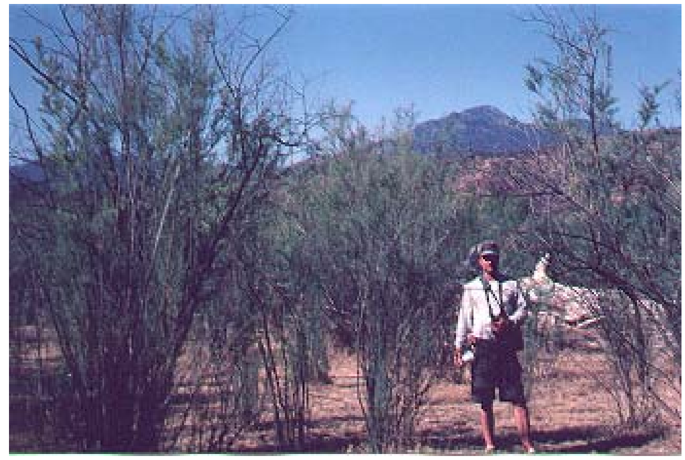


Figure 20. Example of tamarisk-dominated riparian habitat (at Roosevelt Lake, AZ) that is not suitable for Willow Flycatcher breeding. Habitat too sparse and short stature.

Figure 21. High-elevation willow habitat (on San Francisco River, AZ) that is not suitable for Willow Flycatcher breeding. Habitat too narrow, short, and low-density.

Appendix E.
Willow Flycatcher Migration and Winter Ecology

A. Introduction

As with all other Neotropical migrants, willow flycatchers (all subspecies) breed in North America, but winter in portions of Central and South America. This migration requires a round trip migration of about 3,000 - 8,000 km (roughly 2,000 to 5,000 miles) each year, depending upon exact breeding and wintering locations of a particular individual. The migration and wintering periods account for over half of the annual cycle of the flycatcher, and therefore are important to the species' ecology and conservation. Unfortunately, it is very difficult to distinguish willow flycatcher subspecies during migration and on the wintering grounds (Hubbard 1999, Yong and Finch 1999). Thus, little of what is known about willow flycatcher migration and wintering ecology is specific to the southwestern willow flycatcher (*Empidonax traillii extimus*). The information below generally pertains to the entire species and not just the endangered subspecies.

A recurring question in the overall study of Neotropical migrants, and one about which there has been much dispute, is whether these species are limited by recruitment (reproductive success on the breeding grounds in North America) or by survivorship during the winter (Rappole 1995, Bohning-Gaese et al. 1993, Sherry and Holmes 1995). As applied to declining or endangered species, such as the southwestern willow flycatcher, this question becomes one of whether the major problems facing the species are in North America or in the Neotropics. Applying this issue further to management actions, the question arises as to whether management should be focused on North America or the Neotropics. There may be a temptation to use the existence of known or potential migration and wintering ground threats as an excuse for avoiding conservation and management actions on the breeding grounds. This course of action (or inaction) is unsupportable. Neotropical migrant birds such as the willow flycatcher have a complex annual cycle that requires favorable conditions during all stages. Limiting or inadequate conditions during any of three periods (migration, winter or breeding) can cause the population to decline and/or prevent recovery. Managing for the flycatcher by addressing only threats on the migration and wintering grounds will fail to address a number of known problems on the breeding grounds (USFWS 1993, USFWS 1995; refer to Appendices F, G, H, I, and J), and recovery of the flycatcher will not be achieved.

A related but also unsupportable contention is sometimes made that it does no good to document and understand the threats on the wintering grounds because U.S. agencies have no regulatory authority to mandate or enforce conservation actions. While it is true that foreign countries through which flycatchers migrate and in which they spend the winter are not obligated to undertake conservation actions, the USFWS and many non-government organizations and conservation groups have active international programs that have successfully promoted foreign conservation issues in the past. Partners-in-Flight is one example of how governments and non-governmental organizations can interact across international boundaries to accomplish important conservation and research activities. Further, many of the conservation actions for wintering flycatchers may involve relatively small, local actions that can be executed with the assistance of foreign biologists and private citizens, without the need for "official" funds or actions. Thus, it is clearly worthwhile to identify conservation threats and pursue remedial actions outside of the United States.

Although it is important to focus management concerns and actions on both the wintering and breeding grounds of the flycatcher (USFWS 1993, USFWS 1995), one set of data suggests that the primary problems responsible for this bird's endangerment may occur on the breeding grounds. Available data (Unitt 1997) suggest that willow flycatcher subspecies all winter in the same general region (though we do not know if the proportion of each subspecies is similar throughout the winter range). If the southwestern willow flycatcher's decline were due solely or mostly to events on the wintering grounds, then all subspecies of the willow flycatcher should show declines because they all winter over the same region. However, while confirming an overall decline in the western populations (including *E.t. extimus*), Breeding Bird Survey data (from the U.S. Geological Survey) indicate that willow flycatchers are increasing in the central and eastern portions of their range. Willow flycatchers in the eastern and central parts of North America increased at average annual rates of 0.9 and 1.4%, respectively, between 1966 and 1996 (n=628 eastern and 114 western BBS routes; eastern trend significant at $P = 0.05$). By contrast, willow flycatchers in the western regions show an annual decline of 2.3% ($P < 0.01$) for the same period. These differences in population trends are not unexpected, given the fact that mesic riparian habitats that willow flycatchers require in the West are rare and have been severely impacted over the last century (USFWS 1993). In contrast, mesic habitats in which flycatchers breed are widespread in eastern and central North America and are not restricted to riparian corridors. Avian population trends are often difficult to assess, and determining underlying causes can be even more problematic. Factors causing declines in southwestern willow flycatcher populations may occur during the breeding, wintering, and/or migration periods. Prudence dictates that conservation challenges and management actions should be addressed in all three stages of the flycatcher's annual cycle. Certainly there is no justification for suggesting that management actions be restricted only to the breeding grounds or only to the wintering grounds.

B. Migration

Southwestern willow flycatchers are among the latest arriving spring migrants, and typically settle on breeding grounds between early May and early June (Muiznieks et al. 1994, Maynard 1995, Sferra et al. 1997). In south-central Arizona, a few *E.t. extimus* arrive on territories as early as the third week in April (Paradzick et al. 1999). Data on southward departure are few, but it appears that most Southwestern Willow Flycatchers leave their breeding areas in mid- to late August (Arizona Game and Fish Dept unpubl. data, B. Haas unpubl. data).

Because arrival dates of individuals vary annually and geographically, northbound migrant willow flycatchers (of all subspecies) pass through areas of the Southwest in which *E.t. extimus* are actively nesting. Similarly, southbound migrants in late July and August may occur where southwestern willow flycatchers are still breeding (Unitt 1987). This spatial and temporal overlap between migrating and breeding willow flycatchers can cause some confusion as to the actual residency and breeding status of birds detected at a site during May or early June, and detections in the "non-migration" period are often critical in verifying that flycatchers are actually attempting to breed at a site (Unitt 1987, Sogge et al. 1997a).

The migration routes used by southwestern willow flycatcher are not well documented, though more is known of spring migration than of fall migration because it is only during the former that willow flycatchers sing and can therefore be distinguished from other *Empidonax* flycatchers. In spring, mist-netting studies and general flycatcher surveys show that many willow flycatchers (all subspecies) use riparian habitats along major drainages in the Southwest such as the Rio Grande (Finch and Kelley 1999), Colorado River (McKernan and Braden 1999, Sogge et al. 1997b), San Juan River (Johnson and Sogge 1997, Johnson and O'Brien 1998), and Green River (M. Johnson unpubl. data). On these drainages, migrating flycatchers utilize a variety of riparian habitats, including ones dominated by natives or exotic plant species, or mixtures of both. Where native and non-native habitats co-occur, preliminary evidence suggests that migrating flycatchers favor native habitats, especially willow (Yong and Finch 1997), possibly because of higher insect availability (Moore et al. 1993, DeLay et al. 1999). Migrant southwestern willow flycatchers are also found, though less commonly, in non-riparian habitats.

Many of the willow flycatchers found migrating through riparian areas are detected in riparian habitats or patches that would be unsuitable for breeding (e.g., the vegetation structure is too short or sparse, or the patch is too small). Such migration stopover areas, even though not used for breeding, are critically important resources affecting productivity and survival. Willow flycatchers, like most small passerine birds, require food-rich stopover areas in order to replenish energy reserves and continue their northward or southward migration. First-year migrants travel southward through unfamiliar habitats, and may have difficulty locating stopover sites if the sites are small or highly fragmented. If stopover sites are lacking, migrating birds could fail to find sufficient food and perish. Less dramatic, but perhaps as important ecologically, flycatchers forced to spend more time in poor quality stopover habitats could arrive on the breeding grounds late and/or in poor physical condition, both of which could reduce reproductive fitness (Moore et al. 1993).

C. Wintering Locations and Biology

The willow flycatcher winters in Mexico, Central America, and northern South America (Phillips 1948, Gorski 1969, McCabe 1991, Koronkiewicz et al. 1998, Ridgely and Tudor 1994, Unitt 1999). Recent examination of flycatcher museum skins collected on the wintering grounds (Unitt 1997) suggests that the different subspecies do not winter in separate regions, rather, the subspecies co-occur on the wintering grounds. However, we do not know if the relative proportions of each subspecies are similar throughout the winter range. Two wintering southwestern willow flycatchers were recaptured 4230 and 3668 km (2820 and 2445 miles) from the U.S. breeding sites at which they were banded (Koronkiewicz and Sogge 2001). In Costa Rica, male and female flycatchers wintered at the same sites and showed no evidence of sex-based habitat segregation (Koronkiewicz and Sogge 2000, Koronkiewicz 2002).

Popular literature on the birds of Mexico, Central, and South America describes willow flycatcher wintering habitat as humid to semi-arid, partially open areas such as woodland edges (Stiles and Skutch 1989, Howell and Webb 1995, Ridgely and Gwynne 1989). Second growth forest, brushy savanna edges, and scrubby fields with hedges such as at plantations are also used. In Panamá, Gorski (1969) found them in transitional and edge areas, often near a wetland. Similarly, in Costa Rica, Panamá, and El Salvador, Koronkiewicz et al. (1998), Koronkiewicz and Whitfield (1999), and Lynn and Whitfield (2002) detected willow flycatchers in lagunas and intermittent fresh water wetlands, muddy seeps, seasonally inundated savanna/pasture and sluggish rivers, meandering waterways and oxbows (Figure 1). They found willow flycatchers only in areas that consisted of the these four main elements: 1) standing or slow moving water with associated wetland flora; 2) patches of dense woody shrubs; 3) patches and/or stringers of trees; and 4) open to semi-open areas. The most commonly used vegetation was patches of woody shrubs (*Mimosa sp*. and *Cassia sp*.) approximately 1-2 m (3-7 ft) tall, bordering and extending into wet areas.

Willow flycatchers defend winter territories at their wintering sites, and these territories remain relatively consistent over the winter (Koronkiewicz and Sogge 2000). Territorial behavior suggests that wintering flycatchers are defending one or more resources, and that high-quality winter habitat may be limited or limiting (Sherry and Holmes 1996). Individual flycatchers also return to the same wintering sites and territories each year (Koronkiewicz and Sogge 2000, Koronkiewicz 2002).

Figure 1. Willow flycatcher habitat adjacent to a sugar cane field, Pese, Panama. Photo taken by M. Whitfield, 2000.

D. Possible Threats to Migrating and Wintering Willow Flycatchers

As noted above, the migration and wintering periods are critical phases in the life of the willow flycatcher. Conservation of *E.t. extimus* must take into account the challenges and threats that the flycatcher faces during its migration and on its wintering grounds. At this time, it is not possible to identify threats specific to the endangered subspecies. However, because the timing and areas of migration and wintering overlap for all subspecies, threats that affect any one subspecies (or the species as a whole) probably affect *E.t. extimus*.

Following are some of the major and/or most obvious known and suspected threats to the flycatcher and its migration/wintering habitat.

1. Habitat Loss and Degradation

The southwestern riparian habitats through which many (likely most) southwestern willow flycatchers migrate make up only a small fraction of the landscape, are highly fragmented, and often highly impacted by human-related activities. Continued loss and degradation of migration stop-over habitats could lead to direct mortality of migrating flycatchers and/or longer migration periods with subsequent late arrival on the breeding grounds. Any of these outcomes could reduce the chances for recovery of the flycatcher. Researchers have estimated that migrating willow flycatchers can fly from about 150 km (Otahal 1998) to 225 km (Yong and Finch 1997) between stopovers (though greater distances may be possible if weather conditions [e.g., wind] are favorable). Thus, spacing of usable stopover habitats should be as continuous as possible, and should not exceed these distances.

The wintering habitats in which flycatchers have recently been found in Costa Rica, Panama, El Salvador, and Mexico (Koronkiewicz et al. 1998, Koronkiewicz and Whitfield 1999, Lynn and Whitfield 2000, Lynn and Whitfield 2002) are similarly rare at the landscape level, and subject to many human-related threats. If wintering willow flycatchers are restricted to these wet lowlands, any changes or impacts to these relatively scarce wetlands could have profound effects on a large proportion of flycatchers. These areas of the Pacific lowlands are essentially remnant woodland-wetlands in a landscape dominated by man-made savannas, pasture lands, and agricultural areas (especially sugar and rice plantations; Figure 2). Koronkiewicz and Whitfield (1999) reported that the principal threat to flycatcher wintering habitat is agriculture-related destruction, and described the loss of two occupied willow flycatcher wintering sites over the course of their short (two month) survey.

Recent increases in human populations in Central and South America have resulted in widespread loss and degradation of native habitats, including conversion of riparian and lowland wet woodlands (e.g., willow flycatcher migration and wintering habitats) to agricultural landscapes. Even if these habitats are not currently limited with respect to the flycatcher, current trends in human population growth will likely continue and further reduce available natural habitats to the point where winter and/or migration habitat becomes limiting.

2. Agrochemicals

Flycatcher wintering sites in Costa Rica, Panama, and El Salvador are embedded within a matrix of intensive agricultural land uses, many of which involve widespread and intensive use of a variety of agrochemicals (Koronkiewicz et al. 1998, Lynn and Whitfield 2000). Because wintering willow flycatchers forage extensively in wetlands that are adjacent to, or downstream of, agricultural areas, they are potentially exposed (through their prey base) to these chemicals. Recent research on the breeding grounds has identified flycatcher deformities (Sogge and Paxton 2000) and low egg hatchability (Valentine et al. 1988, Whitfield 1999, AGFD unpubl. data) that may be related to environmental toxins on the winter and/or breeding grounds.

Figure 2. Willow flycatcher habitat in La Barra de Santiago, El Salvador. The sugar cane field in the left foreground has been harvested and burned. Willow flycatchers were detected on the other side of the canal. Photo courtesy of M. Whitfield.

E. Potential Actions to Eliminate or Reduce Threats to Migrating and Wintering Flycatchers

At this time, it is not possible to target management actions specifically for the endangered subspecies. However, because the timing and areas of migration and wintering overlap for all subspecies, actions that benefit any one subspecies (or the species as a whole) will probably benefit *E.t. extimus*.

Following are research and management actions that could be used to reduce known and suspected threats to the flycatcher and its migration/wintering habitat.

1. Protect Existing Riparian Habitats

Prevent or minimize loss and degradation of riparian habitats that currently exist. Protection should be afforded to a wide variety of habitats, not simply those that have the characteristics of flycatcher breeding sites. For a migrating flycatcher, almost any riparian vegetation (with the possible exception of *Arundo*) is preferable to rip-rap banks, agricultural fields, or urban development. The presence of water can influence local insect abundance, and thus potential prey base and energy resources. Therefore, keeping water present in or adjacent to riparian habitats is desirable.

2. Restore and Expand Riparian Habitats

Expansion of riparian habitats, and restoration of those that are heavily damaged, will increase the distribution and amount of food (energy) resources available to migrating flycatchers. Thus, opportunities for creation or restoration of riparian vegetation should be pursued wherever possible, especially along portions of major river systems where riparian vegetation is rare or lacking. Again, the presence of water can influence local insect abundance, and thus potential prey base and energy resources. Therefore, riparian restoration or creation projects should include the goal of maintaining water in or adjacent to these riparian habitats.

3. Expand Research on Post-Breeding Movements and Migration Ecology

We know nothing about the immediate movements of flycatchers upon completing their nesting activities. Although recent work has shed some light on migration timing and habitat use within some major southwestern rivers, we know almost nothing about migration. Studies of migration within the U.S. should be expanded. Given that most of the distance that southwestern willow flycatchers travel during migration is outside of the U.S., research should also include the types, locations, and extent of habitats used in these areas. This could identify geographic areas of habitats of particular concern, and allow development of specific management actions. Furthermore, additional research is needed to document important migratory behaviors and pathways in the U.S., including the relative value of different riparian habitats and extent of use of non-riparian habitats. Data on age-specific survivorship during migration could yield valuable insights.

4. Expand Research on Wintering Distribution, Status, and Ecology

Recent work (Koronkiewicz et al. 1998, Koronkiewicz and Whitfield 1999, Lynn and Whitfield 2000, Lynn and Whitfield 2002) has provided valuable information on flycatcher wintering distribution, status, and ecology. However, these data are limited to only Costa Rica, Panama, El Salvador, and Mexico, which represent only a fraction of the willow flycatcher's winter range. Knowledge of winter distribution, habitat use, and threats is needed for other areas. Furthermore, research is needed on how patch characteristics such as size, vegetative composition, and landscape setting affect habitat quality and, therefore, winter survival and site fidelity. It would also be valuable to determine whether remote sensing and Geographic Information System technology could be used to characterize the distribution and availability of wintering habitat. Further information is also needed on the influence of environmental toxins and other human activities.

5. Conduct Education and Outreach

Develop and institute a program to inform the foreign governments and public about the endangered *E.t. extimus*, the importance of migration stopover and winter habitats, and the threats the flycatcher faces during these periods. Work with local biologists, government officials, and private landowners to identify specific actions that can be undertaken, at particular sites, that will benefit wintering and migrating flycatchers.

F. Literature Cited

Please see Recovery Plan Section VI.

Appendix F.

COWBIRD PARASITISM AND THE SOUTHWESTERN WILLOW FLYCATCHER: IMPACTS AND RECOMMENDATIONS FOR MANAGEMENT

1. Introduction

High rates of successful reproduction are essential for the survival and growth of populations of the southwestern willow flycatcher (*Empidonax traillii extimus*), as is the case for all small to moderate sized passerines. Large numbers of young must be produced to make up for the high mortality rates that are normal for adult passerines in temperate regions, about 44.7-64.5% for female willow flycatchers (Sedgwick and Iko 1999, Whitfield et al. 1999). Because of this high annual mortality, most willow flycatchers do not live long enough to breed in more than one breeding season. Many factors act to lower the reproductive output of passerines (Martin 1992), including predation of eggs and nestlings, poor feeding conditions due to marginal habitat or inclement weather, anthropogenic toxins and cowbird parasitism. This paper addresses the ways in which cowbird parasitism affects willow flycatcher reproduction, whether such effects are important to population growth or regulation on local and regional bases, whether population level effects are sufficient to warrant management action and the most appropriate actions that land managers can take if cowbird management is warranted. These are complicated issues because cowbirds are native, widespread songbirds that are closely associated with human activity and because impacts to individual willow flycatchers that are parasitized, no matter how severe, may have little or no effect on flycatcher populations. On the other hand, even small reductions in willow flycatcher reproductive success could be the difference between a declining population versus a stable or slowly growing one if a population is experiencing other difficulties. This paper's goal is to provide the necessary background information needed for managers to make appropriate decisions regarding cowbirds; a basic message throughout the document is that managers need to be flexible rather than reflexive when it comes to cowbird parasitism. Predation of eggs and nestlings lower flycatcher reproductive output as much as or more than cowbird parasitism. However, management actions at present need to focus on parasitism, when it is sufficiently intense according to the guidelines laid out herein, because there are no feasible means of lowering nest predation without severely impacting entire ecosystems, unlike the case for deterrence of cowbird parasitism. Predation and the need for research on acceptable means to deter it are discussed in an appendix to this paper.

To guide the reader through this document an outline of the remaining major sections appears below. Readers familiar with cowbird and host biology can skip to section 7; those wanting a quick guide to management recommendations can skip to section 11.

2. Background on brood parasitism.
3. Cowbird impacts on host populations.

4. Host defenses against cowbird parasitism.
5. Key indicators of impacts at the population level.
6. Recent changes that may be responsible for possible increases in cowbird impacts.
7. Can southwestern willow flycatcher populations survive in the presence of cowbird parasitism?
8. Does cowbird parasitism necessitate management actions? .
9. Potential management approaches.
10. Is cowbird control a longtime or even permanent need?
11. Conclusions regarding cowbird management methods.
12. Potential positive and negative aspects of cowbird control.
13. Recommendations for cowbird management.

Appendix. The importance of nest predation and potential management actions.

2. Background on Brood Parasitism

Brood parasitism is an alternate form of breeding biology in which animals lay eggs in the nests of other individuals, their hosts, which then provide all needed parental care. This form of breeding biology has been widely studied in birds and insects (Davies et al. 1989). Among birds, parasitism can be intraspecific or interspecific. In intraspecific parasitism, which occurs in numerous bird species, individuals lay eggs in nests tended by other members of their own species. Interspecific parasitism involves laying eggs in the nests of other species. Worldwide, about 1% or roughly 100 species of birds are obligate interspecific parasites, meaning that no members of their species care for their own young (Rothstein and Robinson 1998). One or more species of obligate interspecific parasites occur over most of the land masses of all continents except Antarctica and this form of breeding biology has evolved independently six to eight times among extant bird species. Recent books providing general treatments of avian brood parasitism are Johnsgard (1997), Ortega (1998) and Rothstein and Robinson (1998).

Three obligately parasitic birds occur in North America, the brown-headed, bronzed and shiny cowbirds (*Molothrus ater, M. aeneus* and *M. bonariensis*, respectively). Lowther (1993, 1995) provides reviews of the overall biology of the first two species and Ahlers and Tisdale (1998a) have compiled a useful annotated bibliography for the genus *Molothrus*. Only the brown-headed cowbird is widespread in the United States, with breeding occurring in all states except Hawaii and only it has been implicated frequently in declines of other bird species in North America. The bronzed cowbird occurs sporadically from southeastern California to southern Louisiana and may be a factor, along with habitat loss, in declines of several oriole species (*Icterus* spp.) in the Lower Rio Grande Valley (Brush 1993, Brush pers. comm.). Bronzed cowbirds generally parasitize moderate to large passerines (Friedmann and Kiff 1985) and there are no published reports of parasitism on willow flycatchers in the scientific literature.

There was only one case of bronzed cowbird parasitism among the hundreds of southwestern willow flycatcher nests monitored in the 1990s in Arizona and New Mexico, a New Mexico nest cited Skaggs (1996). Therefore, this cowbird is not a management concern at present given the rarity with which it parasitizes willow flycatchers. The shiny cowbird has recently begun to occur in southern Florida and may be breeding there (Cruz et al. 1998). Because of the restricted ranges of the bronzed and shiny cowbirds, this paper focuses only on brown-headed cowbirds. However, if the two former cowbird species were to increase substantially in distribution and abundance, they too might require attention as regards management issues (Cruz et al. 1998). All further mention of cowbirds refers to the brown-headed cowbird.

Most parasitic bird species specialize on one or a few host species, or a complex of similar species, but brown-headed cowbirds are generalists and parasitize most co-occurring passerine species, although at greatly varying intensities. They are known to have parasitized at least 220 bird species and to have been raised by 144 of these (Lowther 1993). Even individual female cowbirds do not specialize on a single host species (Friedmann 1963, Fleischer 1985, Hahn et al. 1999). Therefore, parasitism can drive a rare host species to extinction because there is no feedback process that lowers cowbird numbers and thus parasitism rates when a rare and heavily impacted host species declines (Rothstein 1975a, Mayfield 1977, Grzybowski and Pease 1999). In other words, common host species could maintain high cowbird populations even as a rare host is pushed to extinction by cowbird parasitism. Another aspect of cowbird biology that raises the potential of major effects on host populations is the large number of eggs individual females lay. Studies from diverse regions and habitats across North America used postovulatory follicles or oviducal eggs to assess cowbird laying rates and reported that females lay eggs on about 70% of the days during their breeding season (Rothstein et al. 1986, Fleischer et al. 1987). This laying rate translates to 42 eggs for a two month breeding season and 40 or more eggs per season is commonly cited as the likely number of eggs females lay. However, many, perhaps most, of these eggs have no effect on host productivity because they are laid in nests that are lost to predation or in nests of host species that eject them (Rothstein 1977, Robinson et al. 1995a). Furthermore, a recent study (Hahn et al. 1999) that used molecular markers to determine the identity of laying females responsible for cowbird eggs and nestlings found in host nests estimated that a female's "effective fecundity" is only 2 to 8 eggs. Effective fecundity refers to cowbird eggs that are laid in nests of hosts that accept cowbird eggs. These new data suggest that cowbirds have much less potential to impact host populations than is currently believed to be the case (Hahn et al. 1999). More research is needed on this important issue because it is possible that Hahn et al. (1999) did not find all of the nests in which cowbirds might have laid eggs, whereas previous studies using the postovulatory follicle or oviducal egg methodologies are reliable in revealing numbers of eggs laid.

Unlike some brood parasites, whose young directly kill off all host young, nestling cowbirds take no direct action against host young (see Hoffman [1929] in Ahlers and Tinsdale [1998] and Dearborn [1996] for possible rare exceptions). However, host species divert parental care from their own offspring to cowbird offspring. As a result, hosts nearly always experience some reduction in their own reproductive output. More explicitly, host losses are due to female cowbirds removing one or more host eggs from most nests they parasitize (Sealy 1992), to host egg damage by adult cowbirds (Peer and Sealy 1999) and to cowbird nestlings hatching before those of most hosts (Briskie and Sealy 1990, McMaster and Sealy 1998) and usually being larger (Friedmann 1963, Lowther 1993). The larger, more advanced cowbird nestlings often outcompete host nestlings for food brought to the nest by adult hosts although large host species usually raise some of their own young when parasitized. Small hosts with long incubation periods experience the greatest losses and willow flycatchers, in particular, usually lose all of their own young if a cowbird egg is laid during their laying period and hatches successfully (Sedgewick and Iko 1999, Whitfield 2000). For southwestern willow flycatchers, only 14% of 133 and 13% of 31 parasitized nests in California and Arizona, respectively, produced any host young, compared to 54% of 190 and 60% of 133 unparasitized nests in these two states (Whitfield and Sogge 1999). Lorenzana and Sealy (1999) have provided a recent review of the costs a range of cowbird host species incur when parasitized.

Robinson et al. (1993, 1995) provide comprehensive reviews of cowbird biology and impacts on hosts. Two extensive recent works on cowbird-host interactions and cowbird management are Morrison et al. (1999) and Smith et al. (2000). The latter volumes contain papers presented at two national workshops on cowbirds and their hosts in 1993 and 1997, each attended by at least 200 people (Holmes 1993, Rothstein and Robinson 1994). These two workshops have greatly expanded our knowledge of cowbird-host interactions and related management issues and the resulting volumes are essential reading for anyone contemplating cowbird management. Another recent useful reference is Ahlers and Tinsdale (1998), which provides an annotated bibliography of technical literature on cowbirds. Schweitzer et al. (1998) and Boren (1997) provide reviews of cowbird-host interactions and focus on southwestern willow flycatchers.

3. Cowbird Impacts on Host Populations

It is essential to keep in mind that although the individual hosts that are parasitized incur costs, such reductions in reproductive output do not necessarily have impacts upon host populations or entire species because density dependent processes, such as habitat availability, may limit passerine birds (Sherry and Holmes 1995). The decrease in recruitment to a host population due to cowbird parasitism may simply mean that fewer excess individuals die without producing young because they can not secure a breeding territory or because they can not find enough food to feed themselves. Determining whether cowbird parasitism has an impact at the level of a host population or species is the most significant challenge facing conservation biologists concerned with cowbirds and their hosts. Even if parasitism is shown to limit a host species, one must decide whether that limitation is a cause for concern because every population must ultimately be limited by some factor. Unless population limitation due to parasitism is a recent situation brought about by anthropogenic factors, there is no reason to believe that this limitation is any less natural than limitation by competition, habitat, nest predation or disease.

On the other hand, any factor that limits a species or subspecies that is rare is of course a source of concern, even if the factor is wholly natural. Thus even a moderate loss in recruitment due to parasitism may require management action for a rare species and especially for an endangered one. If parasitism is the only reason for a taxon's rarity, then long-term reduction of cowbird impacts is likely to be needed. However, all endangered passerines that appear to be affected adversely at the population level by parasitism also suffer from a severe scarcity or degradation of habitat due to anthropogenic factors (Rothstein and Cook 2000). It is likely in all cases that these endangered birds would be able to coexist with cowbirds if their habitat problems were remedied.

Besides a reduction in the total number of young produced, parasitism can also affect small host populations negatively by causing some host individuals to suffer complete failure. These failures reduce the number of adults that contribute offspring to succeeding generations. The latter number is known as the effective population size and population viability theory holds that as populations decline, there is an increasing risk that stochastic events and genetic factors will lead to extinction. Another potential cost of parasitism is the possibility that the extra parental effort needed to rear cowbirds and to renest after deserting parasitized nests reduces the subsequent survival of adult hosts. But a long-term study of the willow flycatcher found no evidence for such reductions (Sedgwick and Iko 1999).

Another potential impact of cowbirds is that they may depredate unparasitized nests to cause renesting by hosts with nests too advanced to be parasitized (Arcese et al. 1996). This cowbird predation hypothesis is based on a correlation between nest failure rates and cowbird presence in an island population of song sparrows (*Melospiza melodia*) in British Columbia and could mean that host populations suffer greater losses due to cowbirds than has previously been realized. If cowbirds manage host populations as predicted by the cowbird predation hypothesis, unparasitized nests should have higher predation rates than parasitized ones but no such overall trend has been found among nesting studies of cowbirds and their hosts (Rothstein 1975b, Kus 1999, Whitfield 1999). The hypothesis also predicts that nest predation should decline when host populations are protected by cowbird removal programs. But no such decline is evident for southwestern willow flycatchers, either among years with versus without cowbird removal (Whitfield et al. 1999) or within the same year between areas with and without cowbird removal (Whitfield 2000). There was also no marked change in predation of nests of another endangered species, Kirtland's warbler (*Dendroica kirtlandii*), after a cowbird removal program began (Walkinshaw 1983). Similarly, Stutchbury (1997) reported that removal of cowbirds had a large effect on parasitism rates of hooded warblers (*Wilsonia citrina*) but no effect on reproductive success because nest predation was high in areas with reduced cowbird numbers.

There are direct observations of cowbirds removing nestlings and eggs and therefore acting as predators (Tate 1967, Scott and McKinney 1994) but this is also true for other passerines not regularly thought to be predators such as red-winged blackbirds (*Agelaius phoeniceus*), yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) and gray catbirds (*Dumetella carolinensis*) (Belles-Isles and Picman 1986, Sealy 1994, Cimprich and Moore 1995). Video documentation of predators at nests of two frequently parasitized host species showed that a cowbird was responsible for only one of 25 predation events at a Missouri study site where cowbirds were abundant (Thompson et al. 1999). Observations of removal of eggs or nestlings in Manitoba showed that cowbirds were responsible for five of 26 events. But none of the events involving cowbirds were clear cases of nest predation because only single eggs were removed in each case (Sealy 1994).

Recent studies by the same research group in British Columbia that proposed the cowbird predation hypothesis have produced results generally supporting the hypothesis for song sparrows (DeGroot et al. 1999, Arcese and Smith 1999). However, these recent studies have not determined whether heightened rates of nest failure associated with cowbirds are due to desertion of parasitized nests (a well known phenomenon) or to predation of unparasitized nests. With the present data available, we do not believe that cowbirds depredate unparasitized nests regularly enough to make this a management concern but additional research is needed.

4. Host Defenses Against Cowbird Parasitism

Besides its relevance to conservation biology, brood parasitism has long attracted the attention of biologists due to the opportunities it provides for studies of the evolution of adaptations that facilitate and deter parasitism by parasites and hosts (Rothstein 1990). These studies of parasite-host coevolution have shown that many species have evolved egg recognition in response to brood parasitism and selectively remove foreign eggs from their nests. In North America, such birds are known as rejecter species and nearly 100% of the individuals in their populations reject eggs unlike their own (Rothstein 1975a). Species that possess effective host defenses are unlikely to be impacted at the population level by cowbird parasitism. Most passerine birds in the Old World show some level of egg recognition (Davies and Brooke 1989, Moksnes et al. 1991, Nakamura et al. 1998) probably reflecting their long histories of contact with parasitic cuckoos of the subfamily Cuculinae (Rothstein 1994a). However, cowbird parasitism evolved much more recently than cuckoo parasitism (Rothstein et al. 2002)and only about 25 North American species are rejecters (Rothstein 1975a, Ortega 1998).

Most North American passerines are accepters in that they do not remove cowbird eggs placed in their nests and continue to incubate parasitized clutches. These species even incubate clutches consisting totally of cowbird eggs (Rothstein 1982, 1986). Recent work indicates that a small number of species that have cowbird-like eggs and that were previously classed as accepters actually manifest some degree of egg recognition when experimentally parasitized with eggs divergent from their own and from cowbird eggs (Burhans and Freeman 1997). It has long been known that although accepter species do not remove cowbird eggs from their nests, they often desert naturally parasitized nests and renest (Friedmann 1963, Rothstein 1975a, Graham 1988). This desertion/renesting response is not in response to cowbird eggs, because it is very rare after nests are experimentally parasitized by people (Rothstein 1975a,b) and is apparently in response to detection of adult cowbirds near or at nests (Burhans 2000). A recent synthesis of data from 60 studies on 35 host species showed that heightened desertion tendencies are likely to have evolved in response to cowbird parasitism. Desertion of parasitized nests is most likely in species that have broad habitat overlap with cowbirds and that experience high losses when they accept parasitism (Hosoi and Rothstein 2000).

However, even species with relatively high desertion rates often accept cowbird parasitism (Hosoi and Rothstein 2000) and parasitized individuals that fail to desert commonly suffer extreme reductions in reproductive output. Thus nest desertion, unlike egg ejection, is only partially effective as a host defense. As a number of recent studies on avian breeding biology have shown (Sedgewick and Knopf 1988, Pease and Gryzbowski 1995, Gryzbowski and Pease 1998, 2000; Schmidt and Whelan 1999, Woodworth 1999), the key metric of productivity for birds should be a female's seasonal output of young, not the more easily determined metric of productivity per nest. Because of renesting, the latter metric inflates the impacts of parasitism and nest predation. Southwestern willow flycatcher's desert about 35-57% of parasitized nests (Table 1). Thus the decline in willow flycatcher recruitment due to cowbird parasitism is something on the order of 43-65% of the parasitism rate, i.e., individuals that desert and then are not parasitized during a renesting attempt may experience little or no decline in reproductive output due to cowbirds. Similarly, many parasitized nests will be depredated and this too will often lead to renesting and an unparasitized nest. A small number of flycatchers build over parasitized nests and lay a new clutch in the same structure (Whitfield 1990), which is functionally similar to renesting.

Table 1. Desertion rates of parasitized willow flycatchers in different regions.

Subspecies	Region	New contact[1]	Parasitism rate (N[2])	Desertion rate (N[3])	Reference
extimus	California	Yes	68% (19)	57% (14)	Harris 1991
extimus	California	Yes	63% (60)	45% (38)	Whitfield 1990
extimus	New Mexico	No	22% (129)	35% (26)	Stoleson & Finch 1999
extimus	Arizona	No	7% (203[4])	36% (14)	Paradzick et al. 1999
trailii	Colorado	?[5]	45% (27)	82% (11)	Sedgwick & Knopf 1988
trailii	Michigan	Yes	10% (325)	27% (33)	Berger 1967
trailii	Ohio	Yes	9% (88)	63% (8)	Holcomb 1972

[1] Populations noted as yes under New Contact were allopatric with respect to cowbirds in pre-Columbian times.
[2] N reflects number of nests for which parasitism status (parasitized or unparasitized) could be determined.
[3] N reflects number of parasitized nests for which desertion status (deserted or not deserted) could be determined.
[4] Most of these nests were protected by cowbird trapping. Parasitism at two sites with no trapping was 0 of 8 nests (Alamo Lake) and 6 of 16 nests (Camp Verde).
[5] Sedgwick and Knopf (1988) thought this high elevation population was only recently exposed to parasitism but it is close to the

cowbird's center of abundance in the Great Plains, and Chace and Cruz (1999) suggest that cowbirds occurred in the region in the 1800s before bison were nearly extirpated.

Desertion of a parasitized nest results in total failure for the nest and renesting incurs a risk that a willow flycatcher's new nest will also be parasitized. Nevertheless, desertion and renesting is nearly always the best tactic for parasitized willow flycatchers because it allows them to trade a 100% certainty of parasitism and little chance of producing any young of their own for a lesser chance of parasitism. However, while renesting may allow parasitized flycatchers that desert to raise as many young as unparasitized individuals, it could incur costs such as increased reproductive effort and late fledging of young, which could result in reduced survivorship of adults and young. But extensive analyses have found no clear evidence for such costs (Sedgewick and Iko 1999). For example, 48.9% of 92 parasitized female *E. t. adastus* returned in a subsequent breeding season compared to 55.2% of 255 unparasitized females, a difference that is not significant statistically. Among birds that were successful in fledging one or more flycatcher young, 72.0% of 50 parasitized females and 56.5% of 184 unparasitized females returned in a subsequent breeding season, a significant ($P < 0.048$) difference (Sedgewick and Iko 1999). The lack of detectable deleterious effects of breeding effort on adult willow flycatcher survival is a common result for passerines and only manipulative studies can address this issue adequately (Nur 1988). Sedgewick and Iko (1999) reported that the earliest fledged flycatchers (*E. t. adastus*) were significantly more likely to return to their study sites than were young that fledged in mid-season or later. Whitfield et al. (1999a) found that southwestern willow flycatcher young that fledged early in the breeding season were more likely to return to the South Fork Kern River than those that fledged later but the difference was not significant statistically. Another potential cost of desertion and renesting is that it may not allow birds enough time to engage in double brooding, which is the raising of a second brood after young from the first nest fledge. Paradzick et al. (1999) reported that 15 of 123 southwestern willow flycatchers in Arizona raised two broods in 1998. The extent to which renesting after parasitism deters attempts to raise second broods is unknown, but could have a small to moderate depressing effect on recruitment. Lastly, desertion of a series of nests, each of which is parasitized could leave a flycatcher with insufficient time to raise any young. However, the latter may be a rare occurrence because willow flycatchers continue to breed well after all or most cowbirds have stopped laying (below).

In addition to nest desertion as a host defense, many hosts, including southwestern willow flycatchers (Uyehara and Narins 1995), recognize cowbirds as special threats and attack them or sit tightly on nests in an attempt to keep cowbirds from laying (reviewed in Sealy et al. 1998). However, such tactics are not very effective, especially for small hosts, which are often parasitized at high rates despite their responses to adult cowbirds because they are unable to drive cowbirds away. Heightened aggression towards cowbirds may even be maladaptive as cowbirds may use this host behavior to reveal nest locations (Smith et al. 1984).

5. Key Indicators of Impacts at the Population Level

The degree of lost reproductive output that individual parasitized members of a species incur and the parasitism rate (% of nests parasitized) are the two most vital parameters as regards impacts of parasitism at the population level. The timing and duration of a host species' breeding season are important determinants of parasitism rate. Cowbirds begin to breed later than some of their major hosts. Because early nests tend to have the greatest potential productivity, early breeding hosts may experience little or no impact at the population level even if late nests suffer high rates of parasitism. However, southwestern willow flycatchers are among the last passerines to breed (Whitfield 2000) and may experience high parasitism levels of their earliest and potentially most productive nests. Willow flycatchers may also sometimes be subject to unusually high rates of parasitism due to the scarcity of other hosts species nesting late in the season. Thus cowbird impacts on willow flycatcher populations are potentially greater than on most host species. Late willow flycatcher nests are likely to escape parasitism completely because the cowbird laying season generally ends in early to mid-July (Stafford and Valentine 1985, Fleischer et al. 1987, Lowther 1993), although exceptional eggs have been laid into early August (Friedmann et al. 1977, p. 47).

As with all host species (Robinson et al. 1995a), parasitism rates on willow flycatchers are highly variable in space and time, both within a breeding season and across years. Even populations separated by only a few km may experience markedly different parasitism rates (Sedgewick and Iko 1999). Table 2 lists parasitism rates (for samples of 10 or more nests), in the absence of cowbird control, for populations from throughout the range of the southwestern willow flycatcher. Note that parasitism ranges from 29% to 66% for California sites, and from 3% to 48% for Arizona sites. Parasitism has the greatest impact on willow flycatchers in California because the largest population in that state consistently experienced rates of at least 50% in the absence of cowbird control. By contrast, the largest populations in Arizona (San Pedro River, Roosevelt Lake) and New Mexico (Gila River) have experienced mean yearly rates of 3% to 18% (Table 2).

Because of the large range in parasitism rates of the southwestern willow flycatcher, baseline nesting studies need to be done on each population to determine whether cowbird parasitism is a serious problem (Whitfield and Sogge 1999). Some populations that incur parasitism may be doing well even without management efforts directed at cowbirds. For example, the largest southwestern willow flycatcher population, in the Cliff-Gila Valley of NM, appeared to grow from 1997-1999 (Stoleson and Finch 1999; S. H. Stoleson pers. comm.) despite parasitism rates of 11% in 1997, 27% in 1998 and 16% in 1999. This population declined from 1999 to 2000 and was stable from 2000 to 2001. The parasitism rates in 2000 and 2001 were within the range seen in earlier years.

Table 2. Geographic variation in cowbird parasitism rates (in the absence of cowbird control) of southwestern willow flycatchers from different regions. Data are from Whitfield and Sogge (1999) unless noted otherwise.

Locality	Years covered	No. nests	Mean annual parasitism rate
South Fork Kern R., CA	87, 89-92	163	66%
Santa Ynez R., CA[1]	95-97	17	29%[1]
Virgin R. delta, NV	97	14	21%
Grand Canyon, AZ	82-86, 92-96	25	48%
White Mtns., AZ	93-96	36	19%
San Pedro R., AZ	95-96	61	3%
Roosevelt Lake, AZ	95-96	17	18%
Verde R., AZ	96	13	46%
Verde R., AZ[2]	98	16	38%
Gila R., NM	95,97	49	18%
Gila R., NM[3]	97-99	>129[3]	18%[3]
various sites, NM	95	10	40%

[1] Data from Farmer (1999b). Parasitism rate is an overall one, not a mean for years covered.
[2] Data from Paradzick et al. (1999).
[3] Data from Stoleson and Finch (1999) and Stoleson (pers. comm.). There were 129 nests in 1997-98 and sample size for 1999 nests was not available, hence number of nests is given as > 129.

Given the temporal variability in the frequency of cowbird parasitism (Sedgewick and Iko 1999; Whitfield and Sogge 1999), baseline studies to assess degree of risk due to cowbirds should usually include at least two and preferably more years of data collection before cowbird management is considered. However, a first year of data collection showing a rate of parasitism of >30% may alone warrant cowbird management if based on a reliable sample size free of temporal and spatial biases (see Management Recommendations, below). In addition, field workers can remove cowbird eggs from accessible parasitized nests (or addle them) during baseline studies to lessen the impacts of parasitism if there is concern about the persistence of a parasitized population. This sort of manipulation of parasitized nests has proven effective with another endangered cowbird host (Kus 1999), and is discussed in more detail below.

In reporting data on parasitism rates, workers should always include sample sizes if the intent is to represent region-wide impacts, i.e., the number of nests sampled and not just parasitism rates. Because of sampling error, parasitism rates based on small numbers of nests may have little statistical validity when it comes to assessing overall cowbird impacts, i.e., statements that parasitism can reach 100% may mean little if the 100% rate is based on a small sample. Baseline data on parasitism rates need to control for spatial and temporal variation in parasitism rates. For example, a sample composed of only early or late nests or of only nests from the periphery of a large habitat patch may not reflect overall parasitism rates. In addition, small populations may experience especially high parasitism rates that are not representative of larger ones (see below). However, if a small population is consistently parasitized heavily and if it has enough suitable habitat to allow significant growth, it may still be a good candidate for cowbird management, as discussed below under Management Recommendations.

6. Recent Changes That May Be Responsible For Possible Increases In Cowbird Impacts

The cowbird is a native North American bird with widespread fossils from California, Florida, Virginia, New Mexico and Texas dating from 10,000 to 500,000 years before the present (Lowther 1993). Data on DNA sequence divergence indicate that cowbirds have been in North America for at least 800,000 years (Rothstein et al. 2000). Because cowbirds represent an ancient component of the North American fauna, at least as regards ecological time scales, their impacts are unlikely to endanger host species in the absence of major ecological changes. One such change is a loss or deterioration of breeding habitat, something that is well recognized as the major cause of the southwestern willow flycatcher's decline (Unitt 1987, U. S. Fish and Wildlife Service 1995) and of the declines of other endangered host species that are impacted by cowbirds (Rothstein and Cook 2000). Another possible ecological change that could perturb stable cowbird-host interactions is an increase in the abundance and distribution of cowbirds, which could cause a previously parasitized and stable host population to decline. Host populations that have only begun to experience parasitism due to documented cowbird range extensions in the last century might be especially likely to decline because they could lack evolved host defenses present in conspecific populations with long histories of parasitism. Given these considerations, trends in cowbird numbers and range extensions are important issues.

The first available historical records show the presence of cowbirds throughout the Southwest as far west as the Colorado River in the mid 1800s (Rothstein 1994b). These were members of the dwarf race of the cowbird, *M. a. obscurus*. The much larger Nevada race, *M. a. artemisiae,* occurred to the north of the southwestern willow flycatcher's range in California, Oregon and Washington on the eastern slopes of the Sierra Nevada and Cascades mountain ranges and east to the northern Great Plains (Friedmann 1929, Rothstein 1994b). Dwarf cowbirds colonized southern California and all of the area west of the Sierra and Cascades since 1900. Thus parasitism is a new pressure only for southwestern willow flycatchers breeding in southern California.

However, cowbirds might be more common and more widespread today than under original conditions, even within their historical range. An analysis of parasitism rates of southwestern willow flycatchers showed large increases in data for California and Arizona combined (Whitfield and Sogge 1999). However, more analyses are needed to determine whether cowbird impacts have increased in the original contact zone in Arizona because the increasing trend in the lumped data for both states may have been driven by the cowbird's increase in California. Some early pre-1920s visitors to the cowbird's original range in the Southwest reported that cowbirds were uncommon, while others reported them to be common in habitats used by southwestern willow flycatchers (Whitfield and Sogge 1999).

In contrast to the uncertainty concerning cowbird population trends over the last century, data from the Breeding Bird Survey (BBS) provide more reliable indicators of recent population trends. Averaged across North America, cowbirds have shown a significant decline of 1.1% per year since the inception of the Survey in 1966 (Sauer et al. 1997). Among 21 states and Canadian provinces with statistically significant ($P < 0.05$) increasing or decreasing cowbird numbers, 19 show declines and two increases. Fish and Wildlife Service Regions 2-5 show significant yearly declines of 0.7 to 2.7%. Region 1 shows a yearly decline of 1.6%, which is not quite significant ($P = 0.06$). Only Region 6 shows an increasing trend, 0.2% per year, but this trend is not close to significance ($P = 0.49$). Focusing on the states that contain the largest numbers of southwestern willow flycatchers, cowbirds have shown moderate declines in Arizona and California and a moderate increase in New Mexico (all trends nonsignificant statistically). These data refer to the entire period over which the BBS has been carried out. If data are partitioned by time, and states or provinces with positive or negative trends are tallied (regardless of whether trends for individual states/provinces are significant statistically), 25 of 51 states/provinces had negative trends from 1966-79 versus 37 of 52 from 1980-96. Significantly more states and provinces had decreasing cowbird numbers in the more recent period than in the first period ($X^2 = 5.26$, df = 1, $P = 0.02$). Thus cowbird numbers appear to have gone from no overall trend from 1966-79 to a mostly declining trend from 1980-96. Most recent BBS data for 1997 to 1999 show stable cowbird numbers in Arizona, California and New Mexico for these years. These various data are contrary to the widespread belief (Brittingham and Temple 1983, Terborgh 1989) that cowbirds are increasing over much of their range.

It is worth keeping in mind that even if cowbirds have not increased in recent years or since the 1800s (except in California), willow flycatchers and other riparian species have decreased, so increasing cowbird to host ratios may have resulted in escalated rates of parasitism even in areas of old sympatry between cowbirds and southwestern willow flycatchers. The potential phenomenon of increased cowbird impacts in the absence of increased cowbird numbers may be especially likely in riparian habitats because cowbirds show a distinct preference for riparian habitats in the West (Farmer 1999a, Tewksbury et al. 1999). This preference, along with the massive loss of riparian habitat in the southwestern willow flycatcher's range may mean that the numbers of cowbirds that use riparian habitat may be similar to those that prevailed years ago but that those cowbirds are now highly concentrated into the small remnants of remaining habitat, with consequent large increases in parasitism rates.

7. Can Southwestern Willow Flycatcher Populations Survive In The Presence of Cowbird Parasitism?

It is clear that most southwestern willow flycatcher populations are viable even when exposed to cowbird parasitism, at least under primeval conditions, because cowbirds and southwestern willow flycatchers have long been sympatric over most of the latter's range. Cowbird parasitism is a new pressure only for southwestern willow flycatchers in southern California. These latter populations might not be viable in the presence of cowbirds, regardless of environmental conditions, because they lack evolved defenses against cowbirds, as proposed for the least Bell's vireo, *Vireo bellii pusillus* (U. S. Fish and Wildlife Service 1998). However, the willow flycatcher's only evident defense against parasitism, renesting, is as frequent in southern California populations as in populations further east with longer histories of parasitism (Table 1). Because the latter willow flycatcher populations have coexisted with cowbirds, it is likely that newly exposed populations can also do so, unless they are experiencing a marginal existence even in the absence of parasitism.

Given what is known about rates of subspecific differentiation (Avise and Walker 1998) in birds, southwestern willow flycatchers have probably been undergoing genetic divergence and been at least partially isolated spatially from other willow flycatcher races for more than 200,000 years. Except for the last 10-20,000 years of this period, various species of bison, horses and other ungulates likely to serve as cowbird foraging associates have occurred throughout the range of the willow flycatcher, including southern California (Pielou 1991, Stock 1992). It is unlikely that the southwestern willow flycatcher had precisely the same range in the past as it does today but the ubiquitousness of large ungulates throughout North America (Pielou 1991), leaves little doubt that they and cowbirds occurred everywhere or most places willow flycatchers occurred. Thus it is likely that all southwestern willow flycatcher populations are descended from populations that experienced past episodes of cowbird parasitism and therefore selection for host defenses. The occurrence of high nest desertion tendencies in California willow flycatchers is likely due to retention of host defenses that evolved in ancestral populations that experienced cowbird parasitism, although gene flow from other parts of the flycatcher's range may also be a factor.

The occurrence and long term retention of high nest desertion tendencies in unparasitized populations is characteristic of North American hosts that use habitats similar to those used by cowbirds, namely woodland edges and fields rather than forest interior. Indeed, the degree of habitat overlap with cowbirds is a better predictor of desertion tendency than is current or recent degree of geographic overlap with cowbirds over historical time scales (Hosoi and Rothstein 2000). Another endangered riparian host, and one whose entire range has been occupied by cowbirds in this century is the Least Bell's Vireo. Kus (1999) reported that it deserted 29% of 205 parasitized nests, contrary to the widespread belief (U. S. Fish and Wildlife Service 1998) that it lacks defenses against parasitism. A study of Bell's Vireos in Missouri where the species has experienced cowbird parasitism since pre-Columbian times reported desertion at 59% of 66 parasitized nests (M. Ryan pers. comm.). It is unclear whether these different desertion rates reflect intrinsic differences in the California and Missouri vireo populations or differences in research techniques. Observed incidences of desertion are inversely proportional to the interval between nest checks (Pease and Grzybowski 1995) and nests were checked weekly in the California study but daily in the Missouri one.

Thus given adequate habitat and an absence of unusually severe demographic impacts such as high levels of nest predation and low levels of juvenile and adult survival, it is possible that all populations of these obligate riparian hosts, even ones newly sympatric with cowbirds, can remain viable if exposed to cowbirds. A demographic analysis of the southwestern willow flycatcher population along the Kern River, which is among the largest populations in California, indicates that this population can not grow unless parasitism is about 10% or less (Ueyahara et al. 2000). If a population cannot sustain itself in the presence of a 10% or less loss in recruitment, it must be a marginal one for reasons unrelated to cowbird parasitism. This same population was able to remain stable and possibly even grow from 1982-89 (Whitfield 1999) despite a 68% parasitism rate in 1987 (Harris 1991), the one year this rate was determined. Thus some critical variable, probably a decreaase in egg hatchability (Whitfield 2002), has changed in recent years. In short, data from extant populations and inferences based on the Pleistocene history of North America, indicate that all southwestern willow flycatcher populations can co-exist with cowbirds unless they also experience some new pressure such as severe habitat losses.

8. Does Cowbird Parasitism Necessitate Management Actions?

As described above, cowbird parasitism per se does not necessarily warrant management action. Parasitism is a naturally occurring process and may have no effect on the size of host breeding populations, even if it causes major reductions in host breeding success. But parasitism can push a host population or even an entire host species or subspecies to extinction under certain conditions. Furthermore, even if a local parasitized host breeding population is stable, parasitism may reduce the number of excess host individuals that might become floaters available to replace breeders lost to mortality or that might disperse and sustain other populations or initiate new populations. Nevertheless, there is no need to always attempt to reduce cowbird parasitism whenever it occurs. Cowbirds are native birds and as such are as important to biodiversity as are endangered species. They may even affect overall avifaunas in complex and unexpected ways, by for example limiting the numbers of some common species and thereby allowing the persistence of other species that might be out-competed by these species. Thus cowbirds could serve as keystone species (Simberloff 1998) just as do some predators that enhance biodiversity by reducing the numbers of certain prey species that would otherwise out-compete and cause the extinction of less competitive species.

Nevertheless, there are certainly some circumstances in which it is prudent to employ management actions designed to deter cowbird parasitism. The circumstances that should trigger cowbird management may differ from site to site because a number of potential site-specific factors are involved, including a host population's current size, its recent population trend, its parasitism rate, the amount of suitable habitat and the extent of the losses attributable to cowbird parasitism. These and other factors are discussed in greater detail below but management actions are constrained by what is possible to achieve. So first we review the range of management actions that may be available.

9. Potential Management Approaches

1. Landscape-Level Management

Cowbird distribution and abundance might be reduced to some extent by landscape-wide measures aimed at reducing anthropogenic influences that benefit this species. Cowbirds typically feed in areas with short grass (Friedmann 1929, Morris and Thompson 1998) and in the presence of ungulates such as bison and domesticated livestock. Besides livestock, cowbird feeding is often associated with other anthropogenic influences such as campgrounds, suburban areas with lawns and bird feeders and golf courses. It is unclear whether cowbirds always require anthropogenic food sources or native ungulates (Goguen and Mathews 1999). But the extent to which they associate with anthropogenic food sources depends on local landscapes. In the Eastern Sierra of California where most of the habitat is forests, sagebrush or arid, sparsely vegetated meadows, cowbird foraging is nearly always linked to human influences such as bird feeders, campgrounds, range cattle and pack stations (Rothstein et al. 1980, 1984; Airola 1986). A similar link with anthropogenic influences, has been found in other forested regions in the western (Tewksbury et al. 1999) and eastern U. S. (Coker and Capen 1995, Gates and Evans 1998). Cowbirds probably require anthropogenic food sources in these regions. But human influences and possibly even native ungulates are less essential for cowbirds in areas where mesic grasslands occur naturally, such as the Great Plains.

An essential factor in attempts to limit cowbird numbers on landscape scales is the cowbird's commuting behavior (Rothstein et al. 1984). In most regions, cowbirds spend the morning in areas such as forest edges or riparian strips that have large numbers of hosts. Their major actives in these habitats are related to breeding (e.g., egg laying, searching for nests, courtship and intrasexual aggression) but not feeding and birds occur singly or in small groups of up to several individuals. If these morning breeding areas are adjacent to or intermixed with good foraging habitat, cowbirds may spend their entire day in the same vicinity (Elliott 1980, Rothstein et al. 1986). But optimal feeding and breeding habitat are usually spatially separated and cowbirds typically leave their morning-breeding ranges by late morning to early afternoon and commute to feeding sites (Rothstein et al. 1984, Thompson 1994, Ahlers. and Tisdale 1999a), where large groups of several dozen birds may feed on concentrated food sources.

Several studies showed that the maximum commuting distance between morning/breeding and afternoon/feeding sites was 7 km (Rothstein et al. 1984, Thompson 1994, Gates and Evans 1998, Ahlers. and Tisdale 1999a), thereby implying that anthropogenic opportunities for cowbird feeding need to be at least 7 km from habitat critical of endangered hosts. However, a recent study in northeast New Mexico (Curson et al. 2000) has shown that a small proportion of female cowbirds have daily commutes of 14 km or more each way. Given the pervasiveness of human influence and these large distances over which cowbirds are known to fly between feeding and breeding areas, there may be few areas of North America where landscape-level management measures can completely eliminate local cowbird populations. Rather than complete elimination, cowbird abundance may at least be reduced by landscape-level actions because abundance has been shown to decline with increasing distance from anthropogenic food sources over distances as short as 2-4 km (Verner and Rothstein 1988, Tewksbury et al. 1999, Curson et al. 2000). Candidates for such areas are large expanses of desert or forested habitat with no human influences. Cowbirds may be adept at exploiting feeding opportunities even in regions where such opportunities are not evident to observers. An attempt to produce a region-wide decline in cowbird abundance in the heavily forested western Sierra Nevada by removing all cowbirds from horse corrals that attracted large numbers of birds had at best limited success because cowbirds also fed in small groups at other sites (Rothstein et al. 1987).

Effective landscape-level measures may be costly and time consuming given the likely economic impacts to agricultural and other interests that will occur if activities and facilities such as grazing and golf courses are curtailed. Furthermore, landscape-level measures may have only limited success in reducing parasitism rates. Therefore, although land managers should have long range goals that address landscape-level actions in regions where parasitism is a threat to host populations, effective results may require many years due to resistance from people whose economic and recreational interests are likely to be impacted. These long periods needed to produce benefits may not be acceptable for severely endangered hosts whose populations are strongly impacted by cowbirds and that need quick amelioration of cowbird impacts.

We know of only one landscape-level management action that seems to have been highly effective. Removing cattle from large areas of Fort Hood, Texas resulted in substantial reductions in cowbird numbers (Cook et al. 1998, Kolosar and Horne 2000). However, this was in a larger landscape setting in which cowbirds on adjacent areas with livestock or other foraging opportunities were controlled by extensive trapping and shooting (Eckrich et al. 1999). So removal of cattle might have been less effective if cowbirds had been present in normal numbers in surrounding areas thereby creating social pressures for individuals to disperse into the less desirable areas with no livestock.

2. Habitat alterations

Recent studies have indicated that the structure of riparian vegetation influences rates of cowbird parasitism or cowbird numbers. Parasitism rates and cowbird densities usually decline with increases in the density of vegetation (Larison et al. 1998, Averill-Murray et al. 1999, Farmer 1999a,b; Spautz 1999, Staab and Morrison 1999, Uyehara and Whitfield 2000), probably because nests are more difficult to find in dense vegetation. This relationship with vegetation density, which is not necessarily a universal result in cowbird studies (see Barber and Martin 1997), raises the possibility that cowbird parasitism might be reduced by measures that result in denser riparian vegetation, such as increased water flows (see Appendix I). However, as with landscape level management measures, attempts to increase the quality of riparian habitat may require periods of several years or longer for successful results. Given that habitat loss or degradation is probably the ultimate cause of the problems all endangered hosts face (Rothstein and Cook 2000), managers should vigorously pursue efforts to augment habitat. But endangered hosts severely impacted by parasitism may require actions that produce benefits more quickly.

3. Inhibition of cowbird breeding

A nonlethal method of limiting or eliminating cowbird impacts on hosts might be to inhibit their breeding. Yoder et al. (1998) reviewed the literature on avian contraceptives. They report that several compounds can be delivered via baited food and therefore might be administered to large numbers of birds. But these all have various problems. Some compounds are environmental hazards. Others keep eggs from hatching but allow breeding and would therefore not avoid host loses due to adult female cowbirds. The most promising compound, DiazaCon prevents egg laying and also inhibits fertility in males but must be administered over a 7-14 day period with available modes of delivery. Currently, there is no feasible method of inhibiting breeding of a large proportion of a local cowbird population but this approach is worthy of additional research.

4. Cowbird control

Although altering local landscapes or habitats to reduce cowbird impacts should be long-term management goals, local cowbird populations can often be quickly and easily reduced by intensive trapping efforts. The species is highly social (Rothstein et al. 1986) and is attracted to decoy traps, which can remove most cowbirds from large areas where willow flycatchers and other endangered hosts breed (Eckrich et al. 1999, DeCapita 2000, Griffith and Griffith 2000). These traps are referred to as decoy traps because the vocalizations and even the sight of live decoy cowbirds in the traps, along with food such as millet, attract wild cowbirds (see Dufty 1982, Rothstein et al. 1988, 2000), which then enter through small openings. Trap openings are generally on the tops of the traps and birds walking on the traps enter easily by folding their wings against their bodies and dropping into traps. Escape is difficult because birds cannot fly through the openings and traps are built so as to ensure that no inside perches are near the openings.

In addition to trapping, shooting cowbirds attracted to playback of female calls (Rothstein et al. 2000) can be a valuable supplemental way to reduce cowbird numbers (Eckrich et al. 1999). Removing or addling cowbird eggs from parasitized nests can further reduce host losses (Hall and Rothstein 1999). However, removing or addling cowbird eggs does not recover host egg losses inflicted by adult cowbirds and can not be done at nests too high to be reached. Addling cowbird eggs by shaking them may be preferable to removing cowbird eggs because birds like the willow flycatcher that do not remove cowbird eggs from their nests come to consider cowbird eggs as part of their clutch. Willow flycatchers will even incubate clutches consisting solely of cowbird eggs (M. Sogge pers. comm.). Accordingly, they will desert if the combined volume of eggs is reduced below a certain value by removal of cowbird eggs (Rothstein 1982; Kus 1999). Indeed a close relative of the willow flycatcher, the eastern phoebe (*Sayornis phoebe*) is more likely to desert a nest after cowbird eggs are removed than after its own eggs are removed because the larger cowbird eggs make up more of the combined clutch volume (Rothstein 1986). On the other hand, there may be situations in which a parasitized flycatcher is better off deserting a nest because renesting will allow it to recoup those of its eggs that were lost to damage and removal by female cowbirds. In such cases, it may be best to remove all eggs to induce renesting and to place any viable willow flycatcher eggs in active unparasitized flycatcher nests at a similar stage of incubation. However, there are many factors to consider in such manipulations and few researchers are likely to have the experience necessary to make appropriate decisions. Anyone contemplating such manipulations will need to consult with the Fish and Wildlife Service and obtain permits in addition to those usually needed for study of southwestern willow flycatchers.

Shooting cowbirds and removal/addling of cowbird eggs may be more cost effective and practical than trapping if cowbird and/or local host numbers are low and if experienced personnel are available. These latter measures may also be better options than trapping if an impacted host population is in a remote or rugged area where the set-up and servicing of traps is difficult (Winter and McKelvey 1999). But cowbird trapping is likely to be the most effective management action in most situations.

Cowbird trapping efforts are typically highly successful in reducing parasitism rates. Parasitism is usually reduced from 50% or higher to below 20% and sometimes much less (Table 3). Increases in host reproductive output are well documented for four endangered species (Table 3), although this is on a per nest basis in some cases rather than a per female/season basis. Cowbird trapping was highly successful in boosting southwestern willow flycatcher reproduction along the South Fork of the Kern River. The mean number of young each female fledged per season went from 1.04 before control to 1.88 afterwards (Table 3).

Table 3. Summary of results of major cowbird control programs. Data shown are values for years before--after control.

Host species	Locality	Years	Parasitism rate	Young per female[1]	Nest success[2]	Host increase?[3]
Sw WIFL[4]	California	89-91--94-97	63%--17%	1.04--1.88	23%--43%	No
BCVI[5]	Texas	87-88--91-97	91%--22%	----	9%--40%	Yes
LeBEVI[6]	California	82--84-91	47%--6%	1.33--2.79	----	Yes
KIWA[7]	Michigan	66-71--72-77	70%--6%	0.80--3.11	----	No[7]

[1] Number of young fledged over entire breeding season.

[2] % of nests fledging one or more host young.

[3] Column refers to whether the host showed an increase in breeding population size within 5 years of the initiation of cowbird control.

[4] Southwestern willow flycatcher. Data reported (Whitfield et al. 1999) are for years with no cowbird control (1989-91) and with intensive control (1994-97). Intervening years (92-93) had intermediate levels of control and intermediate values for most parameters.

[5] Black-capped vireo. Data reported (Eckrich et al. 1999; Hayden et al. 2000) are for years with little or no cowbird control (1987-88) and years with extensive and well developed control (1991-97). Even within the latter period, personnel have improved methodology, e.g., parasitism rate ranged from 26-39% in 1991-93 and from 9-23% in 1994-97. Nest success data cover only up to 1994, when it had risen to 56%.

[6] Least Bell's vireo. Data reported (Griffith and Griffith 2000) are for a year (1982) with no cowbird control and for years (1984-91) with extensive and well developed control. Trapping intensified over the latter years, with the parasitism rate close to zero and the young per female 3 or more since 1989.

[7] Kirtland's warbler. Data are from DeCapita (2000). This species began to increase about 18 years after cowbird control began.

Unfortunately, the efficacy of control efforts is difficult to assess in some cases in California and Arizona because baseline data on parasitism rates and host nesting success were not collected before control began (Winter and McKelvey 1999). The latter action deviates from proposed guidelines for cowbird management (U. S. Fish and Wildlife Service 1991, 1992; Robinson et al. 1995a, Whitfield and Sogge 1999, this paper) but might be justified if a local population or an entire metapopulation appears to be in danger of imminent extinction. That is, in some cases, cowbird control may be the only short-term option for increasing willow flycatcher productivity in populations on the edge of extirpation.

Although the productivity of host nests has increased markedly in all cowbird control efforts, cowbird management has a mixed record (Table 3) when it comes to the ultimate measure of success, namely increases in host breeding populations (Rothstein and Cook 2000). The least Bell's vireo and black-capped vireo have generally increased markedly since cowbird control began (Eckrich et al. 1999, Griffith and Griffith 2000), although little attempt has been made in some or all cases to assess the extent to which other management actions, such as improved and expanded habitat, have contributed to the increases. In addition, a key population of the least Bell's vireo (the northernmost in the taxon) declined after cowbird trapping began (Rothstein and Cook 2000), although this is largely attributed to habitat maturation and an associated reduction in suitability (J. Greaves, J. Uyehara pers. comm.). Kirtland's warbler and willow flycatcher populations did not increase in response to cowbird trapping. Trapping may have forestalled further declines in these latter species (DeCapita 2000, Whitfield et al. 1999, 2000) but Rothstein and Cook (2000) argue that the evidence for such effects is far from conclusive. The Kirtland's warbler began to increase dramatically about 18 years after trapping began but only after large amounts of new breeding (DeCapita 2000) and wintering habitat (Haney et al. 1998) became available, although the importance of wintering habitat is in some dispute (Sykes and Clench 1998).

Focusing on the willow flycatcher, cowbird trapping since 1993 has not resulted in population increases in the Kern River Valley. Instead the population has declined from 34 pairs in 1993 to 23 in 1999 and was down to 12 and 11 pairs, respectively, in 2000 and 2001 (Whitfield 2002). A demographic analysis indicates that control needs to be even more intense and that parasitism needs to be reduced from the present 11-19% to < 10% for this population to increase (Uyehara et al. 2000). If this is indeed the case, then other factors affecting this population need to be identified as the population would barely be replacing itself even in the absence of cowbird parasitism. Nor did this demographic model predict the sharp decline in 2000. It is likely that the Kern population has a low rate of nest success relative to other populations of the southwestern willow flycatcher (Stoleson et al. in press). This low rate may relate to recently elevated levels of hatching failure starting in 1997 due to an increased incidence of inviable eggs, 3.0% before 1997 versus 13.1% for 1997 to 2001 (Whitfield and Lynn 2001, Whitfield 2002). However, the population remained stable from 1993 until 1997 when cowbird trapping occurred while hatching rates were at normal levels. Also, as discussed above, the South Fork Kern River population grew or remained stable in the 1980s even though there was no cowbird control then.

Cowbirds have been controlled at Camp Pendleton since 1983 as part of management actions to recover the least Bell's vireo (Griffith and Griffith 2000). Although there was an early report of a modest increase in willow flycatchers as of 1991 (Griffith and Griffith 1994), the population later declined despite intensified cowbird trapping and overall there has been no marked increase in flycatchers as of 2000 after 18 years of cowbird control. It is possible that there may not be sufficient habitat at Pendleton for willow flycatcher population growth but the increase in the riparian obligate Bell’s vireos from 60 to over 800 pairs suggests that there might be at least some unused flycatcher habitat on the base. Because it is designed to protect least Bell's vireos, cowbird trapping at Pendleton ends well before the willow flycatcher breeding season ends so it is possible that the willow flycatcher population there has not been sufficiently protected from parasitism. However, this is unlikely because trapping data show that nearly all cowbirds are removed in the first half of the trapping period, and no parasitism of willow flycatchers has been detected since nest monitoring began in 1999 (Griffith Wildlife Biology 1999, Kus et al. in prep.). Only minimal numbers of cowbirds remain when willow flycatcher breeding begins in June (Griffith and Griffith 2000). As with Camp Pendleton, long-term cowbird trapping to protect least Bell's vireos at another southern California site, the Prado Basin, has not resulted in an increase in the small number of flycatchers (three to seven territories) that breed there (Pike et al. 1997).

Trapping programs to protect flycatchers began in 1996 and 1997in Arizona (Table 4). No baseline data on parasitism rates were collected and local flycatcher habitat was not completely surveyed at some sites before trapping began. These problems, along with subsequent increases in survey area and effort at most sites and increases in suitable habitat at some sites, make it difficult to assess effects of cowbird control. A critical assessment of the efficacy of cowbird control for these Arizona populations can only be done after compensating for changes in survey effort and in habitat area and quality. Unfortunately, available data do not allow such compensations. The best overall assessment of field workers familiar with these populations is that increases at the Roosevelt Lake, Salt River inflow site reflect the effects of increased survey effort and increased habitat but may also be partially attributable to cowbird control. It is worth noting that there may have been population increases at other sites before control began; although it may have already been at dangerously low levels (Table 4).

Table 4. Numbers of southwestern willow flycatcher pairs counted at Arizona sites before and after cowbird control began. Data underlined and in bold denote years with cowbird control. Inferences concerning numerical trends after cowbird control began are complicated by changes in habitat extent and quality, survey intensity and amount of area surveyed (see text). Data are from Arizona Game and Fish Department and White and Best (1999).

SITE AREA	1993	1994	1995	1996	1997	1998	1999	2000	2001
San Pedro River	3	30	26	27	**40**[1]	**38**	**61**[2]	**59**	**67**
Roosevelt Lake, Salt	1	15	9	**18**	**17**[1]	**20**	**52**[2]	**80**	**106**
River inflow	1	7	8	**11**[1]	**18**	**23**	**22**	**25**	**25**
Roosevelt Lake, Tonto									
Creek inflow									
Alpine/Greer	7	10	10	13	**7**	**7**	**5**	**3**	**2**
Alamo Lake	0	0	2	4	6	9	**21**[1]	**20**	**15**
Gila Sites	0	0	0	3	**30**	**46**	**58**	**48**	**40**[3]

[1] **Higher numbers of birds are likely due to increased survey effort not to an actual increase in the population.**

[2] **Higher numbers of birds in these and subsequent years are likely to reflect actual increases in populations due to increases in amount and/or quality of habitat.**

[3] **Cowbird control has occurred at only one of several sites.**

Data from a New Mexico site, San Marcial, along the Rio Grande River show no clear effect of cowbird trapping on flycatcher population size. In the absence of cowbird trapping, this site had six flycatcher nests in 1995 (all data were reported in terms of numbers of nests not pairs). Cowbird control was carried out in 1996, 1997 and 1998 with the following numbers of nests in each year: one, two and two, respectively (Robertson 1997, Ahlers and Tisdale 1998b, 1999b). The small numbers of flycatchers breeding at this site may mean that stochastic effects are overwhelming any benefits derived from cowbird control.

10. Is Cowbird Control A Longtime Or Even Permanent Need?

Even if it results in the growth of a host's breeding population, cowbird control is a stopgap measure (U. S. Fish and Wildlife Service 1995) that must be done for a number of years if a host population is to continue growing, as all studies show that it has either no effect on cowbird numbers in subsequent years (Eckrich et al. 1999, DeCapita 2000, Ahlers and Tisdale 1999, Griffith and Griffith 2000) or too small an effect to negate the need for yearly trapping (Whitfield et al. 1999). Cowbird control efforts are often done with little care to maintaining constant procedures and possibly even with incomplete record keeping from year to year, so long term effects on cowbird populations are hard to judge in some cases. Indeed, the state of Texas encourages landowners to trap cowbirds and does not require trappers to report information on the numbers of cowbirds killed (Texas Parks and Wildlife pamphlet). This is unfortunate because it will be impossible to assess whether such actions have any long-term effects on cowbird numbers and even whether they benefit the targeted host species in the absence of record keeping and suitably designed control programs.

Even though intensive cowbird trapping efforts do not negate the need for trapping in subsequent years, it is possible that trapping may not be needed as a permanent solution to a rare host whose endangerment is due in part to parasitism. If a small host population grows and becomes large as a result of cowbird trapping and possibly other measures, it may experience parasitism rates that are much lower than when it was small. Small host populations may experience high rates of parasitism because they provide few nests for cowbirds to parasitize. But once small host populations have grown, they may experience much lower rates of parasitism because a similar number of cowbird eggs may be dispersed amongst a larger number of nests. These lowered parasitism rates would be similar to the well-known effect that increased numbers of prey have on predators. Just as increased prey numbers may swamp out the per capita risk of nest predation, so too may increased host numbers lower the per capita risk of parasitism. These lower rates of parasitism may have no impact on host population dynamics. Parasitism will not decline if increased numbers of an endangered host result in commensurate increases in cowbird numbers. But given the extent to which some endangered hosts have increased, such as the more than ten-fold increase in Bell’s vireos on Camp Pendleton, it is unlikely that cowbirds would show commensurate increases.

The hypothesis that parasitism rate is inversely proportional to host population size views small host populations as ecological traps that can result in local extinctions due to parasitism. It further views the need for protection from parasitism as essential only until a population becomes large. The hypothesis is compatible with Spautz's (1999) discovery that parasitism rates of common yellowthroats (*Geothlypis trichas*) at sites in the Kern River Valley were inversely proportional to this host's density although other factors may also be involved. The best test of the hypothesis would be achieved by ending trapping, at least temporarily, for host populations that have grown to be large, such as least Bell's vireos at Camp Pendleton or Kirtland's warblers in Michigan and monitoring parasitism rates for two or more years. A temporary cessation of cowbird control would reveal whether parasitism rates are lower than they were with much smaller host populations and whether cowbirds show increases commensurate with those of the targeted host. Although it may be difficult to change current management policies, a temporary halt to cowbird control would be of considerable interest to researchers concerned with basic ecological mechanisms. It could also have high management value because considerable resources would be saved if results show that parasitism rates are so low that yearly cowbird control is no longer necessary.

11. Conclusions Regarding Cowbird Management Methods

In addition to the discussion presented here, Ortega (1998:279) provides a useful discussion of management actions that might lessen cowbird impacts. Management measures such as landscape level alterations in human land use patterns or increases in vegetation density are appealing because they are likely to have long lasting effects on cowbird parasitism and do not involve massive killing of a native songbird. However, we suggest that cowbird trapping seems to be the only viable management measure for most situations involving hosts that are endangered by parasitism. Trapping reduces parasitism levels and does so immediately. Moreover, trapping may need to be carried out for only a limited number of years if it boosts a host's population size and if increased host numbers alone reduce parasitism rates, as described above.

By contrast, landscape level measures may take years to institute and may be impossible in many to most areas given the extent to which humans have altered North America in ways that benefit cowbirds. Similarly, increased vegetation density takes time to develop and may be difficult to achieve in arid areas of the Southwest where water is scarce and likely to become more scarce given the high rate of human population growth in this region. It is likely that any increases in vegetation will benefit endangered hosts much more by increasing the amount of breeding habitat than by direct effects on levels of parasitism. For further discussion of riparian restoration techniques, see Appendix K.

Here we focus further discussion of cowbird management on trapping programs, although we stress that there is as yet no evidence that cowbird trapping results in increases in the breeding population sizes of southwestern willow flycatchers (as discussed above). We further stress that increases and improvements in host breeding habitat should always accompany cowbird management efforts because habitat is a limiting factor for all endangered species impacted severely by cowbird parasitism (Rothstein and Cook 2000) and cowbird control alone is a stop gap measure (U.S. Fish and Wildlife Service 1995). Similarly, regulators should never be satisfied with mitigation under the Endangered Species Act or other management approaches that involve only cowbird management and no attention to habitat augmentation. And they should give careful scrutiny to long-term management plans or actions that are focused mostly on cowbird trapping, even if the plan gives some attention to improving or increasing a host's habitat. Nevertheless, if cowbird parasitism is indeed a limiting factor for an endangered species given the amount of currently available habitat, agencies may have to commit to a number of years of cowbird trapping, with the length of the period determined by criteria in Management Recommendations 3 and 6 (below).

Although trapping is likely to be the most efficacious management tool for reducing unacceptably high cowbird impacts, three caveats are necessary. First, it may not be necessary to carry out trapping indefinitely, much less the trapping in "perpetuity" advocated for the least Bell's vireo in its draft recovery plan (U. S. Fish and Wildlife 1998). The putative need for trapping in perpetuity seems to be based on the mistaken belief (above) that least Bell's vireos cannot withstand any level of cowbird parasitism due to a lack of defenses, even though conspecific populations long exposed to parasitism have been able to coexist with cowbirds. In addition, the need for trapping will be reduced or eliminated if enlarged host populations alone result in lowered parasitism rates, as described above. Secondly, although trapping is likely to be the most effective management tool in most situations in which cowbirds threaten the survival of flycatcher populations that are otherwise viable, managers need to be flexible regarding alternative approaches. Some host populations may be in areas that are so remote and far from roads that it may be difficult to use the large decoy traps that are effective for cowbird trapping. In such cases, it may be more cost effective to shoot cowbirds after they are attracted to female chatter calls (Eckrich et al. 1999, Rothstein et al. 2000) and/or to monitor host nests and remove or addle cowbird eggs in nests that are accessible to field workers (Kus 1999, Winter and McKelvey 1999). Similarly, if a host population is very small, it may be most cost effective to monitor all nests even if trapping is feasible. Although nest monitoring and removal or addling of cowbird eggs avoids the major losses incurred by cowbird nestlings, it cannot recover egg losses due to the actions of adult cowbirds. On the other hand, trapping alone may not remove all adult cowbirds and therefore some nests may still be parasitized. Our last caveat is that, even if trapping is eventually shown to be effective in boosting southwestern willow flycatcher population sizes, managers may find it cost effective and biologically effective to leave some small and or remote host populations unprotected and divert the scarce management funds thereby saved to other actions. With these caveats in mind, this document next addresses the potential benefits and downsides of cowbird control (achieved largely by trapping), at least as it is currently conducted.

12. Potential Pros and Cons Of Cowbird Control

Although the list of potential downsides of cowbird control is longer than the list of potential benefits, choosing whether to control cowbirds should not be a matter of tallying up a score. If the first benefit listed below occurs, an increase in an endangered species' breeding population, it alone is likely to outweigh all negative aspects put together and therefore dictate making control efforts a high priority, at least for a number of years. Although it is currently unclear as to whether cowbird control increases southwestern willow flycatcher breeding populations, more definitive data may be available in several years.

As regards the potential positive and negative aspects of cowbird control, it is also worthwhile to recognize that some managers might not agree that each benefit we have listed is in fact a benefit or that each downside is in fact a potentially negative aspect of cowbird control. But we have chosen to list all of these points so that managers can be as well informed as possible regarding the consequences of cowbird control. We also point out that some of the downsides of control are not inherent in the control methods but may or do occur in some circumstances because of the manner in which control is done.

1. Potential Benefits or Positive Aspects of Cowbird Control

a) Cowbird control appears to have resulted in large increases in the populations of least Bell's vireos and black-capped vireos and this might eventually be shown to be true for the southwestern willow flycatcher as well.

b) Cowbird control clearly increases the reproductive output of willow flycatchers and other hosts. Even if the numbers of breeders in a population protected by control do not increase, perhaps because of limited breeding habitat, control may lessen chances of extinction by increasing the numbers of individuals that colonize other habitat patches or that become floaters, i.e., sexually mature birds capable of breeding but kept from doing so by a shortage of habitat.

c) Cowbird control may have stalled a decline in willow flycatcher numbers along the South Fork of the Kern River in the early 1990s and may have forestalled the extinction of the Kirtland's warbler.

d) Cowbird trapping is easy to do, although ease of application should not itself be used as a reason for choosing to trap cowbirds.

e) Cowbird control may benefit other sensitive species in addition to an endangered species that is targeted for management action.

2. Potential Downsides or Negative Aspects of Cowbird Control

a) Control has to be done every year or at least for sustained periods due to the failure of trapping to sufficiently reduce cowbird numbers in subsequent years.

b) Control has yet to result in an increase in a willow flycatcher population, although sufficient data are not yet available for Arizona willow flycatcher populations where trapping began in the last several years.

c) When cowbird trapping is not needed or has minimal benefits, trapping uses money/resources that could be used for management/research efforts that might result in greater benefits for endangered hosts such as the willow flycatcher.

d) Trapping might result in cowbirds developing either learned or genetic resistance to trapping. An unknown number of cowbirds escape from the decoy traps commonly used to catch cowbirds (S. Rothstein pers. obs.) and some cowbirds appear to be reluctant to enter these traps (M. Whitfield pers. obs.). Cowbirds at long-term Sierran study sites eventually learned to associate Potter traps with danger and flew off at the sight of people carrying these traps (S. Rothstein and others, pers. obs.). Trapping exerts potential selection pressures of enormous strength on cowbird populations and the potential problem here is akin to the well-known tendency of pathogens to evolve resistance to antibiotics. Just as antibiotics should be used only when really necessary, cowbird trapping too should only be employed when it is clearly justified.

e) Because it is easy to do and results in easily cited numerical indicators (e.g., numbers of cowbirds killed, increases in willow flycatcher productivity), cowbird control (usually via trapping) can be used by developers, other private interests or governmental agencies to show that endangered species are being aided or that legally mandated mitigation obligations for adverse impacts are being met, even if cowbird trapping results in little or no actual mitigation or host benefits. It is especially unfortunate if cowbird control is used as mitigation under the Endangered Species Act in the absence of baseline data needed to determine the level of cowbird impacts. Control should never be the sole mitigation measure for habitat destruction of an endangered species. If the availability of ocntrol as a mitigation measure in consultations with governmental agencies allows or legitimizes actions that result in habitat loss, a local flycatcher population may suffer greater detriment than if cowbird control had not been considered as a mitigation option (especially if cowbird parasitism was not a major impact).

f) There are ethical and animal care issues related to cowbird control, especially if the need for control has not been adequately justified. Importantly, excessive trapping efforts that are not justified could create challenges to the use of cowbird trapping and thereby jeopardize the potential to use this approach when it is justified.

g) Personnel involved in cowbird trapping efforts may not be researchers and may provide insufficient documentation, although if the latter occurs, the fault lies ultimately with the supervising agency. Another potential personnel problem relates to the fact that cowbird trapping efforts in the West are often contracted out to private consulting firms. Because of profit incentives, some private parties may lobby unduly for continued or expanded trapping efforts and there may be no motivation for contractees to suggest cost saving changes in trapping methods. Even cowbird control done by governmental agencies may have some momentum towards expansion or continuance because stopping control for a year or more might make it difficult to acquire funds if it appears that control needs to be reinstated.

h) Cowbird control is sometimes initiated without sufficient baseline data to assess cowbird impacts which means that there may be no basis for determining whether the action is having beneficial population level effects on hosts. In the absence of any data on effects, there may be little insight as to decisions about ending control and directing resources towards other goals.

i) Cowbird control without sufficient baseline data could retard some components of the overall effort to recover endangered species such as the southwestern willow flycatcher because vital baseline data on such things as parasitism rates needed for population viability analyses (PVA) may not be available (although the increased numbers of young could result in more data on dispersal, an essential element in most PVA models).

j) Cowbird trapping results in the capture of non-target species. For example, there were 8,453 captures of about 1,500 individuals of non-target species during cowbird trapping efforts at the Camp Pendleton Marine Corp Base in 1994 (Griffith and Griffith 1994). Most species do poorly when left in traps and individuals often die within 24 h or less. Even if non-target birds are released promptly, time spent away from their nests may result in reproductive failure.

k) Because cowbird control constitutes human intervention, it is uncertain whether willow flycatchers can be removed from the endangered species list as long as control continues.

l) Cowbird control constitutes active management intervention and might therefore deter attention from other types of intervention, such as actions that reduce the impacts of nest predators. Because nest predation is usually as harmful to willow flycatcher population growth as is cowbird parasitism or more so, we provide a brief discussion of predation and of possible management actions in an appendix to this paper.

13. Recommendations For Cowbird Management

Managers need to be flexible in their approaches and should not adopt the view that cowbird trapping is one of the very first things that should be done as soon as a willow flycatcher population or a population of any endangered species impacted by cowbirds is identified. Similarly, managers should not adopt cowbird trapping just because funding becomes available for a particular site and regulators should not restrict available management funds to cowbird trapping simply because this is an easily executed action. An endangered host may benefit more in the long run by first using funds to monitor interactions between cowbirds and the endangered host because the data collected may show that the funding will be of more benefit if applied to management actions other than cowbird control. Trapping should be instituted only when baseline data justify its use, as indicated below. Lastly, managers should also address other factors that reduce passerine nesting success, such as nest predation (see Appendix to this paper).

More specifically, our recommendations regarding cowbird management are as follows:

1. Increase the amount and quality of riparian habitat.

Regardless of whether cowbird management actions are undertaken, and what form those actions might take, managers should strive for increased amounts of riparian habitat. Consideration of endangered host species across North America shows that a shortage of breeding habitat (or poor habitat quality) is always a major problem or the major problem if cowbird management is contemplated. Although endangered hosts may have large amounts of habitat in some localities, the amount, and often the quality, of habitat summed over a species' range is considerably less than under original conditions in all cases. Increased amounts of high quality habitat and increased patch sizes of such habitat will allow for larger breeding populations of willow flycatcher and other species. These larger populations are likely to experience reduced levels of cowbird parasitism by dispersing cowbird eggs over a larger number of nests. In addition, larger populations are more resistant to extinction for a range of well-known reasons. Due to their relatively larger amounts of interior habitat, large patches of riparian woodland are likely to further reduce cowbird parasitism and nest predation, both of which tend to be concentrated along habitat edges in some regions (Robinson et al. 1995b, Tewksbury et al. 1998, Farmer 1999b). Measures to increase the quantity and quality of riparian habitat are discussed in Appendices G (grazing management), H (exotic species), I (water management), K (habitat restoration), and L (fire management).

2) Initiate cowbird control to protect a particular flycatcher population only after sufficient baseline data show cowbird parasitism to be a significant threat for that population.

Cowbird control to aid local willow flycatcher populations and other rare/endangered hosts should be instituted only after baseline data show parasitism rates to be above a critical level. The need for baseline data is in accord with recovery plans for other endangered southwestern hosts. Recovery plans for the black-capped vireo and golden-cheeked warbler, *Dendroica chrysoparia* (U. S. Fish and Wildlife Service 1991, 1992) recommend at least two years of baseline data to determine whether cowbird control is warranted. If control is instituted, managers should consider it a stop gap action (U. S. Fish and Wildlife Service 1995) and have a long range goal that includes restoring flycatcher populations to conditions that no longer require cowbird control. Robinson et al. (1993, 1995) discuss conditions that should be addressed in a management decision concerning cowbird trapping and Smith (1999) makes explicit recommendations regarding levels of parasitism that should initiate consideration of cowbird management actions. In general, Smith suggests that management should only be considered if parasitism is > 60% for two or more years but lists a number of considerations that dictate raising or lowering this threshold. In particular, he recommends that the critical parasitism level for management considerations be lowered to >50% if a species is listed as threatened as endangered. Given the southwestern willow flycatcher's low numbers, we suggest that cowbird control should be considered if parasitism exceeds 20-30% after collection of two or more years of baseline data. But even our guidelines must be applied with flexibility that gives weight to available data on local populations, i.e. sites need to be treated individually. An important consideration should be current population trends. For example, there has been a decline in the willow flycatcher population at the South Fork Kern River since cowbird control began, despite a reduction in parasitism rates from 65% to 11-20% from 1994-99 (Whitfield et al. 1999, Whitfield unpubl. data). This decline is in accord with demographic evidence indicating that this population cannot sustain itself if parasitism exceeds 10% (Uyehara et al. 2000), so current data clearly warrant a 10% threshold for this population. However, other populations such as at the Cliff-Gila one in New Mexico increased between 1997-1999, despite parasitism rates ranging from 11-27%, and for them parasitism rates of 30% or even higher may not warrant cowbird control. Monitoring nests to collect baseline data needed to determine whether control is needed can be costly but trapping and other control methods are also costly. Moreover, collection of baseline data could easily save funds in the long run if it shows that control is not necessary. Although available resources may make it unrealistic to monitor nests in all small populations, all populations with more than five nests should be monitored. If available funds allow attention only to some small populations, managers should give higher priority for both control and monitoring nests to populations that are not limited by habitat availability. Cowbird eggs should be removed or addled during years when nests are monitored to determine parasitism rates, unless a population is part of an experiment designed to test whether cowbird trapping alters flycatcher population trends. Although a single parasitism rate that triggers the initiation of cowbird control, rather than a range that spans 20-30% (or even more, see above), would make management decisions easier, it wouldn't necessarily make those decisions better. Rather than adhering to the upper or lower end of the suggested range, managers and regulators should make adaptive management decisions that take into account other important factors in addition to parasitism rates. Such factors are a population's current trend (increasing, stable or decreasing), the potential for growth afforded by a population's current and anticipated habitat availability and whether control is the best use of management funds. There are complex scientific issues to assess, and managers and regulators should consider consulting with members of the USFWS Southwestern Willow Flycatcher Technical Recovery Team or other scientists.

3) When a cowbird control program is initiated, define goals that will lead to a successful completion of the program and plan for periodic, 3-5 year, peer reviews to judge the program's efficacy.

If a cowbird control program is begun, the following actions should be codified as part of the control program: a) a program of periodic reviews, every 3-5 years, by scientists who are not involved in the control program but who will assess the program's efficacy (as regards increases in the sizes of willow flycatcher breeding populations); b) a statement of goals that define conditions that will end the control program; c) provisions for a nest monitoring program for at least 3-5 years after control ceases (and at several year intervals after that) to determine whether parasitism rates exceed acceptable levels as defined in Recommendation 2 (see also Recommendation 6); d) a commitment to seek new funding if cowbird control needs to be reinstated after a period without control. Conditions that would result in cessation of control under item b for a particular flycatcher population include, but should not be limited to, removal of the southwestern willow flycatcher from the endangered species list.

4) Because current cowbird control programs have not yet resulted in increased numbers of southwestern willow flycatchers, design overall control programs as experiments that have the potential for critical assessments of the efficacy of this management approach.

Current control programs may have little or no potential to demonstrate that cowbird control affects willow flycatcher population sizes, regardless of the trends that ensue after control is instituted, because multiple factors are being altered, as is usually the case in the management of endangered species. Available evidence from the Kern River flycatcher populations (Whitfield et al. 1999) indicates that cowbird trapping does not result in increases in the breeding populations of southwestern willow flycatchers. Therefore, trapping efforts should be designed in part as experiments that can determine whether cowbird trapping increases willow flycatcher populations. To accomplish this, populations with cowbird control should be compared with a limited number of similar populations that have no cowbird control. Populations with and without control should be chosen so as to be as similar as possible as regards such parameters as size and recent population trends. Such experiments will mean that cowbird control is not instituted in all willow flycatcher populations that appear to need it under the conditions laid out in Recommendation 2. All willow flycatcher populations with no cowbird control should be monitored for parasitism rates and control should be instituted if there is clear evidence that parasitism threatens survival of the population.

5) Cease cowbird trapping at selected southwestern willow flycatcher populations to allow collection of baseline data and to provide populations without cowbird trapping for the balanced experiment (Recommendation 4) designed to test the efficacy of cowbird control.

Cowbird trapping should be stopped at selected willow flycatcher populations to allow collection of baseline data on flycatcher nesting biology (cowbird parasitism rates and other factors affecting flycatcher productivity, such as egg hatchability, nest predation, etc.) and to provide populations without cowbird trapping for the balanced experiment (Recommendation 4) designed to test the efficacy of cowbird control. After collection of at least two years of baseline data, an adaptive management decision should be made as to whether control needs to be reinstated, as defined under Recommendation 2. However, a limited proportion of populations that meet the conditions for control should become part of the no trapping sample for the balanced experimental studies described in Recommendation 4. Such populations should be selected on the basis of the criteria described under Recommendation 4.

6) Determine the need for continued cowbird control once a southwestern willow flycatcher population has grown to be large.

Cowbird control should be stopped after a local willow flycatcher population reaches a large size because the increased numbers of willow flycatchers may experience a level of parasitism, even in the absence of cowbird control, that is much less than the level that occurred when the population was small, as described above. But qualified researchers should monitor such populations to determine whether parasitism rates are at tolerable levels as defined under Recommendation 2. Because we do not at present know the extent of reduction in parasitism rate as the population of an endangered host increases, we can not precisely determine how much increase a population must show before its enlarged size results in a significant reduction in parasitism rates. Instead, we suggest that a population that is at least two or three times as large as it was when conditions justified initiation of cowbird control should be considered for cessation of cowbird control so long as the increased population has an absolute number of pairs equal to or exceeding 25. A two to three fold increase in flycatcher population size could reduce parasitism rates to one half or one third of their pre-cowbird control levels if cowbirds do not show a commensurate increase in numbers and the target of 25 pairs conforms to the recovery plan's goal of ensuring local population sizes at which the likelihood of persistence and dispersal approach asymptotic levels. Even with these guidelines, managers may need to exercise their own judgement or consult with the Technical Recovery Team or other experts, as there are additional complexities to consider. For example, a flycatcher population inhabiting a habitat patch whose current and potential capacity is fewer than 25 pairs might be considered for cessation of trapping if it has reached its carrying capacity.

7) Consult previous accounts of cowbird control programs and develop guidelines, as regards trap design, placement and seasonality, that maximize the effectiveness of cowbird control under local conditions (including actions alternative to, or in addition to, trapping).

Managers need to keep in mind that the goal of cowbird control is to aid impacted host populations, not to maximize the number of cowbirds killed. In fact, benefits to the host population with the minimum number of cowbirds killed should be the goal. Although the number of cowbirds killed can be increased by trapping at cowbird feeding sites and at times other than a host's breeding season, managers need to determine whether these trapping policies provide increased protection for endangered hosts. There is little justification for trapping outside of an endangered host's breeding season if this trapping results in killing of large numbers of migratory cowbirds. Trapping from 1 May to 31 July should provide maximal protection for southwestern willow flycatchers. These dates would initiate trapping two weeks prior to host arrival times, as with guidelines for black-capped vireos (U. S. Fish and Wildlife Service 1991). Whether trapping is best conducted in the breeding habitat of the host, at cowbird feeding sites or both, probably depends on the local landscape. In many landscapes however, trapping in host breeding habitat is likely to be the best strategy as this removes the cowbirds that are putting hosts at risk. In addition to trapping, managers should determine whether significantly increased benefits could be gained by supplementary activities such as shooting cowbirds and removing or addling their eggs from parasitized nests. Because no single control protocol is best for all situations, managers should consult a range of published, peer-reviewed accounts of cowbird control programs (Eckrich et al. 1999, Whitfield et al. 1999, 2000; Winter and McKelvey 1999, DeCapita 2000, Griffith and Griffith 2000) for information on the design, number, placement, and visit schedule for traps and on euthanasia methods plus activities that may supplement trapping.

8) Minimize impacts on non-target species.

Measures must be taken to minimize impacts on non-target species by following appropriate trapping protocols (see references cited under Recommendation 7), e.g., by adjusting the sizes of trap openings to reduce captures of other species and by daily visits so that all non-target birds that are captured are released daily. However, reasonable levels of unavoidable negative impacts on common, non-target species should not deter cowbird trapping if control is well justified. Just as sacrificing cowbirds is an undesirable but unavoidable consequence of trapping programs that benefit endangered hosts, so too should impacts on non-target species be considered undesirable but acceptable if they are an unavoidable consequence of cowbird trapping. However, if large numbers of non-target birds are captured, research should be undertaken to elucidate the impacts on the survival and reproductive success of these other species.

9) Determine whether cowbird management actions other than control, such as removal of cowbird food sources, can result in drastic reductions in cowbird numbers.

Although cowbird control is likely to be the best management tool in most situations in which there are unacceptably high rates of parasitism (as defined under Recommendation 2), managers should determine whether their situation is best dealt with via other approaches. They should determine whether changing certain landscape conditions might allow for rapid and drastic reductions in cowbird numbers by alterations to one or a few key anthropogenic food sources. This may be especially appropriate in remote regions with little human influence. In addition, if a willow flycatcher population is very small or is in a remote area where trapping would be difficult, managers should consider whether it is preferable to shoot cowbirds and/or remove or addle cowbird eggs in parasitized nests.

10) If cowbird control is undertaken, identify and pursue long-term landscape objectives that can reduce cowbird numbers over large areas.

Even if cowbird control is undertaken, a long-term management objective should be a reduction of anthropogenic influences that provide foraging opportunities for cowbirds so as to reduce cowbird numbers at landscape levels. These influences include bird feeders and other anthropogenic food sources such as livestock. But there should be no standard distance over which livestock must be excluded from flycatcher populations because the effectiveness of livestock exclusion depends on the availability of other food sources for cowbirds in the local landscape, as described above. Indeed, in some landscapes there are so many potential food sources for cowbirds that the only limits on livestock should be exclusion from riparian habitat to protect the habitat itself. For habitat benefits that can be gained by removing livestock from riparian zones see Krueper (1993). Furthermore, livestock grazing, even in uplands, in landscapes containing flycatchers should be at levels that avoid overgrazing, as discussed in Appendix G (grazing management).

11) If cowbird control is undertaken, identify and pursue habitat enhancement actions that reduce levels of cowbird parasitism.

Even if cowbird control is undertaken, a long-term management objective should be reducing parasitism rates by measures that increase vegetation density or alter vegetation in other ways likely to reduce parasitism. Increases in the size and width of riparian habitat patches may also reduce parasitism levels.

12) Initiate programs of public education to inform people about measures that can reduce cowbird numbers and about the justification for controlling cowbirds.

Managers should inform the public that certain activities enhance cowbird abundance. Individuals should be encouraged to suspend bird feeding activities or use bird feeds that are not preferred by cowbirds (such as sunflower seeds as opposed to millet) during the passerine breeding season. Operators of feedlots, pack stations and similar facilities housing livestock should be encouraged to maintain clean conditions that minimize the amount of livestock feed (such as hay and grain) and manure that is available to foraging birds. Certain types of feed may be relatively unattractive to cowbirds. For example, cowbirds appear to show reduced interest in cubed or pelleted hay. If cowbird control is undertaken and people complain that it is wrong to kill one native bird to help another, managers should explain that cowbird control is viewed as a short term management tool necessitated by increased rates of parasitism and/or drastically reduced host populations that are threatened by loss of reproductive potential. Managers should explain that action against one native bird to aid another reflects no value judgement as to the worth of one species over another but instead reflects the need the need to maintain current levels of biodiversity.

N. Literature Cited

Please see Recovery Section VI.

APPENDIX: The Importance of Nest Predation and Potential Management Actions

If cowbird control is indicated by available data, managers should keep in mind that low rates of reproductive success are the basic problem and that factors besides cowbird parasitism, in particular nest predation, may need to be addressed. Predation has a greater effect on nest success than parasitism in many situations, depending on host species and habitat type (Best and Stauffer 1980, Schmidt and Whelan 1999, Woodworth 1999, Grzybowski and Pease 2000). Sedgwick and Iko (1999) determined that nest predation reduced the lifetime reproductive output of willow flycatchers of the race *E. t. adastus*, by 0.70 fledglings per female whereas the overall 23% parasitism rate in their long term study resulted in a reduction of 0.37 fledglings. Some populations of forest nesting host species, especially those in small to moderate sized midwestern forest patches, experience such high rates of nest predation that even complete elimination of parasitism might not be sufficient to make these populations self-sustaining (Rothstein and Robinson 1994, Donovan et al. 1995, 1997; Robinson et al. 1995a,b).
As with all open-cup nesting passerines (Martin 1993, Grzybowski and Pease 2000), nest predation reduces southwestern willow flycatcher breeding success to a significant degree. Paradzick et al. (1999) found that kingsnakes (*Lampropeltis getulus*) victimized two of four flycatcher nests and three of five nests of other riparian passerines that were monitored with video cameras in Arizona. A spotted skunk (*Spilogale gracilis*) depredated one nest of another species. In a long-term study of the South Fork Kern River population of southwestern willow flycatchers in California (Whitfield et al. 1999), predation has been responsible for the loss each year of an average of 40% of all nests, (range 28-57% for five years), even with cowbird trapping. Similarly, predation caused the failure of 37% of 110 nests in 1997-98 in the New Mexico flycatcher population in the Cliff-Gila Valley (Stoleson and Finch 1999). Although these predation rates are not especially high for passerines (Grzybowski and Pease 2000), they are a major burden for an endangered species.

There may be some means of reducing nest predation. For example, chemical repellants might deter nest predators that rely on olfaction, such as snakes and mammals. Cones or collars of smooth plastic or sheet metal or sticky tape (duct tape with the adhesive side facing outwards) placed on the trunks of nest-trees and adjacent tress may sometimes keep snakes and small mammals from reaching nests. Barriers of smooth plastic or sheet metal placed on the ground around trees may keep snakes and small mammals from accessing tree trunks. It may also be possible to make habitat patches less attractive to predators. Although such measures are unlikely to reduce predation by amounts comparable to the reduction in parasitism achieved by cowbird trapping, more research is needed. Furthermore, the uncertain extent to which nest predation can be reduced should not deter managers and researchers from attempts to address losses due to predation. We will never have effective means of dealing with nest predation if managers make no attempts to lessen it, which has been the case so far in all recovery efforts for endangered cowbird hosts. If actions are taken to deter predation, nests will have to be monitored and this means that cowbird eggs can be removed or addled at nests that are accessible, thereby also providing protection against some or most of the costs of parasitism.

Given the lack of highly effective means of predator deterrence and the relative ease with which cowbird parasitism can be reduced, it is unlikely that there will be situations in which this approach should be done instead of cowbird control but managers might give predator deterrence and cowbird control high priority in certain circumstances. Such circumstances might be habitat patches that are just beginning to be colonized or populations that occupy vital spatial positions as defined by population viability analysis. As we have done for southwestern willow flycatchers, recovery efforts for black-capped vireos and golden-cheeked warblers also noted the importance of predation and amelioration of this pressure as a potential management action (U. S. Fish and Wildlife Service 1991, 1992).

If attempts are made to lessen nest predation, managers should focus attention deterring predation of flycatcher nests not on complete predator control or removal, as the latter actions could have ramifications throughout an ecosystem. Any attempts to remove or kill off predators should be done only after in depth consideration of the sorts of issues raised in our list of the downsides of cowbird control, such as ethical considerations and the need for sustained year to year intervention. A similar cautionary note about predator control has been proposed for black-capped vireo recovery efforts (U. S. Fish and Wildlife Service 1991). However, it might be worthwhile to remove individual predators that appear to specialize on flycatcher nests. We note that as with cowbird removal, predator removal consistently boosts avian reproductive output but often does not increase the numbers of breeding birds (Cote and Sutherland 1997).

Appendix G.

Management of Livestock Grazing in the Recovery of the Southwestern Willow Flycatcher

A. Introduction

Breeding habitat for the southwestern willow flycatcher is restricted to riparian ecosystems. As a result of multiple factors, southwestern riparian ecosystems are among the most endangered in North America. In arid western North America, livestock overgrazing has detrimental effects on riparian ecosystems (Ames 1977, Knopf and Cannon 1982, Kaufman and Krueger 1984, Skovlin 1984, Fleischer 1996, Ohmart 1996, Belsky et al. 1999), including many of the attributes of southwestern willow flycatcher nesting habitat (USFWS 1995). However, the effects of livestock grazing vary over the range of the flycatcher, due to variations in grazing practices, climate, hydrology, ecological setting, habitat quality, and other factors. Also, other stressors affect the flycatcher's habitat to varying degrees, including water management practices, stream channel control, recreational use, and agricultural activities. In some situations, these and other factors may aggravate livestock impacts, and are sometimes difficult to separate from grazing effects. Livestock grazing has been a prevalent industry in the region for 200 years or more, but there exists a limited body of rigorous industry records or scientific research that documents livestock grazing affects on the environment (Larsen et al. 1998). Most of the available research has shown negative impacts to a host of biological resources. Addressing the issue of livestock management in the context of recovery of the southwestern willow flycatcher is therefore complicated.

Ideally, this issue would be approached by examining information that specifically compares the effects of various grazing practices on the southwestern willow flycatcher and its habitat. Because this information remains to be researched, the Technical Subgroup was compelled to approach the question indirectly by reviewing literature pertaining to grazing within riparian areas. Questions we tried to address included: What direct effects does grazing have on southwestern willow flycatchers? What are the effects of grazing on southwestern riparian ecosystems? On riparian vegetation specifically? On the plants and other habitat attributes that are key components of flycatcher habitat? On riparian birds that are ecologically similar to the flycatcher?

A large body of literature related to livestock grazing and impacts to riparian habitats, the willow flycatcher, and other riparian birds was reviewed. Much of this literature came from more mesic areas of the West where ecological conditions and riparian recovery potential differ from the arid Southwest. Convincing evidence from within and outside of the flycatcher's range comes from exclosure studies such as the San Pedro River (Krueper 1992), where after major stressors – principally livestock grazing – were removed, the riparian habitat, channel morphology, and riparian bird fauna improved substantially within five years (Figures 1- 4). Although these studies lack experimental rigor, they provide evidence that in riparian habitats where livestock grazing is the major stressor, exclosure may be the quickest method of accomplishing recovery. A critical question for the Technical Subgroup is – after full recovery of flycatcher habitat and occupancy by flycatchers, what level of grazing (other than exclosure) may be compatible with the maintenance of the riparian habitat preferred by flycatchers?

Figure 1. Photopoint 22-B, Highway 90 and San Pedro River, San Pedro Riparian National Conservation Area, July 4, 1987. Photo courtesy of David J. Krueper, BLM.

Figure 2. Photopoint 22-B, San Pedro Riparian National Conservation Area, July 6, 1992, after five years of no grazing. Photo courtesy of David J. Krueper, BLM.

Figure 3. Photopoint 31, Greenbrush Draw and San Pedro River, San Pedro Riparian National Conservation Area, July 5, 1987. Photo courtesy of David J. Krueper, BLM.

Figure 4. Photopoint 31, San Pedro Riparian National Conservation Area, July 17, 1992, after five years of no grazing. Photo courtesy of David J. Krueper, BLM.

While reading this document, it is important to remember that livestock grazing is not a single-faceted activity. Grazing has parameters of extensiveness (wide-spread), intensiveness (number of animals, season of use, various grazing systems), and species-specific (cattle, horses, elk, burros, sheep, goats, llamas, etc.). This discussion is intended to provide general concepts of potential impacts and management measures. The effects of each would vary among these parameters of livestock grazing. Concepts and recommendations expressed herein are derived principally from interpreting research on the effects of livestock on biological resources. The Technical Subgroup acknowledges that, as with domestic livestock, excessive utilization of herbaceous and woody vegetation can occur by ungulates such as elk (*Cervus elaphus*) (Kay and Chadde 1992, Singer et al. 1994, Wagner et al. 1995). Even in the absence of domestic livestock grazing, elk can over-utilize riparian areas if not properly managed (Treadaway et al. 1999), requiring some corrective measures to balance this pressure with maintenance of other ecological functions. Management of ungulates as game animals is the responsibility of State game agencies, and is largely beyond the scope of a livestock grazing review. This issue paper addresses grazing by domestic livestock; grazing and browsing by native ungulates will be discussed in the Southwestern Willow Flycatcher Recovery Plan.

B. How Livestock Grazing Can Impact Southwestern Willow Flycatchers

Impacts of livestock grazing on southwestern willow flycatchers and their habitat fall into several general categories. The primary impacts are on habitat availability and suitability. Of lesser severity are the impacts of destroying nests with eggs or young, and facilitating brood parasitism by brown-headed cowbirds. These impacts are discussed below.

1. Impacts on Habitat Availability and Suitability

Because livestock use riparian vegetation for forage, and because riparian plant structure largely defines southwestern willow flycatcher habitat, grazing can have a variety of effects on flycatcher habitat. Information on this impact exists in a variety of forms, and comes from a variety of sources and perspectives. This information fell into four general categories:

1. Overall effects of livestock grazing on southwestern riparian ecosystems.
2. The effects and/or sustainability of livestock grazing on selected plants.
3. Impacts of livestock grazing on willow flycatchers, other riparian birds, and their habitat.
4. Examples of southwestern willow flycatchers being present where livestock grazing also occurs.

Brief reviews of these information categories follow:

Effects Of Livestock Grazing On Southwestern Riparian Ecosystems

Improper livestock grazing has been a significant factor in the degradation of riparian habitats in arid western North America. Excessive grazing can change watershed hydrology, water quality, aquatic and riparian ecology, and structure and composition of riparian plant communities. In general, excessive grazing results in general drying of riparian areas, reduction in vegetation structure and volume, changes in vegetation composition, soil compaction, increases in sedimentation and water temperature, and other effects (see Bryant et al. 1972, Ames 1977, Carothers 1977, Evans and Drebs 1977, USDA Forest Service 1979, Platts 1982, Knopf and Cannon 1982, Rickard and Cushing 1982, Cannon and Knopf 1984, Kaufman and Krueger 1984, Klebenow and Oakleaf 1984, Skovlin 1984, General Accounting Office 1988, Clary and Webster 1989, Schultz and Leininger 1990, Elmore 1992, Fleisher 1996, Ohmart 1996, Belsky et al. 1999, and others). Excessive livestock grazing activities in uplands contribute to changes in surface runoff quantity and intensity, sediment transport, soil chemistry, and infiltration and water holding capabilities of the watershed; flood flows may increase in volume while decreasing in duration, and low flows may decrease in volume and increase in duration (Brown et al. 1974, Gifford and Hawkins 1978, Johnson 1992). However, Larsen et al. (1998) and Rinne (1999) point out that although a significant body of literature on the effects of grazing on riparian ecosystem components exists, very little of that literature is based on credible experimental research. Common problems include inadequate description of grazing practices under study, weak study design (e.g., lack of replicates, lack of random allocation of treatments, controls either absent or not independent from treatments), and lack of pre-treatment data. The last is an especially pernicious problem, because grazing has been a pervasive land use and recovery may take decades or longer. True controls are difficult to find.

The Technical Subgroup concluded that the preponderance of evidence indicates that excessive grazing is harmful to riparian habitats. Key attributes of southwestern willow flycatcher habitat (dense deciduous vegetation, high water tables) are among the riparian characteristics most affected by livestock grazing. Thus the evidence indicates that excessive livestock grazing is deleterious to flycatcher habitat. However, there are examples of breeding flycatchers existing with livestock grazing (see below). This presents the challenge, addressed by this document, of determining what types of grazing (including grazing intensity, season, and grazing systems) are compatible with conservation and recovery of the flycatcher.

Effects And Sustainability Of Livestock Grazing On Plants

On this topic, development of guidelines for grazing in flycatcher habitat is somewhat limited by lack of directly applicable data. Range science literature tends to examine livestock grazing from the perspective of economic and ecologic sustainability of livestock production, economic sustainability of key forage plants, physiological sustainability of certain forage plants or plant associations, and maintaining or enhancing overall range condition. It is difficult to translate these measurements of grazing into effects on the primary attributes of southwestern willow flycatcher habitat. For example, grazing effects on willows that are physiologically “sustainable” by individual plants may not sustain the type of willow foliage volume and structure that constitutes flycatcher habitat. To characterize a grazing system as “sustainable” by the survival of individual willows says nothing regarding the effects on other key factors such as regeneration, ground cover of herbaceous plants, soil compaction, etc. Further, most literature on grazing effects and sustainability of riparian vegetation originates in regions other than the southwest, where differences in conditions of climate, hydrology, and regional flora limit their application in the southwest. For example, most southwestern willow flycatchers are not found in shrubby willows, but in higher-stature habitats dominated by tamarisk, tree willow, boxelder, or Russian olive. As true for ecosystem levels of assessment, studies on the effects of grazing (heavy versus light or no grazing) on riparian vegetation tend to be compromised by lack of true controls, weak methodologies, and inaccurate or overly broad quantification of grazing intensity and ecological effects (Larsen et al. 1998).

Willows can become a principal source of cattle browse as other more palatable forage resources are depleted or as the palatability of the alternate forage decreases (Kovalchik and Elmore 1992). While in Oregon most browsing damage to willows occurs in late summer (Kauffman et al. 1983, Smith 1982), in the arid southwest such damage may occur at other times, and at greater intensities, because of the more limited alternate forage (Skovlin 1984, Belsky et al. 1999). Willow seedlings may be a preferred forage. As long as palatable herbaceous forage is available in the riparian zone, willow utilization generally remains minor in Oregon (Kauffman et al. 1983). In Oregon, mid- to late-season grazing indicates that cattle begin utilizing the current annual growth on willows when riparian forage use reaches about 45% (4- to 6-inch stubble height), and cattle eat all the willows they can when herbaceous utilization is 85% or more (< 2 inches) (Kovalchik and Elmore 1992). Along the Verde River in Arizona, livestock use of woody shrubs and trees increased during dry winters when herbaceous forage was limited or upland range conditions were poor (Tonto National Forest, unpubl. data). During dry winters use of woody shrubs and trees increased greatly after bud break, which typically occurred in late February to early March (Tonto National Forest, unpubl. data). Cattle display a strong preference for remaining in riparian zones because of the availability of shade, water, and forage. This preference can lead to further habitat degradation that, typically, would not be captured in standard vegetation utilization monitoring. For example, stream bank alteration monitoring by the Tonto National Forest on the Verde River showed that the proportion of alterable stream banks showing degradation (e.g., bank sloughing, compaction, removal of vegetation) reached 100% well before use of woody vegetation by livestock reached the established threshold of 40% (Tonto National Forest, unpubl. data).

The available literature indicates that in some areas and depending on the type of herbaceous forage available, negative impacts on woody riparian vegetation (e.g., willows) can be avoided by not allowing stubble height of herbaceous vegetation to be reduced below 3 to 6 inches (Cook et al. 1967, Cook and Harris 1968, Clary and Webster 1989). Also, cattle generally prefer grasses and forbs to woody vegetation, at least when the herbaceous vegetation is green (Gillen et al. 1985, Holechek and Vavra 1983, Kovalchik and Elmore 1992, Vavra et al. 1980). Therefore, some use of palatable grasses and sedges can occur without undesirable browsing of riparian shrubs and streambank damage (Clary and Webster 1989, Kauffman and Krueger 1984, Kauffman et al. 1983, Kovalchik and Elmore 1992, Platts and Nelson 1989). Damage to stream banks can further be avoided by implementing guidelines established by Fleming et al. (2001). They recommend that the extent of alterable stream banks remaining un-vegetated should not exceed 10%. Alterable stream banks are those portions of banks containing exposed soil or vegetation and that are not composed of bedrock, boulders, or large cobbles.

The applicability of these observations to riparian habitat in the arid Southwest is limited by three factors: 1) The majority of these studies originate outside the Southwest, in more cool and moist climates where upland forage is more abundant; 2) Herbaceous vegetation (understory) was not treated as a significant component of habitat but is sometimes a significant component of flycatcher habitat, so utilization by livestock equates to some reduction in this habitat attribute; 3) These studies concern themselves with avoiding excessive impacts or unsustainable use of woody vegetation. The criteria for defining these concepts (e.g., “excessive” or “unsustainable”) are not always provided, and are not likely to be the same as the criteria for avoiding negative impacts to the woody vegetation component of flycatcher habitat.

Mosley et al. (1997) suggested the following guidelines for stubble heights in riparian systems in Idaho: 1) stubble height of 3 to 4 inches for sedges, tufted hairgrass, and similar species following the growing season; 2) two inches for Kentucky bluegrass; 3) four to 6 inches for large bunchgrasses; and 4) utilization of riparian shrubs should not exceed 50 to 60% during the growing season. However, some researchers caution against recommendations that call for a uniform level of utilization or stubble height to maintain riparian attributes because these recommendations ignore the inherent complexity of riparian systems (Green and Kauffman 1995).

Many riparian shrub species appear to be more tolerant of leaf and twig removal than shrubs inhabiting drier sites. For example, Lammon (1994) reported that planeleaf willow could sustain 58 to 70% utilization. Riparian shrubs are generally more tolerant of browsing because they benefit from greater water availability to support plant growth. However, as noted above, willows that can physiologically sustain these use levels may not ecologically sustain southwestern willow flycatchers. Also, the effect of grazing and browsing on willow reproduction is a concern because willow seeds are short-lived and are not stored in soil seed banks (Brinkman 1974, Densmore and Zasada 1983). First-year willow seedlings can be especially sensitive to browsing. Shoots and roots at this age are generally less than 12 and 8 inches in length, respectively. Browsing of first-year shoots often kills the entire plant, because the plants are easily pulled from the ground or are killed by trampling (Kovalchik and Elmore 1992). However, mature willows have been shown to reproduce well as long as herbaceous utilization in riparian systems does not exceed 70%; at greater utilization willow reproduction is compromised (Mosley et al. 1997).

Excessive livestock grazing can have a considerable effect on vegetation, resulting in depressed vigor, biomass, and altered species composition and diversity (Bryant et al. 1972, Evans and Drebs 1977, Knopf and Cannon 1982). Excessive grazing pressures in riparian zones can significantly reduce herbaceous vegetation (Kauffman et al. 1983, Marcuson 1977) and browse (Kauffman et al. 1983, Knopf and Cannon 1982). Within the riparian zone, livestock use of browse is related to availability and palatability of herbaceous vegetation, and the palatability of the available browse (e.g., tamarisk is generally considered to be relatively unpalatable to livestock). In addition, excessive grazing pressure can prevent the establishment of seedlings (Carothers 1977, Glinski 1977). By high-lining (consumption of forage up to the maximum height of the animal) riparian deciduous shrubs or trees, or removing low-level vegetation altogether, browsing reduces the vegetation's suitability for supporting nests, may increase nest detectability to predators, and reduces foraging options. This may be a greater problem in monotypic, shrubby type habitats than in higher-stature habitats. Changes are somewhat insidious as habitat at a gross scale may persist, and condition or trend may require several years to determine under continued livestock management.

Throughout their evolutionary history, willow flycatchers probably inhabited vegetation that was grazed and browsed by large herbivores (Burkhardt 1996, see also Appendix F). More than 20 now extinct large herbivorous mammals (>45 kg) inhabited the Western United States and Mexico during the Late Quaternary (Martin and Szuter 1999). These were in addition to the nine extant large herbivores. Thus, over evolutionary time, large herbivores used riparian zones to an unknown level but probably not to an intensity that significantly reduced habitat suitability. Platts (1991) asserted that prior to European contact, "wild ungulates usually grazed within the carrying capacity of the range. If forage produced by a given range suddenly became scarce or nonexistent, wild grazing animals either moved to more favorable ranges or perished, bringing populations into balance with range capacity." Additionally, migratory herbivores – by their behavior of migration – inherently yield rest periods for their forage (Frank 1998). Perhaps more importantly than forage/consumer feedback mechanisms, predators (including humans [Martin and Szuter 1999]) played an important role in the condition of vegetation. Kay (1998) asserts that during the Pleistocene, herbivores were predator limited, and not food limited. Over much of the West, large predators have been extirpated enabling large herbivores, including livestock, to over-use the range. Predator prey dynamics of large herbivores and carnivores can have marked effects on riparian bird populations mediated through changes in the habitats (Berger and Stacey, In prep.).

The ecological equivalency of native large herbivores during the Pleistocene to domestic livestock is open to debate. Livestock management is characterized by constraints on movement (fencing) and predator control. Cattle are not frequently herded (Platts and Nelson 1989), and thus will concentrate activity in streamside zones during the spring and summer growing periods.

The Technical Subgroup concluded that the scientific literature on browsing of riparian shrubs and trees, in particular, was inadequate to determine levels of browse that are detrimental or acceptable for flycatcher habitat. Shrub and tree survival do not directly equate with suitable willow flycatcher habitat, particularly with consideration of the flycatcher's preference for dense foliage from the ground up. No studies evaluated or tested grazing levels with habitat metrics such as foliage volume or foliage height diversity.

Effects Of Livestock Grazing On Willow Flycatchers, Other Riparian Birds, And Their Habitats

At this time, specific effects of livestock grazing on southwestern willow flycatcher habitat have not been defined through experimental research. The effects are inferred from more general investigations. Southwestern willow flycatcher habitat is generally typified by high plant density and moist conditions; grazing in riparian habitats can result in reduction of plant density and a drying of riparian habitats. Not all riparian areas in the southwest are southwestern willow flycatcher habitats. However, because grazing can negatively impact riparian ecosystems in general, it follows that southwestern willow flycatcher habitat can be affected. Therefore, the Technical Subgroup concludes a negative correlation between prolonged or heavy grazing and presence of quality flycatcher habitat is probable.

Another strategy to help define the impacts of livestock grazing on the flycatcher is to examine the documented effects of grazing on other willow flycatcher subspecies, other riparian birds that are often associated with and/or ecologically similar to the flycatcher, and their habitats. We reviewed published information on the effects of livestock grazing on riparian birds, and evaluated those findings for their relevance to managing for recovery of the southwestern willow flycatcher (Table 1). As noted above regarding the general literature on environmental effects of grazing, the studies summarized are somewhat compromised by inadequate description of grazing practices, including level of grazing, intensity, lack of replication, and lack of pre-treatment data. With that qualification, the studies show that improper grazing is deleterious to many riparian birds. That southwestern willow flycatchers probably fall into the group that are harmed is supported by the fact that the Great Basin willow flycatcher (*Empidonax traillii adastus*) was harmed. Within the range of grazing practices examined, winter grazing and lighter grazing intensities had lesser negative effects than heavier grazing, summer grazing, or year-round grazing. Similarly, riparian habitats were rehabilitated most quickly and/or completely with no grazing (Ohmart 1996), and more quickly with light and/or winter grazing than with heavy, summer, and/or year-long grazing. Certainly, more research is needed to evaluate differences in rates of riparian recovery under total exclusion versus fall-winter, winter, and early spring grazing regimes. As with the literature on overall ecological effects of grazing, much of the literature on effects of grazing on riparian birds originates from outside the Southwest - generally from the Great Basin and Sierra Nevada. However, this literature is considered relevant because riparian habitats in the arid range of the southwestern willow flycatcher are more vulnerable to livestock impacts than these more mesic regions. As shady, cool, wet areas providing abundant forage, they are disproportionately preferred by livestock over the surrounding warm, xeric uplands (Ames 1977, Johnson 1989, Kauffman and Krueger 1984, Belsky et al. 1999). The negative effects of livestock grazing are typically more severe in warmer, drier environments.

Table 1. Summary of literature examining effects of livestock grazing on riparian birds.

Citation	Location	Site information	Study objectives	Methods & parameters measured	Conclusions	Relevance to southwestern willow flycatcher habitat	Other
1,2	Arapaho NWR, Colorado	Elevation: 2,500 m (8200 ft) Sage-brush outside of flood plain. 8 spp of *Salix*.	Avian community response to differences in seasonal (winter vs. summer) grazing patterns. Both seasons experienced heavy grazing.	2-year study, avian community surveys; multiple vegetation measurements at bird-centered and random points	Bird community segregated into groups that were sensitive, insensitive, and benefited by summer grazing. Sensitive species (e.g.,WIFL[a]) used locations based on bush spacing. Grazing impacts primarily through the horizontal patterning of the vegetation community.	WIFL[a] density 0.2/ha in winter grazed, absent in summer grazed. Significant correlations include height of bush (+,2/2), mean height of nearest bushes (+,½), standing biomass of herbaceous layer (-,½), distance to nearest bush (-,2/2), # of dead stems (+,2/2).	Suggests willows in winter-grazed are healthy, summer grazed are decadent; due in part to drier soils and vegetation. BHCOs[b] more common in summer-grazed. Downplays height relationship as biased by territorial behavior, not necessarily important in patch selection.
3	Lower Truckee River, Nevada	Elevation and adjacent vegetation not reported; pictures suggest sagebrush,	Compare breeding bird abundance between 1868 (Ridgway) and 1972-76.	Ridgway's undefined "rare, common, abundant" categories compared with more-clearly defined categories from multiple transect (2x2 km) surveys and 25 km survey.	Both + and – changes in the avifauna, WIFL[a] common in 1868, not detected in the 1970-80 samples.	Identifies multiple assaults on riparian system since 1868. Protection of 1 site from grazing, troubled by persistent trespass, shows some habitat recovery.	Some interpretation problems, lack of any information on livestock grazing intensity, uncontrolled for other practices.
4	Mountain Meadows	generic	literature review and recommendations			Relative to grazing, recommends eliminating grazing or delaying it until mid-August.	

Table 1. Summary of literature examining effects of livestock grazing on riparian birds.

Citation	Location	Site information	Study objectives	Methods & parameters measured	Conclusions	Relevance to southwestern willow flycatcher habitat	Other
5 & 6	Malheur National Wildl. Refuge, Oregon	Southeastern Oregon, fenced and irrigated pastures.	Response of yellow warbler and willow flycatcher[a] abundance to changes in grazing intensity.	Bird density and grazing intensity. Two bird data sets: BBS routes over 10-years and 9 strip surveys for 2 years within pastures under different livestock management.	On Breeding Bird Survey (BBS) routes, abundance of WIFLs[a] increased from nearly 0 during 1st 5 years to 18-30 during last 4 years of a 10-year period when AUM's decreased by about 75% (120k to 30k AUM) over the same period. When the transects are ordered by frequency of cattle grazing on an annual basis, clear negative correlation.	Reduced grazing increases willow production and enhances bird productivity. WIFL[a] #s not substantial until shrub volume > ≈900 m^3 / 100m transect.	Removal of willows by grazing appeared to be the mechanism. WIFL's[a] habit of nesting within 2 m of the ground made them especially vulnerable.
7	Central Sierra Nevada, California	Elevation: 1525-2285m (5000-7500 ft) Montane meadows.	Document livestock grazing impacts and protection measures.	Bird territory and nest monitoring over multiple years in three meadows. Two study sites fenced to restrict livestock except during early spring and late-fall drop-off and round-up.	Livestock directly caused 20% WIFL[a] nest loss, and damaged another 20% post-fledging. Reduced stocking (40%) and delayed on-date (after July 15) for 75% of remaining livestock eliminated nest losses.	Areas grazed intensively for drop-off and round-up provided nesting habitat. Controlling stock numbers and retarding on-dates reduce conflicts apparently because forage remains more abundant away from nesting areas, thus diminishing the attractiveness of the wet meadow area later in the season.	Prior to the grazing management change, WIFL[a] nests were destroyed by livestock from early July through mid-August. Nests were not destroyed earlier in the season, presumably due to the abundance of succulent forage, drinking water and cool climate earlier in the season and the wetness of the meadows earlier in the summer.

Table 1. Summary of literature examining effects of livestock grazing on riparian birds.

Citation	Location	Site information	Study objectives	Methods & parameters measured	Conclusions	Relevance to southwestern willow flycatcher habitat	Other
8	Southeast Wyoming	Elevation: 2225-2380 m (7300-7800 ft)	Compare birds and habitat at two willow riparian sites with different grazing history: 1) AUMs from >5,000 in 1920s to 900 after 1967, July 1- 30 Sept. season of use; 2) currently (and recent) 1,750 AUMs from 6 June to 30 Sept (prior grazing "overuse").	3-year study, random shrubs and bird species-defined shrubs as point centers to compare shrub density and tunneling effects.	Where grazing intense, *Empidonax* spp used shrubs in density the same as available (ca. 950/ha), whereas where grazing lighter, *Empidonax* spp. used shrubs in less dense (mean about 950/ha) areas than available (ca 2000/ha). Tunnel heights lower on lighter-grazed area, but no relationship with grazing discussed.	Suggests that flycatchers select for a patchy distribution of willows, a condition for which livestock can be used to achieve. However, distribution needs to be controlled to prevent detrimental effects.	SPECIES OF EMPIDONAX NOT DISCLOSED. However, other species discussed are WIFL associates. Tunnel floors were covered by grasses and sedges, suggesting the grazing intensity was relatively low.
9	Nevada & Idaho	Elevation: 1875-1966 m (6150-6450 ft) sagebrush surroundings.	Compare birds in 2 paired grazed (grazing intensity not reported) and un-grazed (excluded for 11 years, light trespass grazing) of high elevation riparian zones.	Measured vegetation cover by growth form. Willow clumps recorded average stem diameter and average stem height, biomass estimated by equation. Birds were spot-mapped from > 10 visits both in 1988 and 1989.	Herbaceous plants differed significantly between grazed and un-grazed. Aspen differed significantly. A large difference between willow standing crop biomass was masked by extreme variation. Non-willow, large shrub biomass was significantly greater in grazed than un-grazed. No meaningful differences in bird species richness, total bird density, and bird biomass between grazed and un-grazed. *Empidonax* spp, presumed to be dusky flycatchers had slightly higher (45.3) on grazed vs. (33.8 pairs/40 ha) un-grazed sites.	Mid-to-late summer grazing (intensity unknown) caused significant changes in herbaceous vegetation and aspen regeneration, and perhaps modified willow standing crop. Differences in riparian bird community were slight.	Only one location had willows. By written description and bird species identified, the other area unlikely to have been WIFL[a] habitat. The discussions here refer only to the more potentially suitable pair of study plots. Small mammal communities differed between the grazed and un-grazed areas.

Table 1. Summary of literature examining effects of livestock grazing on riparian birds.

Citation	Location	Site information	Study objectives	Methods & parameters measured	Conclusions	Relevance to southwestern willow flycatcher habitat	Other
10	Carson Range, Nevada	Elevation: 1920 m (6298 ft) Montane meadow, surrounded by lodgepole and Jeffrey pine and white fir.	Compare vegetation structural differences between a 30-year rested and summer-grazed (cattle and sheep, typically 24 cow-calf units) area; both between 25-30 ha. Compare differences in predation rates on active and artificial nests . No grazing during year of study; thus, differences suggested to be the result of grazing-induced habitat change on predators, and not on the presence of the livestock per se.	Cover within quadrants classified by growth form and the height of the top vegetation layer. Nest searches and monitoring at 4-5 day intervals. Artificial nests experiments in three designs; 1) simulating natural placements of habitat generalists [n = 30 ground and 30 above-ground each]; 2) in willows within 15m of channel [15 ground and above-ground each]; and 3) willows distant (>100m) to stream [15 ground and 15 above-ground nests, each]	Willows more abundant within 15 m of stream on un-grazed. Artificial nests were more successful on un-grazed than grazed plot in all above-ground, but not in the on-ground nests in experiment 1 & 2. Real nests were significantly more successful when grouped, but not for on-ground or above-ground categories.	Long-term grazing may alter productivity via changes in predation pressure; i.e., changes in abundance and make-up of predator community; changes in predator behavior or nest detectability; or decreasing the nesting opportunities of nesters.	No replications in study.
11	Multiple	Various	Literature review and meta-analysis of 9 published empirical grazing/breeding bird studies. Grazing intensity not specified.	Species assessed in >1 study; differences between treatments > 25%, and majority in same direction (harm, benefit)	Eight species benefit from grazing, 17 impacted, and 18 unresponsive or inconsistent responses. Species impacted were nesters and/or foragers in heavy shrub or herbaceous ground-cover, and/or vulnerable to nest parasitism.	Grazing (unspecified intensity, system, etc.) has detrimental effects on some riparian species – especially those occupying the vegetation utilized by WIFLs.	Literature review.

Table 1. Summary of literature examining effects of livestock grazing on riparian birds.

Citation	Location	Site information	Study objectives	Methods & parameters measured	Conclusions	Relevance to southwestern willow flycatcher habitat	Other
12	San Pedro River, Arizona	Elevation: 1097-1280m (3600-4200 ft) Ecotone between Sonoran and Chihuahuan Deserts	Case study of riparian community recovery and changes in bird density.	4 years after livestock exclusion, under-story vegetation increased (documented with before/after picture). Spot mapping of bird populations.	No grazing, more under-story vegetation, marked increase (consistent and > 2x) in most (7) of the neotropical migrants studied (10).	Species positively responding in density are likely associates of WIFLs[c]. Remove grazing, habitat improvement measurable within 4 years.	Uncontrolled case study.
13	See 5 & 6	See 5 & 6	Response of avian community to changes in grazing intensity.	See 5 & 6.	Willow volume significant negative correlation with frequency of grazing, positive correlation with the time since last grazing. Passerine abundance correlated with shrub volume and shrub heights between 2-6 m, but not for shrubs 1 m high. Same for bird species richness.	WIFLs[a] only present on 4 areas: most WIFLs[a] (average 14.3-18.0 males) where livestock excluded for 40 years & maximum shrub volume. Second average 10.3-12.3 males) was 6-yeas of exclusion (1 winter graze) and 2nd greatest shrub volume. Other 2 (averages; 3.7-4.0 males and 0.7-1.3 males, respectively) sites were 7th & 4th in terms of shrub volume. No WIFL[a] use in most recently grazed or impacted units.	One site had reduced passerine abundance than expected based on shrub volume. Accounted for by the heavy camping pressure on the site.

Table 1. Summary of literature examining effects of livestock grazing on riparian birds.							
Citation	Location	Site information	Study objectives	Methods & parameters measured	Conclusions	Relevance to southwestern willow flycatcher habitat	Other
14	Western US	Various	Summarize impacts of livestock grazing on fish & wildlife resources of riparian habitats.	Literature review & pertinent personal observations.	Demonstrable effects of grazing on all forms of wildlife. Suggests impacts to migrants as well as residents (unsupported).	[page 270] "The best way to manage riparian habitats is not to graze them. [Page 272] "With total rest, most systems…show tremendous change within 8-10 years. & "with managed grazing riparian healing time is twice and maybe 4 times longer than exclusion."	Brief discussion of livestock as management tool – but notes that examples of [well] managed riparian grazing are so few and [poor] unmanaged grazing so common that this tool is meaningless. Identifies a couple of cases of good riparian habitat under some grazing regimes.
15	Northeast California, Northwest Nevada	Great Basin	Compare bird and small mammal densities in "heavily" grazed and un-grazed examples of 6 habitat types; one of which (Aspen) appears (based on plant and animal species encountered) to be possibly relevent to WIFLs[a]. The un-grazed Aspen site had livestock exclusion for 87 years.	Vegetation sampled in twenty 1m^2 plots every 5 m along line transects. Height and species composition of the canopy, mid-story and under-story, % cover and count of rooted species. Birds inventoried on 1-mile strip census on 3 consecutive mornings.	Relative to grazed site, un-grazed had lush 1-m deep under-story of forbs. Young aspen and willow in the mid-story. Mid-story almost absent on grazed. Litter 2x as deep on un-grazed site compared with grazed. *Empidonax* sp. density was 21/100 acres on un-grazed, and 8/100 acres on grazed. Total avian density was 792 and 385 birds / 100 acres on the un-grazed and grazed site, respectively. Both treatment and control had a group of unique species.	"Heavy" grazing eliminated the mid-story (shrubby vegetation. Bird species community reflected these changes.	Sites were paired based on its equivalent site potential (as per Daubenmire), not proximity. No replicates. Besides "heavy," grazing not quantified.

[a] Great basin willow flycatcher, *Empidonax traillii adastus*

[b] Brown-headed cowbird, *Molothrus ater*

[c] Southwestern willow flycatcher, *E. t. extimus*

1. Knopf et al. 1988.	6. Taylor and Littlefield 1986.	11. Bock. et al. 1993.
2. Knopf, F. 1999. Pers. comm	7. Valentine et al. 1988.	12. Krueper 1993.
3. Klebenow and Oakleaf 1984	8. Krueger and Anderson 1985.	13. Taylor 1986.
4. Sanders and Flett 1989.	9. Clary and Medin 1992.	14. Ohmart 1996.
5. Taylor and Littlefield 1984.	10. Ammon and Stacey 1997.	15. Page et al. 1978.

Southwestern Willow Flycatchers Coexisting With Livestock Grazing

In some locations, southwestern willow flycatchers breed at sites which experience some degree of livestock grazing. The sites described below are located in exceptionally large floodplain riparian areas, where riparian conditions are of distinctive quality and extent. These examples indicate that under certain circumstances, flycatchers can exist with livestock grazing. Although both livestock and flycatchers occur together, specific data on grazing practices are not yet available, effects on riparian vegetation are not documented, and long-term trends (>10 years) of the resident flycatchers are either fluctuating or unknown. The lack of experimental data on the impacts of grazing to habitat and consequent responses by flycatchers leaves questions of coexistence, suitability, and compatibility unanswered. Translating these examples into refined management prescriptions that allow both grazing and flycatcher recovery will require improved documentation and monitoring of grazing practices, research into effects on riparian habitats, and continued monitoring of flycatcher populations.

The South Fork of the Kern River, California

A relatively large population of southwestern willow flycatchers occurs on the Kern River in south-central California. This population has fluctuated from 44 pairs in 1989 to 27 pairs in 1992, 38 in 1997, 26 in 1998, and 12 in 2000 (Whitfield et al. 1998 and pers. comm.). The variation in these numbers, and that they have been supported in part by cowbird trapping since 1993 (Whitfield et al. 1998), suggest that while the population persists, it may not be stable. The South Fork of the Kern River presents a nearly ideal setting for extensive, high-quality flycatcher habitat. It is a low-gradient broad floodplain with perennial stream flow and a high water table. Riparian habitat is present as a kilometer-wide cottonwood-willow forest with extensive marshy conditions. The Kern River Preserve was established in 1981, and grazing was significantly reduced in that year. Harris et al. (1987) believed that terminating grazing along parts of the South Fork of the Kern River resulted in increases in riparian vegetation and, consequently, nesting southwestern willow flycatchers (Figures 5 and 6).

Livestock presence now varies from year to year with roughly 70% of the flycatcher population occurring in areas grazed at least occasionally. All flycatcher areas that have grazing have light to moderate winter grazing. Except for removing spring/summer grazing, researchers do not believe that flycatcher numbers were significantly affected by the different grazing regimes (M. Whitfield pers. obs.). Data from grazed and ungrazed areas on the Kern River are not comparable because the areas are intrinsically different. Three components of this situation merit mention. First, grazing at the Kern River Preserve is not part of an annual grazing scheme but is conducted at the preference of the Preserve Manager, who determines ecological conditions, as well as on and off dates for livestock. Second, the Preserve comprises 1,127 acres which allows close monitoring of ecological conditions and efficient removal of livestock when conditions warrant removal. Third, forage production of perennial grasses on property adjacent to the Preserve has been measured at a level of biomass that is rarely found in other riparian systems within the range of the southwestern willow flycatcher. During a recent “wet” year, production estimates from a wet meadow on this property were approximately 4,000 and 11,000 pounds/acre in April and June, respectively (M. Whitfield pers. comm.). In the same year, production estimates from an alkaline meadow on the property during April and June were about 2,700 and 2,400 pounds/acre, respectively.

Figure 5. Kern River Preserve driveway in 1988 following about 6 years of no grazing. Photo courtesy of M. Whitfield, Kern River Preserve.

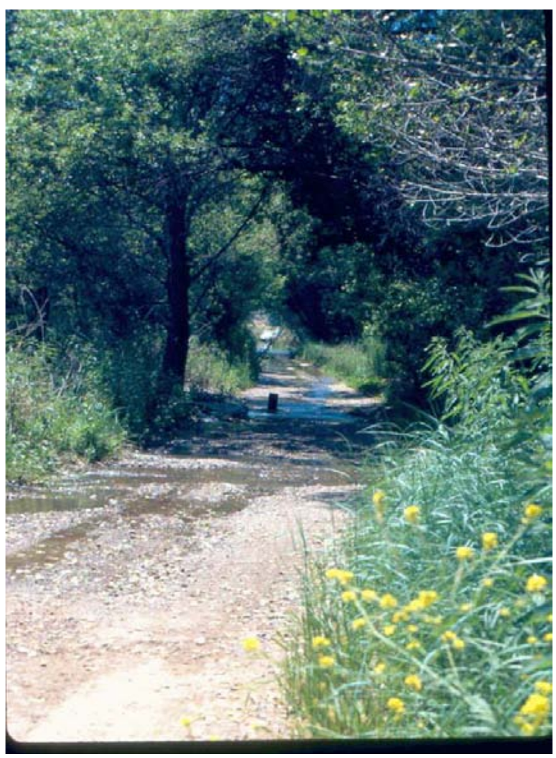


Figure 6. Kern River Preserve driveway in 1998 following about 16 years of no grazing. Photo courtesy of M. Whitfield, Kern River Preserve.

The Cliff-Gila Valley, New Mexico

In the Cliff-Gila Valley of the Gila River in southwestern New Mexico, the largest known population of southwestern willow flycatchers exists. With roughly 200 nesting pairs, this area constitutes a substantial portion of the subspecies' total numbers. This reach of the Gila River presents a unique combination of natural and manmade factors affecting flycatcher habitat. The area has highly favorable hydrological conditions for flycatcher habitat - a broad floodplain with perennial low-gradient streamflow. Some streamflow is diverted onto the floodplain to irrigate pastures, and ranch operators have allowed extensive riparian vegetation to develop along field edges, irrigation ditches, and return flow courses (Figure 7). Although water is diverted from the Gila in this area and upstream, the river is not regulated by dams upstream. Significant floods occur periodically, as in the El Niño events of 1979, 1983, and 1993, and a 1997 flood caused by Pacific typhoon Nora (Stoleson pers. obs.). Thus, natural hydrological functions like floodplain wetting, scouring, flushing of salts, and sediment deposition still occur. During the 1997 event for example, streambanks were damaged in a few areas but in general much sediment was deposited, which has resulted in substantial regeneration of riparian vegetation. Some sediment beds from earlier floods support more advanced regeneration, some of which has become occupied by flycatchers recently (S. Stoleson pers. comm.).

The majority of the Cliff-Gila population is contained in 20 riparian patches on a private ranch. Of these, two are grazed nearly year-round, seven are in a pasture grazed in late fall and winter, and the remaining 11 have had grazing excluded since approximately 1993 but are adjacent to pastures that are grazed periodically throughout the year (S. Stoleson pers. comm.). It is difficult to characterize the grazing in this area. It is closely managed; there are no fixed rotations or stocking rates, rather cattle are rotated among pastures based on visual assessments of range quality. Half of the floodplain pastures are used for off-season grazing only, and the other half are used year round. Pastures are a variety of irrigated permanent pastures, dry pastures, and fields planted in forage crops. The relative proportions of these pasture types varies from year to year. It is possible that the irrigated pastures, which are used extensively in the dry months of May and June, provide the cattle with better quality forage than they might extract from riparian vegetation. Cattle often seem to enter the riparian patches only to drink and seek shade, but not to forage (S. Stoleson pers. comm.).

A significant change in management that provided a potential short-term benefit to flycatcher habitat was the increase in water diversions to irrigate pasture and forage cropland. In approximately 1993, ranch operators experienced an increase in water available for diversion. The additional water was used to rehydrate old irrigation ditches to irrigate several pastures and fields. Stoleson (pers. comm.) suspects that any increases in flycatchers in recent years are directly related to the increase in hydration of the floodplain and corresponding changes in vegetation. The two habitat patches with the most flycatchers (49 and 41 pairs in 1999) are adjacent to irrigated fields where water runs off and produces a densely vegetated, swampy area.

Figure 7. Cliff-Gila Valley, New Mexico, October 1998. Photo taken by S. Sferra, USBR.

The Technical Subgroup is unable to conclude that the livestock management activities at the Kern River and Gila Valley are, on the whole, either detrimental or beneficial to the flycatcher. Similarly, it is unclear whether current management will sustain suitable habitat in the long-term. It is difficult to draw conclusions in the absence of better quantitative and/or experimental data. In both situations, livestock operators have access to alternative pastures in addition to the riparian areas discussed, so their ability to relieve pressure on the riparian areas is increased. Water is relatively abundant in both areas. This factor illustrates that with sufficient water, options for managing flycatchers and other resource uses are substantially increased, and conflicts are likely to be reduced. With sufficient water, riparian and aquatic ecosystems are more resilient and more capable of supporting multiple demands. Despite the above uncertainties, the Technical Subgroup commends these landowners and livestock managers for considering the flycatcher in decisions regarding grazing. The current grazing programs appear to be compatible with the current flycatcher population levels. The Technical Subgroup also commends these managers for enabling researchers to study these important populations. These areas present opportunities for continuing and refining very important research.

2. Destroying Nests with Eggs or Young

In some habitats, livestock may contact flycatcher nests or supporting limbs while watering, foraging, shading, or resting in riparian areas. This may result in destruction of the nest, or loss of eggs or nestlings. This impact is probably most common in high-elevation (1800 m or 6000 ft), low-stature monotypic willow stands. In the Sierra Nevada (the little willow flycatcher, *Empidonax traillii brewsteri*) Valentine et al. (1988) observed four of 20 studied nests destroyed by livestock prior to the young fledging. Additionally, four other nests were destroyed by livestock within days after they fledged young - demonstrating that more nests were susceptible. Strikingly, some of the losses occurred in cattle exclosures that were not adequately maintained. Susceptibility of the nests to livestock was attributed to their low height within the shrubs (approx. 1.5 m or 5 ft), small diameter of their supporting limbs, proximity to water, low branch density near the nests, and proximity to shrub edges. However, the height to which livestock can affect willow flycatcher nests is unknown (Valentine et al. 1988). Loft et al. (1987) illustrated that heavy grazing can reduce the cover attributed by willow up to at least 1.5 m (5 ft). Because southwestern willow flycatcher nest heights vary considerably, so does the magnitude of this threat. For example, southwestern willow flycatcher nests have been reported at heights from 0.6 to 18 m (1.9 to 59 ft) (Sogge et al. 1997). Herbivores have probably always grazed riparian zones over the willow flycatcher's evolutionary history, suggesting that the source of loss is not unique to domestic livestock; however, its frequency may now be out of the species range of variation, especially in low stature habitats. The grazing intensity over that pre-European contact period may well have been sufficiently different from that experienced under current livestock management. Clearly, the biological significance of livestock toppling of nests is large when the entire flycatcher population is low and the number of habitats occupied is few.

3. Facilitating Brood Parasitism by Brown-headed Cowbirds

Livestock grazing can facilitate brood parasitism by brown-headed cowbirds (*Molothrus ater*). Livestock grazing in and adjacent to riparian habitat may provide cowbirds with greater access to southwestern willow flycatcher nests, improve foraging opportunities, and establish foraging areas closer to flycatcher nesting areas. Cowbirds can impact southwestern willow flycatcher productivity even when the grazing is remote (> 8 km or 5 mi) from the flycatcher's nesting habitats (Curson et al. 2000, Rothstein et al. 1984). However, these impacts are variable and site specific. Because cowbird parasitism varies geographically and temporally, data on cowbird abundance, distribution, and levels of nest parasitism must be gathered locally. These data are essential to determine the extent to which cowbird control or cowbird habitat management via livestock management efforts are justified (see Appendix F; cowbird parasitism and management).

C. Measures That Can Be Taken To Alleviate Livestock Impacts

The fundamental approach to recovering an endangered species is to remove the threats to its existence, whether they are contamination, persecution, loss of habitat, or others. In the case of livestock grazing and the southwestern willow flycatcher, our approach was to examine the available information to determine as specifically as possible the degree and the conditions under which livestock grazing is compatible or incompatible with flycatcher recovery. This effort was undertaken because of a desire to avoid recommending undue or unnecessary restrictions on a widespread, traditional land use industry.

With the southwestern willow flycatcher, the effort to fine-tune recovery recommendations with respect to livestock grazing is worthwhile, as livestock operators, biologists, and management agencies increasingly learn that much can be accomplished by working together. However, the primary responsibility of the Technical Subgroup is to chart the recovery of the southwestern willow flycatcher. The goal of a recovery plan is to recommend actions that will bring about recovery of a species. The evidence and field examples indicate that with respect to livestock grazing, southwestern willow flycatcher recovery would be most assured, and in the shortest time, with total exclusion of livestock grazing from those riparian areas that are deemed necessary to recover the flycatcher and where grazing has been identified as a principal stressor. There is also evidence that under the right circumstances, certain types of grazing are likely to be compatible with recovery. While the data are insufficient to identify specifically what grazing systems are compatible in which specific circumstances, exploring the levels of grazing that may be compatible with maintenance of suitable flycatcher habitat is warranted.

During five separate meetings with Implementation Subgroups associated with the Recovery Team, individuals representing the ranching industry repeatedly underscored the importance of maintaining flexibility within livestock management operations. Evaluation of the current system of public lands grazing leads to the conclusion that there is little or no flexibility because allotments are either all committed to permittees or have been withdrawn from grazing for various conservation or other purposes. When permittees find themselves in a situation where the allotment needs rest, their choices may be limited to selling their livestock, finding alternative pastures or private land to graze, and/or continuing to graze the allotment. There is no grass bank for public lands grazing. Also, contemporary public land managers are frequently compelled to manage livestock grazing and a variety of other resource uses and values without adequate staff and funding. In some cases, livestock grazing is conducted in the context of management unit boundaries that may be constraining to flycatcher recovery and inappropriate for the complexities of modern ecosystem-based resource management. Modifications to these management unit boundaries may be necessary to achieve recovery goals. Therefore, in addition to specific recommendations (Table 2), the following general recommendations are made, encouraging Federal land managers to undertake a major conservation planning initiative to:

1. Identify the most important riparian areas for the recovery of the southwestern willow flycatcher and riparian and aquatic organisms in general.
2. Identify the most appropriate areas for permitting livestock grazing given the biodiversity concerns for the particular land management unit.
3. Reconfigure grazing pasture boundaries to reflect the true productivity of rangelands associated with important flycatcher recovery areas, and allow differential management of units of varying ecological sensitivity.
4. Exclude livestock from sites where exclusion would result in the greatest ecological improvement and least economic loss.
5. If monitoring is less than annual, establish livestock use numbers based on drought years, not the average or wettest years, to provide for livestock operations that are viable given this region's propensity to experience prolonged drought. With annual monitoring, adjust livestock levels in response to reduced forage availability, poor vigor and physiological stress on forage plants, and/or decreased cover brought on by drought conditions.
6. Establish an adequate number of ungrazed areas at different elevation and geomorphic settings. These will provide land management agencies and researchers with a much-needed series of sites against which to compare the condition of grazed watersheds (Brinson and Rheinhardt 1996) (see #8 below).
7. Institute and/or improve record-keeping and documentation of grazing practices, retroactively where possible, so that the ecological effectiveness of various grazing practices can be more scientifically evaluated (see #8 below).
8. Work with state universities, private colleges, and research institutions to fund and facilitate research that better defines the ecological and hydrological effects and sustainability of livestock grazing in southwestern ecosystems, particularly southwestern riparian ecosystems.

These recommendations strive to promote flexibility within the confines of conserving willow flycatchers. With flexibility and proper grazing management, grazing may be compatible with recovery and conservation of the southwestern willow flycatcher and other riparian species. This conservation planning effort and adjustment of managing public lands grazing should be completed within the next five years. In the interim, the Technical Subgroup is challenged with providing specific recommendations that will begin the process of recovery. After thoughtful and thorough review of the scientific literature, and much deliberation, the Technical Subgroup is confident there is common ground between the needs of the livestock manager and the southwestern willow flycatcher. Both prosper from efforts that sustain the quality of the landscape. The preponderance of evidence indicates that conservative stocking rates and light-to-moderate utilization levels are generally effective in maintaining range condition while increasing individual animal (livestock) performance (Johnson 1953, Klipple and Costello 1960, Paulsen and Ares 1962, Martin 1975, Houston and Woodward 1966, Holechek 1992, Winder et al. 2000). In all cases, the uniqueness of each area needs to be recognized and considered in developing a management strategy.

Accepting that conservative management is a logical beginning point, the Technical Subgroup recognizes that the spatial and temporal flexibility remaining within the context of conservative management will, by necessity, be further reduced for purposes of recovering the critically endangered southwestern willow flycatcher and the riparian habitats upon which it depends. Recommendations the Technical Subgroup believes will begin the process of recovery while promoting ecologically sustainable grazing practices are presented below (Table 2). A precept of these recommendations is that grazing has been identified as the major stressor, or one of the major stressors. Recommendations are based on the best information available on the effects of livestock on southwestern riparian ecosystems, on selected plant types, and on willow flycatchers and other riparian birds. Because of the impacts discussed in this document, this information in general points toward cessation of grazing to accomplish recovery. However, the information reviewed here also suggests some degree of compatibility between grazing and flycatcher recovery, under certain circumstances. This table explores the variability in southwestern willow flycatcher habitats, grazing systems, and ecological considerations of plant phenology. Southwestern willow flycatcher habitats are allocated to two broad categories. These are the lower stature willow habitats often found at higher elevations (>1,830 m or 6,000 ft), and taller stature habitats found at lower elevation typically comprised of willow, cottonwood, boxelder, tamarisk, and associated trees and shrubs. Grazing is separated into growing season and non-growing season of woody riparian vegetation (non-growing season is from leaf drop to bud break of common woody riparian species).

The recommendations do not address the myriad other grazing variations. This issue paper does not address specific locations where these recommendations should be implemented, but rather identifies management for general categories of sites. Therefore, the recommendations for domestic livestock grazing presented in Table 2 should be interpreted as general guidelines that should be applied according to site-specific conditions (see summary on page G-31). Specific watersheds or portions of watersheds for implementation of recovery actions are identified in the main body of this plan, in the form of recovery goals (e.g., total number of flycatchers, acres of habitat, and distribution of these across the range).

The intent of these general grazing guidelines is to promote recovery of the southwestern willow flycatcher while allowing conservative livestock grazing where appropriate and to provide flexibility for adaptive management in order to maintain or enhance southwestern willow flycatcher habitat. We recognize that private lands will play an important role in the recovery of the flycatcher, and that coordination and cooperation with private landowners and public grazing permittees is critical to the success of this recovery effort. In order to provide incentives for private landowners and public grazing permittees to improve and manage for southwestern willow flycatcher habitat, flexibility through adaptive management must be an integral part of the recommended grazing guidelines. Therefore, if a particular grazing system is improving southwestern willow flycatcher habitat (e.g., grazing system is not preventing regeneration of woody and herbaceous riparian vegetation), then that particular grazing system should be allowed to continue provided it is appropriately monitored and documented.

Table 2. General guidelines for domestic livestock grazing in southwestern willow flycatcher habitat.

Site Conditions			Site-Specific Guidelines	
Habitat Status	**Flycatcher Status**	**Season**	**Low-Stature Habitat: 3-4m shrubby willow**	**All other habitat types ≤1830 m or 6000 ft elevation**
1. Restorable or Regenerating Habitat[1]	1A. Unoccupied	Growing Season[2]	No grazing.	No grazing.
	1B. Unoccupied	Non-Growing Season	No grazing.	Provisional grazing[3] (assumes grazing is not a major stressor).
2. Suitable Habitat	2A. Unoccupied	Growing Season	No grazing.	No grazing, but at discretion of USFWS, provision for a limited number of small-scale, well-designed experiments to determine levels of pre-breeding season grazing that do not adversely affect southwestern willow flycatcher habitat attributes. Grazing not to exceed 35% utilization of palatable, perennial grass or grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use[4] not to exceed 10%.[5]
	2B. Unoccupied	Non-Growing Season	Conservative grazing with average utilization not to exceed 35% of palatable, perennial grasses and grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use not to exceed 10%. Woody utilization not to exceed 40% on average.	Conservative grazing with average utilization not to exceed 35% of palatable, perennial grasses and grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use not to exceed 10%. Woody utilization not to exceed 40% on average.
	2C. Occupied	Growing Season	No grazing.	No grazing until research in comparable unoccupied habitat demonstrates no adverse impact; if unoccupied habitat becomes occupied habitat, continue existing management (grazing should not exceed 35% of palatable, perennial grasses and grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use not to exceed 10%).

Table 2. General guidelines for domestic livestock grazing in southwestern willow flycatcher habitat.				
	2D. Occupied	Non-Growing Season	No grazing.	Conservative grazing with average utilization not to exceed 35% of palatable, perennial grasses and grass-like plants in uplands and riparian habitats, and extent of alterable stream banks showing damage from livestock use not to exceed 10%. Woody utilization not to exceed 40% on average.
3. Uplands & Watershed Condition [6]	3. Occupied & Unoccupied	For any season of use	Average utilization of palatable, perennial grasses and grass-like plants not to exceed 30-40%. Use stubble height guidelines: 3" for short grass, 6" for midgrass, 12" for tall grass. Determine monitoring species prior to grazing.	Average utilization of palatable, perennial grasses and grass-like plants not to exceed 30-40%. Use stubble height guidelines: 3" for short grass, 6" for midgrass, 12" for tall grass. Determine monitoring species prior to grazing.

[1]"Restorable" means riparian systems that are degraded but have the appropriate hydrological and ecological setting to be restored to suitable flycatcher habitat, and could be restored with reasonable costs and actions. Lack of regeneration due to grazing is one factor contributing to habitat degradation; conditions in each habitat should include adequate plant regeneration to ensure habitat sustainability into the future. At these sites, flycatcher habitat is precluded largely or solely by livestock impacts. "Restorable" habitats are those that would be suitable if not for grazing, alone or in combination with other major stressors. This means cessation of grazing is a necessary, but not necessarily a sufficient action.

[2]Growing season is defined as bud break to leaf drop for cottonwood and willow species. Non-growing season is defined as leaf drop to bud break for cottonwood and willow species.

[3]Grazing should only be conducted if it is not a major stressor and does not preclude satisfactory progress toward suitability.

[4]Damage to stream banks from livestock use includes: bank chiseling, trampling, trailing, soil compaction, breakage of vegetation, bank sloughing, etc.

[5]Alterable stream banks are those portions of banks containing exposed soil or vegetation and not composed of bedrock, boulders, or large cobbles (Fleming et al. 2001).

[6]Uplands and watersheds, or portions of watersheds, associated with areas identified as restorable, regenerating, or suitable southwestern willow flycatcher habitat. General guidelines should be implemented unless site-specific data clearly indicate that deviation from the guidelines will not prevent or slow progression toward suitability and/or maintenance of suitable habitat conditions.

The guidance provided in Table 2 is based on the current endangered status of the southwestern willow flycatcher. Flexibility will increase with the eventual downlisting of the flycatcher to threatened status. Overall, the best available information suggests that flycatcher recovery is most assured with no grazing in its habitat during the growing season. In some situations, some light to moderate levels of grazing during the non-growing season may be compatible with flycatcher recovery , if carefully managed and closely monitored. Where grazing is indicated in Table 2, the following set of conditions apply:

1. All grazing is to be accompanied by monitoring. If funding is not sufficient to allow monitoring, then grazing should be discontinued. Monitoring should include exclosed areas, where possible, in riparian habitat on allotments or pastures where grazing has been discontinued, as well as allotments or pastures where grazing is allowed to continue.
2. The target for total utilization of palatable, perennial grasses and grass-like plants should not exceed 35% (±5% to accommodate sampling error) in upland and riparian habitats. Utilization of 35% not only includes direct consumption, but also includes other factors associated with herbivory (e.g., trampling, trailing, bedding). With monitoring, stocking rates may be adjusted to current forage production each year (White and McGinty 1997).
3. Stubble height baselines should have a forage/acre figure associated with them, if possible, so the baseline is not established for areas that are too poor to graze.
4. Annuals are excluded from the forage base because reliance on annuals indicates overuse of perennial grasses and grass-like plants and woody riparian vegetation.
5. The target for utilization of woody vegetation at the pasture level is 40% (±10% to accommodate sampling error), meaning the removal of 40% of the biomass of the current year's growth. This not only includes direct consumption but also includes other factors associated with herbivory (e.g., trampling, breakage of vegetation).

Consideration of uplands is essential. Elmore and Kaufman (1994) reported that "simply excluding the riparian area (from grazing) does not address the needs of the upland vegetation or the overall condition of the watershed. Unless a landscape-level approach is taken, important ecological linkages between the uplands and aquatic systems cannot be restored and riparian recovery will likely be limited." Livestock grazing may alter the vegetation composition of the watershed (Martin, 1975, Savory 1988, Valentine 1990, Popolozio et al. 1994). It may cause soil compaction and erosion, alter soil chemistry, and cause loss of cryptobiotic soil crusts (Harper and Marble 1988, Marrs et al. 1989, Orodho et al. 1990, Schlesinger et al. 1990, Bahre 1991). Cumulatively, these alterations contribute to increased erosion and sediment input into streams (Johnson 1992, Weltz and Wood 1994). They also contribute in changes to infiltration, water holding capacity of the watershed, and runoff patterns, thus increasing the volume of flood flows while decreasing their duration (Brown et al. 1974, Gifford and Hawkins 1978, Johnson 1992). As a result, groundwater levels may decline and surface flows may decrease or cease (Cheney et. al. 1990, Elmore 1992).

1. Narrative Interpretation of Table

Row 1A (Unoccupied restorable habitat in growing season):

Low Stature Habitat: 3-4 m monotypic shrubby willow at high elevation (> 1,830 m or 6,000 ft)

At sites where the goal is to restore habitat to suitable for flycatchers no grazing is recommended, because most of the nesting structure is within the zone of direct livestock impact. This habitat type is highly susceptible to direct impacts, and slow to recover due to the short growing season. With a goal of restoring habitat, the best possible conditions for hydrological recovery, regeneration, and growth of vegetation are desired. The literature indicates exclusion of grazing will facilitate this. For this habitat and the next three (through row 1B), note that the transition from “restorable” habitat to “suitable” habitat will be a regulatory decision made by USFWS with input from land managers, based on habitat attributes discussed in Appendix D.

All other habitat types < 1,830 m or 6,000 ft.

At sites where the goal is to restore habitat to suitable for flycatchers, no grazing is recommended. With a goal of restoring habitat, the best possible conditions for hydrological recovery, regeneration, and growth of vegetation are desired. The literature indicates exclusion of grazing will facilitate this.

Row 1B (Unoccupied restorable habitat in non-growing season):

Low Stature Habitat: 3-4 m monotypic shrubby willow at high elevation (> 1,830 m or 6,000 ft)

The goal is to restore habitat to suitable for flycatchers. No grazing is recommended, because this habitat type is highly susceptible to impacts. With a goal of restoring habitat, the best possible conditions for hydrological recovery, regeneration, and growth of vegetation are desired. The literature indicates exclusion of grazing will facilitate this.

All other habitat types < 1,830 m or 6,000 ft.

The goal is to restore habitat to suitable for flycatchers. No grazing is preferred, but provisional grazing is considered possible if grazing is not a major stressor. With a goal of restoring habitat, the best possible conditions for hydrological recovery, regeneration, and growth of vegetation are desired. Grazing must not preclude satisfactory progress toward suitability. In situations where other significant stressors occur, those should be removed, and the significance of grazing as an additive or synergistic stress should be considered.

Row 2A (Unoccupied suitable habitat in growing season):

Low Stature Habitat: 3-4 m monotypic shrubby willow at high elevation (> 1,830 m or 6,000 ft)

The goal is to maintain and/or enhance flycatcher habitat attributes. No grazing is recommended, because this habitat type is highly susceptible to fragmentation and impacts. With a goal of maintaining and enhancing habitat, the best possible conditions for maintaining hydrological integrity, and maintenance, regeneration, and growth of vegetation are desired. The literature indicates exclusion of grazing will facilitate this.

All other habitat types < 1,830 m (6,000 ft)

The goal is to maintain and/or enhance flycatcher habitat attributes. No grazing is recommended, because with a goal of maintaining and enhancing habitat, the best possible conditions for maintaining hydrological integrity, maintenance, regeneration, and growth of vegetation are desired. The literature indicates exclusion of grazing will facilitate this.

Regarding grazing research, the intent is to collect information that may allow changes in these recommendations, if appropriate. This grazing research offers a reasonable complement to excluding grazing from most of the sites in this category, and is crucial to refining our understanding of grazing effects on riparian ecosystems. Here as elsewhere, documentation and monitoring of grazing systems and effects is important.

Row 2B (Unoccupied suitable habitat in non-growing season):

Low Stature Habitat: 3-4 m monotypic shrubby willow at high elevation (> 1,830 m or 6,000 ft)

The goal is to maintain and/or enhance flycatcher habitat attributes while providing an alternative to no grazing. Grazing is allowed at specified intensities because literature from the Pacific Northwest and other areas indicates these rates of utilization on herbaceous and woody plants can be sustained by the plants. Effects on flycatcher habitat characteristics are not known. Grazing utilization rates must be monitored with emphasis on collecting data that will provide an opportunity to modify this and other recommendations in the future.

All other habitat types < 1,830 m (6,000 ft)

The goal is to maintain and/or enhance flycatcher habitat attributes while providing an alternative to no grazing. Grazing is allowed at specified intensities because literature from the Pacific Northwest and other areas indicates these rates of utilization on herbaceous and woody plants can be sustained by the plants. Effects on flycatcher habitat characteristics are not known. Grazing utilization rates must be monitored with emphasis on collecting data that will provide an opportunity to modify this and other recommendations in the future.

Row 2C (Occupied suitable habitat in growing season):

Low Stature Habitat: 3-4 m monotypic shrubby willow at high elevation (> 1,830 m or 6,000 ft)

The goal is to maintain and/or enhance flycatcher habitat attributes, and protect nesting flycatchers. All current breeding flycatchers are important to recovery. No grazing is recommended, because this habitat type is highly susceptible to fragmentation and impacts, and flycatcher nests are vulnerable to direct disturbance. The literature indicates exclusion of grazing will avoid these impacts.

All other habitat types < 1,830 m (6,000 ft)

The goal is to maintain and/or enhance flycatcher habitat attributes, and protect nesting flycatchers. All current breeding flycatchers are important to recovery. No grazing is recommended, because effects of heavy grazing are known to be deleterious. Effects of light or moderate growing-season grazing on flycatcher habitat are not specifically known. The literature indicates exclusion of grazing will avoid these impacts. Some field examples (e.g., Cliff-Gila Valley) indicate that under some circumstances, flycatchers persist with grazing during the growing season. However, the general effects are unknown. Research is needed to define the relationships and thresholds involved. If research is completed on comparable unoccupied sites, grazing may be considered, at intensities below thresholds that degrade flycatcher habitat.

Row 2D (Occupied suitable habitat in non-growing season):

Low Stature Habitat: 3-4 m monotypic shrubby willow at high elevation (> 1,830 m or 6,000 ft)

The goal is to maintain and/or enhance flycatcher habitat attributes. All current breeding sites are important to recovery. No grazing is recommended, because this habitat type is highly susceptible to fragmentation and impacts. This habitat type may be particularly vulnerable in the non-growing season when snow covers alternate forage plants. Effects of heavy grazing even in non-growing season are known to be deleterious. Effects of light or moderate grazing on flycatcher habitat are not specifically known. The literature indicates exclusion of grazing will avoid these impacts.

All other habitat types < 1,830 m (6,000 ft)

The goal is to maintain and/or enhance flycatcher habitat attributes. All current breeding sites are important to recovery. Conservative grazing is allowed at specified intensities because literature from the Pacific Northwest and other areas indicates these rates of utilization on herbaceous and woody plants can be sustained by the plants. Effects on flycatcher habitat characteristics are not known. Several field examples (e.g., Kern River) demonstrate that flycatchers persist with this grazing system in some situations.

Row 3 (Uplands and watershed condition, all seasons):

Low Stature Habitat: 3-4 m monotypic shrubby willow at high elevation (> 1,830 m or 6,000 ft)

The goal is to rehabilitate and maintain uplands and watersheds in conditions that will facilitate restoration of southwestern willow flycatcher riparian habitat. Evidence suggests this conservative grazing regime will achieve this goal (see Table 1). Monitoring species must be determined prior to grazing, and monitoring must take place.

All other habitat types < 1,830 m (6,000 ft)

The goal is to rehabilitate and maintain uplands and watersheds in conditions that will facilitate restoration of southwestern willow flycatcher riparian habitat. Evidence suggests this conservative grazing regime will achieve this goal (see Table 1). Monitoring species must be determined prior to grazing, and monitoring must take place.

2. Summary:

This issue paper does not address specific locations where recommendations contained herein should be implemented, but rather identifies management for general categories of sites. Because of the variability associated with riparian systems, these recommendations should be interpreted as guidelines that must be applied according to site-specific conditions. The uniqueness of each area needs to be recognized and considered in the development of site-specific management strategies. Specific watersheds or portions of watersheds for implementation of recovery actions are identified in the main body of this Recovery Plan (e.g., total number of flycatchers, acres of habitat, and distribution of these across the range).

The Technical Subgroup recommends against growing-season grazing in southwestern willow flycatcher habitat. Within the range of grazing practices examined, winter grazing and lighter grazing intensities had lesser negative effects than heavier grazing, summer grazing, or year-round grazing. Similarly, riparian habitats were rehabilitated most quickly and/or completely with no grazing, and more quickly with light and/or winter grazing than with heavy, summer, and/or year-long grazing. Research is needed to define the relationships and thresholds involved. A reasonable complement to excluding grazing is to provide for a limited number of small-scale, well-designed, and adequately funded experiments to determine appropriate levels of pre-breeding season grazing. This grazing research is crucial to refining our understanding of grazing effects on riparian systems.

Development of refined management prescriptions that allow both grazing and flycatcher recovery will require improved documentation of grazing practices. The need for monitoring is fundamental. The Technical Subgroup recommends that grazing be discontinued if not accompanied by monitoring. Monitoring should include exclosed reference areas in riparian habitat, where possible, on allotments or pastures where grazing has been discontinued, as well as allotments or pastures where grazing is allowed to continue.

D. Literature Cited

Please see Recovery Plan Section VI.

Appendix H.

Exotic Plant Species in Riparian Ecosystems of the US Southwest

A. Introduction

Species that have recently established in a new ecosystem as a result of human intervention are referred to as exotic, introduced, or alien species. There are an estimated 5,000 exotic plant species in U.S. natural ecosystems, compared with about 17,000 species of native plants (Morse et al. 1995, Morin 1995). Management of exotic species has become an issue of great regional, national, and international concern.

Many exotic species cover only small areas and do not appear to be spreading. Others have become thoroughly enmeshed in native ecosystems and are referred to as being naturalized. Those that continue to spread rapidly and widely are referred to as invasive. Invasive exotics have brought about various types of ecological changes, some of which are perceived as being negative (Simberloff 1981, Williamson and Brown 1986). Economic losses attributed to widespread invasives are high (Sell et al. 1999). A great amount of effort is spent on controlling undesirable exotic species, often with little success.

In response to this problem, the President of the U.S. in February of 1999 issued an Executive Order on Invasive Species, which among other things, created an Invasive Species Council and Advisory Board. Ideally, these bodies will reaffirm the need to approach exotic species management from a rational, scientific perspective. Many aspects of the exotic species issue have become steeped in myth and misinformation, and some management approaches are ill-advised. Some of the beliefs about the causes and consequences of exotic species spread do not hold up under scientific scrutiny (Treberg and Husband 1999). Also, some exotic plant species, including *Polypogon monspeliensis (*now common in riparian zones of the U.S. Southwest*)* are becoming endangered in their native countries, requiring that management actions take on a more global perspective (Jefferson and Grice 1998).

There are fundamental questions to address before formulating exotic plant management plans. Which species and sites warrant management attention? What are the root causes that facilitate the spread of the undesirable exotics? Can we address these root causes and restore conditions that allow native species to proliferate? In addition to attempting to *control* the exotic species, it is paramount to *restore* the desired ecosystem components and functions. In this issue paper, we address these questions from the perspective of restoring habitat quality for the endangered southwestern willow flycatcher within riparian ecosystems of the U.S. Southwest. A more complete discussion of habitat restoration is provided in Appendix K (habitat restoration).

Exotic Species in Riparian Habitats

There are hundreds of exotic plant species in the riparian west. For example, 25% of 340 vascular plant species along the Hassayampa River in central Arizona are exotic, as are 34% of 185 species along the Snake River in Idaho (Wolden et al. 1994; Dixon et al. 1999). Many riparian exotics cover only small areas and are encountered infrequently, but others have become regionally widespread and locally dominate channels or flood plains.

It is beyond the scope of this paper to provide information on the relative risks, invasiveness, or abundance of all the exotics in the many different biotic communities occupied by the flycatcher, although this would be a valuable exercise (Dudley and Collins 1995). In Table 1, we list some of the exotic plant species present in riparian and wetland ecosystems within the range of the southwestern willow flycatcher. Note that classification of a species as exotic or native is not always clear cut, and not all “weeds” are exotic. Sometimes, it can be difficult to determine how long a species has been present in an area. For example, we omit cocklebur (*Xanthium strumarium*) from Table 1 because it appears naturally to be a circumglobally distributed disturbance species.

Many of the species in Table 1, such as Bermuda grass (*Cynodon dactylon*), rabbits foot grass (*Polypogon monspeliensis*), and red brome (*Bromus rubens*), are grasses or forbs that dominate the ground layer of actual or potential habitat for southwestern willow flycatchers. Some, such as athel tamarisk (*Tamarix aphylla*) and pepper tree (*Schinus molle*) have become invasive in other countries (Griffin et al. 1989), but do not cover large areas or spread rapidly in riparian zones of the U.S. Southwest despite having been widely planted in the region. While these and other exotics may be neutral or exert only a minor or localized negative effect, or in some cases, perhaps a positive effect on habitat suitability for Southwestern willow flycatchers, a notable few are highly invasive trees, shrubs, or tall grasses that now constitute the main structural layer in many Southwestern riparian habitats. In this paper, we concentrate our attention on three of these, and devote particular emphasis to tamarisk:

1) *Tamarix ramosissima* (and closely related species) are large shrubs to small trees native to Eurasia. They were sold by U. S. nurseries as early as 1820 and marketed as landscape plants; and escaped cultivation in the late 1800s (Tellman 1997). Some tamarisks (saltcedar) were intentionally planted along the Rio Grande and Rio Puerco in the 1920s to stabilize eroding surfaces (Robinson 1965). Over the past century, tamarisk expanded its distribution, while native forests of Fremont cottonwood, Goodding willow, and mesquite declined (Harris 1966; Everitt 1980). By the mid-1960s, tamarisk covered an estimated one million acres of flood plains and stream beds in North America (Robinson 1965). Tamarisk is abundant along many of the low-elevation, hot desert rivers of Arizona and southern Nevada, such as the lower Colorado, Gila, and Virgin Rivers (Bowser 1957). It also is abundant along several higher elevation rivers including the Rio Grande and Pecos River of New Mexico and Texas, Brazos River in Texas, Green and Colorado Rivers of Utah, and Gunnison River of Colorado. Tamarisk can dominate the canopy or form an understory layer to taller cottonwoods and willows.

2) Russian olive *(Elaeagnus angustifolia)* is a small Eurasian tree that has escaped from cultivation and become naturalized along riparian areas in the western U.S. (Knopf and Olson 1984, Shafroth et al. 1994, Olson and Knopf 1986.). Russian olive is common along many rivers of the Colorado Plateau and other high elevation sites, including the Rio Grande and San Juan River. Russian olive often forms a mid-canopy layer under taller cottonwoods, but at some sites dominates the canopy.

3) Giant reed (*Arundo donax*) is a tall, perennial grass introduced to the Southwest in the 1800's for use as a source of thatch for roofs and for erosion control along canals. It is highly invasive, and spreads rapidly through dispersal of fragmented rhizomes during flood events. Although it produces flowers, sexual reproduction by giant reed is unknown in the areas to which it has been introduced (Bell 1997). In contrast to native woody species in which seedlings become established as flood waters recede, giant reed propagules become established when floods are at or near maximum levels, facilitating invasion into stands of mature vegetation. Rhizomes can sprout from depths of up to 100 cm below the soil surface; but adequate moisture must be present for several months for successful establishment (Else 1996, Dudley 2000). Once established, giant reed forms large, dense rhizome masses up to a meter thick, with stems up to 8 m tall. The established plants are relatively resistant to dessication, and can dominate the canopy layer of riparian sites, replacing willows, cottonwoods, and *Baccharis salicifolia* (mulefat or seep-willow). It has become particularly abundant along the waterways of southern California, including the Santa Ana, Santa Margarita, and San Luis Rey rivers, and is currently perhaps the greatest proximate threat to preservation of California’s remaining native riparian habitat (Bell 1997).

Table 1. A partial list of exotic plant species present in riparian and wetland ecosystems within the range of the Southwestern willow flycatcher.

Scientific name	Common name	Growth form
Ageratina adeonophora	-	shrub
Agrostis stolonifera	creeping bent grass	perennial grass
Agrostis viridis	bent grass	perennial grass
Ailanthus altissima	tree-of-heaven	clonal tree
Alhagi camelorum	camel-thorn	shrub
Arundo donax	giant reed	perennial grass
Avena fatua	wild oats	annual grass
Bassia hyssopifolia	smother-weed	annual forb
Bromus catharticus	rescue grass	annual grass
Bromus diandrus (*B. rigidus*)	brome	annual grass
Bromus rubens	red brome	annual grass
Brassica nigra	black mustard	annual forb
Centaurea melitensis	star-thistle	annual forb
Chenopodium album	lamb’s quarters	annual forb
Chenopodium murale	goose-foot	annual forb
Cirsium arvense	Canada thistle	perennial forb
Conium maculatum	poison hemlock	biennial forb
Cortaderia jubata	-	perennial grass
Cortaderia selloana	pampas grass	perennial grass
Cynodon dactylon	bermuda grass	perennial grass
Cytisus scoparius	Scotch broom	shrub
Digitaria sanguinalis	crab grass	annual grass
Echinochloa colona	jungle-rice	annual grass
Echinochloa crus-galli	barnyard grass	annual grass
Elaeagnus angustifolia	Russian olive	tree
Eragrostis cilianensis	stink grass	annual grass
Eragrostis lehmanniana	Lehmann's love grass	perennial grass
Foeniculum vulgare	fennel	perennial forb
Galium aparine	goosegrass bedstraw	annual forb
Gnaphalium luteo-album	cud-weed	annual forb

Table 1 *continued*. A partial list of exotic plant species present in riparian and wetland ecosystems within the range of the Southwestern willow flycatcher.

Scientific name	Common name	Growth form
Hedera helix	English ivy	woody vine
Hordeum murinum	wild barley	annual grass
Lactuca serriola	wild lettuce	annual forb
Lepidium latifolium	perennial pepperweed	perennial forb
Lythrum salicaria	purple loosestrife	perennial forb
Marrubium vulgare	horehound	perennial forb
Melilotus albus	sweet clover	biennial forb
Melilotus officinalis	sweet clover	biennial forb
Nasturtium officinale	water cress	perennial forb
Nicotiana glauca	tree tobacco	large shrub/small tree
Paspalum dilatatum	Dallis grass	perennial grass
Pennisetum spp.	fountain grass	perennial grass
Phalaris aquatica	harding grass	perennial grass
Phleum pratense	timothy	perennial grass
Plantago major	plantain	perennial forb
Poa pratensis	Kentucky bluegrass	perennial grass
Polygonum aviculare	knotweed	annual forb
Polygonum lapathifolium	knotweed	annual forb
Polypogon monspeliensis	rabbit's foot grass	annual grass
Ricinus communis	castor bean	shrub
Rosa multiflora	multiflora rose	woody vine
Rubus discolor	Himalayan blackberry	shrub
Rumex crispus	curly-leaf dock	perennial forb
Salsola iberica	tumbleweed	annual forb
Schinus molle	pepper tree	tree
Sisymbrum irio	tumble mustard	annual forb
Sonchus asper	sow-thistle	annual forb
Sonchus oleraceus	sow-thistle	annual forb
Sorghum halepense	Johnson grass	perennial grass

Table 1 *continued*. A partial list of exotic plant species present in riparian and wetland ecosystems within the range of the Southwestern willow flycatcher.

Scientific name	Common name	Growth form
Tamarix ramosissima & *T. chinensis*	tamarisk, saltcedar	large shrub/small tree
Tamarix parviflora	tamarisk, saltcedar	large shrub/small tree
Tropaeolum majus	nasturtium	ann. or per. forb
Ulmus pumila	Siberian elm	tree
Verbascum thapsus	mullein	biennial forb
Veronica anagallis-aquatica	water speedwell	perennial forb
Vinca major	periwinkle	perennial herb
Tamarix aphylla	athel tamarisk	tree

Why the concern?

Exotic species that are of greatest management concern are those that are highly invasive and that strongly modify their environment. The relationship between exotic species and community structure and function is complex, and determining causes and effects is difficult. Following, we identify some types of general impacts, and speculate about specific impacts on southwestern willow flycatchers:

Simplification of ecosystems. Generally, when plant species diversity declines, ecosystem functions, such as provision of animal habitat, decline as well. Functions can be reduced as monotypic stands of exotics (or natives) replace more diverse mosaics and mixes of species. For example, reduced diversity of the woody species in the canopy layer may reduce habitat quality for southwestern willow flycatchers by decreasing the number of vegetation layers and nest site areas.

It can be difficult to determine whether exotic plant species are directly reducing habitat quality or whether the cause of the impairment is management-related simplification of the ecosystem. Many management actions simplify the plant community and select for one or two species (often exotic) adapted to a particular combination of stresses and disturbances. For example, livestock grazing can cause a diverse mix of native grasses and forbs to be replaced by monotypic stands of bermuda grass. River regulation and flood suppression reduce channel dynamics and can result in a simplified community dominated by dense tamarisk thickets with little understory vegetation. Without flood disturbance, dense piles of leaf and twig litter accumulate on the forest-floor and little light penetrates to the understory, conditions unfavorable for many understory species. Some reports of low diversity of understory plant species in tamarisk stands may be due to the interaction of tamarisk and river regulation actions (Brock 1994). Along freely flooding rivers, in contrast, fluvial dynamics create many niches and allow for high species diversity. Floristic understory diversity in tamarisk stands along the frequently flooded San Pedro River was not lower than in nearby cottonwood stands (Stromberg 1998b). There are other cases, however, in which biodiversity has increased after removal of tamarisk (Barrows 1993), indicating the complex and context-dependent nature of ecological interactions.

Loss or replacement of functions supplied by native species. Each species has particular functional values that can only partially be duplicated by another species. Examples of ecological functions include provision of food, nesting substrate, shade, and cover for animals, nutrient cycling, production of organic matter, and erosion control. From the perspective of the southwestern willow flycatcher, some exotic plant species are strongly inferior replacements, while in other cases or situations, exotic plants assume some of the functions of native riparian species (Brown and Trosset 1989, Westman 1990, Ellis 1995, Stromberg 1998b). Throughout its range, over 50% of the confirmed southwestern willow flycatcher breeding sites are in sites that are either dominated by or co-dominated by exotic woody species. Among the habitat-suitability factors that can differ between the native and exotic-dominated vegetation types are presence of suitable branching structure for nest placement, quality and quantity of the insect food base, thermal environment (microclimate), and abundances of parasites and predators.

Southwestern willow flycatchers have not been reported nesting in any vegetation patches that are dominated by *Arundo donax*. *Arundo donax* does not itself produce the physical structure required for southwestern willow flycatcher nest building, in that it does not produce small, forked branches. It has been speculated that insects are sparse in sites dominated by *Arundo donax*, because of the abundance of chemical defense compounds produced by the plants (Bell 1997). *Arundo*-dominated sites provide poor habitat for songbirds, partly because of the extremely high density of the plant stems (Morrison et al. 1994).

In contrast, some tamarisk stands do mimic, to some degree, the riparian woodland structure once provided by willows. In the absence of willows, southwestern willow flycatchers nest in tamarisk at numerous river sites (and in some cases preferentially use tamarisk even when willows are present). Southwestern willow flycatcher have been reported to nest in tamarisk at sites along the Colorado, Verde, Gila, San Pedro, Salt, Santa Maria, and Big Sandy Rivers in Arizona (McCarthey et al. 1998, McKernan and Braden 1999), Tonto Creek in Arizona (McCarthey et al. 1998), the Rio Grande in New Mexico (Hubbard 1987, Maynard 1995, Cooper 1995, S. Williams, New Mexico Department of Game and Fish, pers. comm.), and the San Dieguito River in California (Kus and Beck 1998). Along the Lower Colorado River and immediate tributaries, about 40% of the flycatcher nests were in tamarisk in 1998 (McKernan and Braden 1999). In Arizona in 1998, three-quarters (194 of 250) of the flycatcher nests were in tamarisk (Paradzick 1999). Tamarisk stands provide habitat for other birds, as well as for insects, mammals, and even fish, although they often do not support the same species richness, guilds, and population sizes as do native stands of cottonwood-willow (Glinski and Ohmart 1984, Hunter et al. 1988, Ellis 1995 and 1997, Converse et al. 1998). For example, cavity nesters and timber gleaners were present in cottonwood forests but rare or absent from the tamarisk patches studied on the Rio Grande (Ellis 1995).

Flycatcher productivity in tamarisk-dominated sites has been variously found to be equal to or lower than in sites dominated by native willow species (*S. exigua, S. goodingii*) (Sogge et al. 1997, McKernan and Braden 1999). One possible cause for between-site differences in nesting success is difference in food availability, in terms of total insect biomass or biomass of particular insects. While flycatcher distribution appears to be unrelated to insect biomass at the native-dominated Kern River (Whitfield et al. 1999b), we do not know whether food availability limits the abundance or breeding success of Southwestern willow flycatchers in tamarisk vs. native-dominated sites. Insect diversity and biomass are lower in some tamarisk-dominated stands than in some native riparian forests (Drost et al. 1998). Finch et al. (1998) found that willow patches along Rio Grande low-flow conveyance channels had greater total numbers of arthropods and of certain high-quality prey items (dipterans and hymenopterans; data were not reported on lepidopterans, another possible high quality item) than did tamarisk patches. Miner (1989) reported similar findings for the Sweetwater River in California, where tamarisk ranked low relative to natives with regard to arthropod abundance and diversity. The insects in the tamarisk patches tend to be small, which presumably require more expenditure of foraging energy by the flycatchers. More information is needed on the relationships between flycatcher breeding success and insect abundance, and between insect biomass and diversity, vegetation biodiversity and productivity, and surface water availability.

Extreme thermal environments can limit reproductive success and habitat suitability for some bird species. McKernan and Braden (1999) found that tamarisk patches were marginally hotter and sometimes more humid than cottonwood-willow stands. They also report that the flycatchers nest in a wide range of microclimates. Additional research would be valuable on the role of microclimate on flycatcher breeding success; such studies should measure maximum temperatures in addition to mean temperatures.

Not all tamarisk stands are the same with respect to southwestern willow flycatcher habitat suitability. Among sites with tamarisk, highest quality habitat is provided where the tamarisk is intermixed with other trees and shrubs (i.e., there is a high degree of plant species diversity and habitat complexity of the flood plain) and where tamarisk is tall and dense. Flycatchers nest in the low stature tamarisks in the understory of cottonwood-willow forests as well as the very tall (6-10 m) mature saltcedar that have dense canopies. The presence of natural flood regimes, ample water, and beaver activity are among the site factors that favor high species diversity and habitat complexity. Site factors that favor tall height of the tamarisk and dense vegetation structure include ample water (e.g., high soil moisture availability, shallow groundwater, or frequent surface inundation) and warm air temperatures. Dry soils and frequent burning reduce canopy height and habitat quality.

Russian olives also provide an appropriate branching structure for nest building by southwestern willow flycatchers. In New Mexico, a few southwestern willow flycatcher nests have been found in Russian olive trees along the Zuni River, Rio Grande (upper and middle), and Gila River (Cooper 1997). Overall, the number of nest sites in Russian olive trees is far less than the number in tamarisks. Generally, the Russian olive nest trees are part of a diverse riparian forest. Along parts of the Rio Grande, for example, Russian olive and coyote willow (*Salix exigua*) form a canopy layer below the cottonwood overstory. Along the Gila River in Cliff Valley New Mexico, Russian olives grow with several other tree species (Stoleson and Finch 1999). At this site, there were fewer flycatcher nests in Russian olive trees than in boxelder (*Acer negundo*) or willow trees (*Salix* species). However, Russian olive and boxelder were used more frequently than expected relative to their abundance, suggesting an active preference at this site for these trees over the willow. Nest success rate in the Russian olive and willow were lower than in boxelder and Fremont cottonwood.

Indirect effects of exotics on willow flycatcher habitat. Exotic riparian plant species have the potential to modify habitat indirectly by altering disturbance regimes, (e.g., fire regimes), hydrologic conditions, geomorphic processes (e.g., erosion and sedimentation rates), and species abundance and diversity patterns. Here again, we note that the functional role of the exotic species should not be assessed independently of river management actions. For example, fire size and frequency tend to increase on sites dominated by tamarisk and giant reed, with consequences for vegetation structure (see Appendix L; fire management). The probability of fire, however, is enhanced by river regulation because of the propensity for flammable biomass to accumulate on regulated, flood-suppressed rivers (Busch 1995, Shafroth 1999). Similarly, the potential for tamarisk to increase the salinity of soil water, and thereby contribute to the decline of salt-sensitive willows and cottonwoods, is enhanced when farmers or water managers release salty water into river channels or prevent the release of salt-flushing flood flows. Along the undammed middle San Pedro River, salts are no higher under tamarisk stands than under cottonwood forests (Stromberg 1998b).

Some reports suggest that tamarisks can contribute to the decline of native riparian plants by contributing to river dewatering or lowering of water tables (e.g., Thomas 1963). The suspected mechanism is greater rates of transpiration by tamarisks than by native riparian species. Higher transpiration could arise due to higher per-plant water use rates or greater density of plants. On a per-leaf area basis, various studies report that tamarisk transpires the same amount or less water than the native shrub *Salix exigua*, and less than cottonwood trees (Sala et al. 1996, Cleverly et al. 1997, Smith et al. 1999). Based on its high sap-flow rates, Smith et al. (1999) conclude that tamarisks have greater stand level water use than cottonwood and willows. However, there is little direct data at the stand level comparing water use rates of native and exotic woodlands and forests. Such stand level comparisons, for plants growing in similar conditions, would help to shed light on this issue. Transpiration rates of riparian plant species vary with many factors including depth to ground water, stand density, and patchiness of the habitat (Devitt et al. 1997; Devitt et al. 1998).

Along the Virgin River, Cleverly et al. (1997) report that young stands (<10 years old) of riparian plants were vegetated by a mix of tamarisk and native shrubs and trees (*Salix exigua, Pluchea sericea, Prosopis pubescens*), and that older stands (50-60 years) were dominated by tamarisk. The apparent loss of the natives from the older stands was attributed to increasing stresses from salinity and dessication in the older stands and to direct competitive effects of tamarisk. On the middle San Pedro River, the oldest woodlands (>50 years) were dominated by cottonwoods, middle-aged woodlands (10-40 years) were dominated by tamarisk, and the younger stands (<10 years) were again dominated by cottonwoods. Stromberg (1998a) attributed this shift to changes in river flows and grazing stresses during the times of establishment of the different-aged stands, which led to different initial stand compositions. Salinization and dewatering effects were not apparent at this site. Clearly, further research is needed to determine the environmental contexts under which tamarisks do and do not exert physical and biotic stresses on native plants.

Direct competitive interactions can occur between tamarisks and native riparian plants. Busch and Smith (1995) observed that removal of tamarisks from around willow trees improved the water relations and growth of the willows, indicating competitive effects of mature tamarisk on willow. In contrast, studies of competition between seedlings show that tamarisks can decline when cottonwoods and willows are present (Sher, unpubl. data). Competitive outcomes may vary with water availability, with the natives out-competing the exotics under wet conditions.

With respect to the southwestern willow flycatcher, a key question is, is habitat quality impaired in the area dominated by the exotic species? Although it may be relatively easy to determine whether quality is impaired, it can be harder to determine the causes. The changes in habitat quality may be due to loss of the natives, presence of the exotics, or to synergies of species composition, site conditions, and management-influences. There are few rigorous comparisons of function between stands of exotics and natives growing under similar site conditions, partly because of the difficulty in finding appropriate spatial controls (Parker and Reichard 1998).

B. Why Are Exotics So Abundant In Riparian Ecosystems?

If we desire to improve riparian habitat quality by controlling or eradicating exotic plant species, we must understand the mechanisms and factors contributing to their presence and spread. This can be a difficult task, despite the considerable amount of research investigating the mechanisms and conditions under which exotic native species replaced natives (Vitousek et al. 1996, D'Antonio et al. 1999). Identification of the root causes of the native species replacement speaks directly to the type of management approaches that should be undertaken.

One school of thought holds that exotics have proliferated because we have created physical conditions that allow them to be more successful than the natives. For example, altered disturbance regimes can favor some exotic species. Other schools hold that the exotics are actively displacing the native plants due to biotic factors. These biotic factors including release from herbivorous insects and other natural 'enemies', introduction of exotic herbivores such as domestic livestock, continuous input of seeds, and self-favoring mechanisms produced by the exotic plants. Certainly, there may be multiple mechanisms operating at any given time. The mechanisms differ between different exotic species, and may vary between locations within the range of a particular exotic.

There is ongoing debate about the mechanisms that have allowed for the proliferation of tamarisk. Many researchers point to human-alterations to physical conditions as the primary factors that have allowed this particular species to thrive in the western US. D'Antonio et al. (1999) state that "In the almost complete transformation of floodplain forests in the Colorado River basin in the United States over the past 50 years, it is the combination of decreased water table, increased soil salinity, and reduced vigor of native species as a result of alterations in natural disturbance regimes, that have led to massive invasion by tamarisk". Tamarisks are well-adapted to conditions now prevailing in many southwestern riparian areas, allowing them to gain particular prominence along regulated and intensively exploited rivers. Under water stress, salinity stress, flood flow alteration, livestock grazing, and recurring fire, tamarisk can outcompete cottonwoods and willows and, perhaps, hasten their demise (Horton 1977, Smith et al. 1998). Under extreme stress, if water tables are too deep, soils are too salty, or spring flood flows are circumvented, populations of the native species disappear regardless of competition from the exotic species (Stromberg 1998a, Everitt 1998, Anderson 1998).

However, there are some situations where it is unclear as to what human-caused changes, if any, have contributed to the proliferation of tamarisks (Barrows 1993, Lovich and DeGouvenain 1997, Barrows 1998). In such cases, it can be instructive to ask, were there past actions, such as livestock or burro grazing, now discontinued, that precipitated the invasion? Are tamarisk seed sources now more abundant than those of the natives? Are insect herbivores reducing fecundity or survivorship of the natives but not the tamarisk? As did Everitt in 1980, we make a plea for additional research: We call for regional studies and synthesis to identify present-day characteristics and historical events common to sites where tamarisks are infrequent, where they dominate, and where they have undergone recent decline.

Generally, human actions have contributed to the invasion of exotic plant species in the following ways: We have facilitated the dispersal of species to new locales; and we have created opportunities for their establishment by clearing vegetation, modifying physical site conditions, altering disturbance processes, and disrupting biotic interactions. Following, we review some of the human actions that have allowed exotic species to thrive in riparian areas, the characteristics of the exotics species that have allowed them to do so, and provide general management recommendations.

Introduction and spread of seeds and plants. Many riparian exotics became established in the U.S.

Southwest during the European settlement phase, some as early as the 1500s. Exotics continue to have many opportunities to arrive at, and spread within, riparian areas. Roads and railways often follow rivers, introducing and spreading seeds from distant locales (Frenkel 1977). Many urban centers are located along rivers, providing opportunities for spread of landscape plants. Fertile floodplain soils have been extensively used for agriculture, a practice that spreads accidentally introduced, non-native crop weeds. Almost 100 years ago, McClatchie (1901) warned that wild (foxtail) barley would become a 'problem invasive' in flood plains of the Salt River (Arizona), if no measures were taken to halt its spread from agricultural fields. Today, his prediction has come true.

Other species have been intentionally introduced. Giant reed, Russian olive, and tamarisk were all intentionally planted, to beautify landscapes and/or stabilize soils (Tellman 1997), and continue to be sold by nurseries. Lehmann's lovegrass (*Eragrostis lehmanniana*), a species native to Africa, was seeded in southern Arizona to promote revegetation of overgrazed grasslands, providing an abundant seed source for spread to flood plains (Anable et al. 1992, Bock et al. 1986).

Management actions: It is unrealistic to completely halt the spread of exotics (for example, we cannot re-route all roads out of riparian corridors). There are measures, though, that can be undertaken to reduce the frequency of spread. For example, educational campaigns about landscaping practices could encourage the planting of native species and discourage the planting of exotics, particularly in urban areas and golf courses situated in flood plains. Some municipalities have legally prevented the planting of some exotics, to prevent the landscape use of allergenic plants. Such a ban would be a particularly appropriate means for controlling giant reed by eliminating opportunities for introduction into drainages lacking this exotic, or reintroduction into drainages from which it is being eradicated.

State and federal agencies should utilize native species during revegetation efforts and not fund those that propose otherwise. For example, transportation agencies should use native species to seed road edges, the U. S. Forest Service should use natives to revegetate watersheds after fire, and the National Resource Conservation Service should utilize or promote the use of native species to revegetate degraded rangelands.

Because the spread of exotics in riparian systems is a drainage-wide issue, effective control and eradication requires coordination among multiple landowners and users with diverse interests and management goals. In the absence of such coordination, control efforts are likely to fail as individual sites are reinvaded by exotics present elsewhere in the drainage. “Team Arundo” in California (http://www.ceres.ca.gov/tadn/index.html) is an example of a successful partnership formed to address shared concerns regarding the spread of giant reed, including its impacts on flood control, wildfire, and habitat for endangered species. Consisting of representatives from agencies, conservation groups, academia and the private sector, Team Arundo offers a comprehensive plan for reed eradication by sharing information and funding, coordinating control efforts across a broad range of projects and implementing groups, including volunteer citizen’s groups, providing public education, and promoting research on exotics control. While its primary focus is on giant reed, Team Arundo provides a model for a partnership approach that would benefit control programs targeting other species.

Increased abiotic stress (particularly salinity and drought). Human alterations of habitat have been central to the persistence and spread of many riparian exotics. For example, current management practices in riparian corridors have caused many flood plain soils to become saltier and drier, factors that can favor a new assemblage of stress-tolerant species (DeCamps et al. 1995). Many exotics have broad tolerance ranges for stress factors such as soil moisture, inundation duration, and salinity, and many are unusual in being able to tolerate a combination of abiotic stresses and disturbances. Bermuda grass, for example, has high survivorship of floods, drought, and salinity, and can maintain itself for long time periods through rhizomatous spread. Similarly, giant reed survives and spreads during floods through dispersal of rhizomes, and resprouts rapidly after fire, outgrowing native species. Invasive species with such traits have been classified as "survivors", long-lived individuals resistant to many causes of mortality (Newsome and Noble 1986).

As one of its common names suggests, tamarisks are physiologically adapted to salt levels that would stress or kill most native willows (Shafroth et al. 1995). They also have high water-use efficiency, root deeply, and tolerate prolonged drought (Busch and Smith 1995, Smith et al. 1998). Cottonwood and willow forests thrive where groundwater is less than 3 m deep, but tamarisk woodlands persist where groundwater is up to 7 to 10 m below the surface (Graf 1982, Stromberg 1998a). Tamarisks thus can dominate where diversions and/or ground water pumping have dewatered the river and where salt levels are high due to agricultural return flows, large upstream reservoirs, or naturally high salt levels.

Anderson (1995, 1995, 1998) provides data showing that for many rivers in this region, ground water tables have become too deep and soils too salty to allow native cottonwood and willows to survive, contributing to replacement by stress-tolerant tamarisk. While tamarisks may exacerbate salinity and dewatering stresses in some circumstances, it is not clear that tamarisk removal in and of itself would restore conditions suitable for the natives in the majority of dry sites presently dominated by tamarisk. Such a question could be answered through sophisticated models that compare ground water levels before and after simulated tamarisk removal or thinning; however, such models should take into account water use rates of the native replacement vegetation and should be based on accurate transpiration rates.

Russian olive also has wide tolerance range for several abiotic factors. Relative to cottonwoods and willows, Russian olive is drought tolerant at both the seedling and adult stages. Although not as salt tolerant as tamarisk, Russian olive is more salt tolerant than many cottonwoods and willows (Carman and Brotherson 1982; Shafroth, Auble et al. 1995).

Management actions. Eliminate specific stress factors, such as dewatering and salinity, that are known to favor the exotics. This will entail a suite of difficult-to-implement actions, such as reducing diversions, managing livestock grazing to increase flood plain water availability, and reducing salt levels in agricultural return flows. Conduct further study on the role of tamarisk as a stressor, to determine the environmental contexts under which tamarisks do and do not exert physical and biotic stresses on native plants.

Alteration of natural disturbance regimes, including flood suppression. Although exotics certainly grow in apparently pristine habitats, alteration of natural disturbance regimes or imposition of new disturbances increase the chances that they will dominate a site (Fox and Fox 1986, Hobbs and Huenneke 1992, Pyle 1995, Parker and Reichard 1998). Natural flood regimes have been altered by dams, diversions, urbanization effects, and watershed degradation (see Appendices I and J). Many rivers flood less frequently and at different times than their climatic legacy dictates, favoring exotic species that are better adapted to the new conditions. Conversely, restoration of natural flooding regimes can sometimes favor the native species. There is evidence, for example, that tamarisk are less tolerant of physical flood scour than are natives. Tamarisk seedlings have less ability to survive flood-borne sedimentation than do cottonwood seedlings (Stromberg, unpubl. data). Small tamarisk trees had greater flood mortality than did small cottonwood and willows at the Hassayampa River (Stromberg et al. 1993). D'Antonio et al. (1999) found that tamarisk was sparse on free-flowing Sycamore Creek in the Sonoran Desert, likely due to frequent (once every 3 year) flood scour; but that it was abundant on another free-flowing stream which had large scouring floods only about once every 10 years. Lowered ability to tolerate flood scour may explain why tamarisk population levels are low relative to the natives on some free-flowing, frequently-flooded rivers, and contribute to its tendency to proliferate on flood-regulated rivers (Shafroth 1999; Dixon and Johnson 1999).

Russian olive similarly may be benefitting from flood suppression. Unlike the native willows and cottonwoods, and similar to tamarisk, it does not depend on spring flooding for establishment. Russian olive exhibits some traits typical of late-successional species, such as larger seed size. This enables it to establish in the understory of tree species such as cottonwood, and allows regeneration to be decoupled from flood disturbance. Together with tamarisk, Russian olive has spread and replaced cottonwoods-willows on spring-flood suppressed rivers including the Rio Grande (Howe and Knopf 1991, Everitt 1998).

Giant reed appears to be insensitive to flood regime: it survives and expands during long periods without flooding through vegetative propagation, but spreads during flood events as well. Giant reed may thus be able to thrive under a broad range of flood regimes.

As floods have decreased, fire disturbance has increased (see Appendix L). Tamarisks can prolifically resprout after fires, as can giant reed; producing a positive-feedback scenario in which the exotics contribute to the type of disturbance that favors their continued dominance.

<u>Management Actions</u>. Strive to restore the natural flood disturbance regime. This means restoring

flood regimes in terms of the magnitude, frequency, and timing of flood flows.

Unpredictability of flood disturbances, including timing of water drawdowns. Besides altering the frequencies of various types of disturbances, we also have changed the timing of disturbances and increased their unpredictability. This, in turn, has selected for generalist species over specialists. Generalists often are better able to compete in a newly fluctuating and less predictable environment. Specialist plant species, in contrast, are quite successful under a fairly narrow range of environmental conditions. For example, tamarisks are reproductive generalists when compared to their native counterparts, which are phenologically adapted to exploit the receding limbs of early spring floods. Like cottonwoods and willows, tamarisks annually produce large crops of tiny, wind-dispersed seeds which require bare, moist soil for germination. Tamarisks, however, flower and disperse seed over a longer time period during the growing season than do cottonwoods and willows. Tamarisks flowered well into October along the Bill Williams River (a tributary to the Lower Colorado River), whereas cottonwoods blossomed only into mid-April and willows into June (Shafroth et al. in 1998). Tamarisks thus can thrive on dammed rivers where high water flow is delayed by the timing of irrigation water storage and release schedules. Tamarisks can also take advantage of the techno-littoral zone of reservoir edges, a new riparian habitat type where potential seed beds are exposed in midsummer during irrigation-driven drawdowns.

Like tamarisk, giant reed is less constrained in the timing of reproductive events than are natives, creating opportunities for establishment that natives cannot take advantage of. Because it does not reproduce sexually, giant reed is not affected by the timing of spring flows, but can establish any time that flood flows carry and deposit rhizomes or stem fragments. It, too, thrives along the margins of reservoirs, irrigation canals, and other structures where the timing of drawdowns is incompatible with maintenance of native species.

Management actions. Generally, conform as closely as possible to the natural river hydrograph. Time flood releases, reservoir drawdowns, and soil disturbances to coincide with the early spring seed dispersal of cottonwoods and willows, thus creating conditions that favor these species.

Other 'new' disturbances. Clearing of channels for water salvage or increased flood water conveyance, plowing of flood plain fields, and channel-narrowing caused by flow-regulation are disturbances that have provided large-scale opportunities for establishment of exotics (Everitt 1998). Many other types of disturbance, such as soil disturbance from vehicles, livestock, and recreationists, have increased in riparian habitats. One net effect has been to select for an increase in ruderals or pioneer species. Ruderals thrive in frequently disturbed areas because they have short life-spans (annuals or biennials or short-lived perennials), rapid growth rates, and high reproductive effort. At the Hassayampa River, for example, 74% of the exotics were ruderals (Wolden et al. 1994). There are many native riparian ruderals as well, particularly where floods disturbances are common. However, each type of disturbance is unique and will select for different species assemblages. When we impose new disturbances, or superimpose other disturbances over the existing framework, there is even greater selection for ruderals and for species that can tolerate multiple disturbances. Ruderals such as brome grass, for example, thrive in response to repeated soil compaction and loss of plant stems and leaves caused by cattle grazing, trampling, or vehicle use (Brothers and Spingarn 1992, Morin et al. 1989).

Floods can enhance invasion opportunities by exotics, because they disperse seeds and create opportunities for species replacement. Natural flood cycles generally help to maintain an abundance of native species and high species diversity (McIntyre et al. 1988, Naiman et al. 1993). However, exotics can rapidly become abundant after floods, particularly if site conditions and selective pressures are altered and nearby seed sources are plentiful (Planty-Tabacchi et al. 1996).

Management actions. Do not clear native riparian vegetation from flood plains or channels. When clearing patches of undesirable exotics, make sure that the site conditions and timing of clearing are favorable for the establishment of the desired native species. Restrict heavy recreational use.

Alteration of herbivory patterns, including increased herbivory from domestic livestock and native ungulates. Domestic livestock grazing, since Spanish Colonial times in some places, has altered vegetation composition throughout the Southwest by favoring unpalatable or grazing-tolerant exotic species. Among the exotic riparian species that increase under grazing are bermuda grass and annual brome grasses (Mack 1986, Billings 1990, Brooks 1995). Tamarisks and Russian olive also appear to be favored by grazing. When browsing among the multi-species patches of seedlings that germinate on bare sediments after floods, livestock feed upon the more palatable cottonwoods and willows. This can favor the tamarisk by allowing them to overtop the native seedlings that might otherwise shade them out (Hughes 1993, Stromberg 1997). Russian olive exhibits several traits that allow it to thrive in grazed habitats, including sharp thorns, which increase in density if the tree is cut back. The large seeds have ample reserves that may enhance the survival of seedlings following browsing (Armstrong and Westoby 1993). These adaptations presumably contribute to the spread of Russian-olive into heavily grazed meadows and pastures.

Management actions. Strive to restore ungulate herbivory levels to those under which the native riparian species evolved, or at least under which the native species retain competitive dominance.

Release from native herbivores and pathogens. There is evidence that insect communities associated with tamarisk stands are less diverse than those associated with native cottonwood and willow stands (Drost et al. 1998, Finch et al. 1998, Miner 1989). Periodically, willow and cottonwood stands undergo extensive defoliation from insect herbivores, and symptoms of wetwood disease are present on many cottonwoods (Hofstra et al. 1999). However, we are not aware of any evidence showing that insect herbivory rates or impacts (e.g., reduced seed production) are lower on tamarisk than on cottonwoods and willows. Perhaps most important from a management perspective, we are not aware of any studies showing that release from natural enemies is a mechanism that has allowed tamarisk to dominate.

Release of biocontrol insects (DeLoach 1991, 1997; Hennessey 1999) is an approach that is being tested to reduce the abundance of tamarisk. There are risks associated with biocontrol of exotic species (Thomas and Willis 1998). Biocontrol has been an effective strategy for reducing the abundance of many targeted non-native plants. However, biotic interactions are complex and introduction of a new species into a food web can produce unexpected and sometimes undesirable results. Callaway et al. (1999) describe a case wherein release of a biocontrol insect *increased* the competitive ability of the targeted exotic plant, due partly to herbivory-stimulated compensatory growth. We are not convinced that the benefits of tamarisk biocontrol outweigh the risks. "In the rush to solve local and acute pest problems, we may be creating diffuse and chronic problems that are harder to solve" (McEvoy and Coombs 1999).

Like other active approaches to exotic removal, such as mechanical or herbicidal control, the use of biocontrol insects will be most effective in restoring willow flycatcher habitat if used as part of an overall plan that addresses underlying causes of the loss of the desired native species. Although there are sites that seem to respond favorably simply to the direct removal of tamarisk (Barrows 1993, 1998), this effect is not guaranteed (Anderson 1998). Because biocontrol insects can spread beyond their release sites, potentially throughout the range of the southwestern willow flycatcher, we cannot be assured of net gain in habitat quality. There are risks to the willow flycatcher if the tamarisk stands are not replaced by plant species of equal or higher habitat value, or if the tamarisk stands simply lose quality, for example, by undergoing loss of foliage density. At some tamarisk-dominated sites that support willow flycatcher, such as reservoir edges, the physical conditions (e.g., water, salinity) may be present that allow willows *to survive*, but there is no assurance that reservoir edges will be managed in such a way that allow willows *to establish*, were tamarisk to decline. In other cases, such as along the Rio Grande or Colorado, there is no assurance that reduction in tamarisk density would restore the water levels or salinity levels that allow the natives to thrive.

Management actions. In the absence of a plan to address and correct underlying reasons for the decline of native riparian forests and marshlands in southwest riparian systems, we advocate site-specific approaches to tamarisk control (e.g., local site clearing followed by other restorative measures as needed) rather than region-wide biocontrol.

C. Exotic Species Management Plans

In this section we summarize guidelines for maintaining or restoring habitat quality for southwestern willow flycatchers with respect to the issue of exotic plant species. Our basic approach involves restoring the natural fluvial processes and conditions under which the native species evolved, and thus has ecosystem-wide benefits. We propose two preliminary assessments that should precede formulation of a restoration plan: (1) identification of underlying factors promoting the presence and abundance of exotics in the ecosystem, and (2) the potential for restoration of physical and biotic conditions favoring natives. We then identify four approaches to restoration, based on the outcome of these assessments: (1) no restoration, (2) passive restoration, (3) active restoration, and (4) partial rehabilitation. Finally, we recommend actions to implement each plan. The overall approach is summarized in Table 2, and described in more detail, including case studies, below.

Much additional research is needed to refine management actions and ensure their success. Nevertheless, we make preliminary recommendations here, all of which have a high likelihood of improving habitat conditions for southwestern willow flycatchers and many other native riparian plants and animals. Generally, we recommend adopting an adaptive management approach, and continuing to conduct scientific research to increase our knowledge base.

CONDITION A. Sites that are occupied or unoccupied AND that have healthy riparian plant communities, dominated by natives in all vegetation layers:

We recommend that no restoration of these sites be pursued as long as this condition prevails. Maintain the management status quo, i.e., maintain the conditions that are producing high habitat quality. For example, maintain free-flowing conditions (= no dams), maintain base flows and ground water levels, etc.

Action 1: To avoid potential impacts to flycatchers in occupied sites, do not actively intervene to remove the exotic species unless there is a trend for steady increase in exotic vegetation.

Action 2: Assess vegetation composition annually to detect at an early stage trends of increases in the exotics, and causes thereof.

Action 3: Assess and monitor physical site conditions in the riparian corridor.

Action 4: Monitor conditions in the watershed, such as trends for increased ground water pumpage, that might favor exotics.

Should the above assessments reveal a trend for increase in abundance of exotics, conduct an evaluation of underlying causes, and pursue restoration as described for Conditions B or C (see below).

CONDITION B. Occupied and unoccupied sites that are dominated in the upper canopy layer by exotic plant species of potential habitat value to flycatchers (e.g., tamarisk or Russian olive) .

Preliminary Assessment:

1. Determine the root causes for the dominance of the exotics. Thoroughly assess the hydrologic regime (including timing and magnitude of flood flows, stream base flow rates, and ground water levels), water quality (including salinity levels), fluvial geomorphic regime, and grazing regime. Ask:

a) are there stressors or habitat alterations that are preventing the native species from thriving? (e.g., are livestock favoring the exotics? are ground water depths and salinities precluding survivorship of desired natives? has flood disruption contributed to the establishment of the exotic species?) OR

b) does it appear that the exotics are dominating because of some past chance event or some condition that is no longer in effect, and that current conditions appear suitable for the desired conditions?

2. Assess the potential for restoration and need for different restoration techniques. Ask:

a) are native seed sources naturally available for recolonization or must seed sources or plants be brought on site?

b) are natural processes available to create the opportunities for species replacement or must the sites be manually cleared?

c) are the conditions suitable for the survivorship of a diversity of native species, or is it feasible to restore these conditions?

d) context: what are the conditions up- and down-stream with regard to 1) the presence of the exotic species(s) targeted in the restoration project, and 2) the presence of and distance to a seed source for native species?

Depending on the answers to the above questions, different approaches should be undertaken. For example, if it appears that some stressor is precluding the natives from thriving but that this stressor(s) can be eliminated, and if nearby seed sources are available, and if natural floods still occur, then adopt **Passive restoration**.

Action 1: Remove the stressors and patiently allow for natural recovery. Nearby seed sources and natural processes (e.g., floods) should slowly create opportunities for replacement of the exotics by the natives. Costly revegetation/ planting may be unnecessary. If passive restoration does not appear, to be effective, utilize more active measures.

Case Study for Passive Restoration: This case study demonstrates how process-restoration and stressor-removal can work for some tamarisk-dominated sites. The San Pedro is a free-flowing desert river that flows northward from Sonora, Mexico to the Gila River in southern Arizona. Stream flows vary from perennial to ephemeral depending on local geology and tributary inputs, and on the extent of local and regional groundwater pumping. Flood plain agriculture and cattle grazing are common along the river, but some reaches have been set aside as conservation areas. Tamarisk, Fremont cottonwood, and Goodding willow are all present, but vary in relative abundance depending on site characteristics. Over time, tamarisks have been declining in abundance and cottonwoods increasing in abundance at sites where livestock have been removed, stream flows remain perennial, and upstream groundwater pumping has been reduced (Stromberg 1998). Under these conditions, cottonwoods are able to outcompete tamarisks. Also necessary to this recovery were several winter/spring floods that created opportunities for species replacement. Tamarisks continue to dominate along ephemeral reaches where water tables are 5 to 7 meters below the flood plain surface.

An important caveat must be added to Passive Restoration when giant reed is the targeted exotic. Because of its ability to spread rapidly throughout drainages, it is essential that reed removal be conducted in an upstream-to-downstream manner in order to achieve lasting restoration. Thus, the context of the proposed restoration with regard to the presence of giant reed upstream is a critical determinant of its likely success, and consequently its prioritization relative to other potential restoration efforts.

If it appears that stressors are precluding the natives and that these stressors can be eliminated, but there are no natural mechanisms to allow for species replacement, then pursue **Active Restoration to naturalize processes**. For example, if it is possible to restore base flows and ground water to levels that favor cottonwoods and willows, or possible to reduce high daily fluctuation of water levels, but seed sources are sparse and natural opportunities for species replacement (site clearing) are sparse, one may need active clearing and planting measures. On some river reaches, due to a variety of constraints, processes such as periodic flooding can only be 'naturalized'.

Action 1: First ensure that the stressors have been removed (e.g., water levels restored, livestock removed (see Appendix G), salts reduced, etc.) and that the desired native species will be able to survive.

Action 2: Use fire, earth- and vegetation-moving equipment, or approved herbicides to clear small parcels of habitat. Do not attempt to clear large areas at a time. We propose a guideline of clearing/restoring no more than 5% of the exotic-dominated area per year, followed by a waiting period of 5 years to determine the success of the restoration project. This staggered approach will create a mosaic of different aged successional stands. Plus, it will allow the benefits of an adaptive management approach to be realized: if the restoration effort fails, one will be able to learn from the mistakes and prevent failure on a grand scale. If the site is occupied, make sure that the areas targeted for clearing do not have any endangered species nest sites, and are at least 100 m away from the closest nest site. Clearing and earthmoving should be timed to avoid the breeding season of the flycatcher and other sensitive species (e.g., late March-September).

Action 3: Remove aggraded sediments, if necessary, to create cottonwood-willow seed beds that are within one meter of the ground water table; and/or excavate side channels.

Action 4: Plant or seed with native species if seed sources are not naturally available. Use locally collected seed or seed banks.

Action 5: Release flood ways in a way that mimics the natural hydrograph, to stimulate natural regeneration of desired native species.

Case study 1 for Active Restoration. Along the highly regulated Rio Grande in New Mexico, large scouring floods that would create opportunities for extensive species replacement may not be feasible. Moreover, water levels are too deep and soils too salty in some areas to support native cottonwood-willow forests. However, managers of the Bosque del Apache National Wildlife Refuge are mimicking the effects of large floods by using bulldozers, herbicides, and fire to clear the extensive stands of tamarisk that have developed, at a cost of from $750 to $1,300 per hectare (Taylor and McDaniel 1998). Most importantly, they are then releasing river water onto the bare flood plains in spring, with an appropriate seasonal timing and quantity that mimics the natural flood hydrograph of the Rio Grande, and thereby favors a diverse assemblage of native (and exotic) plant species.

Case study 2 for Active Restoration. On some regulated rivers, including the Bill Williams in Arizona, Truckee River in Nevada, and Rio Grande in New Mexico, water managers are releasing flood flows directly into the channel to restore the riparian habitat (Taylor et al. 1999). Recruitment models have been developed and tested that indicate how waters should be released from dams during spring, and at what drawdown rate, to allow for cottonwood-willow establishment and to favor these species over tamarisk (Mahoney and Rood 1988, Shafroth et al. 1998). We may be able to further manage for natives and against tamarisk by releasing post-germination summer floods that breach tolerance thresholds of the exotics but allow for some seedling survivorship of natives: tamarisk seedlings are less able to tolerate prolonged flood inundation than are seedlings of native willows (Gladwin and Roelle 1998), although they are very tolerant of prolonged flooding when mature (Taylor and McDaniel 1998). Knowledge of tolerance ranges for soil salinity gives us the information we need to determine if, and how often, we may need to release salt-flushing flows (Shafroth et al. 1995). However, constraints remain. On the Bill Williams River, for example, the largest flows that can be released from the dam are an order of magnitude lower than historic floods (Shafroth 1999). With the dam still present, we are not able to naturally produce extensive seed beds for new generations of riparian trees; thus, intervention in the form of mechanical clearing of seed beds in tamarisk-dominated habitat, followed by removal of aggraded sediments, may be necessary.

If there are stressors that are precluding native survival, but these stressors CAN NOT be sufficiently reversed, pursue **Partial Rehabilitation**. For example, if ground water levels are greater than about 3 meters deep and fluctuate by more than about 1 meter annually; if surface water is ephemeral; or if root zone salinity exceeds about 4 g/ l, many cottonwood and willow species will not have a high probability of surviving or thriving (Jackson et al. 1990, Busch et al. 1992, Busch and Smith 1995, Stromberg 1998a, Scott et al. 1998, Glenn et al. 1998). Under these conditions, and given the present state of our knowledge, strive to increase the habitat quality of the exotic stand rather than attempting species replacement. Encourage or implement studies that assess to what degree the exotic itself is acting as a stressor, and if so, what degree of site condition amelioration would occur upon removal of the exotic.

Action 1: Do not remove the exotics. The replacement vegetation (e.g., younger stands of the same exotic, or non-riparian species such as quailbrush *Atriplex lentiformis*) may have lower habitat quality than the initial vegetation.

Action 2: Do attempt actions to increase habitat quality within the exotic stands, such as seasonally inundating tamarisk stands to improve the thermal environment or increase the insect food base.

CONDITION C. Occupied or unoccupied sites dominated by exotics in a mid-canopy or understory layer, but dominated by natives in the upper canopy.

Follow the steps outlined for Condition B, except DO NOT clear any vegetation. Strive for passive restoration or partial rehabilitation.

CONDITION D. Occupied or unoccupied sites dominated by exotics possessing little to no habitat value.

This will typically be the case when giant reed is the exotic species of concern. Pursue passive or active restoration, as appropriate, paying attention to the need to work from upstream-to-downstream. If the site is not restorable and is not occupied by southwestern willow flycatchers, it should nevertheless be cleared so as to prevent the spread of propagules to other parts of the drainage, and to alleviate the impacts of giant reed on flood control, wildfire prevention, and maintenance of roads, bridges, and other structures.

D. Closing Words

Abundance of exotics, to a large extent, appears to be a symptom of the ways in which we have managed our riparian lands and waters. The solution requires a shift of emphasis, away from demonizing exotics and toward re-establishing a functional semblance of the conditions that allow native plants to thrive. We must fully address the root causes that have allowed the exotics to be so successful, and restore those natural processes and site conditions under which the native species are most competitive (Briggs 1996). It is unlikely under such a scenario that exotics would be completely driven out of southwestern riparian systems. But it is also unlikely that simply removing exotics, if that were practically possible, would allow natives to thrive where conditions no longer favor them.

When factors like hydrology and herbivory have been returned to original, natural conditions, there is evidence that native riparian trees can hold their own, remain or reestablish as co-dominants, and outcompete exotics (Horton 1977, Stromberg 1997, 1998a; Taylor et al. 1999). This is not always the case, however. For example, exotic annual grasses and other herbs dominate some riparian sites long after removal of suspected stressors. Along some rivers with naturally high salt loads and infrequent or small summer floods, such as the Virgin River, tamarisk may remain as a dominant even with removal of potential stressors such as water diversions (Williams and Deacon 1998). In such cases, active restoration measures, such as of clearing of exotics accompanied by soil manipulations or reintroduction of native seeds, may be necessary for full restoration. Heavily regulated, diverted, and grazed rivers such as the Colorado and its major tributaries will remain prime tamarisk habitat, and exist as simplified ecosystems, until their management changes to once again favor native species and habitat complexity.

Literature Cited

Please see Recovery Plan Section VI.

Table 2. Recommendations for Habitat Management with regard to Exotic Vegetation

	Habitat Condition			
	A	B	C	D
Restoration Approach	Native-dominated in all canopy levels	Exotics-dominated in upper canopy only	Exotics-dominated in mid-canopy or understory only	Exotics-dominated in all canopy layers (giant reed)
1. Identify root causes of exotics	NA	x	x	x
2. Do current conditions prevent natives or favor exotics?	NA	x	x	x
3. Assess restoration potential: high/low	NA	x	x	x
4. Approach:				
If (2)=no and (3)=high, **Passive Restoration:** -remove stressors, allow natural recovery		x	x	
If (2)=yes and (3)=high, **Active Restoration to Naturalize Processes:** -remove stressors -clear vegetation -remove aggraded sediments -plant or seed with natives		x	Do not clear vegetation	x Active clearing required
If (2)=yes and (3)=low, **Partial Rehabilitation:** -leave exotics in place -enhance habitat quality		x	x	
None -maintain existing management -monitor for conditions favoring exotics, increase in exotics	x			

Appendix I.
Implications of Water and River Management for the Southwestern Willow Flycatcher: The Fluvial, Hydrologic, and Geomorphologic Context for Recovery

A. Introduction

The rivers of the Southwestern United States create and maintain most of the riparian habitat that hosts the remaining population of the endangered southwestern willow flycatcher (Figure 1). For breeding habitat the bird relies on riparian forests composed primarily of willow and tamarisk, an ecological niche that in turn depends on the operation of the region's rivers to provide a substrate of water and near-channel landforms. Any policy seeking to enhance the recovery of the southwestern willow flycatcher population must therefore take into account the geographic distribution, hydrologic behavior, and geomorphologic processes associated with the host rivers. The purpose of the following review is to identify the impacts that water management has had on the fluvial system of the region, outline the recent history of changes in hydrology and geomorphology, and provide recommendations for the recovery of the southwestern flycatcher population.

This review concerns hydrography, hydrology, and geomorphology. *Hydrography* is the science of measuring, describing, mapping, and explaining the distribution of surface water. *Hydrology* addresses the physical and chemical processes related to water in the environment, including precipitation, surface runoff, channel flow, and groundwater. The primary focus of any review of hydrology related to the southwestern willow flycatcher is on channel flow because of the preference by the bird for riparian (or stream-side) habitats, but the connections with other parts of the hydrologic system such as groundwater cannot be ignored. *Fluvial geomorphology* addresses river processes and forms related to earth materials and surfaces, particularly the sediment that is eroded, transported, and deposited by channel flow in streams and rivers. The geomorphic work of sediment erosion and deposition creates the landforms, surfaces, and soils that support the riparian forests critical for southwestern willow flycatcher survival. The ultimate fate of the bird population rests in large part on successful creation and management of these physical systems. No matter what other measures are employed to encourage the recovery of the population, none will be successful without insuring that the physical basis exists to support the appropriate habitat.

The southwestern willow flycatcher population depends on breeding habitat in the southwestern United States with particular characteristics (Marshall, 1995). The birds prefer riparian forests with a dense understory of shrub-like vegetation where they typically construct their nests, with a more open canopy of larger trees, all situated near still or slow-moving open water. Commonly, the dense understory consists of willow (*Salix* sp.), seep-willow *(Baccharis sp.)*, arrowweed (*Pluchea* sp.), tamarisk (*Tamarix* sp.), or Russian olive (*Eleagnus* sp.). The scattered overstory often consists of cottonwood (*Populus* sp.). Flycatchers are most abundant in these habitats when they are located adjacent to slack water, also known as lentic water. These riparian habitats were once much more common and spatially continuous, but human intervention in the southwestern river systems has now produced a geography of willow flycatcher habitat that is widely scattered, with small linear patches separated by dryland conditions. This habitat is the product of particular hydrologic and geomorphic conditions that are the subject of this appendix. The following sections of the appendix begin by establishing the general large-scale geographic framework of the issue of southwestern willow flycatcher recovery by describing the region's watersheds and river basins. Next, this appendix describes how humans have altered the hydrologic and geomorphic components of rivers through water and land management. A final section offers recommendations for management of water and water-related resources to enhance the probability of success for southwestern willow flycatcher recovery.

B. Fluvial Systems Components of Flycatcher Habitat

The hydrography of the Southwestern rivers is a geography of watersheds and water courses created by the interaction of the regional geologic and climatic systems. These systems form the physical foundation of the habitat for the southwestern willow flycatcher. Annual precipitation exceeds 50 cm (20 in) only in coastal California or at higher elevations in the interior mountains and high plateaus. California coastal streams have enough precipitation in their headwaters to maintain perennial flow in most of their lengths, potentially supporting southwestern willow flycatcher habitat. In the interior, the arrangement of high terrain with intervening lowlands creates a river system with dichotomous characteristics. The small streams of the region are either at higher elevations and are perennial, or they are ephemeral lowland channels without southwestern willow flycatcher habitat.

The large rivers of the region, the Green, Colorado, San Juan, Little Colorado, Gila, and Rio Grande, accumulate water in their headwaters areas and loose water in their low elevation watercourses (Figure 2). This reflects the elevational and geomorphic forces on in-channel water balance factors. The net water balance in the channel goes from positive (or gaining) in the headwaters to negative (losing) in the lowlands. Natural factors that affect the balance include precipitation, evaporation, transpiration, and groundwater dynamics. The consequences of removal vary over the elevational/temporal gradient. For example, the withdrawal of water from lowland streams for agricultural, industrial, and urban uses causes depletions that are not replaced by natural runoff and the remaining water is lost to evaporation and groundwater recharge. On the other hand, a river's discharge may still increase downstream of the point of water removed from high elevation, water-source areas due to runoff, subsurface seepage, and precipitation. Southwestern willow flycatcher habitat occurs mostly in water deficit areas of the region. Intermediate scale streams such as the Virgin, Escalante, upper portions of the Little Colorado, and San Pedro have mostly perennial flow and support some willow flycatcher habitat, the habitat is of lesser extent than that found in association with the large regional streams.

C. River Basins and Watersheds

Because the southwestern willow flycatcher is a riparian bird, its population depends directly on water and water-related resources. From the standpoint of resources related to water, the American Southwest divides itself into watersheds which serve as obvious regions for analysis, decision-making, and management. Watersheds are drainage basins, portions of the surface that collect runoff from the surface, concentrate it into channels, and conduct the resulting flow to a definable outlet. Large watersheds are aggregations of smaller watersheds, producing a natural hierarchy. By conventional usage, the term watershed refers to a smaller drainage basin, while the term river basin refers to a larger one, but there are no specific definitions to separate the two. Watershed concepts are those analytic and management principles whose application relates directly to a geographic region defined by a drainage basin. Recent reviews of water-related resource management by the National Academy of Sciences (National Research Council 1999) and by a Presidential commission on western water (Western Water Policy Review Advisory Commission 1998) recommend watersheds as the spatial framework for planning and management of water and water-related resources.

Watershed boundaries are porous, in the sense that artificial transfers of water between watersheds are common, so that planning and management considerations may extend beyond the physical watershed boundaries. Examples include the export of water from the Lower Colorado River Basin to California, and the transfer of water from the Upper Colorado River Basin to the Rio Grande. Because of the importance of water and riparian environments to the recovery of the southwestern willow flycatcher population, planning and management for the opportunities and threats to the species should use watersheds as a geographic framework.

Definition of the watersheds and river basins of the Southwest is standardized among federal and state agencies by the National Water Resources Council and the U.S. Geological Survey who have created a series of watershed outlines (U.S. Water Resources Council 1978). It is therefore logical that a southwestern willow flycatcher recovery plan use the same definitions to facilitate interagency communication. This standard approach uses a hierarchical series of numbered hydrologic units, with each unit being a watershed or collection of watersheds (Seaber et al. 1987). The identification numbers, called hydrologic unit codes, use two digits for the largest divisions or regions, four digits for subdivisions, and six or eight digits for still finer subdivisions. The largest divisions in the classification system are 21 *water resource regions*, with each one containing either an entire river basin or a series of closely related basins, each identified with a two digit hydrologic code. The regions containing southwestern willow flycatcher habitat are the Rio Grande (region number 13), Upper Colorado River (14), Lower Colorado River (15), Great Basin (16), and California (18), with a total area of 1,738, 950 km^2 (671,410 mi^2). Table 1 summarizes the watershed regions, their hydrologic characteristics, dams, and human populations; Figure 3 provides a map of their extent. Although the California region extends into northern California areas not inhabited by the southwestern will flycatcher, the entire region is involved because of engineered water transfer facilities that connect the northern to the southern parts of the region.

The creators of the hydrologic unit code subdivided the water resource regions into *planning subregions*, designated with 4-digit code numbers; 6-digit code numbers identify the members of a still finer subdivision consisting of *accounting units*. The accounting units are aggregates of the smallest subdivisions, or *cataloging units*, identified by 8-digit code numbers. The 21 water resource regions of the nation contain 2,150 of these smallest units, which have an average drainage area of about 1,750 km^2 (700 mi^2). For the purposes of the southwestern willow flycatcher recovery plan, the most useful scale of analysis is the accounting unit, or 6-digit coded watersheds. In Arizona, for example, this implies that watersheds such as the Verde River Basin, Salt River Basin, and San Pedro River Basin represent the most convenient scale (Figure 3).

D. Stream Channels

Runoff within watersheds and drainage basins concentrates into channels and creates the distinctive streams and rivers of the Southwest with their associated willow flycatcher habitat. Streams begin flowing at higher elevations and flow to lower elevations. Generally, the gradients of watercourses are relatively high near the source areas and decline to nearly level at lower elevations. Variations in geology, artificial structures, and even beaver dams produce localized reaches of exceptionally steep or shallow gradient. The high elevation, steeper gradient regions are the primary source areas for water, but they are also the primary source area for alluvium (substrate particles that typify flowing waters). In addition to their roles in delivering water and alluvium to the channel, steeper areas tend to be transport zones where water and particles move quickly downstream. Because of their gradient and stream power, these rivers tend to flow through narrow, incised channels and valleys with little storage of alluvium. The lower elevation and lower gradient areas are usually storage zones for water and alluvium, as indicated by flood plains that typify the larger, low elevation systems.

The spatial distribution of southwestern willow flycatcher habitat is a reflection of these dynamics. Relative to upland areas, riparian areas are usually richer and of greater areal extent where the substrate is comprised largely of inorganic alluvium, subject to flooding, and with high soil moisture and shallow groundwater. Thus, southwestern willow flycatcher habitat was naturally very limited along high gradient, high elevation watercourses that flow through canyons. At higher elevations, the bird was probably reasonably common in topographic situations that resulted in low gradients such as mountain meadows. The bird was probably very abundant and optimal in low elevation zones with broad flood plains. In the low elevation areas, habitat quality probably was suboptimal where water levels remained stabile and the substrate was highly organic (including cattail or tule marshes) because of the anaerobic conditions within the shallow root zone.

In the low elevation, low gradient rivers of this region, the temporal and spatial variability of runoff results in three common types of river channels: single-thread, braided, and compound. Each channel type has particular dynamics and spatial arrangements, and each supports a different arrangement for willow flycatcher habitat. *Single-thread channels* contain their flows between well defined banks, and may have planimetric configurations ranging from relatively straight to meandering. They usually result from hydrologic regimes that have only modest fluctuations of flow. The channels conduct flows of low magnitude, but those flows that are so large that they occur only once every few years exceed the channel capacity, and spill onto the adjacent flood plain. Flood plains are relatively flat surfaces, located next to the channel and outside the channel banks, and consist of sediments that are active in the present regime of the river (that is, they are mobilized at least once every few years). Dense riparian forests occupy the flood plain when they are undisturbed by direct human activities. Relative to those of thee other channel types, the riparian forests although patchy are relatively continuous.. When composed of an appropriate assemblage of plant species and when located adjacent to open water, these forests can provide suitable willow flycatcher habitat. The flowing (lotic) water of the channel is sometimes augmented by slack (lentic) water in abandoned channels on the flood plain surface, usually the abandoned meanders (or oxbows) of the single-thread channel. Typical, large-scale examples of single-thread channels are the Lower Colorado River near Yuma and the Rio Grande downstream from Albuquerque, cases where controlled flows and levees have produced a single-thread channel. Natural examples of single thread channels include Aravaipa Creek in southern Arizona and many small coastal California streams.

Braided channels consist of a broad flow zone delimited at the edges by low but well defined banks. Between these banks are several channel threads intertwined among each other, with numerous mid-channel islands and bars. Occasionally, braided channels in the Southwest have flood plains which behave similarly to the flood plains of single-thread channels. In cases where braided streams occur without flood plains, their banks divide the channel from adjacent terraces, surfaces that do not experience flows during the present hydrologic regime of the river. Braided channels commonly result from highly variable flow regimes, channels with weakly consolidated bank materials, and/or watercourses with very heavy sediment loads. The islands and bars experience less overflow than other areas associated with many braided channels, and they tend to be the locations for willow flycatcher habitat, along with narrow ribbons of riparian vegetation on the banks. Unlike the flood plain forests, braided channels are unstable, and as floods rearrange the subchannels, islands, and bars, riparian forests change and are characterized by patchy vegetation with many inherent gaps.

Many lowland rivers of the Southwest were braided streams before human controls altered their flows, and under these conditions they hosted southwestern willow flycatcher populations. Historical accounts of streams ranging from the Los Angeles River to the San Juan River in southwestern Colorado describe such conditions for the pre-development era (*e.g*., Kino 1919, Griffin 1943). In the Los Angeles River and the general Los Angeles Basin, for example, the wide-spread existence of wetlands associated with the low-gradient coastal rivers produced substantial southwestern willow flycatcher habitat. Willett (1912) reported willow flycatchers in the Los Angeles and Pasadena areas, and indicated that they were common in riparian areas. Egg collections at the Western Foundation of Vertebrate Zoology include 44 clutches collected in the period 1901-1910 in Los Angeles County alone. The specific sites included water courses in Los Angeles, Pasadena, and along the San Gabriel River in Cerritos and Artesia. Unitt (1987) reported 67 egg sets were collected in the Los Angeles basin before 1940. Subsequent urbanization with its attending channelization and changes in riparian land use decimated the southwestern willow flycatcher habitat in the basin.

Although single-thread and braided channels are archetype morphologies for rivers, southwestern streams most commonly are of a third, hybrid type. The *compound channel* has the characteristics of both single- and multiple-thread arrangements (Gregory and Park 1974, Richards 1982, Graf 1988). At the lowest point of the cross section of a compound channel is the low flow channel, which conducts the usual low flow of the system either from natural sources or from low flows released by dams. Outside the banks of this low flow channel lie the braided channels, islands, and bars of the high flow system. This high flow portion is occupied by water only during the once in ten- or twenty- year flood under natural conditions, or by the rare spill or uncontrolled flow from dams. Beyond the banks of this high flow channel lies the terrace that is not active in the present regime of the river. There usually is no flood plain in the normal sense of the term in this compound system. Southwestern willow flycatcher habitat occurs in the form of threads of riparian vegetation along the banks of the low flow channel, and if the watertable is high enough, dense forests may also occur within the high flow, braided portion of the channel. With the physical processes that form the compound channel being intermediate between those that drive single-thread and braided channels, the riparian vegetation is similarly intermediate. It is arranged as somewhat patchy with moderate levels of connection. Compound channels are common in the Southwest under present conditions, exemplified by the Salt and Gila Rivers in Arizona and many southern California streams. The Hassayampa, Santa Cruz, and San Pedro rivers are smaller inland examples.

E. Flow Regimes: Water Quantity and Patterns of Water Flow

Six components of flow regimes, amplitude, magnitude, frequency, duration, timing, and rate of change of hydrologic conditions, strongly influence the structure and function of riparian ecosystems (Poff et al. 1997). With respect to magnitude, for example, the width of riparian vegetation communities and their biomass increases with mean and median annual flow volume and drainage size in alluvial river channels (Stromberg 1993). Low flows and peak flows are of particular importance to regeneration and maintenance of southwestern willow flycatcher habitat in the arid Southwest. With insufficient low flows or extended loss of surface flow in the summer dry season, alluvial ground water levels decline. These changes can result in mortality of the shallow-rooted native trees and shrubs in which the willow flycatchers nest and cause a narrowing or contraction of the riparian corridor. Extensive research on cottonwood species, and to a lesser extent on willows and tamarisk, has defined the threshold values for depth to water table and water level recession rates that seedling and adult plants can tolerate. Smaller reductions in stream flow or ground water levels can cause plants to undergo physiological stress and lose productivity, with possible adverse implications for the southwestern willow flycatcher habitat. Even short-term loss of surface flows may reduce bioproductivity and habitat quality by stressing those insects with aquatic larval forms, a portion of the southwestern willow flycatchers food base.

Flooding is characterized by amplitude (difference between minimum and maximum flows in a given period), timing, magnitude, frequency and duration. Floods are the primary natural disturbance in riparian ecosystems (Poff et al. 1997). Floods exert important physical and biological controls on riparian zones. They inundate and moisten flood plain soils, raise water tables and recharge aquifers, mobilize and deposit sediment of various textures on flood plains that creates a seed beds for riparian plants, flush salts and redistribute nutrients, cause river channels to relocate and/or meander, create abandoned channels and backwater depressions, disperse and scarify plant propagules, scour and relocate vegetation, and deposit organic materials that have higher water-holding capacity than the inorganic materials in the substrate. These flood-driven fluvial processes maintain high species diversity, bioproductivity, and habitat complexity in riparian ecosystems.

The forces controlling the timing of floods large enough to destroy southwestern willow flycatcher habitat operate at regional and local scales. At the regional scale, these destructive floods result from global and sub-global atmospheric circulation patterns that deliver moisture from warm ocean surfaces to the continental areas by way of decaying tropical storms and major frontal systems in mid- or late winter. Extensive regional flooding results in these cases, as happened in

1941, 1978, or 1993, with widespread lose of riparian habitat. In the intervening years, the habitat recovers and regrows. On the time scale of decades to a century, therefore, it is reasonable to expect regional changes in the amount of available riparian habitat for southwestern willow flycatchers regardless of human-induced changes. Local flooding results from conditions connected to local thunderstorms in summer months which affect a single or a few watersheds. In these instances, loss of riparian habitat is small compared to the large regional events, but at the end of the twentieth century there are so few active southwestern willow flycatcher sites that even these events affecting limited areas may be important for the bird population.

Many of the riparian plant species in the Southwest such as Goodding willow are pioneer species that depend on periodic winter and spring flood disturbance for regeneration. Other species in the plant community regenerate in response to periodic summer floods. With respect to magnitude, the infrequent but very large floods reset the successional clock and rejuvenate large stands of the riparian forests upon which southwestern willow flycatchers depend. Smaller floods that inundate but do not destroy the forests help to maintain a diversity of understory and herbaceous plant species that may play important roles in maintaining the food base of the flycatcher.

Most of the human population of the Southwest views the water flowing through the river systems as a commodity with specific legal and economic attributes. From a fluvial hydrology and geomorphology perspective, as well as from the standpoint of southwestern willow flycatcher habitat, the water is a vital landscape component, not a separate commodity. Any attempt to utilize water to improve conditions for the flycatcher population, however, must take into account the legal and economic aspects of water. River flows in the Southwest are appropriated, meaning that individuals, corporations, and government entities own the rights to withdraw and use the water within a specific set of allocations and priorities. These rights may be bought and sold, offering the opportunity in some cases for purchase of water for use by wildlife. However, purchase of water rights for the flycatcher population has been limited and will likely continue to be insufficient to maintain or recover southwestern willow flycatchers. Instead, they have and will likely continue to rely on the existing (or highly similar) arrangement of water flows and rights.

The restoration of habitat for the willow flycatcher along channels throughout much of the Southwest can introduce reclaimed riparian landscapes that will benefit the flycatcher population. However, this restored landscape will not be the original natural landscape that existed prior to the advent of modern technological river controls. Two types of changes altered that original landscape: 1) reduction of downstream flows caused the active part of the channel and its associated landforms to shrink in their overall areas, and 2) a variety of influences resulted in substantial simplification of the remaining landscapes and habitats. These influences include the storage of sediment behind upstream dams, channelization, dredging, construction on banks, levee building, and urbanization. Because it is unlikely that all of these forces will be removed, restoration of flycatcher habitat will produce a viable habitat area, but one that is smaller than the original habitat. Because it will be smaller than the original habitat, this restored habitat does not require a return to the original hydrologic regime, but rather needs only modest flood events. Complexity of the habitat also will be on a smaller scale, but landscape variety can be introduced within the limited restored area.

The cost of water varies throughout the region, depending on the value of the end use, the availability of water, and the expense of transporting it from source to use. Individual cases in limited areas have wide ranges in the value of water. Agricultural users in areas supplied by the Salt River Project in central Arizona, for example, may pay as little as $15 per acre foot, while some water used for fishing and whitewater boating in the Rio Grande has a value of $1,615 per acre foot (Frederick et al. 1995). In the Southwest, the highest single example for marginal values is $2,642 for fishing in the Lower Colorado Basin. Another indicator of economic value is marginal price, the cost to develop additional water supplies and deliver them to the user. Marginal costs are low where facilities are well developed and water is relatively plentiful, and high where water is scarce or where the available supply is fully developed. Marginal costs for the river basins of the Southwest include $191 per acre foot in the Rio Grande basin, the highest regional value in the nation. Marginal costs for other basins in the region are $122 in the Lower Colorado basin, $51 in California, $38 in the Great Basin, and $32 in the Upper Colorado basin.

Water rights, delivery contracts, legal commitments to power generation, and requirements for flood control are among the common constraints on making changes to the distribution of water in southwestern rivers and the management of dams and reservoirs. In the Colorado system, the "Law of the River" is the collection of international treaties, interstate compacts, court decrees, laws, rules, regulations and policies that govern the management, allocation and distribution of Colorado River water. Similar arrangements exist on all large rivers of the region that potentially provide southwestern willow flycatcher habitat, including coastal streams in California, the Rio Grande, and the Gila. However, there is some flexibility in these management systems, including the timing of some releases, storage locations, "bucket-for-bucket" transfers, and the handling and distribution of excess water, the amount that occasionally flows through the system in amounts greater than the allocations. Innovative use of this management flexibility and flood control releases can aid the recovery of the southwestern willow flycatcher without disrupting established legal commitments for water. In some cases, water purchases or modifications of legal arrangements might be negotiated.

F. Water-Related Activities that Impact Flycatcher Habitat

Human activities have introduced numerous modifications to the hydrography of southwestern rivers, so that the resulting hydrology and geomorphology are partly natural and partly artificial. These modifications included dams, diversion structures, canals, groundwater management, waste and tail water discharges, channelization, and levees.

1. Dams

Dams are the most pervasive and significant changes because they are ubiquitous and have radically altered the flows of water, energy, and sediment throughout the region. The five water resource regions of interest for the recovery of the southwestern willow flycatcher include 4,659 dams (U.S. Army Corps of Engineers 1996; structures are generally those 2 m or 6 ft high or higher, or those with reservoirs of 18,000 m^3 or 15 ac ft or more). Most of these structures are small but in the aggregate in local basins they are significant. A few very large ones exert substantial control with far-reaching consequences for hydrology and geomorphology of the region's rivers (Graf, 1999). Dams in the Rio Grande Basin, for example, can store an amount of water equal to almost 4 times the mean annual runoff (Table 1). These structures provide societal benefits including urban water supply, irrigation, hydroelectric power, flood control, and recreation, but also cause environmentally costly changes in fluvial environments that include adjustments in potential habitat for the southwestern willow flycatcher. Important changes brought about by dams include upstream impacts related to reservoirs and downstream impacts related to controlled flows, sediment dynamics, water quality, and water temperature (Collier et al. 1997).

The impoundment of water and sediment upstream from dams causes changes in the fluvial hydrology and geomorphology because of inundation and the change in stream gradient as the streamflow enters the reservoir area. Those channels and near-channel surfaces that are in the reservoir area are drowned, either permanently or periodically, so that the habitat associated with them is lost. The shoreline of the newly formed reservoir may create new habitats where none existed previously. The headward-most portion of the reservoir, where the stream enters the lake formed by the dam, is a dynamic zone where deposition of sediment creates a delta because the lake area reduces the energy gradient of the flow. Flow velocity and stream power decline, with associated deposition of sediments that previously were carried by the stream. If the reservoir level fluctuates, the location of this delta building process also changes. If the reservoir level rises, the location of the deposition shifts upstream, and if the reservoir level declines, the location of deposition shifts downstream.

The delta surface is often the most important potential area for southwestern willow flycatcher habitat, because it offers moist sand deposits suitable for willow or tamarisk growth, and the associated lake surface offers slack water nearby. During the 1990s, southwestern willow flycatcher habitat of this type existed at the headwaters of Lake Mead behind Hoover Dam on the Colorado River; Lake Isabella on the Kern River in California; and Lake Roosevelt behind Roosevelt Dam on the Salt River, Arizona. This habitat situation is unstable, however, because it depends on a relatively unchanging lake level. Hydro-climatic variability that change inflow to the reservoir, and dam operations that change its outflow produce fluctuations in lake level, location of the delta deposition, and changes in the vegetation communities on the delta surfaces. If lake levels are stable for 3 to 5 years, substantial riparian vegetation may develop, only to be destroyed by changes in lake elevation. If the new levels remain relatively unchanging (that is, water levels do not fluctuate more than about 20 feet) for another 3 to 5 years, new deposition and vegetation growth will develop in the new location. Because of these adjustments, any specific southwestern willow flycatcher habitats at the headwaters areas of large reservoirs are temporary, but over a period of decades it is likely that some such habitat will be present temporarily at some location for many large reservoirs.

The downstream impacts of dams and their operations include depletion of sediment which is trapped in reservoirs, and several adjustments to fluvial hydrology including reduced total annual flow, reduced annual flood peaks, changes in low flows, changes in the timing of high and low flows, and altered short-term fluctuations (Figure 4). All these adjustments in river mechanics result in changes in the downstream geomorphology of channels and near-channel landforms, with accompanying changes in the potential to support vegetation communities favored by southwestern willow flycatchers. The changes in sediment flux downstream from dams is especially important because the relatively sediment-free water released by the dams erodes mid-channel bars, channel-side bars (or attachment bars), beaches, and flood plains, all important substrates for southwestern willow flycatcher habitat. Because sediment from upstream is trapped behind the dams, eroded features downstream are not replenished. At further distances downstream, where tributaries deliver sediment to the dammed watercourse. However, without a flood hydrology, the sediments may continue to accumulate to a point where the riparian vegetation potential is altered. The increase in sediment may convert a reach from a single-thread to a braided channel, and may lower the depth from the grounds surface to the water table.

The specific hydrologic changes downstream from a particular dam depend on the inflows to the reservoir, the engineering characteristics of the dam, and its operating rules (Figure 4). For example, if the dam is primarily a diversion structure, it will drastically reduce the normal flows downstream, and at some distance downstream often to the point of near desiccation and loss of most riparian vegetation. On the other hand, a dam that is primarily for hydroelectric power will pass through to downstream areas an amount of water that is similar to the pre-dam amount. However, the delivery will be in a highly altered schedule determined by power grid demands, often with substantial daily river flow fluctuations that previously did not exist and may approach the amplitude of flows only seen over annual cycles. Table 2 summarizes common hydrologic changes downstream from dams of various types. Very large dams on major rivers are multi-purpose, and their operating rules represent an optimization strategy (including storage of water, generation of electrical energy, enhancing recreation opportunities, and flood control) that produces mixed results for river flows downstream.

Uncontrolled flows from dams cause instability and changes in willow flycatcher habitat in the impacted streams of the Southwest when the channels shrunken by levees and/or a response to the damming cannot contain the large floods. Riparian forests developed in compound channels are often partially or completely destroyed by uncontrolled or exceptionally high flows, but the forests redevelop on the surfaces abandoned by flood waters when flows return to normal.

Dams also alter water quality. Salinity increases can be very high in the downstream reaches of dams or intensive agricultural areas, as in the lower Colorado River. Generally, according to the U. S. Environmental Protection Agency, the primary sources of salinity are irrigation water and reservoir evaporation (Briggs and Cornelius 1998). In the lower Colorado River, these sources contribute 50% of the salinity. Salinity increases can be biologically significant. Most native willows and cottonwoods are relatively intolerant of salt (Jackson et al. 1990, Shafroth et al. 1995). Germination rate of Goodding willow declines continuously with salt content, falling to less than 50% germination at values above 100 meq/l of sodium chloride (Siegel and Brock 1990). Tamarisk germination, in contrast, increases with salinity. Dams also eliminate the floods that otherwise would flush salts from flood plains.

Levels of nutrients can be reduced downstream from dams. Phosphorous typically adheres to clays and silts and thus tends to decline in below-dam systems as the fine sediments are deposited in the reservoir. Nitrogen levels can remain high if nitrogen-fixing plants such as mesquite remain abundant. Effects of nutrient reductions or changes in nitrogen-to-phosphorous ratios on quality of southwestern willow flycatcher habitat are unknown.

Water temperature regimes downstream from dams are often substantially modified from pre-dam conditions. Solar energy is stored in the surface waters of reservoirs and deeper waters remain cold. Most dams withdraw water from the hypolimnion, the cold, deep water below the thermocline, a sharp temperature boundary in the vertical stratification of many reservoirs. As long as storage is adequate to keep the withdrawal levels below the thermocline, the dam releases cold water. The distance downstream that the dam influences the water temperature varies based largely on water velocity, its turbulence, channel velocity, and air temperature. The cooler water temperature modifies microclimates in riparian zones and alters the aquatic invertebrate base which forms the flycatcher's food base. When a reservoir's withdrawal level coincides with the thermocline and the epilimnion (the warmer waters above the thermocline), downstream water temperature rapidly and dramatically increases. The result is severe stress on the aquatic communities.

Stratification of reservoirs poses other consequences to downstream river reaches. At depths, there is often intense biological oxygen demand that results from the decomposition of incoming organic material and the "rain" of surface-water algae. It is amplified by the lack of turnover with oxygenated waters. As a result, deep waters often are very anaerobic and of low pH and many ions are reduced to forms inhospitable to aquatic life. When water is discharged from that reservoir level, downstream impacts on the aquatic community can be severe until the flowing water oxygenates.

The hydrologic and geomorphologic effects of dams in the Southwest have only recently become apparent, partly because of increased interest in environmental quality and changes, but also partly because of the relative recency of dam closures in the region. The impacts of dams on southwestern willow flycatcher habitat is also relatively recent, becoming apparent only within the past two or three decades. The three major river basins in the region, however, have somewhat different histories in the development of their cumulative reservoir storage, a general measure of the impacts of dams on the regional hydrology (Figure 5). The greater the reservoir storage in a basin, the greater the impact on hydrologic systems, including those upon which the southwestern willow flycatcher depends. In the case of the Rio Grande, reservoir storage has increased gradually over the past century. Closure of flood control structures during the 1960s represented the most significant additions to the storage system. In the combined Upper and Lower Colorado River basins, the completion of two large structures, Hoover Dam in 1936 and Glen Canyon Dam in 1963, dominate the history of reservoir storage. After the early 1960s, dams had their most significant influence on the basin hydrology, geomorphology, and riparian ecology in the Lower Colorado River. Significantly, riparian bird populations appear to have begun their decline in the Lower Colorado in the 1960s and thereafter (Rosenberg et al. 1991). In California, rapid increases in storage associated with federal, state, and local water projects dramatically increased the total storage between about 1955 and the late 1960s. Therefore, taken together, the major basins of the Southwest experienced their most important increases in reservoir storage and artificial hydrologic adjustments in the decade of the 1960s.

The effects of dams on riparian ecosystems vary widely depending on many factors, including the nature of the dam management and the fluvial geomorphic setting. If accompanied by extensive water diversion that eliminate water from the channel, such as the Salt River below Granite Reef Diversion Dam near Phoenix or the Gila River below Ashurst-Hayden Dam near Florence, the downstream riparian vegetation inevitably is lost, reduced in area, or replaced by more xeric vegetation. In cases where base flows are unchanged or increased, and the magnitude and/or frequency of large scouring floods is decreased, the channel often narrows while riparian vegetation increases (Williams and Wolman 1984). This increase in vegetation is a result of high water tables and lack of destructive floods, and is particularly evident on braided rivers (Friedman et al. 1998) or in canyons downstream from dams. Moderation of peak flows may be responsible for increased vegetation cover on river sections such as the middle Gila below Coolidge Dam between Hayden and Kelvin (Graf 1982). Along the undiverted Bill Williams River, where summer base flows have increased and the natural cycle of flood scour and pioneer plant recolonization has been disrupted by Alamo Dam, the flood plain presently supports more extensive vegetation than it would were the dam not present (Shafroth, 1999).

Due to the many changes that accompany dam construction and management, the quality and structure of the post-dam vegetation often differs substantially from the pre-dam state. Compositional changes include a simplification of the flora, an increase in exotic species, a loss of native species, shifts from pioneer to later successional vegetation and older individuals, closing in towards the narrowing channel, and shifts from hydric to xeric species. Along the Bill Williams River, as well as along the Gila River and Upper Colorado, most of the 'added' vegetation is composed of exotic tamarisk. Tamarisk is reproductively opportunistic, has high water-use efficiency and deep roots, and is tolerant of drought and salinity (Busch and Smith 1995, Smith et al. 1998). Thus, tamarisk has a competitive advantage over cottonwoods and willows on regulated rivers subject to altered seasonal timing of regeneration floods, reduced stream flows and overbank floods, lowered water tables, and increased salinities. Increase in tamarisk abundance, together with a general increase in live and dead plant biomass, sets the river up for a shift from a flood-disturbance system to a fire-disturbance system, with implications for southwestern willow flycatcher habitat quality.

Dams have played a role in the decline of riparian cottonwood and willow forests throughout the western United States (Rood and Mahoney 1990). This decline is attributed to many factors: reduced rates of sediment deposition and increased rates of scour, reduced river meandering and channel realignment reduce availability of the "nursery bars" needed for seed germination, reduced frequency and size of winter and spring flooding reduces establishment rate of these spring-germinating species, more rapid declines in stream flows on the receding limbs of flood hydrographs cause seedlings to die, and reduced flows of water stresses and sometimes kills very young and very old trees in particular, as do increases in salinity (Braatne et al. 1997).

2. Diversion Structures

Diversion structures are low dams designed to divert river flows into the headings of canals and their distribution systems. Unlike other dams, diversion structures do not primarily store water. They are run-of-the-river dams; that is, they can not control the downstream discharge during medium or high flows and do not significantly reduce flood peaks. Neither do they redistribute downstream flows according to a release schedule. During low flow conditions, however, diversion works usually divert some or all of the flow from the river, so that downstream reaches of the river are desiccated. The result is the loss of riparian vegetation and potential southwestern willow flycatcher habitat downstream from such structures. The reaches upstream from diversion works may offer opportunities for southwestern willow flycatcher habitat because these are typically reaches with sedimentation and associated islands, bars, beaches, and banks suitable for willow or tamarisk and other riparian trees. There is usually also some slack water nearby created by ponding of water before it flows through canal headings at the diversion structure.

Perhaps the most dramatic case of diversion of surface flow, and ultimate restoration of flow to an arid region stream, involves Mono Lake and its tributary streams in the Sierra Nevada of California. While outside the range of the southwestern willow flycatcher, the case is nonetheless instructive in considering water management options for the recovery of the bird elsewhere. After a ramp-up in the rate of stream diversion by the City of Los Angeles, the riparian forests along some of the diverted tributary streams underwent a massive die-off and the level of Mono Lake declined. Invoking the Public Trust Doctrine, the California Supreme Court ultimately ruled that the ecosystems on federal lands had high value to the public and required the city of Los Angeles to restore flows to the diverted stream channels (Wiens et al. 1993). Flows are now being released from the diversion dam at sufficient quantity to maintain the base flows and shallow water tables required by the cottonwood-willow forests (Los Angeles Department of Water and Power 1995). Los Angeles since has been pursuing alternative and creative measures to attain municipal water. For example, in return for expending the money to increase the efficiency of agricultural irrigation techniques such as laser-leveled fields, the city obtains the water 'salvaged' as a result of the increased efficiency.

Stream diversions sometimes have more subtle ecological effects. In central Arizona, for example, mid-summer diversions for agricultural use sharply reduce the base flows in the free-flowing Verde River. Although the Verde River still supports cottonwood-willow forests, the seasonal dewatering may be exerting subtle effects on southwestern willow flycatcher habitat quality by causing physiological stress in the trees and variously reducing bioproductivity rates, plant cover and density, and age class diversity (Smith et al. 1991).

3. Canals

Once diversion works direct water out of river channels, canals and lateral distribution ditches conduct it to fields or urban treatment plants. These canals often offer the potential for southwestern willow flycatcher habitat because they have slow moving flows by design, and if their beds and banks are not completely sealed, seepage from them supports canal-side vegetation. These strips of vegetation and associated artificial water courses provide southwestern willow flycatcher habitat in the Upper Gila River Valley near Cliff, New Mexico. In many areas, managers remove the canal-side vegetation to improve flow efficiency or eliminate evapotranspirational water loss. Alternately, canals that are lined with impervious materials to prevent seepage and eliminate substrate for riparian vegetation growth. Removal or prevention of riparian shrubs and trees reduces the amount of potential flycatcher habitat. Where seepage from canals supports recharge to other water bodies, its control can diminish the amount or quality of potential habitat.

4. Wastewater and Tail Water Discharges

Stream reaches desiccated by diversions receive water inflows downstream from the diversion points through the return of some flow via wastewater or tail water discharges. Wastewater from urban treatment plants sustain continuous flows below the outfall points for the plants, often creating compound channels with enough water on and near the surface to provide for riparian forests potentially suitable for southwestern willow flycatcher habitat. An example of this arrangement is Las Vegas Wash, downstream from the city of Las Vegas, where wastewater discharges sustain an extensive area of tamarisk and other riparian species that host a southwestern willow flycatcher population. Along other rivers, cottonwood-willow forests have developed as an unintended consequence of return of treated municipal wastewater to dry river channels (Stromberg et al. 1993). If untreated or inadequately treated, urban return flows can be of reduced water quality, threatening to flycatcher food quality and quantity.

Two reaches of the Santa Cruz River in southern Arizona exemplify contrasting consequences of releasing effluent into channels where the flood-plain aquifers are deep relative to the channel. The Santa Cruz flows freely from it's headwaters in Arizona's desert grasslands, through northern Mexico, and back into the United States near Nogales. Some of the upper Santa Cruz River remains ephemeral and devegetated as a result of groundwater pumping to supply water to the border cities known as Ambos Nogales. In the reach below the Nogales International Wastewater Treatment Plant, release of effluent directly into the channel has caused stream flows and water tables to once again increase to levels that support cottonwood-willow forests. This hydrologic restoration, coupled with natural flood flows, has allowed for flood-plain wide recovery of cottonwood-willow forests along several miles of the river. Much farther downstream, release of similar amount of effluent from Tucson into a similarly sized channel but underlain by a heavily overdrawn groundwater basin has produced only a narrow, short stringer of riparian vegetation. The effluent rapidly percolates into the aquifer and falls below the zone available to riparian plant species, producing habitat of limited quality for species such as the flycatcher.

The example of the Santa Ynez River illustrates the changeable nature of habitat strongly influenced by human activities, including the release of urban wastewater. Suitable riparian habitat for the bird probably existed on a sporadic basis during relatively moist periods, but the release of urban waste water insured continuous maintenance of the habitat even during drought periods. During the middle 1990s, at least 3 territorial pairs used the riparian area of the river partly sustained by wastewater. However, the habitat eventually was lost as part of channel controls instituted by Santa Barbara County for flood protection (Holmgren and Collins 1995).

There is reticence on the part of some land and water managers to release effluent into river channels or constructed wetlands because of concerns over odor, human health risks from mosquito-borne diseases, or poor water quality. Along the Salt River downstream of Phoenix, managers are finding that some of these concerns can be alleviated by managing for, or allowing for habitat complexity. For example, complex habitats that support insect predators, such as topminnows, allow natural predation-prey interactions to keep the disease organisms at low levels.

Non-urban activities also create discharges of water into otherwise dry channels and provide for useful flycatcher habitat by supporting the appropriate vegetation communities. Agricultural irrigation usually returns some flows to the river that supplied the original withdrawals, and these tail waters occupy low flow channels bordered by dense growth of riparian vegetation. Tail waters are rarely able to sustain continuous flows of distances of many km, but in some cases downstream from large irrigation areas a semblance of dense riparian forest is possible. Such forests are not as extensive as the ones that existed in pre-development periods, but they may serve as the only available substitutes. Irrigation return flows to the Middle Rio Grande support extensive riparian vegetation that hosts some of the currently active southwestern willow flycatcher habitat in that system. Irrigation return flows typically are higher in dissolved solids and salts than are the irrigation inflows due to the tendency of irrigation to concentrate solutions through evapotranspiration and dissolution form the soils. Saltier water can shift the potential species mix of riparian vegetation from natives to salt cedar, and potentially beyond the tolerance limits of salt cedar. Pesticides and herbicides and their breakdown products can potentially alter the flycatcher’s food quantity and quality in discharge areas.

5. Groundwater Management

In many areas of southwestern agriculture, the return of irrigation tail waters to streams results in elevated groundwater levels. Saturated landscapes in and near river channels sustain extensive growth of phreatophytes in an arrangement that is determined partly by surface flows feeding water to the system and partly by groundwater pools whose influence extends far beyond the points of release of the surface waters. The extensive thickets and forests that survive on these groundwater pools cover thousands of km^2 along the large southwestern rivers with variable implications for flycatcher habitat. Along the middle and lower Gila River, some reaches have flycatcher habitat, such as those in the Safford Valley. On the other hand, flycatchers have not been recorded at seemingly similar reaches near the confluence with the Salt River and near Gila Bend.

River managers do not always view groundwater-supported phreatophyte forests positively. Water users suspect that the water transpired by the vegetation could be "salvaged" and used if they remove the phreatophytes, a concept that has given rise to phreatophyte removal programs beginning in the mid-1940s. Although extensive published research has indicated that water savings from phreatophyte removal would be very limited, such programs continue. Additional pressures to remove phreatophyte cover come from flood control interests who see phreatophyte growth in and near channels as reducing flow capacity and increasing the likelihood of flooding. Channel clearing efforts, followed by channel maintenance for phreatophyte control and flood conveyance reduce the forest and thicket coverage and are common in many parts of the southwest, including coastal California streams.

Groundwater pumping for municipal, agricultural, and/or mining activity has resulted in groundwater declines along many rivers in the southwest. Riparian water tables can decline if water is pumped directly from the alluvial aquifer or from the regional basin-fill aquifer. Along the San Pedro River in Arizona, aggressive pumping from the regional basin-fill aquifer has decreased flow into the local alluvial aquifer of the San Pedro River. The rate of groundwater flow from the regional aquifer to the alluvial aquifer has steadily declined in recent decades, as the nearby municipalities have pumped groundwater at a rate in excess of the recharge from runoff from the Huachuca Mountains. The net result has been a steady decline in base flows in the river. If the pumping and associated declines in river flow and water tables continue, the eventual loss of southwestern willow flycatcher habitat is inevitable. Remedial measures include recharging the aquifer with urban effluent, as in an experimental effort by the City of Sierra Vista and the U.S. Bureau of Reclamation.

On the other hand, Tucson and other cities, recharge groundwater through flow into streambeds, though all such efforts do not greatly benefit southwestern willow flycatchers. In some cases water is being recharged into small naturally ephemeral rivers, producing small patches of riparian vegetation that may not have appropriate nesting structure or may be distant from larger river networks. Planning efforts may be able to identify recharge sites that accommodate needs of water users and southwestern willow flycatchers.

The combination of ground water pumping and surface water diversion can be severe. Along the lower Gila River near Casa Grande, Arizona, groundwater was once within a shovel's reach of the flood-plain surface. But between loss of surface recharge following river diversion and pumping from agricultural wells, this water table has dropped by as much as 200 meters during this century (Judd et al. 1971). Riparian vegetation has been entirely replaced by upland vegetation along some stretches of the Gila River. Throughout the desert Southwest, practically all intermediate and large rivers are affected by surface flow diversion and/or groundwater mining. Lowered water tables have cause death of riparian vegetation and/or replacement of hydric vegetation types by more xeric types as along the Mojave River and Carmel River in California, and the Santa Cruz River in Arizona (Bryan 1928, Groeneveld and Griepentrog 1985).

There are ample opportunities to enhance or restore riparian vegetation by recharging ground water into appropriate sites. For example, the State of Arizona was allotted 3.4 x 10^9 m^3/yr (2.8 million acre-feet/year) of Colorado River water annually under the 1928 Boulder Canyon Project Act (45 Stat. 1057) and the 1964 decree in *Arizona vs. California*. Through water-banking, some of the Colorado River allocation of Arizona is recharged or “banked” in aquifers along the 530 km of the Central Arizona Project canal from Parker to Tucson, Arizona. In this arid region of the southwest, with open water evaporation rates greater than 2.7 m per year, aquifer recharge is considered to be a more viable and desirable method of water storage than storage in surface impoundments. Importantly for the southwestern willow flycatcher, it is feasible to accomplish the dual goals of ground water recharge and riparian restoration. A recent modeling study predicted that extensive riparian forests could be re-established in a dewatered reach of the Agua Fria River below the New Waddell Dam in central Arizona, if Central Arizona Project water was released from the dam. The river corridor could essentially be used as a conduit for water delivery to the recharge/recovery zone, with the key side benefit of providing water accessible to riparian vegetation (Springer et al. in review). The total amount of water transpired by the vegetation is predicted to be less than the amount that presently evaporates from the storage reservoir. If managed appropriately, such a project could produce southwestern willow flycatcher habitat along the Agua Fria analogous to that along the nearby Hassayampa River. However, it should be noted that during extreme drought periods, Central Arizona Project water may not flow to Arizona, so that a disruption of this recharge and restoration process is possible.

6. Channelization and Levees

The protection of near-channel properties often leads to the construction and maintenance of channelized rivers and levees along southwestern streams. Channelization consists of a variety of structures including jetties, bridge abutments, grade crossings, and pilot channels to impose a single-thread, relatively straight geometry on the previous meandering or braided system. Pilot channels are trapezoidal in cross section, are small compared to the natural braided channel they replace, and lead low flow channels through otherwise more complicated arrangements in simple straight lines. Levees provide further flood protection, and are usually situated at some distance away from the low flow channel. Because of the value of near-channel property, there has been a historical tendency to construct levees as close to the low flow channel as possible, restricting active channel width as much as possible, so that land outside the levee is available for use.

To gain a cross-sectional area adequate to pass flood flows while minimizing land allocated (channel width) for that purpose, high levees are required. During peak flows, high levees restrict water to a high level relative to the surrounding protected area. This arrangement creates a great pressure differential (or hydraulic head) that stresses levee systems and the ground upon which they are constructed. The high pressure differential results in a high risk of failure, mandating intense maintenance of the levees themselves. Little habitat for any species is allowed in these cases due to the fact that it, or some of the species it attracts, jeopardizes the levees integrity. Inside the levees, optimal flood control designs of waterways include allowances for only the most limited impedance to flow (roughness elements) such as riparian vegetation. To maintain its design flood capacity, management agencies are mandated to remove vegetation before it becomes limiting to flow. Deposition of sediment that was once spread across a broad cross section then becomes concentrated in a more narrow zone, and the bed of the channel between the levees gradually becomes elevated with respect to surrounding land. In some cases, the surrounding land subsides after being cut off from the hydrology of the river. The ironical result is that this situation reduces the hazard from moderate floods, but increases flood hazards in large floods because if the levee is accidentally breached in an uncontrolled situation, flows spilling from the elevated bed into surrounding lowlands are exceptionally damaging and difficult to control.

Flycatcher habitat is likely in some southwestern streams in the area between or within the levees. Such areas have slack water in low flow channels and have riparian forests and tickets if the vegetation is not mowed or removed. Active competing land uses are uncommon or within the levees because by definition such zones are high flow channels and subject to occasional inundation. Examples of these arrangements include extensive reaches of the Lower Colorado River, the Rio Grande in New Mexico (Figure 6), and some coastal California streams.

Southwestern willow flycatcher habitat can be restored or improved along some rivers by removing the physical barriers that separate a channel from its flood plain. Along the Colorado River, for example, there are opportunities to remove the dikes and levees and restore some degree of channel-flood plain connectivity. By allowing the water to periodically flow onto the flood plain, it is possible to provide the input of water, nutrients, sediments, and plant propagules to sustain the productivity and diversity of the riparian forest (Crawford et al. 1993).

G. History and Geography of Water-Related Impacts on Southwestern Willow Flycatcher Habitat

During the period after about 1880, significant changes in the fluvial hydrology and geomorphology of the Southwest resulted in the reduction, modification, and redistribution of willow flycatcher habitat. In most rivers of the region, human intervention in the flow of surface and groundwater as outlined above resulted in substantial reductions in the total length and width of flowing streams, and their riparian vegetation. In Arizona, for example, only about 15% of the original perennial flow remains. Throughout the region on small- to medium- scale rivers, dams and diversions have desiccated stream channels and changed them from moist corridors which supported southwestern willow flycatcher habitat in the nineteenth century to dryland conditions without suitable habitat. The Santa Cruz River in southern Arizona is an example.

Along small streams throughout the Southwest, marsh-like conditions existed on many alluvial valley floors which are likely to have been suitable willow flycatcher habitat similar to that now found in wet meadows of northeast Arizona. These valley-floor marshes, or cienegas, were reported by early Spanish, Mexican, and Anglo-American observers and were common up to the late 1800s. During the last two or three decades of the nineteenth century, intensive development that included road construction, railroad building, installation of drainage lines, and overgrazing lead to the destruction of almost all the cienagas of the southwest. The removal of their surface vegetation and the concentration of surface water flows led to their excavation by vertical erosion of stream channels, resulting in the arroyos commonly found in their former locations today (Cooke and Reeves 1976). The arroyo cutting in turn lowered groundwater levels, so that dense vegetation suitable for southwestern willow flycatcher habitat is now absent from these locations.

Large regional rivers have a more complex history. Photographs, drawings, and paintings made of the rivers during the 1800s show that potentially suitable southwestern willow flycatcher habitat was discontinuous along such rivers as the Lower Colorado, San Juan, and Gila rivers, probably because of the general instability of these systems resulting from occasional large floods (Figure 7). The streams had large expanses of bare sand in the late 1800s as shown by the photographs of major survey parties such as the Powell and Wheeler Surveys on the Colorado River, and by various other investigators on other streams of the region. Floods may have been especially common in the early twentieth century, temporarily reducing cover of riparian vegetation by destroying it, with vegetation recovering between floods. Research using ground and aerial photography of generally unregulated streams shows that the vegetation communities and channels on the Gila River gradually expanded after flood events, only to see channel widening and loss of riparian vegetation in the next flood event (Burkham 1976; Figure 8). Thus, under pre-development conditions, southwestern willow flycatcher habitat was likely to be highly changeable over a period of decades, with habitat being simultaneously gained and lost in various places throughout the southwest. A result of the flood cycle driving riparian vegetation distribution was likely a broken pattern of habitat that was somewhat naturally fire-proof.

When modern photographers have rephotographed these historic sites, they document inconsistent changes (Stevens and Shoemaker 1987). Some sites are now more heavily vegetated than they were more than a century ago because upstream dams have controlled destructive floods, but other sites appear similar to their nineteenth century barren conditions. In many cases, modern vegetation is more dense than in the views of the late nineteenth century because of the invasion of tamarisk (*Tamarix* sp.), an exotic species from the Middle East which was a rapid and effective colonizer of exposed moist sand accumulations. Tamarisk spread rapidly throughout southwestern rivers after about 1900 (Graf 1978), and it replaced much of the willow cover lost because of dams and diversions. Tamarisk, with its aggressive, deep tap roots effectively survived depleted surface flows in many areas, and it dominates the communities in many of the rephotographed locations.

Groundwater management has affected southwestern willow flycatcher habitat through an intricate series of connections with surface flows to produce a complicated history of changes. Under pre-development conditions, most of the medium and large rivers of the Southwest had flow almost continuously, with the channel water seeping into the groundwater system which had its upper surface connected to the channels from which it derived its water. This condition was common throughout the region until the early 1900s. When dams and diversions removed this surface flow and severed this nourishing connection, groundwater levels declined in those areas downstream from the diversions. Often, groundwater pumping further depressed the water table, so that phreatophyte vegetation (even the exotic tamarisk with its extensive tap root systems) could not survive in riparian environments. In many agricultural and urban areas, this groundwater depletion accelerated with the introduction of high capacity electric pumps beginning in the 1950s; from that time on, reductions in the coverage of riparian forests was common in many areas, including coastal California and the interior alluvial basins

(Figure 9). The replacement of riparian trees with barren surfaces is usual course of events in urban areas of the Southwest that produces no suitable habitat for the willow flycatcher without extensive restoration efforts (Figure 10).

The changes imposed upon the southwestern fluvial system through human activities take place against a backdrop of otherwise natural changes in the prevailing hydroclimatic system. The arrangement of the atmospheric circulation system, frequency of incursion of major storms and ordinary low pressure systems, sea surface temperatures, and teleconnections such as the El Niño and La Niña phenomena have caused some measurable adjustments in the frequency of storms and in regional flooding (Hirschboeck 1988). These changes are small compared to the local changes caused by human activities. It is unlikely that future local hydrologic responses from global climate change will be directly significant in the recovery of the southwestern willow flycatcher, because such changes will only be a maximum of about 15-20 percent of present flows (Intergovernmental Panel on Climate Change 1995). This change is small compared to the changes brought about by dams which have altered annual water yields by as much as 100% and have provided the opportunity to store several year's flow of the regional streams (Table 1; storage compared to annual runoff). If global climate change affects southwestern willow flycatcher recovery, it will be through minor changes in an already over-appropriated water economy, and by increasing the marginal cost of water that might purchased from other uses and applied for restoration.

Nevertheless, extremes of drought and flooding do influence southwestern willow flycatcher habitat, particularly if compounded by synergistic interactions with human activities. For example, the American Southwest experienced an "extreme" drought in the 1950s (Swetnam and Betancourt 1998). This contributed to the collapse of the cottonwood-willow communities and aquatic ecosystems along those portions of the Santa Cruz River that were subject to ground water pumping. The combined effects of drought and pumping from the small alluvial aquifer caused water tables in the 1950s and 1960s to decline below cottonwood and willow rooting depths (Arizona Department of Water Resources 1994). Since the mid-1970s, the Southwest has been in a wet cycle, allowing for expansion of riparian forests in some areas.

Seasonal changes in precipitation and flood patterns can influence southwestern willow flycatcher habitat, as well. After 1960, for example, climatic fluctuations tied to El Nino-southern oscillation weather patterns (Webb and Betancourt 1992) created a pattern of flood flows that was more favorable to cottonwood-willow establishment in parts of the southwest. Increased activity of Pacific frontal winter storms and of dissipating late summer and fall tropical cyclones resulted in increased magnitude of fall and winter floods (favoring the growth of willow and cottonwood seedlings by establishing enlarged potential seedbeds), while activity of convective summer thunderstorms decreased (favoring seedling survivorship). These flood patterns presumably facilitated the mid-century expansion of cottonwoods and willows over the length of the San Pedro River (Stromberg 1998) and possibly other rivers, as well. Of course, drought conditions and less favorable flood patterns may return at any time, underscoring the need for preservation of a variety of southwestern willow flycatcher river sites including the larger rivers and others with stable aquifers that are less subject to the vagaries of annual precipitation.

Several attempts have been made in western United States and Canada to restore riparian ecosystems by prescribing controlled flood flows (see Appendix K; habitat restoration). Some of these efforts have achieved notable success. To facilitate regeneration of cottonwoods, flood flows on the Oldman River tributaries (Canada) and Truckee

River (Nevada) were released at specific times in spring that coincided with the germination phenology of the target species, and with specific draw-down rates that were within the tolerance limits of the seedlings (Mahoney and Rood 1998). El Niño has assisted in the restoration of other rivers such as the lower Gila by filling reservoirs to levels that required spills from the reservoirs during spring and summer. With prior planning, water managers could be prepared to routinely release water in ways that facilitate riparian tree regeneration.

The case of the lower Gila River offers an object lesson in water management for habitat restoration for the flycatcher, and demonstrates the sorts of changes that would be needed in operating rules. Painted Rock Dam stores as much as 4 million acre feet of water, but is not designed to retain the entire amount. The dam is primarily a flood control structure, and present operating rules require that it be essentially empty by October 1 each year. If this requirement were relaxed to allow a minimal amount of storage, just enough to permit trickle flows downstream from the dam, habitat restoration would be greatly aided. The amount of flood storage thus reduced would be relatively small while at the same time improving sustainability of the flycatcher population.

Methods to manage flows on regulated rivers to favor native willows and cottonwoods over the tamarisk are being refined. Tamarisk overlaps with willows and cottonwoods in many of its ecological requirements. It is possible, however, to restore to regulated rivers some of the flow conditions under which the cottonwoods and willows are more competitive. For example, one can adjust the timing and duration of the spring floods to coincide with the desired needs of the desired species, or adjust the size and duration of the post-germination floods to levels that exceed seedling survivorship thresholds of the exotic species, but not the native species (Gladwin and Roelle, 1998).

H. Water-Related Recommendations for Flycatcher Recovery

Along with its population, the Southwest’s demand for municipal and agricultural water, hydropower, and aquatic recreation continues to grow. The time for management compromise has arrived. We need to adopt strategies that will both protect our natural resources and allow sustainable human use. There are creative ways to allow for continued flow-regulation on dammed rivers, while also allowing for the return of more natural flow regimes, including the flood flows that are paramount in the regenerative process of native riparian woodlands. Because there are pre-existing demands on water supply or power supply , we must find creative ways to work within the political and institutional constraints to rehabilitate, if not fully restore, the ecosystems.

Ultimately, we can manage our water resources to restore the conditions that favor a diversity of native riparian species. With appropriate planning, we can intermingle these habitat restoration efforts with direct human uses of the flood plain, such as agriculture. There are indirect benefits to undertaking such dual approaches. For example, native riparian forests in agricultural landscapes supply farmers with a wide variety of insects to pollinate crops and a variety of insectivorous birds to consume crop pests (Anderson et al. 1984). Such ecological services are critically important and ultimately economically cost-effective.

I. General Guiding Principles for Recovery

1. ***Reestablish and maintain physical integrity of rivers first, then proceed to biological integrity for flycatcher habitat.***

Physical integrity for rivers implies the restoration and maintenance of their primary functions of water and sediment dynamics, with some variability over time and space. The vegetation communities needed for flycatcher habitat require specific hydrologic and geomorphic conditions, the most basic of which are floods, sediments, and persistent water. Sediment supply is restricted below dams, and inflows from tributaries supply all that is readily available. Each case will need to be examined separately, but in some instances the reduced amount of sediment will coincide with reduced transport capacity, so that the imbalance is not as great as might be imagined.

2. ***Monitor physical integrity for rivers using simple indicator parameters such as stream flow and channel morphology, particularly width and channel pattern.***

Monitor physical conditions photographically using repeat ground station or aerial photography.

3. ***Set reasonable restoration and maintenance targets for physical integrity, recognizing the restored system will be a combination of natural and artificial processes.***

It is not possible to return the physical system to its pre-development condition, but it is possible to establish and maintain conditions that mimic those that existed before extensive development, although at a limited scale and at a limited number of sites.

4. Design flycatcher recovery strategies and objectives to accommodate rivers and lakes that change from time to time and place to place, rather than depending on a static, unchanging fluvial system.

Such an approach assumes that flood events and reservoir level changes will destroy some existing habitat, but that they will create opportunities for new habitat. Because of this changing nature of the fluvial system, target more of the fluvial system for recovery than will be needed at one time, because it is likely that at any one time, some of the system will not be useful.

J. Geographic Framework for Flycatcher Recovery

1. Focus recovery plans involving water-related resources locally on individual river reaches, but take into account the watershed areas upstream in planning and management.

Specific places for establishing or maintaining flycatcher habitat should be river reaches, stretches of channel and riparian zones that are a few km long and relatively similar geomorphologically throughout their extent. However, these localized efforts must take into account the entire drainage basin upstream, because activities (dam operations, tributaries, and other land-uses) in this larger framework influence water and sediment flows through individual reaches.

2. Manage and plan water-related resources in the southwestern willow flycatcher recovery effort on a watershed basis.

Use the six-digit coded hydrologic units as the basis of planning for water and water-related resources to facilitate communication among agencies and water users.

K. Opportunities in the Water-Related Resource System to Enhance Flycatcher Recovery

1. Modify dam operations to take advantage of system flexibility and water surpluses to create and maintain flycatcher habitat.

Although legal and economic considerations limit the flexibility of operations management, environmental restoration and maintenance are part of the operating strategies of many large, multi-purpose structures, and habitat considerations should be a part of decision-making for operating rules. Creative management offers many opportunities where water resource decisions can lead to important benefits to flycatcher habitat.

Use surplus / flood flows to increase or add water to marsh areas between levees and on flood plains where there are no conflicts with other land uses.

Experience on the Lower Colorado shows that occasionally flood flows are so large that water flows into the Sea of Cortez and it is not used. Rather than losing this water, it should be used through diversions onto flood plains behind levees (as discussed elsewhere) and stored as long as possible so that it may be used for restoration. Availability of the waters of flood flows and uncontrolled releases depends largely on climatic events. The use of the water in the Colorado River is presently regulated by laws and treaties; an Interim Surplus Criteria presently defines the use.

Maintain reservoir levels as constant as possible to allow the establishment of lake-fringe habitat.

Reservoir level fluctuations are inevitable, but when choices for change or stability are available, stability or slow change should be the objective. When changes are needed, seek a new level with the smallest changes possible to encourage the development of new vegetation at the new lake level on headwater deltas. Loss of habitat when one level is abandoned may provide the opportunity to establish replacement vegetation at a new reservoir level at a different delta location. Structurally create sub-impoundments at major and tributary inflows to settle sediments and remain moist environs to develop stable riparian deltas.

Keep daily ramping rates and absolute amplitude for dam releases as low as possible.

Ramping rates, the rates at which releases are increased or decreased, should be kept as gradual as possible to prevent bank erosion and loss of riparian vegetation through mechanical processes at the margins of downstream channels.

Maintain instream flow releases below dams at suitable levels to conserve or enhance instream values and public trust resources.

For those dams that are primarily flood control structures, release storage volumes to take advantage of both flood scouring processes and trickle flows over long periods to maximize groundwater recharge and small amounts of surface flow downstream from the structures.

Investigate multi-objective optimization methods for deciding best strategies for operating rules that explicitly take into account flycatcher habitat maintenance in addition to the other objectives for dam operations.

For those structures that have operating rules including environmental values, use the same analytic techniques for assessing options to maintain flycatcher habitat that are used for other water resource objectives. Operate dams systematically to attempt to mimic natural river processes at least occasionally. Distribute flood storage capacity differentially between dams in various years so the intervening watercourses will occasionally experience floods while the systems flood protection integrity is maintained. Release flows for purposes that will better simulate natural hydrology and/or specifically to enhance riparian systems – e.g., release water for recharge purposes along with peak flows to enhance the flood-like processes between the dam and point of diversion.

2. Focus some restoration efforts on river reaches that include outfall points for urban waste water and rural irrigation tail waters.

Such areas have the potential to support vegetation suitable for flycatcher habitat and often have open water surfaces. In the lower Colorado River flood plain, for example, irrigation of riparian trees and shrubs planted as part of revegetation / restoration efforts with agricultural return flows have increased the survivorship over plantings without irrigation (Briggs and Cornelius 1998). When utilizing return flows to support or create southwestern willow flycatcher habitat, it may be necessary to periodically flush the soils to reduce the concentrations of salts below the levels that are toxic to willows. Success also will be enhanced if water level fluctuations do not exceed tolerance ranges of the plant species (see Appendix K). Restoration efforts in waste-water systems need to monitor water quality and contaminant levels to minimize risks.

Investigate the feasibility of lining presently unlined canals and using the savings of previously lost water for habitat restoration purposes.

Substantial amounts of water are lost to the surface water system through the walls of unlined canals. Lining of these canals can result in savings of surface water that can then be redistributed to habitat restoration efforts. This same approach has been used by Southern California farmers whose canals were lined by cities who then have the use of the saved water. A similar arrangement should be explored for habitat, including identification of likely funding sources.

3. Manage ground water more effectively.

Integrated, watershed-based approaches to water management may suffice to reverse some of the changes resulting from ground water mining in some river reaches. All water users- be they municipal, agricultural, or industrial, need to work together and bear their share of water overdraft problems to achieve results. Approaches should focus on reducing withdrawals (e.g., xeriscaping, replacement of high-water-use crops by those with high water-use-efficiency) and increasing recharge (e.g., recharge of aquifers with effluent). In cases of extreme dewatering, restoration of water tables may require importation of water from other basins.

4. Increase the width of the flow zone between levees to expand flood conveyance potential and to foster wider areas likely to support flycatcher habitat.

If the distance between levees is increased, more space results for dense riparian vegetation outside the low flow channel. Flood conveyance channels should be designed to provide adequate flood-flow capacity with a large portion of the width in riparian vegetation. For example, doubling the width of channel dedicated to flood conveyance could free half the width from the necessity of channel clearing. Schedule channel clearing activities in such a way that riparian habitat is continuously available in the area –i.e., do not mow or grade entire flood control systems simultaneously. In some cases, levees may need to be rebuilt, with attending restrictions of space on flood plains outside them, but this loss is compensated by increased flood conveyance capacity, reduced maintenance costs, and reduced flood hazard. Sizing the channel width using the "meanderbelt" concept has potential for yielding both flood control and aquatic/riparian values. Discourage other land uses (e.g., cultivated agriculture) within flood conveyance facilities when they are inimical to riparian vegetation growth.

5. Breach levees temporarily during occasional high flows to reactivate flood plain areas in marsh conditions suitable for flycatcher support and not dedicated to other purposes.

Along some channels where the flood plain marshes can be maintained, construct additional levees around them to set them off from nearby flood plain areas used for other purposes, and install gates or valves to connect them through the main river levees to the channel to facilitate occasional diversions.

6. Reactivate abandoned channel segments now isolated on flood plains away from the active channel.

Abandoned channels and oxbows can be excavated to remove sediment and can be reconnected to the main river channel through artificial channels with gates or valves to supply temporary flows.

7. Use areas characterized by at least occasional standing water and the potential to support a dense understory of tamarisk or willow for restored or newly created flycatcher habitat, including:

a. Canals, laterals, and irrigation drains

b. Flood channels

c. Recharge basins

d. Minor lakes and reservoirs.

These activities can become multi-purpose projects including southwestern willow flycatchers if the areas are sized and maintained so that riparian vegetation is permitted. The basins should be lined only when water is lost to unusable sources. Managers should maintain water in unlined facilities beyond their original intended function so that they can act as recharge source areas where the aquifers are depleted. Along some streams, moving the point of diversion downstream as far as possible will ensure that a greater length of natural watercourse is watered.

8. Avoid creating a need to control riparian vegetation.

For example, size culverts and bridges so they are large enough to pass not only peak floods, but also the debris that the floods transport.

9. Land management agencies should assure through their activities and monitoring activities that all of their watercourses are rated as "properly functioning" (Bureau of Land Management 1995).

This basic management objective is the foundation upon which flycatcher habitat will result given adequate water, sediment, and rest from grazing.

10. Repatriate beaver in stream reaches devoid of flycatcher habitat to create still waters by impoundment and sediment storage.

L. Conclusions

The recovery of the southwestern willow flycatcher population depends on the restoration and maintenance of suitable riparian forests which the bird uses for nesting. The forests, in turn, depend on a physical substrate that includes functioning river channels and near-channel sediments and landforms. There is intense competition among users for the water and landscapes that constitute the region's functioning fluvial systems, and in many cases making provision for a recovering southwestern willow flycatcher population resolves itself into a conflict over space. If the flycatcher population is to survive, some space must be allotted for that purpose, and water which is in transit or that is being used for other purposes may also be used to aid in the recovery of the bird population. Many water-related resources of the Southwest serve multiple purposes. The key to using those resources to aid the southwestern willow flycatcher population is to extend this multi-purpose approach to sustaining the physical and biotic environments needed by the birds. Multi-purpose approaches ultimately reduce costs to other users of the water related resources, and reduce conflict among competing objectives. Creative and innovative use of existing water-related resources can make possible economic and environmental productivity without sacrificing one for the other.

L. Literature Cited

Please see Recovery Plan Section VI.

Table 1. Southwestern Water Resource Regions and Dams

Water Resource Region	Rio Grande	U. Colorado	L. Colorado	Great Basin	California
Region Identifier	***13***	***14***	***15***	***16***	***18***
Total Area (sq mi)	132,510	112,110	139,130	140,110	147,550
Total Number of Dams	716	1,164	446	803	1,530
Total Storage (ac ft)	21,013,562	46,364,999	48,373,154	5,979,380	74,161,688
Total Annual Runoff (ac ft)	5,487,880	15,063,670	18,982,714	6,596,655	72,910,402
Population	2,566,000	714,000	5,318,000	2,405,000	32,060,000
Area/Dams (sq mi/dam)	185	96	313	174	96
Storage/Area (ac ft/sq mi)	159	414	348	55	503
Storage/Runoff	3.83	3.08	2.55	0.91	1.02
1st Year Storage > Runoff	1935	1950	1936	NA	NA
Persons per Dam	3,584	613	11,924	2,995	20,954
Storage / Person (ac ft/pr)	8.19	64.94	9.10	2.49	2.31
Numbers of Dams by Size Classes					
Size = 10^x ac ft, where x =					
Unknown	2	4	19	16	7
0-0.99	0	0	0	0	0
1-1.99	134	221	80	214	209
2-2.99	406	620	171	314	693
3-3.99	119	212	108	186	345
4-4.99	37	82	45	60	182
5-5.99	13	21	16	11	69
6-6.99	5	3	6	2	25
7+	0	1	1	0	0
Storage of Reservoirs by Size Classes					
Size = 10^x ac ft, where x =					
0-0.99	0	0	0	0	0
1-1.99	8,142	12,523	4,339	9,804	11,479
2-2.99	126,532	214,674	58,020	112,704	242,597
3-3.99	416,734	646,016	362,490	529,651	1,118,433
4-4.99	961,056	2,357,803	1,303,178	1,535,752	7,476,134
5-5.99	5,072,502	7,195,673	4,519,487	3,091,140	21,633,085
6-6.99	14,428,596	7,117,310	11,888,640	2,452,894	43,679,960
7+	0	28821000	30237000	0	0

Table 2. Summary of Downstream Impacts of Dams

Dam Operations →	Hydrologic Changes →	Geomorphic Responses →	Willow Flycatcher Habitat Responses
General system-wide	Reduced annual water yield; dessication in cases of diversion of all normal flow	Shrinkage of high and low flow channels, expanded flood-plain areas with increased stability; falling water tables in the case of dessication	Expanded flood-plain forest areas; elimination of riparian forests if water tables decline below 10 m (33 ft)
Flood control	Reduced flood peaks	Shrinkage of high flow channel, change from braided to single-thread or compound patterns	Expansion of riparian forests given sufficient water table support
Irrigation and urban water supply delivery	Increased low flows	Expanded low flow channel, change from braided to single-thread or compound patterns	Maintenance of ribbon or gallery riparian forests along the low flow channel
Local diversions of flows	Decreased low flows, dessication	Shrinkage of low flow channel	Loss of most riparian vegetation
Spills, uncontrolled flows	Rare, very large flows	Destruction of the established low flow channel, occupation of the high flow channel of the compound system	Temporary loss of riparian vegetation, establishment of a new arrangement
Most operations	Decreased annual fluctuations in flow	Simplification of the channel system, loss of medium-level forms such as beaches, attachment bars, flood plains	Simplification of habitats, reduced variety of ecological niches, reduced area of riparian forest, conditions more conducive to tamarisk and other exotic species, less favorable for native species
Hydropower (run-of-river)	Little change	Little change	Little change
Hydropower (peaking)	Increased daily fluctuations	Creation of a scoured low flow channel, erosion and instability near the channel	Unsuitable for riparian forest within the zone of fluctuation

Table 3. Water Withdrawals and Uses in Southwestern Willow Flycatcher Water Resource Regions. Data from Solley and others, 1998.

Surface Water Withdrawals						
Region	**Public Supply**	**Irrigation**	**Livestock**	**Industrial**	**Mining**	**Thermal Power**
	acre feet per year					
Rio Grande	147	5150	39	11	62	2
Upper Colorado	119	7840	60	7	26	164
Lower Colorado	782	4710	45	53	17	19
Great Basin	285	4500	96	102	83	24
California	3230	20400	507	605	87	226

Surface Water Uses				
Region	**Pop Served**	**Acres**	**Thermal Power**	**Hydropower**
	thousand persons	thousand acre feet	millions kilowatt hours	millions kilowatt hours
Rio Grande	735	968	7780	464
Upper Colorado	407	1470	94000	7220
Lower Colorado	2510	938	62400	9740
Great Basin	1050	1060	16300	633
California	17400	7060	76000	47000

Appendix I. Figures

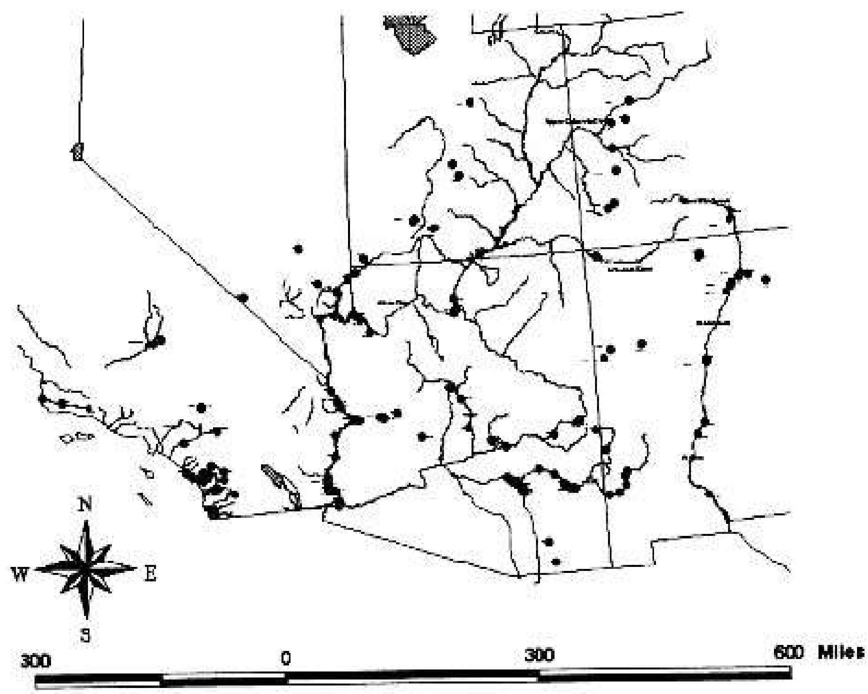


Figure 1. Map showing the present distribution of willow flycatcher nesting sites in the Southwestern United States.

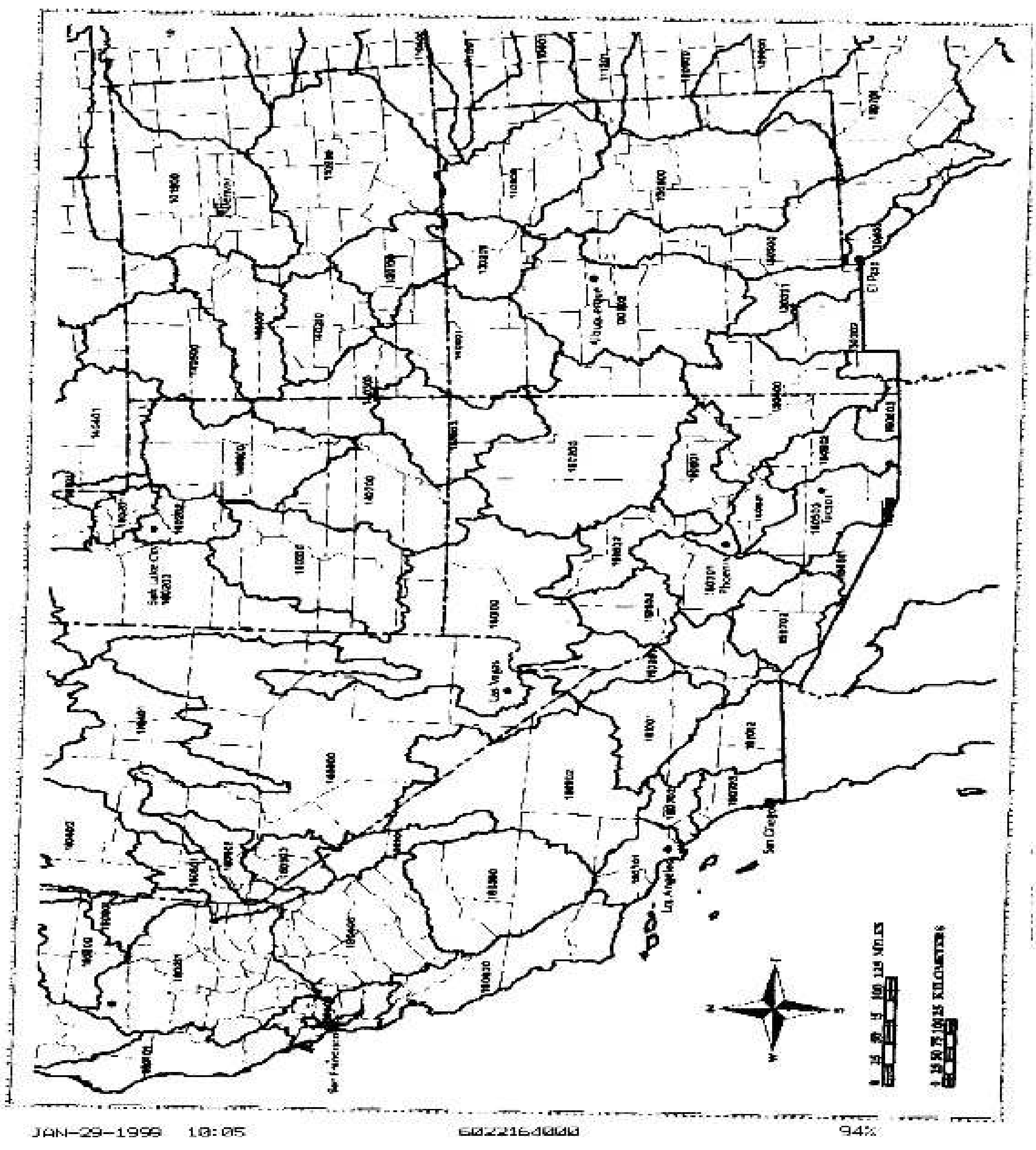


Figure 2. The watersheds and streams of the Southwest. Map created by William Cosgrove, U.S. Bureau of Reclamation, Phoenix.

Figure 3. Varying scales of watersheds and river basins illustrated by watersheds in Arizona. Upper: the watersheds of the state outlined at using the 6-digit codes of the planning areas defined by the U.S. Geological Survey and the Water Resources Council. Small triangles are major stream gage sites (from the web site http://az.water.usgs.gov/rtaz/html /rtsw.html). Lower: the Upper Verde Watershed, an 8-digit code watershed, the smallest of the defined areas. It is 6,374 km^2 (2,461 mi^2) in extent. (From the web site http://www.epa.gov/surf2).

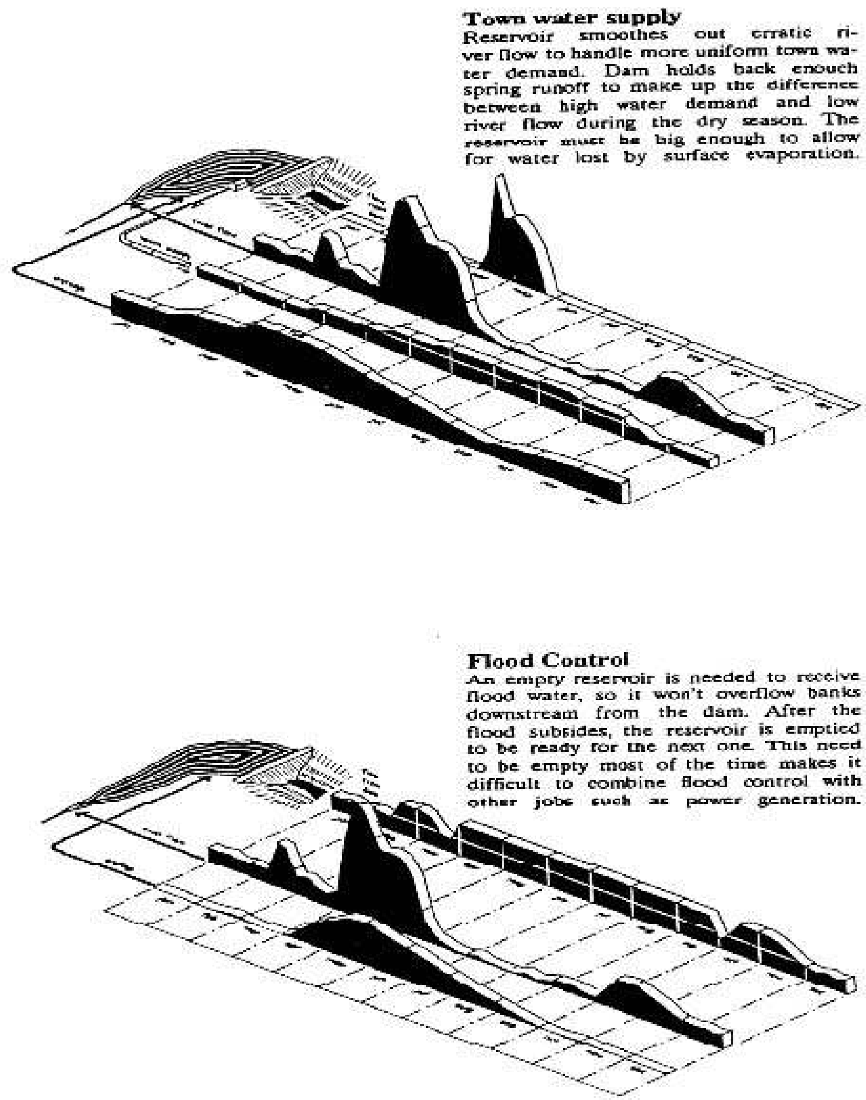
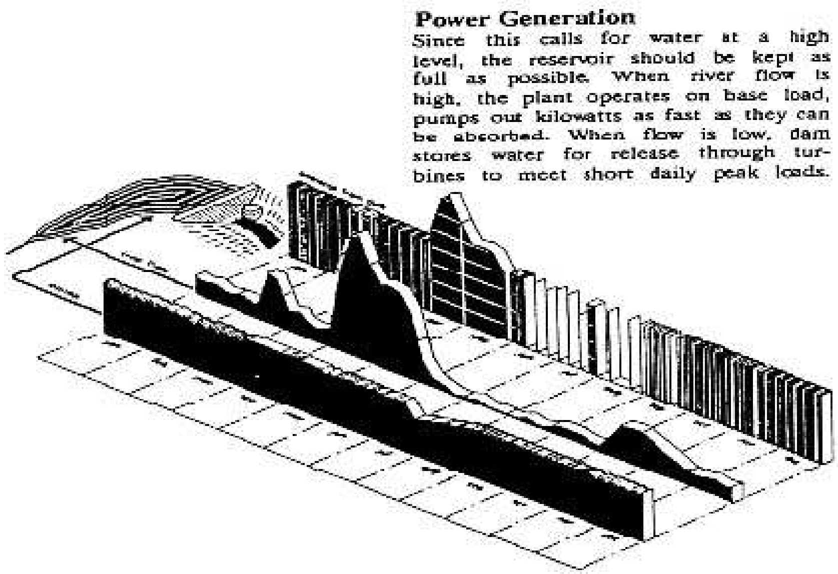


Figure 4. Effects of dams under varying operating rules in four hypothetical cases. (From Black, 1992).



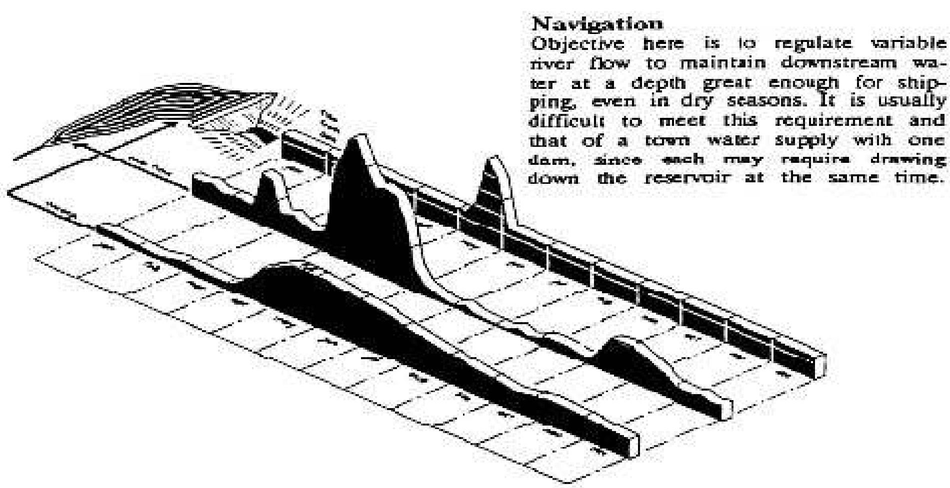


Figure 4 (continued). Effects of dams under varying operating rules in four hypothetical cases. (From Black, 1992).

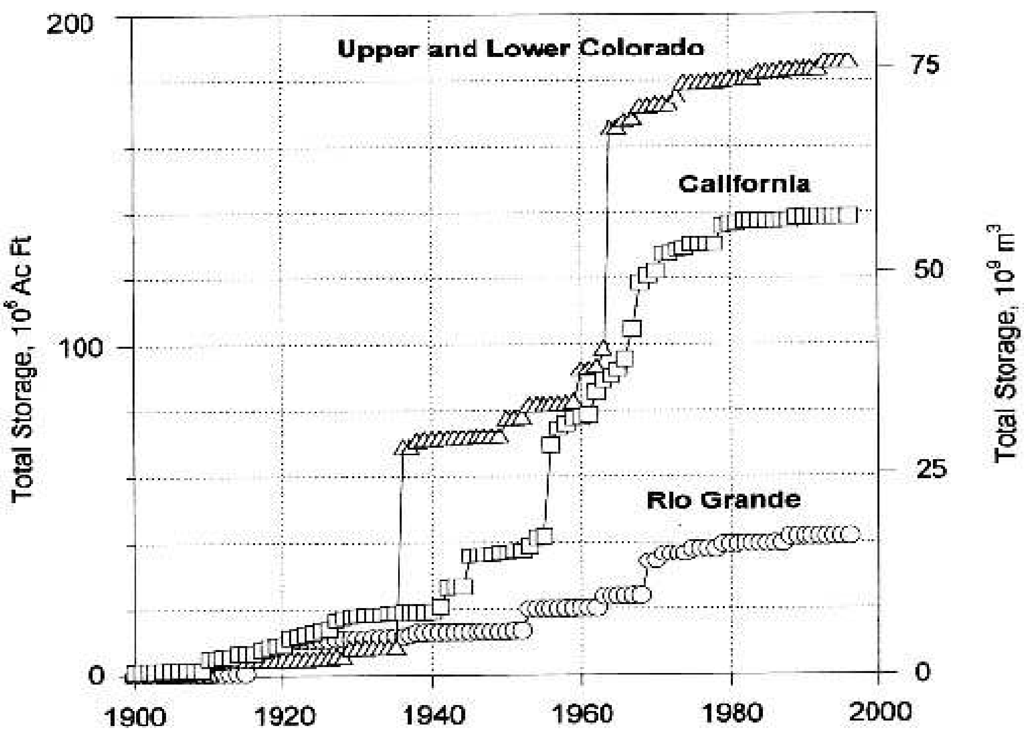


Figure 5. The history of increasing reservoir storage in Southwestern river basins. Data from U.S. Army Corps of Engineers, 1996; calculations from Graf, 1999.

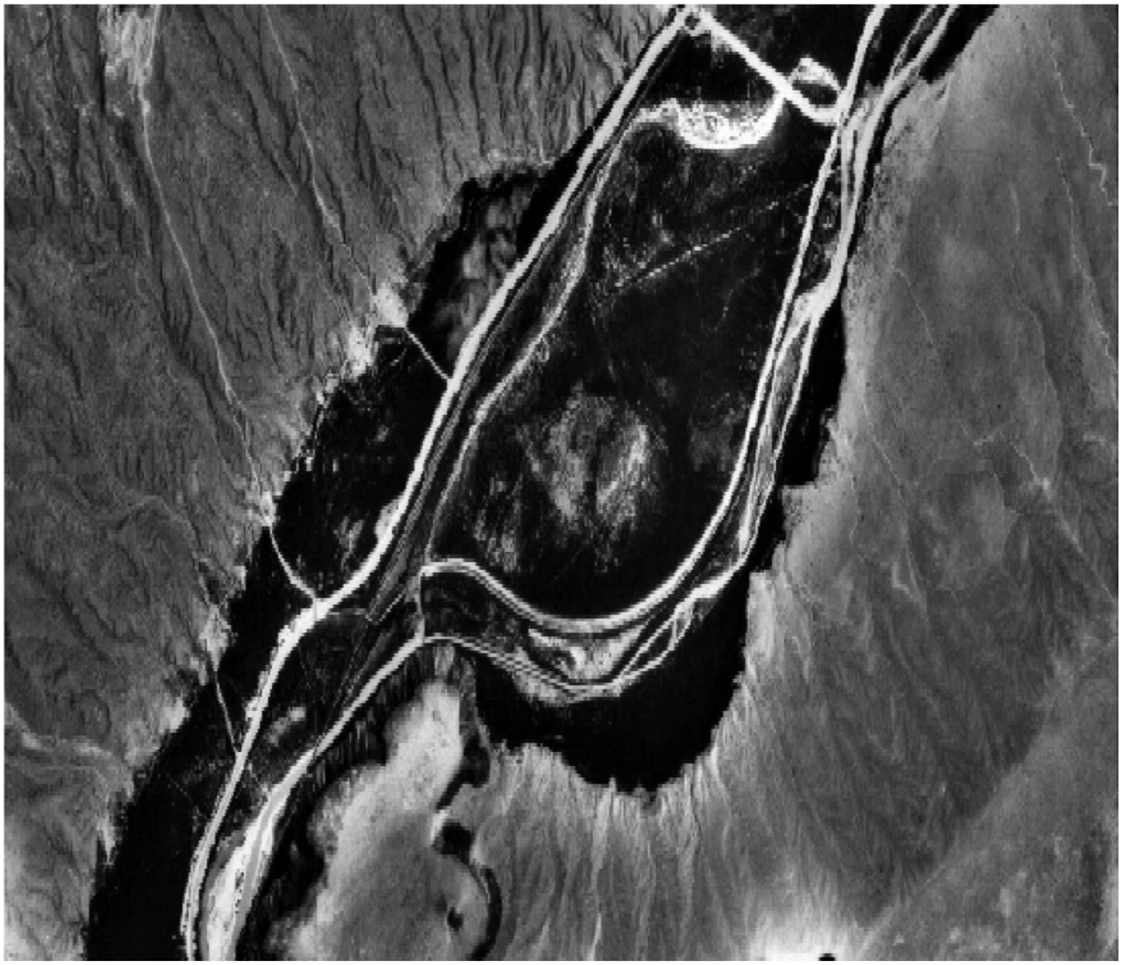


Figure 6. Aerial photograph of Rio Grande near San Marcial, New Mexico, in 1984 showing the density of riparian vegetation associated with a shrinking channel system and extensive diversions. The white lines are drains and canals with roads on their banks. U.S. Geological Survey mapping photograph from the EROS Data Center, Souix Falls, South Dakota.

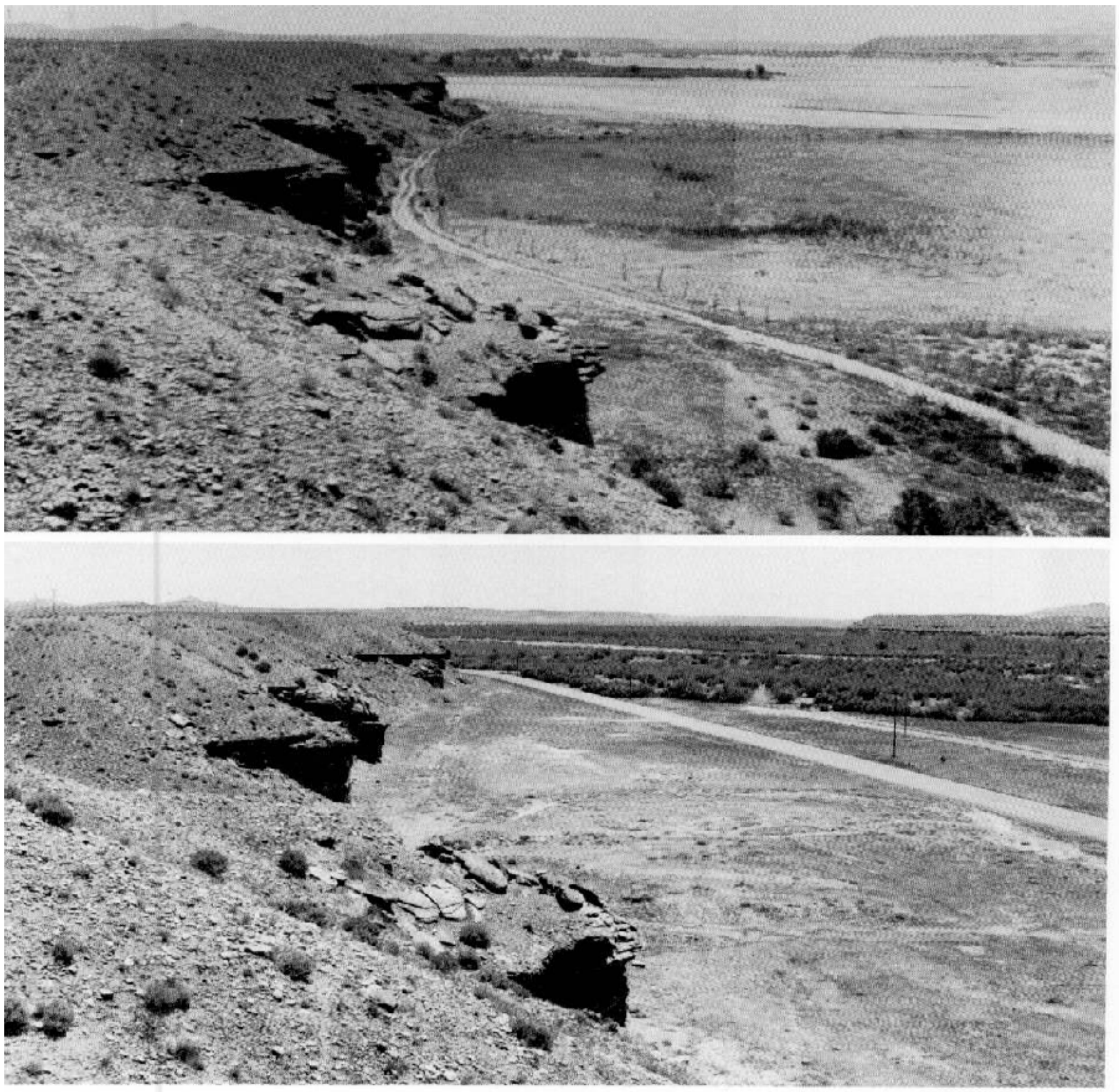


Figure 7. Repeat photographs of the San Juan River near Aneth, southeastern Utah, showing the change from a braided channel with little vegetation to a single thread channel with extensive phreatophyte cover. Navajo Dam substantially changed river flows in this reach after the completion of the structure in 1962. Above: 1928 photograph by H. E. Gregory. Below: 1982 photograph by W. L. Graf.

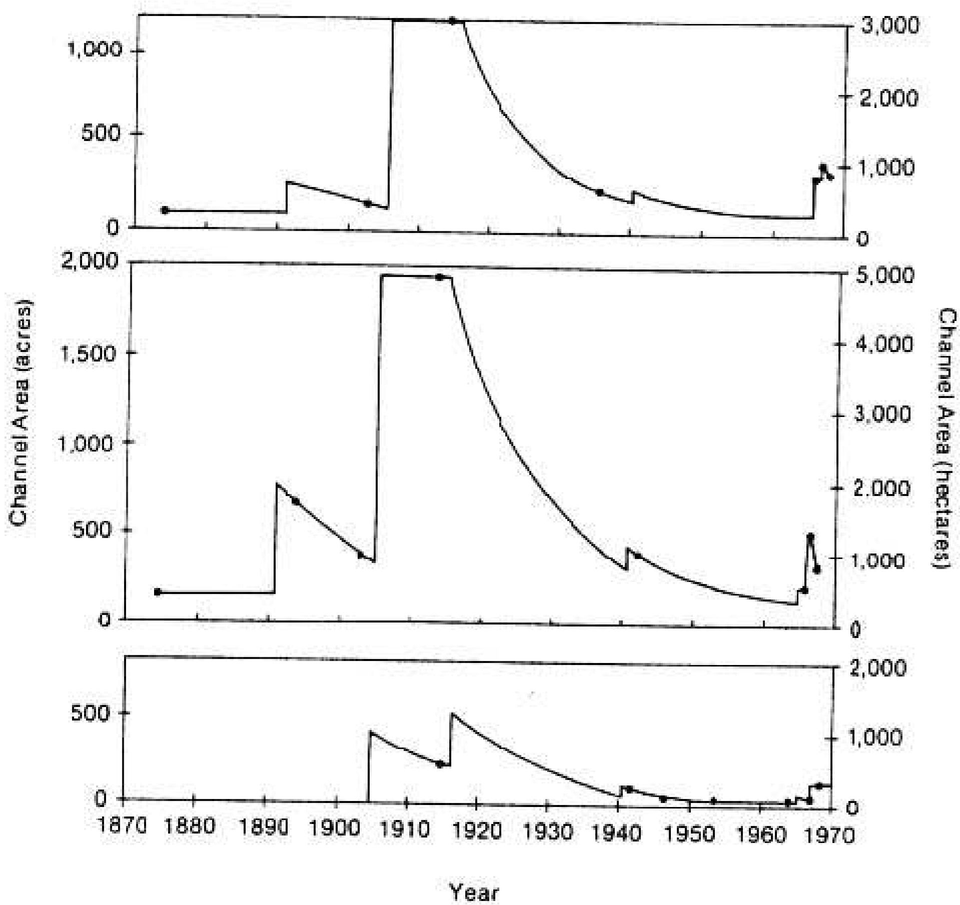


Figure 8. Channel and riparian vegetation area fluctuations on the Gila River in the Safford Valley, southeast Arizona. Each box represents a different river reach, with the total vertical extent of each box representing the total valley width. Within each box, the area below the plotted line is the channel, and the area above the plotted line is the riparian vegetation area. Rapid increases in channel width accompany the destruction of riparian vegetation in large flood events, followed by slow encroachment of vegetation on a gradually shrinking channel. There are no large dams upstream from these reaches. Data and design from Burkham, 1972.

Figure 9. Repeat photographs of the Gila River west of Phoenix at the Cotton Lane Crossing, showing the effects of groundwater pumping. The dense cover of tamarisk, fed by surface flows and groundwater, has given way to a nearly barren river bed with some temporary standing water but little else. Depth to groundwater is greater than 15 m in the later view. Above: 1949 photograph by the U.S. Army Corps of Engineers, with an arrow added by the photographer to show the direction of surface flow. Below: 1980 photograph by W. L. Graf.

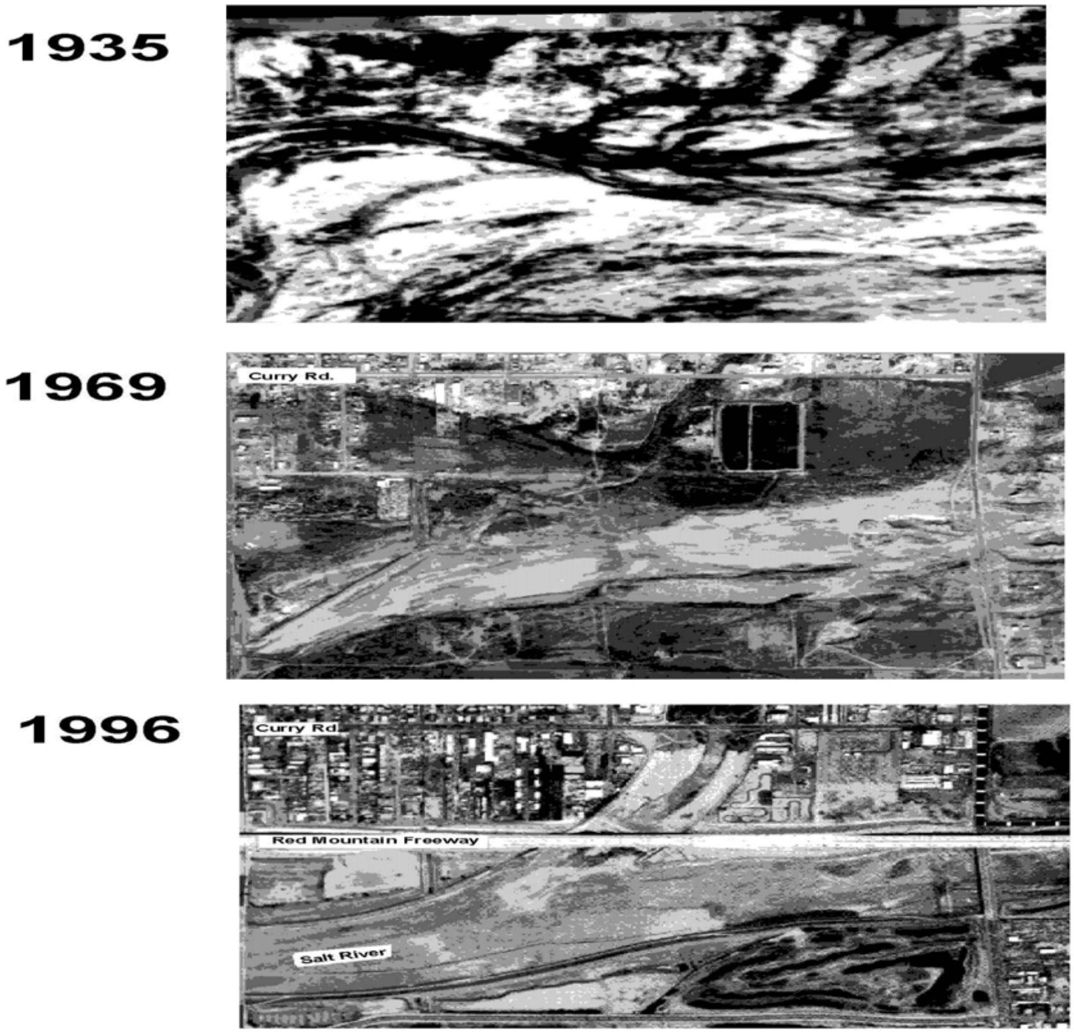


Figure 10. Series of aerial photographs showing the sequence of channel and riparian vegetation changes resulting from urbanization on the Salt River in Tempe, part of the Phoenix metropolitan area. All the photographs are registered to a common base using geographic information systems, and all show exactly the same one-mile reach of the river. 1935, prior to urbanization: Soil Conservation Service photograph showing a braided channel with a well-defined low flow channel, islands, bars, and ribbons of dark vegetation. 1969, urban fringe entering the area: Landis Aerial Survey, Inc., photograph showing the narrowed, simplified channel as a result of upstream dam closures, with building activities on the north bank and groundwater pumping that has lowered the water table. No riparian vegetation remains. 1996, urbanization complete: Landiscor, Inc., photograph showing a completely artificial channel, scheduled for some restoration, but none that is likely to reestablish the pre-development vegetation. Photographs from Nobel Science and Engineering Library, Map Collection, Arizona State University.

Appendix J.

Fluvial Hydrology of Regulated Rivers in the Range of the Southwestern Willow Flycatcher

A. Purpose

Dams, large and small, are important components of the economic infrastructure of the American Southwest. They were constructed with specific purposes and objectives designed to foster economic development through flood reduction, irrigation supply, urban supply, hydroelectric power generation, and provision of recreation. Dam management and administration during most of the twentieth century viewed rivers simply as sources of commodity water and electrical power, but changing social values have now expanded the roles of dams and the rivers they control. Rivers are now viewed by decision-makers and the public as complex landscapes and ecosystems that, in addition to providing commodities, are also the habitats of endangered wild species that our culture deems worth preserving. Part of this new mission for water managers is a rethinking of the role of dams, not as sources of problems for endangered species, but as opportunities for recovery. To use dams effectively in this effort, decision-makers require an understanding of the effects that dams and their operations have had on rivers and the hydrology, geomorphology, and riparian habitats.

Water is a key component of the natural, social, economic, and cultural fabric of the American Southwest (Table 1). The availability of water is highly variable through time and across space, but the construction and maintenance of an engineered water delivery system has permitted extensive economic development in the region. Early uses of water as a commodity focused on mining and agriculture, but subsequent uses broadened to include industrial, commercial, and livestock purposes. Cities in the region have always depended on diverted water from rivers (and later, groundwater), but explosive urban growth in the region in the latter half of the twentieth century has brought about new pressures on water resources. At the end of the twentieth century, however, agriculture still withdraws several times more water from Southwestern streams and groundwater sources than any other sector of the economy (Table 1). Dams, a portion of the critical infrastructure that supports the region's society and economy, store water, dispense it in economically useful patterns, and provide for flood suppression. More than 20 million people in the region depend directly on water from the system dams and delivery structures, and as many as 50 million enjoy at least indirect benefits such as electricity from the regional power grid and recreation opportunities afforded by the rivers and reservoirs.

When most of the dams in the region were built, water was viewed by the public and decision makers as a commodity, and rivers were simply conduits for the movement of that commodity from one place to another. By 1996, the major water resource regions that include the willow flycatcher range contain 4,659 dams of all sizes, and 173 dams with storage capacity of greater than 100,000 ac ft (Table 1). In recent decades, however, ecosystem perspectives, recognition of the loss of valued species, and a change in social values has brought new emphasis to the undesirable changes associated with dams. While the upstream implications of reservoir development have often been clear, the unintended downstream consequences of river regulation are only now becoming obvious and of general interest. General works reviewing the downstream impacts of dams include a general review by Petts (1984), and a more ecologically oriented review by Brown (1988). Williams and Wolman (1984) provided a comprehensive evaluation of hydrologic and geomorphic changes by dams on selected American rivers, including some in the southwestern willow flycatcher range. The following report is more specific, and shows that the regulation of Southwestern rivers has had a detrimental effect on southwestern willow flycatcher habitat by changing the water and sediment flows, river landforms, and their associated vegetation communities important for flycatcher use.

The purpose of this appendix is to report the hydrologic characteristics of regulated rivers in the range of the endangered southwestern willow flycatcher of the southwestern United States. This exploration focuses on the apparent effects of dams and their operations on several major rivers that support riparian habitat for the bird by comparing the hydrologic behavior of the rivers as affected by dams with their behavior before dams or on reaches unaffected by them. Because one of the primary threats to the viability of the species is the loss of riparian habitat by means of stream flow altered by dams, restoration of the habitat depends on a clear understanding of the natural flow characteristics that have been lost through impoundment and regulation.

While it would be informative to review all the dams with reservoirs larger than some minimum threshold capacity (perhaps 100,000 ac ft) within the range of the southwestern willow flycatcher, the following detailed analysis is limited to the main stem of the Gila River, Verde River, Middle Rio Grande, and Lower Colorado River. These rivers and their dams receive emphasis here for three reasons. First, large amounts of stream flow data are readily available for them, while records for other streams with dams are less useful because they are discontinuous, or the measurement sites do not provide for highly informative comparisons between regulated and unregulated portions of the rivers. Second, general conclusions and lessons about the effects of dams on river hydrology are likely to emerge from these data rich sources that are widely applicable to other rivers in the American Southwest. Finally, these four main rivers are the region's largest, and they host important flycatcher nesting sites. California coastal rivers with dams that provide occupied habitat for the southwestern willow flycatcher and that offer restoration and population recovery potential include the San Luis Rey and Santa Clara systems, as well as the Santa Ynez downstream from Bradbury Dam. These regulated rivers have sediment and terrain characteristics that are somewhat different from the interior streams, but their hydrologic responses to dams and the consequences of those responses are similar to those of the inland rivers. Figure 1 shows the approximate location of the dams mentioned in the text below.

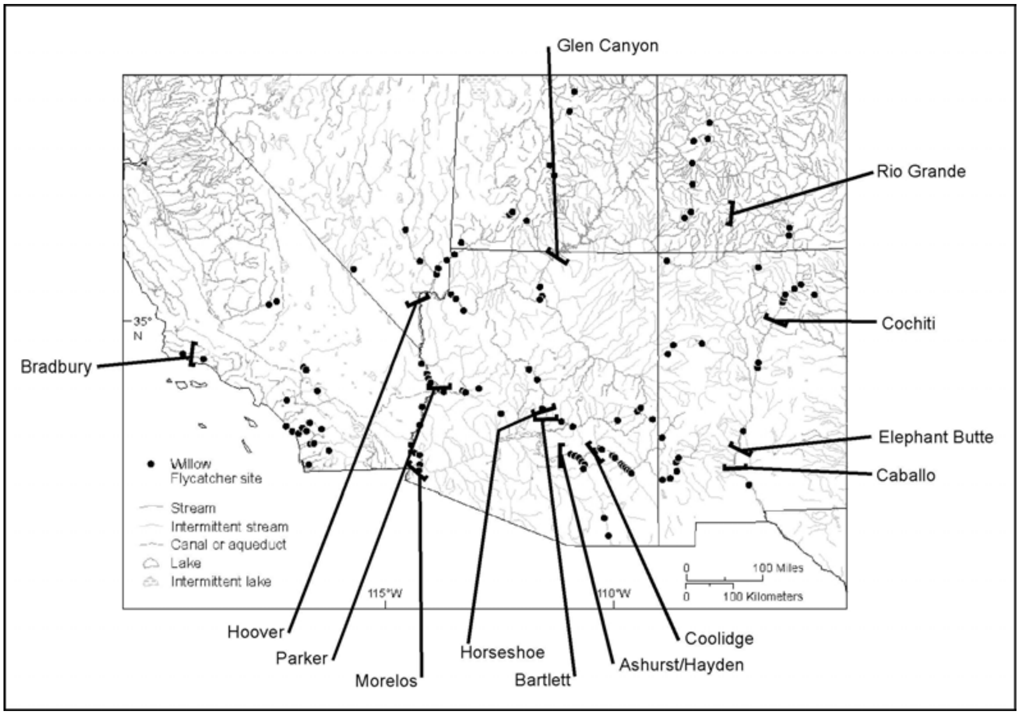


Figure 1. Approximate location of dams discussed in this appendix.

Extensive studies of the impacts of one dam on one river within the southwestern willow flycatcher range are available, and have resulted in changes in dam operations (National Research Council 1991). For over a decade, the Bureau of Reclamation, Glen Canyon Environmental Studies Program, analyzed the downstream effects of the operation of Glen Canyon Dam on the Colorado River (U.S. Bureau of Reclamation 1995). This effort, the most extensive ever undertaken for a regulated river, produced large amounts of data, information, and generalizations about the effects of the dam on the river (Carothers and Brown 1991), and resulted in a series of adjustments in the operation of the dam to partially reverse downstream changes brought about by the structure. Adjustments included the introduction of occasional moderate peak flows, maintenance of low flows that are larger than those released previously, and reduced ramping rates (that is, slowing the rate of change from one discharge level to another). Outside the range of the southwestern willow flycatcher, operators have adjusted the operations of many dams to mitigate downstream damages sustained through regulation (Collier et al. 1996).

The following paragraphs outline the parameters that describe important characteristics of river flows in the region, identify the sources of data, and report on the effects of dams on the Gila, Verde, Rio Grande, and Lower Colorado rivers. This appendix concludes by using these demonstrated effects of dams to make general recommendations for the recovery of the southwestern willow flycatcher population, generally by restoring a portion of the pre-dam flow characteristics of the rivers to support appropriate flycatcher habitat.

B. Flow Parameters

The construction and operation of dams have dramatically changed downstream flows, the channels they create and maintain, and the riparian vegetation that provides habitat for the southwestern willow flycatcher. Although a complete hydrologic analysis would include a myriad of flow parameters, the following investigation focuses on only a few measure that describe stream flow in simple terms:

- *Annual peak flow*: the largest daily flows found in each year of record for stream gages (the technical spelling for gauges); there is one annual peak flow for each year representing the largest flow for that particular year.
- *Mean annual peak flow*: the average annual peak flow for all the years of record; the average of the individual values for each year; there is one mean annual peak flow for each gage representing its entire record.
- *Annual mean flow*: the average of each of the mean daily flows for each year of record; the average of all the 365 (or 366 for leap years) single days of record for the year; there is one annual mean flow for each year.
- *Mean annual mean flow*: the average mean daily flow for all the years of record; the average of means for each year; there is one mean annual mean flow for each gage representing its entire record.
- *Annual low flow*: the lowest daily flow found in each year of the record; there is one annual low flow of each year, representing the lowest flow for that particular year; in the cases where the lowest flow is zero, the lowest flow may occur on more than one day.
- *Mean annual low flow*: the average annual low flow for all the years of record; the average of the individual values for each year; there is one mean annual low flow for each gage representing its entire record.

There are three reasons to emphasize investigation of the annual peak flows. First, the annual peak flows are the most important channel forming and maintaining flows because they shape channel and near-channel landforms, transport much of the sediment in the system, and directly influence biotic processes in the channel and on nearby flood plains. Second, data for annual peak flows are readily available in published records and are easily analyzed. Third, annual peak flows represent a parameter of the river discharge below dams that can be controlled through operating rules for the dams, and they are therefore subject to direct management.

There are three reasons to emphasize investigation of the annual mean flows. First, although the annual mean flow is not geomorphologically significant, it indicates the amount of water generally available for biotic systems in the river. Fluctuations from year to year give indications of drought or moist conditions. Second, the variability of the mean annual flows provides indications of the influence of dam operations which tend to dampen the variability. Third, the annual mean flow provides a method of standardizing the annual maximum flow when comparing one stream system with another of a different size. The annual maximum flow divided by the annual mean flow is a scale-free value that permits comparison among rivers.

There are two reasons for investigating annual low flows. The magnitude of these flows show the range of hydrologic conditions when they are compared to the mean and high flows, thus indicating the range of flow conditions to which the riparian vegetation must adjust. The mean annual low flows generally do not perform geomorphological work, but their magnitude also is significant for groundwater recharge and the maintenance of near-channel vegetation dependent on shallow groundwater. Streams with zero low flow conditions cease contributions to the groundwater system and contribute to falling water tables.

C. Sources of Data

The analysis of annual peak, mean, and low flows in the following paragraphs is simple and straight-forward. Although more sophisticated statistical analysis is possible, a fundamental and basic approach is best because the trends are most obvious. The major parameter not included in this analysis is the low flow information, which is more difficult to measure and analyze. The raw data for the annual peak flows are available from the U.S. Geological Survey in that agency's *Water-Supply Papers*, in its *Water Resource Investigation Reports*, or at its web site (http://water.usgs.gov). The analysis of data for stream gages in this investigation includes investigation of pairs, with one gage upstream and one downstream from a major dam on a single stream. Other analyses are of two sets of stream gages, with one set drawn from dammed rivers and the other drawn from free flowing streams.

Information on dams is from data bases collated by the U.S. Army Corps of Engineers and the Federal Emergency Management Agency. Individual state agencies created the original data and forwarded it to the federal agencies. The Corps and the Federal Emergency Management Agency made the data generally available in 1994, with an updated version in 1996, in the form of a CD-ROM disk. Although the data were temporarily available through the Corps' web site, this not presently the case. Data for this appendix are from the 1996 disk.

D. The Main Stem of the Gila River

Although a major concentration of southwestern willow flycatcher nesting sites occurs in the upper Gila River in New Mexico, the river is reasonably free flowing there except for local diversions. The middle Gila River in southeastern Arizona has many willow flycatcher nesting sites, but it is impacted by Coolidge Dam. The hydrology of the middle river provides a key to understanding and controlling the riparian habitat favored by the bird. From a hydrologic perspective, the main stem of the upper Gila River has two distinct parts: the segments upstream from Coolidge Dam and those downstream from the dam. The dam has a storage capacity that is very large with respect to the annual water yield of the river, because the reservoir can store 3.5 times the mean annual water yield of the stream. This figure implies that the dam has the potential to substantially alter downstream hydrology, as well as the downstream geomorphology and ecology dependent on the river flows. The basic descriptive information for Coolidge Dam are as follows:

Coolidge Dam

Dam closed: November 15, 1928

Reservoir: San Carlos Lake

Storage Capacity: 1,073,000 ac ft

Storage Capacity as a Function of the Mean Annual Water Yield: 3.5

Maximum Release Capacity: 120,000 cfs

Owner: U.S. Department of Interior, Bureau of Indian Affairs

The three gages for assessing the fluvial hydrologic effects of the dam are as follows:

Upstream from the dam: Gage 09448500, Gila River at head of Safford Valley, near Solomon, Arizona, period of record 1914-1991.

Downstream close to the dam: Gage 09469500, Gila Rive below Coolidge Dam, period of record 1921-1991.

Downstream distant from the dam: Gage 09474000, Gila River at Kelvin, Arizona, period of record 1913-1991.

Given these records, it is possible to explore the downstream effects of Coolidge Dam two ways. First, it is possible to compare the downstream impacted flows with those unaffected flows upstream from the dam for the period after the dam was completed. Second, it is possible to compare pre-dam and post-dam conditions at the same gage sites. The upstream gage is located above diversions of irrigation waters for Safford Valley. The downstream gage is directly affect by the operations of Coolidge Dam, and includes inflows from the San Pedro River. All three gages have records extending to 1999, but the data that are pre-processed and readily available for this analysis extend only to 1991. This limitation is unlikely to affect the conclusions of the following analysis.

1. Did Coolidge Dam reduce the magnitudes of the annual peak flows downstream?

Yes. In the pre-dam record, mean annual peak flows were larger at Kelvin downstream from the dam, but in the post-dam era they were larger at Safford, upstream from the dam (Table 2). The gage immediately downstream from Coolidge Dam dramatically indicates the magnitude of the effects of the dam. Before the dam was closed, the gage site near the dam location had peak flows that were 74% as large as those upstream near Safford. The remaining 26% (and minor tributary inflows) entered the groundwater system of Safford Valley between the two sites and was lost to direct surface flow. When Coolidge Dam was closed, the flows in the main stem were substantially reduced immediately downstream from the dam: mean annual peak flows were reduced to only 5% of the magnitude of the flood peaks upstream from the dam at Safford. Further downstream, the annual peaks at Kelvin consist of flows from the dam and from tributaries. Before the dam was closed, the peak flows at Kelvin were about one and a half times larger than the peak flows near Safford, because the inflows from the San Pedro River were added to flows in the main stem of the Gila. After the dam closure, peak flows at Kelvin were only 66%the magnitude of flows at Safford. In absolute terms, before the dam was closed, the mean annual peak flow at Safford was 21,900 cfs, and at Kelvin it was 33,500 cfs. After the dam closed, the average annual peak flow was 18,000 cfs at Safford, a modest decline probably related to climatic adjustments, but at Kelvin the mean plunged to 12,000 cfs because of storage in San Carlos Lake behind Coolidge Dam. The result of these substantial declines in annual peak flows has been considerable channel shrinkage and simplification downstream from the dam, with the greatest changes occurring between the dam and the confluence with the San Pedro River.

2. Did the closure of Coolidge Dam change the timing of the annual peak flows downstream?

Yes, the dam altered the timing of annual peak flows (Table 3). Exact date of the annual peak flows are readily available for the Gila River near Safford and at Kelvin. During the pre-dam era, 60% of the annual peak flows of the Gila River near Safford and at Kelvin occurred in the months of July, August, and September. After the closure of the dam, flows upstream occurred in July, August, and September in 49% of the years, a moderate decline in temporal concentration probably related to climatological changes over the watershed. These changes were not transmitted to the segments downstream, however, because the annual peak flows at Kelvin remained concentrated in July, August, and September, months that accounted for 64% of annual peak flows even after the closure of Coolidge Dam. Inflows from the San Pedro River probably account for the late-summer concentration in the river near Kelvin.

3. Did the closure of Coolidge Dam change the variability of the annual peak flows downstream?

Yes. Before the dam was closed, the standard deviations of the annual peak flows at all three gage sites were greater than the average peak flow, indicating great variability (Table 4). In the period after the closure of the dam, the standard variation remained similar for the annual peak flows at the unimpacted site near Safford, but at the gage just downstream from the dam, the standard deviation declined to only 3% of its former value. At Kelvin, further downstream, the introduction of flows from the San Pedro restored some of the variability, but the standard deviations were still only 42% of the pre-dam value. The importance of these changes to the geomorphology and riparian ecology is that the natural arrangements of the fluvial environment were dependent on highly variable annual peak flows. After the closure of the dam, that variability disappeared, resulting in high simplified channel configurations and much less spatial diversity in the riparian vegetation system.

4. Has Coolidge Dam changed the mean annual mean flows downstream?

No. The mean annual mean flow has declined at all three gage sites, partly as a result of upstream withdrawals and partly as a result of hydro-climatic changes (Table 2). The mean annual flow downstream from the dam is maintained by releases from the reservoir to supply downstream water users, so the structure does not have a significant impact on changing the annual mean flow.

5. Has the dam affected low flows downstream?

No. The annual low flows in the Gila River have approached zero throughout the record. At the gage near Safford, the change between pre-dam and post-dam conditions is statistically insignificant for the annual low flows, and downstream from the dam many years experienced no flow both before and after the dam.

6. What are the geomorphic and ecologic implications of the downstream impacts of Coolidge Dam?

The closure of Coolidge Dam signaled major changes in the geomorphology and riparian ecology of the Gila River downstream from the structure. The dam affected these changes largely be changing the magnitude and variability of the annual peak flows. The dam drastically reduced the size of the annual flood, which is the channel-forming discharge in the river. In continuously flowing streams the channel forming discharge is usually considered to be the bankfull discharge, which also often recurs approximately once per year over a decade or longer. Because the annual flood peaks were reduced by the dam, their channel forming power was also reduced, and the overall size of the channel declined downstream from the dam. The dam also substantially reduced the variability of the annual flood, so that the resulting channel was not only smaller than its predecessor, it was also much more simplified in its form and materials as shown in historical ground photographs. The highly variable floods that created and maintained a complex channel with islands, bars, subchannels, braids, and an active flood plain was replaced by a simple, single thread channel with almost no islands, bars, subchannels, or braids. The once active flood plain has converted (mainly through decreased flows with minor channel incision) to an inactive terrace, a change wherein the surface once had frequent interaction with the main channel by being overflowed and through sediment exchanges, but now it is isolated from the channel and no exchanges occur. Coolidge Dam stores all the fine sediment (sand and silt) than once moved downstream as part of the system. As a result, the only fine materials in the downstream river system are fine sands that make up the inactive terraces high above the active river.

The riparian vegetation developed on this geomorphic substrate is also simplified, because the constantly changing fluvial landscape has become geomorphologically frozen. Monotypical riparian forests, especially those dominated by tamarisk, became increasingly common in some reaches, while in other reaches the normal locations for cottonwood and willow became less common, so that forests of those types also became less common. The lack of fine materials restricts the available substrate for willow. The available natural habitat for southwestern willow flycatcher therefore has declined since the closure of the dam. As distance from the dam increases, tributary flows from the San Pedro River restore some natural characteristics to the river's flow, forms, and vegetation, but does not restore the biological component of the ecosystem in the sense that tamarisk dominates the native vegetation. Still further downstream, however, Ashurst-Hayden Dam diverts all the flow of the river except unusual floods, and from that point downstream the channel is little different from the surrounding desert

E. The Verde River

The Verde River hosts several nesting sites for the southwestern willow flycatcher, and offers potential for recovery of the bird. Major features of the river impacted by human activities are the dams and the hydrology they control. The Verde River has several distinct segments determined by human use of the stream. The upstream portion, above Clarkdale, experiences only minor diversions and no impacts from dams. A dam at Sullivan Lake, the starting point of the river, has completely filled with sediment, so that it functions as a run-of-the-river structure with few hydrologic effects. The middle portion of the river through the Verde Valley has significant diversions but no dams, while the lowest portion has flow controlled by Bartlett and Horseshoe Dams. The basic descriptive information for the dams are as follows (U.S. Army Corps of Engineers 1996):

Bartlett Dam

Dam closed: 1939

Reservoir: Bartlett Lake

Storage Capacity: 178,186 ac ft

Storage Capacity as a Function of the Mean Annual Water Yield: 0.44

Maximum Release Capacity: 175,000 cfs

Owner: U.S. Bureau of Reclamation and Salt River Project

Horseshoe Dam

Dam closed: 1945

Reservoir: Horseshoe Lake

Storage Capacity: 131,500 ac ft

Storage Capacity as a Function of the Mean Annual Water Yield: 0.33

Maximum Release Capacity: 250,000 cfs

Owner: U.S. Bureau of Reclamation and Salt River Project

In order to analyze the combined effects of Bartlett and Horseshoe dams, the investigation reported in the following paragraphs used the data from two gage sites.

Upstream from the dam: Gage 09508500, Verde River below Tangle Creek, above Horseshoe Dam, Arizona, period of record 1945-1991.

Downstream close to the dam: Gage 09510000, Verde River below Bartlett Dam, Arizona, period of record 1904-1991.

Given these records it is possible to explore the combined effects of Bartlett and Horseshoe dams by comparing the flow of the Verde River below Bartlett Dam after the dams were completed in 1945 with the flow near Tangle Creek upstream from the dams during the same post-dam period.

1. Did Bartlett and Horseshoe dams reduce the magnitudes of the downstream mean annual peak flows?

Yes. The mean annual peak flow downstream from Bartlett Dam declined by two thirds after the dams were built (Table 5). The annual peak flows below Bartlett Dam were also only about half the magnitude of the annual peak flows upstream from the dams near Tangle Creek. The resulting active channel downstream from the dams is smaller than it was previously. However, large releases from the spillway at Bartlett Dam in floods of 1978, 1980, and 1993 restored some of the high flow channel processes on a temporary basis. The largest flows in the post-dam period are similar to the largest ones in the pre-dam period, but these very large flows were much more common in the pre-dam era as opposed to the post-dam period. Because the *mean* annual peak is much lower in the later period, the original high-flow geometry is not now functionally maintained. It does not receive periodic infusions of water, sediment, and nutrients, so that it is now an unchanging, inactive part of the landscape.

2. Did the closure of Bartlett and Horseshoe dams affect the variability of the annual peak flows?

Yes, but not in the expected way (Table 6). Coolidge Dam reduced the variability of downstream annual peak flows because it has a large storage volume with respect to the mean annual flow and flood flows of the Gila River. Bartlett and Horseshoe dams, on the other hand, are smaller relative to the Verde River (their combined storage amounts to only 77% of the mean annual water yield of the watershed), and they have large spillways and outlet works. By reducing the mean annual peak flows through storage, but releasing large amounts of water in a few floods, Bartlett and Horseshoe increased the variability of peak flows downstream. The geomorphic and ecologic implications of this change are that the functional part of the channel is limited (as it is in the Gila River case), but there are geomorphic surfaces downstream from the dams that are like the previous natural high flow channels, but they are only remnants of unusual events and are not active.

3. Have Horseshoe and Bartlett dams affected mean annual mean flows downstream?

Probably not. The mean annual flows downstream from the dams were greater after the dams were completed, probably as a result of increased precipitation and runoff in the watershed during the post-1945 period. Because there are no records from the Verde River below Tangle Creek, this explanation cannot be directly tested. In any case, the dams did not reduce the mean annual mean flow, and their variation is similar in the pre- and post-dam period.

4. Have Horseshoe and Bartlett dams affected mean annual low flows downstream?

Yes. The mean annual low flows are lower after the dams were closed. Before the closure of the dams, the mean annual low flow values were all greater than about 50 cfs, but after the closing of Bartlett Dam in 1939, most years experienced low flows below 50 cfs, with many years recording some days with zero flow. The generalization that dams increase low flows in order to deliver water to downstream users does not apply to the dams on the Verde River. As a result, ecosystems downstream from the dams often experience no-flow conditions.

5. What are the geomorphic and ecologic implications of the closure of Horseshoe and Bartlett dams?

Because of the hydrologic changes introduced into the Verde River hydrology by Horseshoe and Bartlett dams, the channel downstream from the structures is smaller and less complex than the original pre-dam channel. Because flood discharges shape the channel, and because these flows have been significantly reduced by the dams, the downstream channel has a limited active component. Spills from the dams have scoured enlarged channel geometries, but these high-flow channels are not active. They were created and then immediately abandoned by the subsequent small discharges, whereas in the pre-dam conditions they would have been periodically reoccupied.

The ordinary low flows during the year must be somewhat higher than in pre-dam conditions because although the daily mean discharges are broadly the same in pre- and post-dam eras, the lack of large annual high flows means that the only way to achieve the observed means in the post-dam period is to have somewhat elevated low flows. These low flows do not influence the geomorphology of the channel, because they do not generate sufficient stream power to move the bed and bank materials. The ordinary low flows do provide ecological benefits in the form of increased groundwater recharge and more abundant surface water most of the time. The dams have created a new situation for the lowest flows each year (as opposed to ordinary low flow conditions). Before the dams, the Verde flowed continuously, but after the dams, many years experience one or more days of zero flow. The absence of water on the surface and the resulting dry channel clearly represents a radical departure from the ecological conditions that existed before the dams. If these non-flow conditions occur for several weeks during the months when the southwestern willow flycatcher is in the region, the lack of water in the channel would be a deterrent to use of the impacted river and its riparian habitat by the bird.

Horseshoe and Bartlett dams store fine sediments that prior to their construction would have continued to move downstream. With the dams in place, these fine sediments are now largely absent from the Verde River below the dams. The channel and its near-channel active landforms are dominated by cobbles and boulders which do not form suitable substrate for vegetation likely to be useful as willow flycatcher habitat. The remaining dense vegetation along the system is mostly confined by inactive terraces and consists mostly of mesquite bosques that are remnant populations. Cottonwood, willow, and tamarisk colonize only a few small and isolated locals.

F. The Middle Rio Grande

The middle Rio Grande is the location of several nesting sites of the southwestern willow flycatcher, and potentially offers more habitat for the recovery of the species than is presently available. A key to habitat management and restoration of the river is its hydrology and the effects of dams. The northern Rio Grande flows from its headwaters in the San Juan Mountains into the large basin of the San Luis Valley in southern and southwestern Colorado. After crossing the border with New Mexico, the stream flows generally southward through the Rio Grande Gorge, and then through a rift valley to the southern edge of the state near El Paso, Texas. Three dams along this main stem are of interest in considering impacts on southwestern willow flycatcher habitat. The Rio Grande Dam and Reservoir is located in the Rocky Mountains headwaters area, and does not impact flows in the lower elevation riparian areas used by the southwestern willow flycatcher. Cochiti Dam is a large flood control structure at Cochiti Pueblo, near Santa Fe, in the middle reaches of the stream, and is a potential consideration for flycatcher habitat. Elephant Butte Dam is near Truth or Consequences in southern New Mexico. The dam is one of the oldest large dams in the United States and serves as a flood control, water storage, and diversion structure that may also affect flycatcher habitat. Basic information about the dams follows:

Rio Grande Dam
Dam closed: 1916
Reservoir: Rio Grande Reservoir
Storage Capacity: 52,192 ac ft
Storage Capacity as a Function of the Mean Annual Water Yield: No Data
Maximum Release Capacity: 8,300 cfs
Owner: San Luis Valley Irrigation District

Cochiti Dam
Dam closed: 1975
Reservoir: Cochiti Lake
Storage Capacity: 722,000 ac ft
Storage Capacity as a Function of the Mean Annual Water Yield: 0.61
Maximum Release Capacity: 136,360 cfs
Owner: U.S. Army Corps of Engineers

Elephant Butte Dam
Dam closed: 1916
Reservoir: Elephant Butte Reservoir
Storage Capacity: 2,337,298 ac ft
Storage Capacity as a Function of the Mean Annual Water Yield: 2.03
Maximum Release Capacity: 47,500 cfs
Owner: Bureau of Reclamation

Stream gages with long records geographically bracket Cochiti and Elephant Butte dams, and are useful for assessing the dams' impacts on downstream hydrology, geomorphology, and ecology.

Upstream from Cochiti Dam: Gage 08313000, Rio Grande at Otowi Bridge, NM, 1895-1991
Downstream from Cochiti Dam and upstream from Elephant Butte Dam: Gage 08319000, Rio Grande at San Felipe, NM, 1927-1991

Downstream from Elephant Butte Dam: Gage 08361000, Rio Grande Below Elephant Butte Dam, 1916-1991

The lengths of these gaging records provides data for a before and after assessment of the hydrologic effects of Cochiti Dam, as well as upstream vs. downstream comparisons for both Cochiti and Elephant Butte dams.

1. Did Cochiti Dam affect the magnitude of the mean annual peak flows of the Rio Grande?

Yes, but not as much as might be expected. Annual peak flows were always less downstream from the site of the dam, because flows were dissipated across flood-plain surfaces downstream from the dam site (these flood plains are likely to have supported important willow flycatcher habitat). Annual peak flows declined downstream after the dam was closed, but they also declined upstream, so part of the change was produced by hydroclimatic controls and operations of dams in the Rio Chama, a major tributary upstream from Cochiti and the gage at the Otowi Bridge (Table 7). The mean annual peak declined about 20% upstream from the dam, and about 24% downstream, but the means are only part of the story. Cochiti Dam eliminated the extreme flows downstream, as evidenced by floods in 1979 and 1985. The dam reduced the downstream peak flows by one third to one half in these two events. As the record becomes longer (it is now only 24 years long for the dam) more instances of this type will likely affect the mean annual peak values more strongly.

When the annual peak flow is expressed as a function of the annual mean flow, the Rio Grande appears to have a hydrologic behavior that is different from the behavior of the Gila and Verde rivers described above. In those streams, the annual peak flows were 20 to 40 times greater than the annual mean flows, showing tremendous variability. In the middle Rio Grande, the annual peak flows are only 2 to 5 times greater than the annual mean, with or without Cochiti Dam. As a result, the downstream impacts of the dam are played out within a more narrow range of hydrologic conditions and a more restricted set of river landforms than was the case with the Gila and Verde rivers.

2. Did Cochiti Dam affect the variability of annual peak flows of the Rio Grande?

Yes, the dam reduced the variation, but that variation was already relatively small before the structure was closed (Table 8). The standard deviation of annual peak flows of the Rio Grande at San Felipe, downstream from Cochiti, declined by about a third after the closure of the dam. Some of that decline would have occurred in any case because of upstream controls on the Rio Chama and hydroclimatic changes. In the case of the Gila and Verde rivers, the standard deviation of annual peak flows was greater than the mean of those values in pre-dam periods and even in the post-dam periods. In other words, the peak flows may have been reduced in magnitude by the dams, but they retained some variability. In the middle Rio Grande, this variability is much less, with the standard deviation of annual peak flows generally less than the mean. In other words, the peaks flows are more consistent and produce a much less complex geomorphology and riparian ecology. The maintenance of levees, pilot channels, and other engineering efforts in the middle Rio Grande also promote this simplification of the geomorphology and riparian ecology.

3. Did Cochiti Dam alter the annual mean flows of the Rio Grande?

Partly. Although the dam is large with respect to the river, capable of storing 60% of the mean annual runoff upstream, its operation is predicated on passing normal flows of water through to downstream users in agricultural and urban areas (Tables 7 and 8). Upstream from the dam, moderate hydroclimatic changes caused mean flows to increase after the dam was closed, and the dam appears not to have a detrimental effect on this parameter downstream. On the other hand, the variation of mean flows declined about 20% downstream from Cochiti, indicating that the structure is modulating the variability of mean flows.

4. Did Cochiti Dam affect mean annual low flows in the Rio Grande?

Partially. The dam sustains low flow conditions that existed prior to its construction. The variation of low flows declined by about one third, meaning that low flows were less variable after the closure of the dam.

5. What are the likely downstream geomorphic and ecological effects of Cochiti Dam?

Reduced magnitudes for annual peak flows combined with decreased variation in annual peak, mean, and low flows all promote a geomorphic and riparian system downstream that is simplified from its original configuration. Engineering structures along the river downstream from Cochiti have designs that use this simplification to constrain the river and eliminate its processes from large areas of what were once active riparian zones along the course of the river. The river functions more like a canal than a natural river.

Cochiti Dam stores sediment in its reservoir, so that the reaches of the river immediately downstream from the structure are starved for material. Erosion of some river reaches has resulted along the stream for a distance of up to 150 miles, where infusions of sediment from the Rio Puerco and Rio Salado restore large amounts of sediment to the system. Some sediment augmentation is in order below the dam for restoration purposes, appropriately limited, however, to avoid excessive sedimentation in reaches of the channel where elevation of the bed poses tributary flooding problems in the Albuquerque area.

6. What have been the downstream effects of Elephant Butte Dam?

Elephant Butte Dam completes the conversion of the Rio Grande from a river to a canal. Mean annual peak flows downstream from the dam are less than one third their values in the middle river upstream, and the annual variability of the peak flows is tiny compared with other river reaches (Tables 7 and 8). Water diversions, and to a lesser degree evaporation and seepage losses, depreciate the flow, so that annual mean flows in the channel are also low. These mean flows are predicated on downstream water delivery requirements, and because the dam and reservoir are so large (able to store more than twice the mean annual inflow from upstream) the downstream system is highly consistent with respect to annual mean flows. Annual low flows show more variability, but in recent years they have been exceptionally low, with many years experiencing some days of zero flow.

7. What are the geomorphic and ecological effects of Elephant Butte Dam?

The Rio Grande downstream from Elephant Butte Dam is not a river in the normal sense of the word. It does not physically function in response to hydroclimatological forcing mechanisms, and is a simple conduit for water viewed as a commodity. The channel is highly simplified and relatively unvariable. Though the channel and near-channel landforms can support riparian habitats suitable for southwestern willow flycatchers, such arrangements are highly limited and artificial.

G. The Lower Colorado River

The lower Colorado River contains several southwestern willow flycatcher nesting sites, and prior to about 1950 numerous willow flycatcher specimens were observed and collected there. Because of the potential extent of riparian forest in the lower Colorado River, the hydrologic behavior of the river as influenced by upstream dams is critical for understanding environmental change and planning restoration of the river. Numerous large dams throughout the upstream basin exert some control on the flow of the Colorado River between Arizona and California, but the major controls on that segment of the river are three dams immediately upstream: Hoover, Davis, and Parker dams. These dams strongly influence the hydrology of the river, and thus also influence the geomorphology and riparian ecology of the stream, both of which are directly linked to habitat useful for the southwestern willow flycatcher. Basic information about the dams follows:

Hoover Dam
Dam closed: 1936
Reservoir: Lake Mead
Storage Capacity: 30,237,000 ac ft
Storage Capacity as a Function of the Mean Annual Water Yield: 2.24
Maximum Release Capacity: 200,000 cfs
Owner: U.S. Bureau of Reclamation

Davis Dam

Dam closed: 1953

Reservoir: Lake Mohave

Storage Capacity: 1,818,300 ac ft

Storage Capacity as a Function of the Mean Annual Water Yield: 0.13

Maximum Release Capacity: 216,000 cfs

Owner: U.S. Bureau of Reclamation

Parker Dam

Dam closed: 1938

Reservoir: Lake Havasu

Storage Capacity: 619,400 ac ft

Storage Capacity as a Function of the Mean Annual Water Yield: 0.05

Maximum Release Capacity: 314,000 cfs

Owner: U.S. Bureau of Reclamation

The most useful stream gage for assessing the hydrology of the river from Parker Dam to the United States/Mexican border is at Yuma: Gage: 09521000, Colorado River at Yuma, AZ, 1905-1984. The gage provides a data-based view of the hydrology of the river during three distinct periods: first, before any of the large dams was in place (1905-1936); second, when Hoover and Parker dams were the only influence on the lower river (1937-1953); and third, when all three structures were in place along with their associated withdrawal systems. Unfortunately the gage record ends too soon to assess the most recent history of the river after 1984.

1. Have the dams changed the mean annual peak flows on the Lower Colorado River?

Yes, dramatically. One of the primary reasons (in addition to water supply and hydropower) that the dams are in place is to provide flood control, and they excel at this mission (Table 9). Before the dams were in place, the Lower Colorado River had a large channel to accommodate annual peak flows that averaged almost 93,000 cfs. With Hoover and Parker dams in place, these annual peak flows declined to about 18,000 cfs, and with all three dams in place after 1953 the annual peak flows averaged only 5,500 cfs, a mere 6% of their former, pre-dam magnitude. The dams reduced the variability of these annual peaks in absolute terms as well (Table 10), so that the standard deviation of the annual peak flows declined from their natural value of 51,500 cfs to only 3,500 cfs. However, in terms of the prevailing means, the variability was roughly the same throughout the record, with the standard deviation always less than the mean.

2. Have the dams changed the mean annual mean flows on the Lower Colorado River?

Yes, the dams have substantially reduced annual mean flows for the Lower Colorado River (Table 9). Before the dams were in place, the mean annual mean flow in the Lower Colorado River was more than 21,000 cfs, but by the time all three dams were in place and water withdrawals from their reservoirs into canals became a feature of the system, the mean annual mean flow had dropped to only 2,100 cfs. This annual mean flow is now less that the annual lowest flows that existed prior to the construction of the dams. The variability of the mean annual mean flows also declined to a similar degree, so that the relative variability when assessed as a function of the mean remained little changed (Table 10). In other words, the entire hydrologic system has shrunken in response to dams and diversions.

3. Have the dams changed the mean annual low flow conditions on the Lower Colorado River?

Yes, to a degree similar to the other changes outlined above (Tables 9 and 10). Before the dams were in place, the mean annual low flow was 2,900 cfs, but now the mean annual low flows are a paltry 500 cfs, or a reduction to only 17% of the pre-dam values. Absolute variability has declined in a similar fashion, with standard deviations expressed as a function of the mean remaining less than one throughout the record.

4. What are the geomorphic and riparian ecological implications of the hydrologic effects of the dams?

The Lower Colorado River is a miniature ghost of its former self, with its entire hydrologic, geomorphic, and ecologic system shrunken to a fraction of its former size. Channelization and levees have aided the effects of major water withdrawals and successful flood control efforts centered on the major dams of the river. The channel has changed completely from a braided, multi-threaded system to one characterized by a narrow single thread. Where once there was a complex series of landforms and environments at each cross section of the stream, there now remains a highly simplified system that is more similar to a canal than a river. The flood plain outside the channel that once was active is now largely inactive. The diverse riparian habitat system, favorable for a variety of species including the southwestern willow flycatcher, has become a highly simplified system with limited diversity.

The timing of these impacts of dams is instructive. Biologists observed that the decline in many riparian bird species became significant in the 1950s. By that time, the effects of Hoover Dam had been seen in the fluvial system of the Lower Colorado River for a decade and a half. But they were then compounded by the closure of Davis Dam in 1953. From 1954 onward, the full impact of flow changes with associated geomorphic and ecologic changes became apparent. The accelerated decline of bird populations that had depended on the previously existing hydrologic, geomorphic, and vegetative system, simply reflected these dramatic changes in river processes and forms.

H. Recommendations

The foregoing review of the effects of dams on regulated rivers in the range of the endangered southwestern willow flycatcher leads to a set of logical recommendations for the recovery of the bird population. The purpose of these recommendations is to set out what is needed for the reestablishment of a functional hydrologic and geomorphic system, which serves as a physical substrate for an ecosystem likely to support suitable habitat for the bird in the Southwestern United States.

1. Dam Operating Rules and Rivers as Ecosystems and Commodities

Issue: Dam operating rules and decision-making are focused on obvious, direct economic goals, and treat rivers simply as commodity water and power resources, leaving little administrative space for endangered species. As a result, operating rules address commodity management rather than broader objectives.

Recommendation: Treat the rivers as landscapes and ecosystems, and as public trust resources rather than merely as commodity resources. Laws, regulations, and agreements governing the distribution of water are exceptionally difficult to change, but in the past these arrangements have evolved to meet new needs. The continued evolution of the arrangements benefits everyone and avoids a potential judicial clash between the laws of the river and the ESA. Generally, include these broadened objectives in revisions of the laws of the river as well as interstate water compacts and administrative rule decisions. Include recovery of endangered species as one of the multiple objectives in all dam operating rules so they are recognized as part of the multiple objective decision process, and to insure that tradeoffs and costs can be clearly understood. Apply this recommendation generally in the recovery plan, and specifically to all major dams in the range of the southwestern willow flycatcher.

2. Hydrodiversity, Geodiversity, and Biodiversity

Issue: Downstream geomorphic systems have become highly simplified because of dam operations, with the resulting loss of ecologic complexity needed for flycatcher habitat.

Recommendation: Allow occasionally complex flow regimes with a wide range of discharge levels within the shrunken channel system as well as flood or spike flows, all to reintroduce the complexity of hydrodiversity and geodiversity, which will lead to biodiversity. In many years, this new regime would not necessarily result in increased water releases, but rather releases on a schedule different from the present one. High or spike flows should be released in winter months to most benefit the native vegetation and should be avoided in summer months when they most benefit exotic vegetation. Examples where this recommendation should be explored in detail include Cochiti, Elephant Butte, Coolidge, Bartlett/Horseshoe, Stewart Mountain, and Hoover/Parker dams, as well as Bradbury Dam on the Santa Ynez River of California and other smaller California coastal streams.

3. Water for Recovery

Issue: Many solutions for improving habitat for the southwestern willow flycatcher require increased availability of water in active channels or in near-channel areas. This issue is important throughout the range of the southwestern willow flycatcher.

Recommendation: Water purchases, other acquisition procedures, and other water management strategies are likely to be required in a comprehensive recovery of the species. Because agricultural withdrawals from rivers and groundwater are much larger than by any other economic sector, the agricultural community must be part of any long-term solution. Engage agricultural interests in all major watersheds in the range of the southwestern willow flycatcher to consult with agencies and other parties to take proactive measures to provide more water in rivers throughout the range of the southwestern willow flycatcher. Examples where this recommendation should be explored in detail include the Lower Colorado River near Yuma, lower San Pedro River, middle Gila River, and the Middle Rio Grande.

4. Instream Flows, Reactivated Channels, and Habitats

Issue: Flycatchers, Rio Grande silvery minnow, and many other endangered species require a continuous flow of water in the rivers they use, yet dams and diversions dessicate some channel reaches and completely eliminate flow.

Recommendation: Provide low level instream flows (enough merely to establish a wetted perimeter and a visible surface flow) during low flow periods downstream from dams and diversions as a general policy in the recovery plan applicable throughout the range of the southwestern willow flycatcher. Measure these flows at stream gages to assure the water is positively affecting the intended flycatcher habitat and at the appropriate times such as winter to sustain native vegetation and during the late spring to late summer breeding season of the bird. Procure water rights for delivery at desired times to hydrate flycatcher habitat.

Examples where this recommendation should be explored in detail include the Colorado River near Yuma, the Rio Grande downstream from San Acacia Dam, and the Gila River downstream from Ashurst/Hayden Dam.

5. Shrinkage of River Channels and Habitat

Issue: Reservoir storage and diversions have caused river channels and their associated landscapes to become drastically more narrow through shrinkage because of water withdrawals. Levees with narrow spaces between them have stabilized the restricted widths. As a result, the original natural riparian forest and potential southwestern willow flycatcher habitat has also shrunk, becoming discontinuous along the alignment of channels.

Recommendation: Increase the width of the active channel zone and improve the along-channel connectivity of rivers by insuring continuous instream flows and allowing occasional minor floods with peak flows large enough to expand channel systems from their present shrunken dimensions. Make flows large enough to accomplish this expansion and increase the space between the levees (by moving them further apart, leaving a larger channel area) throughout the range of the southwestern willow flycatcher. Examples where this recommendation should be explored in detail include the Rio Grande, Lower Colorado River, coastal California streams, and streams in the Central Valley of California.

6. Reactivated Flood Plains and Habitats

Issue: Flood plains, oxbows on single-thread channels, and secondary channels on braided streams have become inactive because of flood suppression by dams, entrenchment, and isolation by levees, and elimination of beaver, all of which have reduced the vitality of native riparian forests or completely eliminated them.

Recommendation: Permit overbank flows in selected locations to expand wetlands and riparian forests by larger releases from dams when excess water is available, or manage conveyance to include peak flows. Install gates temporarily (permanently where possible) in selected levees to reactivate flood plains and abandoned channels behind the structures. Pump, syphon, or divert water to flood plains abandoned by channel entrenchment. For these rivers (e.g., Colorado River), the flood plain refers to the flood plain of the existing river rather than the pre-dam historic flood plain. Reintroduce beaver on small and intermediate systems.

7. Sediment Augmentation and Habitat Restoration

Issue: Dams trap sediments and release erosive clear-water discharges, stripping downstream areas of sediment (mostly sand, silt, and clay in interior streams, mostly sand and coarse sediments in California streams) and eliminating the native vegetation and habitats that were developed on the deposits, including habitat areas for the southwestern willow flycatcher.

Recommendation: Augment the sediment supply of river reaches downstream from Coolidge, Bartlett, Stewart Mountain, Parker and smaller dams on Coastal California streams to replace the fine sediments artificially removed in upstream reservoirs, with due care to insure that sediments containing hazardous levels of heavy metals, pesticides, and herbicides are not re-mobilized, and that downstream fish habitats are not adversely affected. Augmentation may use sediments from the upstream reservoirs delivered through a slurry system, or from other sources using mechanical methods. A thorough assessment of anticipated consequences should precede such an effort to insure that there will be sufficient water discharges to move the sediment to desired locations on bars and flood plains.

8. Multi-Species Planning

Issue: Planning for recovery of the southwestern willow flycatcher is directly related to planning for other endangered riparian bird species and native fishes, because they all are dependent on the same hydrologic, geomorphic, and vegetation systems. Decisions that affect one species will inevitably affect all of them, yet recovery planning and implementation efforts are not formally connected.

Recommendation: Formally connect planning and decision making for the recovery of the southwestern willow flycatcher with the recovery of the Rio Grande silvery minnow on the Rio Grande, and with the native fishes in the Lower Colorado River. Determine likely interaction effects of implementing a plan for one species on the other endangered species.

I. Conclusions

Dams were structured to regulate flows to simplified regimes in order to deliver water to downstream users, generate hydroelectricity, enhance navigation, and provide recreation. The unintended and unforeseen effects of creating this artificial hydrology have included simplified fluvial geomorphology and riparian systems which reduce potential southwestern willow flycatcher habitat and restrict restoration. To increase habitat and provide restoration of riparian habitat and the physical systems on which it depends requires partially reversing some of the changes in hydrology produced by dams. Dams and their operations provide opportunities to resolve some of the habitat issues in recovering the southwestern willow flycatcher population. Existing theory and practice for the management of dams and the hydrology they produce, both downstream and upstream in their reservoirs, provide enough understanding to use the structures in recovery efforts.

The hydrology of the Gila, Verde, Rio Grande, and Lower Colorado rivers has been dramatically altered by dams, but all dams are not created equal (Table 11). Their effects vary from one river to another, depending on the original purpose of the structures, their architecture, their operating rules, and the original natural characteristics of the stream channels downstream. Despite these differences, however, dams generally cause the restriction of southwestern willow flycatcher habitat by reducing the extent and complexity of riparian ecosystems through two mechanisms: channel shrinkage and reduced hydro- and geocomplexity. Reduced peak flows and reduced variability of flows of all magnitudes and frequency leads to this channel shrinkage and simplification of the riparian system. These changes in scale and complexity have caused environmental changes unfavorable to the maintenance of willow flycatcher habitat. Restoration of such habitat depends in part on reversing the hydrologic changes brought about by dams to reintroduce larger and more variable flows downstream from dams. Dams and their operation represent opportunities to manage the hydrology, geomorphology, and vegetation that are indispensable components of the flycatcher's habitat. Dams have been major actors in the changes of southwestern rivers and their riparian habitats, and they represent tools for reversing the changes to more favorable conditions for the recovery of the willow flycatcher population.

J. Literature Cited

Please see Recovery Plan Section VI.

Table 1. General water and dam data for major water resource regions of the American Southwest.

Water Resource Region	Rio Grande	U. Colorado	L. Colorado	Great Basin	California
Dams and Storage Capacity, Runoff					
Total Number of Dams	716	1,164	446	803	1,530
Number of Dams Storing more than 100,000 ac ft.	18	25	23	13	94
Total Storage (ac ft)	21,013,562	46,364,999	48,373,154	5,979,380	74,161,688
Total Annual Runoff (ac ft) [1]	5,487,880	15,063,670	18,982,714	6,596,655	72,910,402
Storage/Runoff	3.83	3.08	2.55	0.91	1.02
Human Population [2]	2,566,000	714,000	5,318,000	2,405,000	32,060,000
Surface Fresh Water Withdrawals (ac ft per yr)					
Public Supply	146,720	118,720	781,760	284,480	3,225,600
Domestic	0	448	224	1,792	13,440
Commercial	2,240	784	8,400	16,800	357,280
Irrigation	5,152,000	7,828,800	4,704,000	4,502,400	20,384,000
Livestock	9,520	56,000	7,616	86,240	248,640
Industrial	112	4,480	6,160	34,720	21,280
Mining	2,240	4,480	29,120	2,240	69,440
Thermoelectric	2,240	163,520	243,040	23,520	226,240
Total	5,308,800	8,187,200	5,566,400	4,950,400	24,528,000
Ground Fresh Water Withdrawals (ac ft per yr)					
Public Supply	398,720	39,200	533,120	392,000	3,057,600
Domestic	28,000	12,320	49,280	14,560	125,440
Commercial	19040	6270	24,640	11,200	86,240
Irrigation	1,590,400	42,560	2,475,200	1,220,800	12,208,000
Livestock	30,240	4,480	36,960	10,304	258,720
Industrial	11,200	2,240	47,040	67,200	584,640
Mining	59,360	22,400	141,120	79,520	17,920
Thermoelectric	17,920	15,680	50,400	2,912	4,032
Total	2,161,600	129,920	3,360,000	1,803,200	16,352,000

[1] Total annual runoff is the USGS estimate from Solley et al. (1998) for the amount of water yielded from the watershed. The upper basin is that which passes Lee's Ferry, while the lower basin is that plus additions from the lower basin.

[2] For the Lower Colorado River, population data do not include those living outside the watershed but who use water from trans-basin diversions. In southern California, about 17 million depend in some degree on water from the Colorado River, and other diversions from the basin affect residents in New Mexico (and by connection Mexico and Texas) as well as Colorado. Note: Public Supply data for the Lower Colorado River do not account for 2.6-2.7 maf/yr diverted to southern California.

Sources: Dams and runoff data from Graf (1999), human population data from U.S. Census information 1990, surface and ground water data from Solley *et al.* 1998.

Notes: Figures may not add to totals because of independent rounding. Original published water use data were in millions of gallons per day, converted to ac ft per year by dividing by 3.259×10^5 to convert gallons to ac ft, and multiplying the result by 365 to convert from days to year.

Table 2. Mean annual peak, mean, and low flows for the Gila River upstream (near Safford), immediately downstream (below Coolidge Dam), and more distant downstream (at Kelvin) of Coolidge Dam. The notation "/m" indicates values expressed as divided by the mean annual mean flow.

Flow	Near Safford		Below Coolidge Dam		At Kelvin	
	cfs	(/m)	cfs	(/m)	cfs	(/m)
Mean Annual Peak Flow						
Pre-Dam	21,834	29.78	16,236	32.47	33,512	89.13
Post-Dam	18,015	42.79	902	2.81	12,076	28.08
Mean Annual Mean Flow						
Pre-Dam	733	1.00	500	1.00	376	1.00
Post-Dam	421	1.00	321	1.00	430	1.00
Mean Annual Low Flow						
Pre-Dam	53	0.07	4	0.01	9	0.02
Post-Dam	47	0.11	3	0.01	33	0.08

Table 3. Monthly frequency of annual peak flows, Gila River gages upstream and downstream from Coolidge Dam, before and after closure of the structure.

Safford				**Kelvin**		
Month Frequencies				**Month Frequencies**		
Pre-Dam				**Pre-Dam**		
Month	**Frequency**	**%**		**Month**	**Frequency**	**%**
1	1	7%		1	1	7%
2	0	0%		2	1	7%
3	0	0%		3	0	0%
4	1	7%		4	0	0%
5	0	0%		5	0	0%
6	0	0%		6	0	0%
7	1	7%		7	3	20%
8	6	40%		8	3	20%
9	2	13%		9	3	20%
10	1	7%		10	1	7%
11	0	0%		11	0	0%
12	3	20%		12	3	20%
Total =	15	100%		Total =	15	100%
Safford				**Kelvin**		
Month Frequencies				**Month Frequencies**		
Post-Dam				**Post-Dam**		
Month	**Frequency**	**%**		**Month**	**Frequency**	**%**
1	5	7%		1	4	6%
2	7	10%		2	4	6%
3	6	9%		3	4	6%
4	0	0%		4	0	0%
5	0	0%		5	0	0%
6	1	1%		6	0	0%
7	7	10%		7	9	13%
8	14	21%		8	28	41%
9	12	18%		9	7	10%
10	10	15%		10	5	7%
11	1	1%		11	0	0%
12	5	7%		12	7	10%
Total =	68	100%		Total =	68	100%

Table 4. Standard deviations (S.D.) for the annual peak, mean, and low flows for the Gila River upstream (near Safford), immediately downstream (below Coolidge Dam), and more distant downstream (at Kelvin) of Coolidge Dam. C.V. is the coefficient of variation, or the standard deviation divided by the mean, a way of standardizing comparisons across different magnitudes of discharge.

Flow	Near Safford		Below Coolidge Dam		At Kelvin	
	S.D., cfs	C.V.	S.D., cfs	C.V.	S.D., cfs	C.V.
Standard Deviation of Annual Peak Flow						
Pre-Dam	27,299	1.25	25,441	1.57	34,404	1.03
Post-Dam	23,194	1.28	787	0.87	14,468	1.20
Standard Deviation of Annual Mean Flow						
Pre-Dam	122	0.17	137	0.27	177	0.47
Post-Dam	281	0.67	204	0.64	254	0.59
Standard Deviation of Annual Low Flow						
Pre-Dam	2	0.04	1	0.25	3	0.33
Post-Dam	3	0.06	5	1.67	3	0.09

Table 5. Mean annual peak, mean, and low flows for the Verde River upstream from Bartlett and Horseshoe dams at Tangle Creek, and downstream from the structures, below Bartlett Dam. No data are available for the gage below Tangle Creek for the pre-dam period. The notation "/m flow" indicates values expressed as divided by the mean annual mean flow.

Flow	Below Tangle Creek		Below Bartlett Dam	
	cfs	(/m)	cfs	(/m)
Mean Annual Peak Flow				
Pre-Dam	--	--	22,231	26.9
Post-Dam	15,065	27.1	8,173	8.3
Mean Annual Mean Flow				
Pre-Dam	--	--	826	1.0
Post-Dam	555	1.0	991	1.0
Mean Annual Low Flow				
Pre-Dam	--	--	79	0.10
Post-Dam	94	0.17	14	0.01

Table 6. Standard deviations (S.D.) for the Verde River annual peak, mean, and low flows upstream from Bartlett and Horseshoe dams at Tangle Creek, and downstream from the structures, below Bartlett Dam. No data are available for the gage below Tangle Creek for the pre-dam period. C.V. is the coefficient of variation, or the standard deviation divided by the mean, a way of standardizing comparisons across different magnitudes of discharge.

Flow	Below Tangle Creek		Below Bartlett Dam	
	S.D., cfs	C.V.	S.D., cfs	C.V.
Standard Deviation of Annual Peak Flow				
Pre-Dam	--	--	18,734	0.83
Post-Dam	16,963	1.12	15,395	1.88
Standard Deviation of Annual Mean Flow				
Pre-Dam	--	--	465	0.56
Post-Dam	376	0.68	383	0.69
Standard Deviation of Annual Low Flow				
Pre-Dam	--	--	39	0.49
Post-Dam	23	0.25	20	1.43

Table 7. Mean annual peak, mean, and low flows for the Rio Grande upstream from Cochiti Dam (at Otowi Bridge), downstream from Cochiti Dam (at San Felipe), and downstream from Elephant Butte Dam. The notation "/m" indicates values expressed as divided by the mean annual mean flow.

Flow	At Otowi Bridge		At San Felipe		Below Elephant Butte	
	cfs	(/m)	cfs	(/m)	cfs	(/m)
Mean Annual Peak Flow						
Pre-Cochiti	7,633	5.16	6,342	4.80	2,324	2.40
Post-Cochiti	6,156	3.74	4,839	3.04	2,596	2.59
Mean Annual Mean Flow						
Pre-Cochiti	1,478	1.0	1,322	1.0	969	1.0
Post-Cochiti	1,646	1.0	1,591	1.0	1001	1.0
Mean Annual Low Flow						
Pre-Cochiti	261	0.18	208	0.16	75	0.08
Post-Cochiti	363	0.22	211	0.13	11	0.01

Table 8. Standard deviations (S.D.) for the mean annual peak, mean, and low flows for the Rio Grande upstream from Cochiti Dam (at Otowi Bridge), downstream from Cochiti Dam (at San Felipe), and downstream from Elephant Butte Dam. C.V. is the coefficient of variation, or the standard deviation divided by the mean.

Flow	At Otowi Bridge		At San Felipe		Below Elephant Butte	
	S.D., cfs	C.V.	S.D., cfs	C.V.	S.D., cfs	C.V.
Standard Deviation of the Annual Peak Flow						
Pre-Cochiti	5,099	3.45	4,358	0.69	902	0.39
Post-Cochiti	3,376	0.55	2,104	0.43	833	0.32
Standard Deviation of the Annual Mean Flow						
Pre-Cochiti	715	0.48	685	0.52	379	0.39
Post-Cochiti	696	0.42	663	0.41	407	0.41
Standard Deviation of the Annual Low Flow						
Pre-Cochiti	130	0.50	155	0.75	203	2.71
Post-Cochiti	155	0.43	99	0.47	27	2.45

Table 9. Mean annual peak, mean, and low flows for the Colorado River at Yuma, downstream from Hoover, Davis, and Parker dams. The notation "/m flow" indicates values expressed as divided by the mean annual mean flow.

Flow	At Yuma	
	cfs	(/m)
Mean Annual Peak Flow		
Pre-Dam	92,913	4.41
With Hoover and Parker	17,899	2.00
With all dams	5,479	2.55
Mean Annual Mean Flow		
Pre-Dam	21,067	1.00
With Hoover and Parker	8,949	1.00
With all dams	2,145	1.00
Mean Annual Low Flow		
Pre-Dam	2,901	0.14
With Hoover and Parker	2,568	0.29
With all dams	514	0.24

Table 10. Standard deviations (S.D.) for the Colorado River at Yuma, downstream from Hoover, Davis, and Parker dams. C.V. is the coefficient of variation, or the standard deviation divided by the mean, a way of standardizing comparisons across different magnitudes of discharge.

Flow	At Yuma	
	S.D., cfs	**C.V.**
Standard Deviation of the Annual Peak Flow		
Pre-Dam	51,471	0.55
With Hoover and Parker	7,004	0.39
With all dams	3,499	0.64
Standard Deviation of the Annual Mean Flow		
Pre-Dam	7,844	0.37
With Hoover and Parker	4,299	0.48
With all dams	1,338	0.62
Standard Deviation of the Annual Low Flow		
Pre-Dam	1,755	0.61
With Hoover and Parker	2,228	0.87
With all dams	253	0.49

Table 11. Summary of the most significant downstream effects of dams on river regulation for selected river segments in the southwestern willow flycatcher range.

River	Segment	Effects of Regulation
Gila River	Below Coolidge Dam	Loss of annual peak flows, loss of complex flows, sediment starvation (fine materials)
	Below Ashurst/Hayden Dam	No instream flows
Rio Grande	Below Cochiti Dam	Decreased flow variability at all discharges, loss of annual peak flows
	Below San Acacia Dam	No instream flows
	Below Elephant Butte Dam	Loss of peak flows and variability at all flows
	Below Caballo Dam	No instream flows
Lower Colorado River	Below Parker Dam	Reduced flows at Yuma
	Below Mexican Diversions	No instream flows
Verde River	Below Horseshoe and Bartlett Dams	Loss of annual peak flows, frequent loss of low flows, loss of flow variability at all levels, sediment starvation (fine materials)
California Coastal Rivers	Santa Ynez below Bradbury Dam	Loss of annual peak flows, frequent loss of low flows, sediment starvation (sand and coarse materials)

Appendix K.
Habitat Restoration

A. Introduction

Extensive loss and degradation of riparian habitat throughout the U.S. Southwest is considered to be the primary factor responsible for the decline of the southwestern willow flycatcher (*Empidonax traillii extimus*), as well as of other species dependent upon this habitat during part or all of their annual cycles (Unitt 1987, USFWS 1995). Consequently, recovery of the flycatcher will require increasing the availability of suitable habitat through the combined approaches of habitat protection and restoration. In this paper, we present an approach to habitat restoration, supported by examples, that we believe will provide the greatest long-term success in reversing the decades-long loss of riparian woodlands and thereby augment habitat for obligate riparian species such as the flycatcher. We use the term "restoration" in a broad sense to include enhancement of degraded habitat, and re-establishment of riparian vegetation to sites where it occurred historically but is currently absent as a result of reversible alterations of the conditions necessary for supporting it (Jackson et al. 1995). We also include the concept of "creation" of habitat in our restoration category, recognizing that ingrained changes in the infrastructure of flowing water in the U.S. Southwest may necessitate spatial shifts in habitat from historical sites to new areas that have greater potential for restoration success. There are different degrees of restoration that are achievable at any given site, ranging from full restoration to partial restoration, sometime referred to as rehabilitation or naturalization (Cairns 1995).

We begin by describing some of the causes of symptoms of habitat degradation, referring to other Appendices in this Recovery Plan that treat these topics more fully. We then describe methods for restoration, including restoration of physical elements and processes, restoration of animal populations and processes, and restoration of essential plants, fungi, and biotic interactions. We also address some of the factors to consider when selecting sites, to optimize restoration success. Finally, we address the topic of restoration as mitigation, and offer some recommendations regarding design, implementation, and evaluation of projects within this context.

1. Goal of Restoration: What Do We Want to Restore?

Our scope in this discussion includes river systems throughout the seven-state historic range of the southwestern willow flycatcher, recognizing that not all riparian habitat within this range was or can again become suitable for flycatchers. An implicit goal is to restore habitat to a level that is deemed *suitable* for flycatchers as evidenced by (1) the presence of breeding flycatchers (although even some of this habitat may benefit from enhancement) and (2) the presence of habitat attributes that characterize suitability for flycatchers. These attributes include dense shrubby and forested vegetation interspersed with small openings near surface water or saturated soil (see Appendix D for a complete description).

Although we offer guidelines for habitat restoration within the context of willow flycatcher recovery, our scope in this issue paper is a general one and not specific only to the flycatcher. Habitat loss has produced declines in many riparian species; thus, we strive for an approach that will restore entire plant and animal communities and the physical processes upon which they depend. To the degree possible, we seek to restore ecosystem integrity, defined as the "...state of ecosystem development that is optimized for its geographic location, including energy input, available water, nutrients and colonization history... It implies that ecosystem structures and functions are unimpaired by human-caused stresses and that native species are present at viable population levels" (Woodley 1993). We recognize that this developmental state is neither feasible nor desirable in all areas, given the large size of the human population. Thus, we also suggest compromises that allow rivers and riparian ecosystems to meet human needs and the needs of other riparian-dependent biota. This ecosystem-based approach is consistent with the goals of the Endangered Species Act, which include conserving the ecosystems upon which the endangered species' depend.

The approach we advocate is guided by the recognition that functional plant communities are necessary to support the large and diverse animal communities typical of native riparian habitat. With this perspective, restoring structure to the plant community means restoring a wide array of plant species and functional groups, restoring viable age structures for the dominant species, restoring vertical complexity, and restoring a mosaic of vegetation patches in the flood plain. Restoring function includes restoring bioproductivity, and restoring the ability of the plant communities to capture and store nutrients, build soils, stabilize stream banks, and create habitat for animals. Essential to ecosystem integrity is that the plant community be self-sustaining and resistant or resilient to various types of natural disturbances. Once structure, function, and self-sustainability have been restored to the plant community, the potential exists for establishment of viable animal populations through the provision of food, cover, shade, breeding sites, foraging sites, and other resources essential to survival and reproduction.

2. Causes and Symptoms of Habitat Degradation.

Before we attempt to restore an ecosystem, we need to understand the factors that have caused the degradation (Briggs 1996, Hobbs and Norton 1996, Goodwin et al. 1997). This step in the identification of root causes hinges upon an understanding of the ecological impacts of a lengthy list of human activities relating to water and land use, and species introductions and extirpations. Symptoms of degradation vary depending on the type and extent of anthropogenic stressors. Fluvial geomorphic changes such as reduced channel movement and channel incision can result from dams and diversions; channel widening can be symptomatic of overgrazing by livestock and/or stream dewatering and loss of streambank vegetation. Hydrologic indicators of degradation, including lowered ground water levels or stream flow regimes that deviate from climatic patterns, can be direct results of water management and/or indirect consequences of land use actions in the watershed that influence the water cycle (Richter et al. 1996). Plant communities may lose their capacity for self-repair or revegetation after flood disturbance, if subject to stressors such as dewatering or overgrazing. Replacement of species-rich communities by homogenous thickets of single species, be they native or exotic, can be symptomatic of dam-related reductions in fluvial disturbances and/or imposition of stressors such as grazing that select for a small number of tolerant species. Many factors, including landscape-level habitat fragmentation, can produce symptoms in the animal community such as declining diversity of bird species, or population declines of riparian specialist species such as southwestern willow flycatchers or yellow-billed cuckoos (*Coccyzus americanus*). A loss of biotic interactions, such as a loss of pollinators, a breakdown of plant-disperser interactions, or a loss of symbiotic relationships such as plant-fungi mycorrhizal relationships, are other indicators of degradation. Suites of symptoms, such as soil compaction, stream channel downcutting, lack of tree regeneration, and spread of unpalatable plant species together can be symptomatic of a particular stressor such as overgrazing (Prichard et al. 1998). Collectively, these and other symptoms provide a list of inter-related ecosystem components that form the basis for examination of root causes of degradation, and identification of appropriate strategies for restoration.

B. How Do We Restore Degraded Ecosystems?

1. Restoration of Physical Elements and Processes

Hydrologic regimes and fluvial geomorphic processes are prime determinants of riparian community structure (see Appendices I and J). To restore a diversity of plant species, growth forms, and age classes, we need to restore the diversity of fluvial processes, such as movement of channels, deposition of alluvial sediments, and erosion of aggraded flood plains, that allow a diverse assemblage of plants to co-exist. To restore bioproductivity and maintain plant species with shallow roots and high water needs, we have to ensure the presence of the necessary hydrogeomorphic elements; notably water flows, sediments and nutrients. We need to restore flows of water, sediment, and nutrients not only in sufficient quantities but with appropriate temporal patterns (Poff et al. 1997).

Hydrogeomorphic conditions have been altered and fluvial processes disrupted over much of the U.S. Southwest. There are over 400 dams that are managed for municipal or agricultural water supply, flood control, hydropower, or recreation (Graf 1999). Surface water is diverted from dammed and undammed rivers alike. Ground water is pumped from flood plain aquifers and regional aquifers. Dikes and berms constrain channels, reducing or eliminating river-flood plain connectivity. Throughout watersheds, livestock grazing, fire suppression, and urbanization reduce rates of water infiltration into soils and increase surface runoff. This, in turn, results in larger flood peaks, higher sedimentation rates, and reduced base flows.

Flood flows and river dynamism.

Full restoration of riparian ecosystems hinges on removing impediments to the natural flow regime (Schmidt et al. 1998). This type of approach, wherein one restores natural conditions and processes by removing stressors, and then allows the biotic communities to recover of their own accord, falls within the realm of passive restoration (Middleton 1999).

Dam removal is a passive restoration approach that allows for full ecosystem restoration. Dams are being removed throughout the U.S. for the purpose of restoring habitat, most often for endangered fish species. Working within drainage basins or at larger spatial scales, some groups have contrasted the relative costs and benefits of a suite of dams with respect to economics and ecology (Shuman 1995, Born et al. 1998). In some cases, removal of a dam can provide substantial ecological benefit, while causing minimal reduction in the production of 'goods': along the Elwha River in Washington State, removal of two dams is expected to cause a small loss of hydropower but a gain in fisheries productivity (Wunderlich et al. 1994). In Arizona, a recent decision was made to decommission the hydropower dam on Fossil Creek and restore full flows to the stream, because the benefits from restoring aquatic and riparian habitat outweigh the small loss of hydropower. Elsewhere in the arid Southwest, storage of water in ground water recharge basins may be a feasible alternative to reservoir storage, obviating the need for some dams.

Dam removal and decommissioning should be explored systematically throughout the range of the southwestern willow flycatcher. During this process, attention should be paid to effects of dam removal on the upstream as well as downstream riparian ecosystem, and an assessment should be made on a landscape or regional level of the overall net change in suitable habitat expected from dam removal. Many reservoir edges, because of the availability of water, fine sediments, and nutrients, support large patches of riparian habitat suitable for flycatchers and other wildlife. Much of this habitat is at risk or has been destroyed due to reservoir management for water supply or flood control, but additional losses could occur with dam removal. In other cases, flood-suppressing dams may stabilize habitat to some degree, perhaps locally buffering bird populations from the strong temporal fluctuations that may have characterized the pre-dam system. Assessments would be needed to determine whether habitat gains would compensate for habitat losses, were the dam to be removed.

If dams are to remain in place, there are ways to meet dual management goals of improving ecological integrity and maintaining the production of goods. Creative ways can be found to rehabilitate, if not fully restore below-dam ecosystems, while still allowing for municipal or agricultural water supply, hydropower, or flood control. Sediment and nutrients can be restored to some below-dam reaches by adding sediment bypass structures to dams (Schmidt et al. 1998). Riparian ecosystems on regulated rivers can be rehabilitated by naturalizing flows so as to mimic the natural hydrograph, or flow pattern, of the river. In arid parts of Australia and South Africa, there is growing recognition of the need to incorporate environmental flow requirements into river management plans (Arthington 1992). In Alberta, Canada, input from scientists and Environmental Advisory Committees has led to changes in the operation of dams (Rood et al. 1995, Rood et al. 1998, Mahoney and Rood 1998). The St. Mary and Oldman rivers, for example, are managed for delivery of summer irrigation water, and still flood fairly regularly during wet years. Rates of river meandering and channel realignment are relatively intact, and so too are the processes that create the "nursery bars" needed for germination of cottonwood (*Populus* spp.) seeds. Changes have been made, however, such that flood waters now recede slowly enough to allow for high survival of the seedlings; ecological models call for the stream stage to drop less than four cm per day, allowing the roots of cottonwood seedlings to keep in contact with moist soil. Another part of the agreement calls for an increase in summer base flow levels, thereby reducing the risk of tree death from drought. Operating agreements that address ecological concerns and restore 'environmental flows' should be incorporated into the management of dams that effect the habitat of the willow flycatcher throughout its range.

Large flows are released from many dams during occasional wet years, and the water often flows downstream in a fashion that does not optimize its environmental benefits. Sometimes, these releases fortuitously meet the regeneration needs of riparian plants. In 1992-93, for example, El Nino weather patterns assisted in the restoration of populations of cottonwood and willow (*Salix* spp.) trees along the lower Gila and Colorado, by filling reservoirs to levels that required large releases during winter and spring (Briggs and Cornelius 1998). With operating agreements in place, dam managers could be prepared in periodic wet years to intentionally release flows in ways that mimic the natural hydrograph and favor the establishment of native species adapted to the natural flow pattern. To keep the trees alive, 'maintenance' water sources would have to be secured. Certainly, the flood releases would not be essential every year. On unregulated rivers, cottonwood and willow recruitment flows occur only about once a decade or so (Mahoney and Rood 1998).

Along some dammed rivers, there are constraints on the degree to which the natural flood regime can be restored. The Bill Williams River in western Arizona is regulated by Alamo Dam, which was built to minimize flood pulses into the Colorado River. Over the past 25 years, the size and frequency of winter and summer flood peaks in the Bill Williams River have decreased, while base flows have increased. The U. S. Fish and Wildlife Service, Army Corps of Engineers, and university scientists have worked together to develop a flow-release plan that calls for high base flows and restoration of periodic flood (flushing) flows. The goals are to improve the quality of the riparian habitat in the below-dam wildlife refuge, while also maintaining recreational and wildlife benefits in Alamo Lake and flood control. However, there are constraints on the maximum flow release from the dam, that need to be addressed to allow for increased riparian restoration. Without the large scouring floods, rates of establishment of pioneering cottonwoods and willows are predicted to decline in the future, despite the release of appropriately timed spring flows (Shafroth 1999). Without the large floods to remove dead stems and woody debris, the dense post-dam vegetation (much of which is the exotic shrub tamarisk: *Tamarix ramosissima*) will remain susceptible to fire damage (see Appendix L).

There are other 'active' restoration measures that can mimic hydrogeomorphic processes and conditions at sites where these natural processes cannot be fully restored (Friedman et al. 1995). Flood pulses can be released through water control structures to small, cleared areas of the flood plain (Taylor and McDaniel 1998). Wet habitats can be created by excavating side channels or back-water depressions, and/or releasing water into off-channel sites, along rivers that no longer receive large, channel-moving floods (Ohmart et al. 1975, Schropp and Bakker 1998, Bays 1999). Low check dams can be constructed across channels, to locally concentrate sediments and nutrients and raise water tables to levels that support desired species. Such a structure (called a gradient restoration facility), with a fish apron, is planned to improve habitat for the willow flycatcher and endangered Rio Grande silvery minnow as part of the Bureau of Reclamation's Santa Ana project along the middle Rio Grande in New Mexico (Boelman et al. 1999). Additional research is needed to assess the efficacy of these and other rehabilitation approaches to restore desired conditions such as channel complexity, high water tables, or desired levels of fine sediments and nutrients in below-dam reaches.

Restoration efforts should strive to restore hydrogeomorphic conditions needed for more than just one or two of the many biotic elements in riparian ecosystems. It is impossible to manage directly for every single species in an ecosystem. We can, however, focus on a subset of species that we treat as indicators of intact physical processes (Lambeck 1997). We increase our odds of meeting the needs of more native species and providing sustainable ecosystem improvement if we take an ecosystem approach that accounts for natural cycles of disturbance, stream hydrology, and fluvial geomorphology (Bayley 1991, Stanford et al. 1996). This concept is exemplified in the case of the Truckee River in Nevada (Gourley 1997). Dams, channelization, and diversions of water from the Truckee have contributed to a loss of age class and structural diversity within the cottonwood forests and a collapse of native fish populations including the endangered cui-ui (*Chasmistes cujus*). To stimulate spawning of the fish populations , the U. S. Fish and Wildlife Service began managing Stampede Reservoir for spring flood release; an ancillary benefit was the establishment of cottonwood seedlings particularly in abandoned channels where the water table was close to the surface. The take-home message here is that "when restoring a basic ecosystem process, such as the natural flow regimes of the river, a whole array of ecosystem components may begin to recover" (Gourley 1997).

Water Quantities

Although stream water is fully-allocated and even over-allocated in parts of the arid Southwest, there are opportunities for restoring perennial flows and raising ground water levels in dewatered river reaches. Recycling of paper, plastic, and aluminum has become a way of life for many urbanites; if we approach municipal water the same way, we can create restoration opportunities by recycling treated municipal water back into river channels near to the point of initial diversion. Indeed, many cities are releasing their effluent directly into stream channels. At sites where the alluvial aquifer has not been depleted, the net result has been restoration or rehabilitation of large expanses of riparian vegetation. Below the 91st Avenue water treatment plant in Phoenix, Arizona, the channel of the Salt River is lined by herbaceous plants and young stands of cottonwoods, willows, and tamarisk trees. Vegetation extends across the wide flood plain, sustained by ground water that is recharged by effluent and agricultural return flows. Along the Santa Cruz River near Nogales, Arizona, cottonwood and willow forest ecosystems similarly have redeveloped as a consequence of the release of treated municipal wastewater to the dry river channel (Stromberg et al. 1993). Effluent also is released into the Tucson-reach of the Santa Cruz River. Due to long-term dewatering in the region, the stream flow is no longer hydraulically connected to the alluvial aquifer, thereby limiting the extent of the effluent-stimulated riparian corridor. Release of effluent from Lompoc, California into the mostly dewatered Santa Ynez River channel produced riparian habitat that was used by flycatchers for a number of years. There can be a short 'sacrifice zone' below the effluent-release point where poor water quality selects for a depauperate and pollution-tolerant aquatic biota, but the presence of a functional riparian and aquatic ecosystem can allow nutrient concentrations to return to ambient levels after a short distance (Stromberg et al. 1993).

Riparian vegetation also can be restored by recharging ground water into appropriate sites. Through water-banking, some of the Colorado River allocation of Arizona is recharged or “banked” in aquifers. In the arid Southwest, where open water evaporation rates exceed 2.7 m per year, aquifer recharge is a more viable and desirable method of water storage than storage in surface impoundments. At some sites, we can accomplish the dual goals of ground water recharge and riparian restoration. In a dewatered reach of the Agua Fria River below the New Waddell Dam in central Arizona, the shallow-bedrock layer would allow for re-establishment of extensive riparian forests, if Central Arizona Project water was released from the dam (Springer et al. 1999). The river corridor could be used as a conduit for water delivery to the recharge/ recovery zone, while also providing surface and ground water to sustain riparian vegetation. The total amount of water transpired by the vegetation would be less than the amount that presently evaporates from the reservoir. This and other such projects could restore diverse and productive riparian ecosystems to dry river reaches.

Agricultural return flows constitute another source of water for riparian restoration efforts. For example, agricultural return flows are being considered as a water source to maintain cottonwood-willow habitat in the Limnitrophe area of the Lower Colorado River, to allow for survivorship of plants that established after the 1992-93 winter floods (LCRBR 2000). Elsewhere in the lower Colorado River flood plain, agricultural return flows have been used to increase the survivorship of riparian trees and shrubs planted as part of revegetation efforts (Briggs and Cornelius 1998). Such efforts could be expanded. When using return flows to maintain or restore riparian habitat, it may be necessary to periodically flush the soils to reduce the concentrations of salts below the levels that are toxic to the desired species.

A recent decision in Pima County, Arizona allows the county to buy reclaimed water for riparian restoration projects. Projects that secure endorsement by the U.S. Fish and Wildlife Service will be eligible for a portion of a 5,000 acre-foot pool for each of the first five years of conservation efforts. A key question is, "where to utilize the water to maximize its habitat value?" Up-front regional planning efforts would be of great value in allowing Pima County and other groups to identify sites that would maximize the environmental benefits of reclaimed water. Planning efforts are needed throughout the flycatchers range to determine the best locations for effluent-based and groundwater-recharge-based riparian restoration efforts. Hydrogeologic studies can identify sites where shallow water tables exist or are likely to develop, and thus sites where phreatophytic riparian vegetation is likely to develop. Ecological studies can identify sites likely to have high wildlife value by virtue of traits such as proximity and connectivity to existing high quality patches of riparian vegetation. In some cases, it may make sense to release the reclaimed water closer to the aquifer-pumpage or stream-diversion sites, to reduce the length of the river that is dewatered.

Channel-Floodplain Connectivity

Riparian ecosystems can be restored or improved along some rivers by removing the physical barriers that separate a channel from its flood plain. Along the Colorado River, for example, there are opportunities to remove dikes and levees and restore some degree of channel-flood plain connectivity (LCRBR 2000). By allowing water to periodically flow onto the flood plain, one provides the input of water, and in some cases the nutrients, sediments, and plant propagules to sustain the productivity and diversity of the riparian forest. Small flood releases along the Rio Grande in New Mexico, although too small to serve as recruitment flows, have reconnected the floodplain vegetation with the river water and served to partially restore riverine functioning in cottonwood forests (Molles et al. 1998).

Integration of Natural and Managed Ecosystems

On flood plains managed for agriculture or as urban centers, there are some benefits to be had from restoring small patches of native riparian vegetation. Riparian forests restored to strips between agricultural fields, similar to the hedgerows used in Europe and elsewhere (Petit and Usher 1998), can provide services such as crop pollination and consumption of crop pests. We caution, however, that some of the restored riparian patches that are small and isolated might not be self-sustaining and might have adverse environmental effects on overall recovery efforts of the southwestern willow flycatcher or other riparian species. For example, riparian bird populations in small habitats might be populations sinks, producing a net-drain on an overall metapopulation. Such projects could draw water resources, funding and planning efforts from other project sites that have the potential for greater environmental benefit.

Watersheds

Full restoration of riparian ecosystems depends on restoration of hydrogeomorphic conditions and processes throughout the watershed. Long-term overgrazing and extensive urbanization have, in places, reduced plant cover and soil in the uplands. In many cases this has produced 'flashier' systems characterized by larger flood peaks and smaller base flows. In other areas, fire suppression has resulted in higher tree densities, higher transpiration rates, and smaller stream flows (Covington and Moore 1994, Covington et al. 1997). Watershed restoration will require a mix of passive measures, such as restoring natural fire regimes and grazing regimes, and active measures (see Appendices G and L). Controlled burns may be useful for restoring structure and function to upland forests. Check dams on tributaries may allow for more infiltration of water into the aquifers, thereby helping to sustain base flows year round while also reducing the frequency of catastrophic floods.

2. *Restoration of Animal Populations and Processes*

Ungulate Grazing

Just as it is important to restore the hydrogeomorphic regimes to which native riparian species are adapted, it also is important to maintain biotic interactions, such as herbivory, within evolved tolerance ranges. Herbivores exert strong selective pressure on plant species. Alteration of herbivore grazing patterns or grazing intensity selects for a different assemblage of plant species. In the past few centuries, cattle ranching has been a nearly ubiquitous influence, constituting a new and major stressor for riparian plant communities in the hot deserts of the U.S. Southwest. High intensities of grazing, from cattle or elk, similarly constitute a major stressor for riparian communities of higher elevations. Many adverse changes to riparian ecosystems have been documented as a result of overgrazing (GAO 1998, Belsky et al. 1999). Heavily grazed plant communities, more often than not, do not provide us with a wide range of desired functions and services (see Appendix G).

Will livestock exclusion restore riparian health? Natural recovery of some ecosystem elements after cattle exclusion can be slow and problematic, particularly on severely overgrazed sites or where there are ongoing stressors including improper livestock grazing elsewhere in the watershed (Kondolf 1993). For example, water tables that have been depressed as a result of livestock grazing may be slow to rise to desired levels (Dobkin et al. 1998). Sometimes, though, eliminating a stressor is all that is needed to enable natural recovery (Hobbs and Norton 1996). Removal of livestock or reductions of higher-than-typical populations of elk and deer can result in dramatic and rapid recovery of some elements of the riparian ecosystem, particularly where the ecosystem has not been degraded by other factors. Along the free-flowing upper San Pedro River in Arizona, exclusion of cattle (in tandem with other management restrictions) was followed by rapid channel narrowing and vegetative regrowth (Krueper 1992). New stands of cottonwood and willows and herbaceous plants developed in the wide, open stream banks, and songbird populations increased dramatically.

Elmore and Kauffman (1994) provide other examples of rapid recovery of riparian vegetation structure, diversity, or productivity after livestock exclusion. They indicate that recovery of stream features and woody and herbaceous vegetation is more rapid in response to livestock exclusion than to other types of riparian livestock management. If exclusion is accomplished through fences, the fences should be constructed to standards that allow for wildlife movement (Gutzwiller et al. 1997).

Can we manage for economically viable livestock grazing and riparian ecosystem health on the same parcel of land? There is some consensus that this compromise is best met by reducing the stocking rate rather than by imposing rest and rotation schemes (Holechek 1995). Restriction of grazing to certain seasons of the year can allow for recovery of certain components of the riparian ecosystem, but may not always provide for full recovery (Elmore and Kauffman 1994). Probabilities of achieving restoration success increased when there is coordination, communication, and goal-consensus among land managers throughout the watershed, such as has occurred in the Mary River watershed of Nevada (Gutzwiller et al. 1997).

Ungrazed reference allotments, located at a variety of elevations and in different geomorphic settings, can provide benchmark or reference sites against which to compare the condition or integrity of grazed allotments (Bock et al. 1993, Brinson and Rheinhardt 1996). Ideally, the ungrazed areas should encompass entire watersheds. Monitoring efforts in grazed and ungrazed sites should focus on a wide variety of measures of ecosystem integrity, such as herbaceous plant cover and composition, woody plant growth, establishment rate, and structure, and stream channel morphology, in addition to traditional range measures such as utilization rates (Ohmart 1986). Monitoring of the reference sites can help to identify factors responsible for riparian ecosystem changes, and to separate the effects of weather from land use. In the past few decades, for example the Sonoran Desert has been wetter-than-normal (Swetnam and Betancourt 1998), and conditions have been favorable for regeneration of many pioneer riparian trees including cottonwoods, willows, and sycamores (*Plantanus* spp.) (Stromberg 1998). Without ungrazed reference sites, it is difficult to determine if changes such as increased willow regeneration or increased bird populations are due to land use change or weather change.

Keystone Species

Reintroduction of missing or extirpated keystone species, such as beaver, can be an effective restoration tool in some areas. Beaver are considered to be a keystone species in riparian ecosystems because of the extent to which they modify local hydrology, stream geomorphology, and habitat conditions for plants and animals. Dams built by beavers serve to raise ground water levels, minimize seasonal variations in surface and ground water levels, and expand the areas of the flood plain and channel inundated by shallow water, all of which enhance habitat suitability for southwestern willow flycatchers (see Habitat Paper) and other wildlife. Because of the flashy, highly variable nature of stream flow in the arid Southwest, these changes increase habitat for hydrophytic, wetland vegetation and promote shifts in vegetative communities from facultative to obligate wetland species. Unlike large dams constructed by humans, the beaver dams tend to be short-lived and do not impede the flows of flood-borne sediments and propagules.

The combined effect of beaver activities serves to create a more heterogeneous flood plain. The felling of trees, building of dams and lodges, and impoundment of water create a diverse mosaic of habitat patches, such as open ponded water, marshland, and various types of forested swamps. Habitat can be created for the many threatened and endangered aquatic and wetland species that depend on slow-moving, nutrient-rich waters. There is a need, however, for additional scientific study of the effects of beaver on arid region riparian ecosystems (Naiman and Rogers 1997).

Prior to reintroducing beaver, one should assess site conditions to insure that the habitat and food supply are suitable. As with other natural forces such as floods, beavers can be problematic and cause further loss of quality at degraded sites. For example, if preferred food sources such as cattails (*Typha domingensis*) are sparse as a result of stream dewatering, beaver may be forced to feed heavily on cottonwoods and willows. The net effect can be further reduction in site quality. Restoration actions could be undertaken at degraded sites to improve them to a level that would enable beaver to exert positive effects.

3. *Restoration of Plants and Fungi*

<u>*Restoration Plantings*</u>

Opportunities exist to restore integrity to riparian ecosystems in the U.S. Southwest by re-establishing riparian vegetation, including cottonwood-willow forests and shrublands, to sites where it has been eliminated. Such sites include abandoned or retired agricultural fields, burned sites, or sites from which exotic plants have been removed. These efforts can augment the amount and structural complexity of habitat available to animal populations, and generally enhance ecological diversity. Before forging ahead with plantings, the potential restoration sites should be assessed for limiting factors including ground water depth, soil texture, and salinity; for the potential to alleviate intolerant conditions; and for the potential to manage the river to allow for natural plant establishment processes.

A decade or so ago in the U.S. Southwest, 'riparian restoration' was synonymous with 'cottonwood pole planting'. Not long after, the idea that riparian habitat could be created through plantings of native trees and shrubs took hold in southern California, where it has been used extensively to produce habitat for the endangered least Bell's vireo (*Vireo bellii pusillus*). While several sites have been successfully colonized by nesting vireos within 3-5 years of planting (Kus 1998), we have concerns regarding the self-sustainability and long-term value of planted sites to vireos and other riparian species. These concerns center on the fact that many planted sites are isolated from the river channel. They are not subject to the natural processes, such as flooding, which influence plant establishment as well as other ecosystem processes such as maintenance of bioproductivity of mature trees (Stromberg 2000).

Planted cottonwoods and willows often die, because water tables are too deep or too variable, or because the soils at the restoration site are too salty (Anderson 1998). In cases where the plantings are isolated from the ground water table, water is supplied through irrigation. Long-term watering commitments often are not met, and the increased water needs of the rapidly growing plants are not always taken into account, sometimes resulting in plant death. These experiences have taught us that planting is most successful as a restoration tool only if accompanied by other actions, i.e., if the root causes of the absence or scarcity of the native species are addressed (Briggs 1996). If the plants do survive, but we do not alter river management, the net effect often is the restoration of a single age class rather than restoration of a dynamic, multi-aged population. Nonetheless, such measures can constitute an important stop-gap measure to restore forest structure and bird communities as we also work towards longer-term and more sustainable solutions (Farley et al. 1994).

To attain the greatest ecological benefits, we propose the following hierarchy, with respect to establishment of desired native plant species such as cottonwoods and willows: (1) Where possible, fully restore natural processes by removing the management stressors that restrict riparian plant establishment; (2) Next best, modify the management stressors, by naturalizing flow regimes or modifying grazing regimes to allow for natural plant establishment. If a water source can be manipulated on the flood plain, use techniques such as 'wet soil management' combined with seeding to allow for natural seedling establishment; (3) Plant nursery grown plants or cuttings (e.g., pole plantings) if the above options are not available, or if there is a need to achieve more rapid results.

In cases where the natural processes that allow for plant establishment can not be restored, care should be taken to monitor and document the success of the restoration plantings. Along the Sacramento River in California, where there are societal constraints on river flooding, various species of willow, cottonwood and other woody plants were planted on sites that were considered suitable based on criteria including depth to ground water and proximity to existing riparian forest (Alpert et al. 1999). Analysis of survivorship patterns provided information of use to future projects, such as finding greater plant survivorship on sites with fine-grained vs. coarse-grained soils.

Where local seed sources are sparse, seeding or planting is necessary to achieve restoration success or hasten recovery in response to removal of stressors. On the Owens River in California, physical integrity was restored when stream flows were released back into the river (Hill and Platts 1998). Few trees had survived the long-term dewatering, however, so seed sources were in short supply. Cottonwood seeds were collected from other river sites and released into the Owens River gorge at an appropriate time in spring. Such natural seeding is preferable to plantings of poles, cuttings, or nursery-grown seedlings, because it typically allows for greater genetic diversity within the plant population and allows for selection at the seedling-stage for plants adapted to the local conditions. Seeds collected for sowing should consist of a genetically diverse mix obtained from the local area.

We need to remind ourselves, periodically, of the biological complexity of riparian corridors. The lower Rio Grande Valley has about 1000 native vascular plant species (Vora 1992). Cottonwood-willow streams in Arizona support several hundred plant species, the relative abundance of which changes from year to year depending, in part, on rainfall and flooding patterns (Wolden and Stromberg 1997). These diverse plant communities have many functions, including sustaining a diverse insect community and thus a rich food base for insectivorous birds. There have been many efforts to plant the woody dominants of riparian forests, including Fremont cottonwood (*Populus fremontii*), Goodding willow (*Salix gooddingii*), mesquite (*Prosopis* spp.), and quailbush (*Atriplex lentiformis*), as well as efforts to plant herbaceous species. It is a daunting task to attempt to restore hundreds of species through direct plantings or seedings (Vora 1992). Donor seed banks is a technique that may serve to restore some of this biodiversity to degraded sites. A soil seed bank is defined as a soil's reserve of viable, ungerminated seeds. Donor soils have been obtained from high-integrity reference ecosystems to restore biodiversity to various types of degraded or newly created wetlands (Brown and Bedford 1997, Burke 1997). Seeds of woody riparian dominants generally are not present in the seed bank, but many of the annual plants and herbaceous perennials form persistent or at least transient seed banks. Before adopting the donor soil approach, additional studies are needed to identify which species, and how many species, are present in the seed bank of possible donor sites.

Exotic Plant Species

Exotic species (those that have been introduced accidentally or intentionally by humans to a new ecosystem) pose a definite challenge to riparian restorationists. There are hundreds of exotic plant species that have become naturalized in riparian corridors. A small percentage of these have become management issues due to their prevalence, negative influences on the ecosystem, or inability to completely mimic the functions of displaced natives (see Appendix H).

In many cases, removal of exotics is an effective restoration strategy only if part of a larger plan that includes restoration of processes and conditions (but see Barrows 1998). We need to ask, "is the exotic the cause of degradation, a symptom of degradation, or both"? Often, the abundance of riparian exotics is one symptom or facet of a complex, systemic resource allocation problem. If we don't address the root causes of degradation that led to the loss of the native species, there is a risk that traditional control measures, such as herbicides and biocontrol insects, could worsen the situation by resulting in replacement vegetation of lower quality (Anderson 1998). Additional studies are needed on a river by river basis, to identify the stressors on the native vegetation and assess the ability for re-establishment of natives, under scenarios of exotic-removal with and without active changes in river and land management.

Restoring natural processes and removing stressors, and then stepping back, can be an effective strategy for restoring native riparian species to some exotic-dominated sites. Theoretically, by restoring natural flow regimes and herbivory patterns, we can tip the ecological balance in favor of the native species (Poff et al. 1997). The middle San Pedro River provides an interesting case study of natural recovery (Stromberg 1998). Stream flows in the San Pedro vary from perennial to ephemeral depending on local geology, tributary inputs, and the extent of local and regional groundwater pumping. Tamarisks dominate in the reaches with ephemeral flow and deep water tables, but grow intermixed with cottonwoods in the wetter reaches. In these perennial reaches, cottonwoods have been increasing in abundance relative to tamarisk in the past decade. During this time period, livestock have been removed from the sites, groundwater pumping has been reduced immediately upstream, and spring flows have been high. Under these conditions, cottonwoods apparently can outcompete tamarisks. Also necessary to the recovery were several winter/spring floods that created opportunities for species replacement. Without suitable control sites, however, it is difficult to determine the relative influence of weather and management actions on the vegetation change. Again, we stress the need for additional studies that assess the potential for natural recovery of native species to exotic dominated sites, upon removal of stressors and/or removal of the exotic species.

Populations of some exotic species can persist for a long time after removal of the disturbance factor(s) that facilitated their invasion. They may produce self-favoring conditions (e.g., tamarisk promote fire cycles that they can withstand more easily than can many native species), or may simply have a long life span. In such cases, there is a need to manually remove the exotics before, coincidental with, or even after the implementation of other restoration measures. In some cases, removal of the exotic species may be all that is needed to allow for restoration of the native community. In others, it is important to obtain a firm commitment to naturalize processes before proceeding attempting to expedite recovery of the natives by mechanically removing the exotics.

At the Bosque del Apache Wildlife Refuge, as on much of New Mexico's highly regulated Rio Grande, tamarisk has become the dominant plant species. Lowered water tables, increased river salinity, and lack of winter/spring floods for several decades have all contributed to a declining cottonwood forest, while past flood plain clearing and at least one appropriately timed summer flood allowed for the influx of tamarisk (Everitt 1998). To restore the site, managers of the Refuge have mimicked the effects of large floods by using bulldozers, herbicides, and fire to clear the extensive stands of tamarisk at a cost of from $750 to $1,300 per hectare (Taylor and McDaniel 1998). They then released water onto the bare flood plains in spring with a seasonal timing that mimicked the natural flood hydrograph of the Rio Grande. This allowed for the establishment of a diverse assemblage of native and exotic plants. Long-term monitoring will be required to determine whether the multi-level canopy, diversity of vegetation structure, and diversity of insect life provided by the riparian assemblage provides superior wildlife habitat to the tamarisk thickets that existed before. Tamarisk clearing was essential, but it is the appropriate timing and quantity of water flows that will drive the system toward an increasingly native composition. This type of 'wet soil management' also can be used on other bare sites, such as abandoned agricultural fields.

Team Arundo in California (http://www.ceres.ca.gov/tadn/index.html) is another example of a program implementing mechanical means to remove exotics. In this case, they are removing giant reed (*Arundo donax*), from rivers into which it was introduced decades ago. Giant reed, an aggressive rhizomatous weed, spreads rapidly through drainages, and appears to thrive under a wide range of hydrologic conditions. It produces dense stands that are used by few native birds. Using a combination of herbicides, burning, and manual clearing, Team Arundo designs and coordinates efforts to eradicate giant reed while simultaneously promoting public awareness of the problem and the need to prevent future introductions stemming from the use of giant reed as a landscaping plant.

Fungi

Soil fungi are an important, but often overlooked, component of riparian ecosystems. Many human actions that affect soils, such as various agricultural practices, can deplete populations of mycorrhizal fungi. Re-introduction of mycorrhizal inoculum may improve the chances of restoration success on the many abandoned agricultural fields that line arid-region rivers. There is evidence that growth and survival of giant sacaton (*Sporobolus wrightii*), a plant that once dominated flood plains of many rivers in the U.S. Southwest, is improved on abandoned fields by the addition of mycorrhizal inoculum (Spakes, unpubl. data). Additional research is needed to determine the functional relationships between fungi and other riparian plant species, and to assess the need for restoration of mycorrhizal fungi in a variety of riparian settings.

C. Restoration as Mitigation

The resiliency of riparian vegetation and the relative ease with which the structural dominants can become established under proper conditions has prompted interest in the use of habitat restoration to mitigate the loss of endangered species habitat accompanying otherwise legal and permitted activities. For example, in southern California, habitat restoration is a typical form of mitigation for actions that adversely affect habitat of the least Bell’s vireo. The nature of the restoration varies from removing exotics from stands of native vegetation to the more commonly required creation of habitat through planting of cuttings or nursery stock. The success of created habitat in attracting nesting vireos (Kus 1998) and thus achieving mitigation goals, coupled with the fact that least Bell’s vireos and southwestern willow flycatchers share the same habitat where their ranges overlap, offers a tempting rationale for applying this approach to flycatcher recovery. We advise caution in yielding to this temptation too quickly. We have little confidence that efforts to enhance or create habitat in the absence of treating root causes and restoring proper physical conditions will be successful. Restoration ecology is a young science, and we do not know yet whether our attempts to create habitat will yield functioning, self-sustaining ecosystems that support the full complement of species we seek to protect (Williams 1993, Goodwin et al. 1997). Failure in either of these regards will result in a net loss of riparian habitat, and does not constitute mitigation.

Given this, we recommend that restoration performed within the context of mitigation be carefully designed, implemented, and monitored (Kondolf 1995, Michener 1997). Below, we list some considerations to maximize the potential for success of the mitigation, and minimize risks to the flycatcher:

1. “Up-front” mitigation (mitigation achieved prior to destruction/degradation of habitat) is preferable to mitigation concurrent with habitat loss because it avoids even a temporary net loss of habitat, and increases the probability that the mitigation has been successfully achieved.

2. Mitigation plans should include the following:

a) *Goal*: The goal of the restoration must be clearly stated, as it sets the stage for the other elements of the plan. Examples include 1) to provide suitable habitat for willow flycatchers, 2) to provide habitat supporting nesting willow flycatchers, 3) to remove exotics and restore dominance to native vegetation, 4) to restore a more natural flooding regime, 5) to achieve a self-sustaining ecosystem. There are many other potential goals that could be specified; the important point is that a goal must be explicitly identified in order to establish relevant criteria by which the success of the restoration can be measured.

b) *Model:* A model provides a picture of what the restored habitat should look like and how it should function, with little or no further human intervention. It should be based on a natural, functioning system that the restoration is attempting to mimic (White and Walker 1997). A model of the desired conditions is necessary to design appropriate restoration and to provide a basis from which quantitative performance criteria can be developed (Baird 1989, Baird and Rieger 1989, Kus 1998).

c) *Performance criteria*: These criteria constitute the yardstick by which success of the mitigation will be evaluated. They must be quantifiable, and pertinent to the overall goal (National Research Council 1992, Kentula et al. 1993, Hauer and Smith 1998). For example, success criteria for the above goals might include 1) production of habitat with the following habitat characteristics (e.g., vegetation volume >x, perennial water present), or, alternatively, the following bird community (enumerate), 2) the presence of x nesting pairs of flycatchers, 3) cover of natives between x and y percent, 4) the occurrence of winter and spring floods with the following characteristics (enumerate), and 5) vegetation or bird goals met with no human intervention required. It is imperative that these criteria not be subjective (e.g., based on “how the site looks”). In instances where some level of maintenance is involved in establishing the site or modifying conditions (e.g., irrigation of plantings, weeding, etc.), the maintenance should have ceased for a specified period prior to final site evaluation.

d) *Monitoring plan*: A detailed plan for collecting and analyzing data on the project's performance is necessary to ensure that it will adequately monitor progress towards success, and reveal the need for remedial action when appropriate. The period of time over which monitoring is required should be long enough to have a high probability of capturing temporal variability in the events or processes being monitored. Adaptive management should be built-in to the plan: mechanisms should be in place to trigger alternate restoration approaches or require restoration of additional habitat should the current effort fail to achieve its goals and/or be functioning at lower levels than reference sites (Hauer and Smith 1998).

3. The greatest potential for successful mitigation occurs when the physical processes required for long-term site maintenance are present or restored. Projects proposing short-term approaches, such as riparian vegetation dependent on irrigation, independent of attention to intrinsic factors related to habitat maintenance should receive low priority as candidates for mitigation.

D. Closing Words

Habitat restoration has the potential to greatly improve the suitability of existing willow flycatcher habitat, and provide additional habitat for population expansion. We encourage scientists, managers, and others interested and involved in restoration to be creative in developing new approaches, adopting an experimental framework and to share results, even if they include failures. Only from an extensive and shared knowledge base can we avoid repeating the mistakes of the past and move towards a more desirable future.

E. Specific Recommendations

To allow for full ecological restoration, we recommend these general guidelines:

(1) Restore the diversity of fluvial processes, such as movement of channels, deposition of alluvial sediments, and erosion of aggraded flood plains, that allow a diverse assemblage of native plants to co-exist.

(2) Restore necessary hydrogeomorphic elements, notably shallow water tables and flows of water, sediments, and nutrients, consistent with the natural flow regime.

(3) Restore biotic interactions, such as livestock herbivory, within evolved tolerance ranges of the native riparian plant species.

(4) Re-introduce extirpated, keystone animal species, such as beaver, to sites within their historic range.

We recognize that the potential for restoration success varies among sites with many physical, biological, and societal factors. Where possible:

(1) Fully restore these natural processes and elements by removing management stressors.

(2) Next best, modify the management stressors, by naturalizing flow regimes, modifying grazing regimes, removing exotic species, or removing barriers between channels and flood plains, for example, to allow for natural recovery.

(3) Take over processes such as plant establishment (e.g., nursery stock plantings) only if the above options are not available.

Some additional general recommendations:

(1) Focus restoration efforts at sites with the conditions necessary to support self-sustaining ecosystems, and at sites that are connected or near to existing high quality riparian sites.

(2) Develop restoration plans that encompass goals, models, performance criteria, and monitoring.

(3) If mitigation is required, call for "up-front" mitigation (mitigation achieved prior to destruction/degradation of habitat).

Some specific recommendations dealing with water and channel management:

(1) Conduct regional planning to identify sites most suitable for riparian restoration upon the release of reclaimed water (effluent), ground water recharge, or agricultural return flows.

(2) Conduct regional assessments to determine the merits of dam removal as a riparian ecosystem restoration strategy.

(3) Secure operating agreements for dams that incorporate environmental flows, for example to allow for tree and shrub regeneration flows during wet years and maintenance (survivorship) flows at other times.

(4) Pursue options for restoring sediment flows to below dam reaches.

(5) Secure operating agreements to manage reservoir drawdowns in such a way as to allow for regeneration of desired plant species.

(6) Develop water use management plans for river basins that will sustain or restore shallow ground water tables and perennial stream flows.

(7) At appropriate sites, remove barriers that reduce the connectivity between channels and floodplains.

Some specific recommendations dealing with land management:

(1) Within grazed watersheds, coordinate and communicate to establish goal-consensus among land managers and to achieve grazing levels compatible with riparian restoration.

(2) Establish a series of livestock exclosures that encompass riparian lands and/or watersheds, to provide benchmarks against which sites managed for livestock production can be compared.

(3) Monitor reference sites and grazed sites for a wide variety of measures of ecosystem integrity, including stream channel morphology and plant cover, composition, and structure, in addition to direct measures of plant utilization.

F. Literature Cited

Please see Recovery Plan Section VI.

Appendix L.

Riparian Ecology and Fire Management

A. Introduction: General Concepts of Disturbance

Disturbance has been defined as "any relatively discrete event that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment" (Pickett and White 1985). The size, intensity, frequency, and timing of a disturbance all influence ecosystem structure and function. Generally, natural disturbances maintain high diversity of habitat patches in the landscape and thus maintain species diversity. Many plant and animal species depend upon periodic disturbance.

Different types of disturbances - be they fire, flood, or landslide - produce different effects on ecosystems. Plant species have evolved suites of traits that adapt them to the particular types and patterns of disturbance that they routinely experience. “Novel” disturbances, new combinations of disturbances, or changes in the intensity, timing, duration, and/or scale of a disturbance all can alter ecosystem structure and function outside the range of conditions to which the species are adapted (Paine et al. 1998). For many of our Southwestern riparian ecosystems, due largely to land and water management practices, fires have replaced floods as the primary disturbance factor. This change has had adverse consequences for many native species.

B. Historical Fire Regimes in Southwestern Willow Flycatcher Habitats

Fires require an ignition source and adequate amounts of fine, dry fuel (McPherson 1995). Historically, fire was probably uncommon in southwestern willow flycatcher habitat. However, there is little quantitative information on the frequency, seasonality, intensity, and spatial extent of fire, all of which are components of the fire regime (Agee 1993). Turner (1974), for example, in a review of vegetation change over the past century along the Gila River (Arizona), stated that "the dense seasonally dry vegetation along the Gila River and other sites of the region periodically caught fire, but with what frequency cannot be determined."

The frequency of riparian fire probably varied temporally with drought cycles and the prevalence of lightning strikes, the primary natural ignition source for riparian fires. Spatially, riparian fire regimes probably varied with those in the surrounding uplands. Although riparian zones tend to burn less frequently than the uplands (Skinner and Chang 1996), fire probably was more frequent along rivers located in grassland and savanna biomes than along those in deserts, chaparral shrublands, and conifer forests. Other factors being equal, fires probably were more frequent in narrower, smaller riparian zones than in wide ones (Agee 1993).

In the following sections, we discuss in more detail the fire regimes in two broad vegetation types used by the willow flycatcher: 1) low to mid-elevation riparian forests, and 2) high elevation willow shrub lands.

1. Low to Mid-Elevation Riparian Forests

In this category, there are several types of biotic communities: Sonoran riparian cottonwood-willow gallery forests, dominated by Fremont cottonwood (*Populus fremontii)* and Goodding willow *(Salix gooddingii)* trees; Great Basin gallery forests vegetated by Rio Grande cottonwood (*P. deltoides* subsp. *wislizeni)* and peach leaf willow (*S. amygdaloides*); Interior riparian mixed broadleaf deciduous forests vegetated by Fremont cottonwood, Goodding willow, and other trees such as box elder (*Acer negundo*) and Arizona ash (*Fraxinus pennsylvanica* var *velutina*); and California Riparian Deciduous forests vegetated by Fremont cottonwood, Goodding willow, California sycamore (*Platanus racemosa*) and white alder (*Alnus rhombifolia*). Many shrubs including seep-willow (*Baccharis salicifolia*), coyote willow (*S. exigua*) and buttonbush *(Cepthalanthus occidentalis*) grow under or adjacent to the riparian trees.

Three lines of evidence suggest that fires historically were not a primary disturbance factor in these forest types. First, some of the dominant trees, notably Fremont cottonwood and Rio Grande cottonwood are not considered to be fire-adapted (Abrams 1986, Adams et al. 1982, Busch 1995). In general, plants are considered to be fire-adapted if they have traits that allow them to maintain their structure and not be altered by the fire, or that allow them to rapidly regenerate afterwards. Thick bark, for example, allows some trees to resist fire damage. Other traits allow for resilience, or the ability to rapidly return to the pre-disturbance condition. For example, some seeds germinate only in response to very high temperatures, allowing for post-fire regeneration. Cottonwoods show neither resistance nor resilience to fires. The cambium of Fremont cottonwood can be damaged by even light ground fire (Turner 1974), indicating low resistance. Burned cottonwood trees have a low probability of resprouting. Stuever (1997) reported that light burns completely killed about 50% of Rio Grande cottonwood trees, moderate burns about 75%, and highly severe burns killed all the cottonwoods in a stand (Figure 1). Higgins (1981) observed that Fremont cottonwood had high post-fire mortality and no recovery. Davis et al. (1989), however, observed that two of three burned Fremont cottonwoods vigorously sprouted three years after a fire. Summer burns tend to cause more mortality than winter burns, because less heat energy is required to raise plant tissue to lethal levels.

Several tree and shrub species in these biotic communities show some resilience to fires. White alder, buttonbush, Arizona ash, California sycamore, Goodding willow and coyote willow, for example, are readily top killed by fire, but can recover by resprouting (Barstad 1981, Barro et al. 1989, Davis et al. 1989). Resprouting provides some resilience to fire disturbance as well as to flood disturbance. Fires, however, generally do not create the opportunities for seed-based regeneration of these riparian tree and shrub species. The seeds of many species of willow and cottonwood are adapted to germinate at particular times of the year when flood disturbance is most likely -- a time that rarely coincides with high fire risk. This life-history strategy provides resilience to floods but not necessarily to fire.

Figure 1. This fire, called the Rio Grande Complex, occurred on April 18, 2000, and burned over 1,900 acres from La Joya to Los Lunas in the Rio Grande bosque. The intense fire burned the bark from the Rio Grande cottonwoods. Photo taken by Charlie Wicklund, April 20, 2000.

Another factor contributing to infrequent fires is the high water content of most riparian forests. Willows, cottonwoods, and many other obligate riparian trees and shrubs grow at sites with perennially available shallow ground water, enabling them to maintain high water content even during dry seasons. Additionally, the riparian forests are often associated with other vegetation types that had high moisture content. Large expanses of river flood plains in the Southwest were wet and marshy, and thus not very fire-prone (Hendrickson and Minckley 1984). Some parts of the flood plains are drier than others, however. Desert rivers carry high sediment loads, and flood plains can aggrade appreciably over time. The old cottonwood or willow forests that grow on the aggraded flood plains can develop a seasonally dry understory of non-phreatophytic grasses and forbs. These older stands were probably more likely to catch fire than were the younger forest stands along channel edges.

Fire was historically uncommon in many of the upland biomes that surround the low to mid-elevation riparian habitats. The rivers that support Sonoran riparian cottonwood-willow forests, which include segments of the Gila, Salt, Verde, Bill Williams, Santa Maria, Kern, Mojave, Virgin, San Pedro, and Colorado Rivers, were surrounded by Sonoran or Mojave Desert. The sparse vegetation in these deserts generally had insufficient fuel loads to carry fire (Brown and Minnich 1986). Portions of other rivers with riparian zones inhabited by flycatchers, such as the Rio Grande, San Pedro, and Gila, were surrounded by Chihuahuan Desert. Others, such as the San Juan, flowed through Great Basin Desert scrub vegetation. The drier portions of these deserts also had insufficient fuel loads to carry fire. Thus, there were few opportunities for fire to spread from uplands into riparian zones located along the desert rivers.

Some rivers were bordered by fire-prone upland vegetation. For example, the San Luis Rey River flowed through California Valley grasslands, the upper San Pedro River and upper Gila River flowed through semidesert grassland, and the upper Rio Grande flowed through Plains grasslands. All of these grasslands are fire-adapted and burned fairly frequently. Semidesert grasslands historically burned about once every ten years, started by lightning strikes in June or July that signaled the end of the summer dry season (McPherson 1995). In dry years, fires probably did occasionally spread from the grasslands into the riparian zones. Reports from explorers in the 1800s, for example, describe periodic riparian fires along the San Pedro River in the reach bordered by desert grasslands (Davis 1982). Generally, the riparian forests along such rivers were vegetated by mixed riparian broadleaf forests or other vegetation types rather than by 'pure' cottonwood-willow forests. Frequent fires probably allowed the fire-adapted riparian grass, giant sacaton (*Sporobolus wrightii*) to maintain its high abundance along the upper San Pedro River (Bock and Bock 1978). Cottonwoods and willows were historically present, but were less abundant than they were in the lower reaches of the San Pedro River that were bordered by desert vegetation. Other rivers, such as New Mexico's Rio Chama, flowed through Great Basin conifer woodland (pinyon-juniper savannahs). These pinyon-juniper savannahs historically had an abundance of grasses that carried frequent fire that probably occasionally spread into the riparian corridor.

Many of the coastal California rivers that support willow flycatchers flowed through California chaparral or California coastal sage scrub ('soft chaparral'). Both of these seasonally dry vegetation types are fire-adapted. Chaparral tends to burn with low frequency but high intensity. Chaparral fires have a recurrence interval of 30-65 years, for example, in the Santa Barbara area of California (Davis et al. 1989). Severe chaparral fires can spread into riparian zones in hot, dry years, such as occurred at the upper Santa Ynez River in July, 1985 (Barro et al. 1989).

2. High Elevation Willow Shrublands

At these high elevation riparian sites (which range to about 2600 m), shrub willows are a major component of the vegetation. The canopy generally is less than 7 m tall. Several species of willow may be present, including coyote willow (*Salix exigua*), Geyer willow (*S. geyeriana*), red willow (*S. laevigata*), arroyo willow *(S. lasiolepis*) and yellow willow (*S. lutea*). Peach-leaf willow (*S. amygdaloides*), a tree-like willow that grows to 9 m tall, also may be present. Sometimes, flycatcher nests are placed in or near other associated shrubs species such as Wood's rose (*Rosa woodsii*), twin-berry (*Lonicera involucrata*), or river hawthorn (*Crataegus rivularis*). The willow groves often are interspersed with wet meadow vegetation and open water.

The surrounding upland vegetation includes various types of montane conifer forests. Several of the flycatcher-inhabited riparian zones are bordered by ponderosa pine (*Pinus ponderosa*) forests. Historically, ponderosa pine stands were more park-like and open than they are today. Low intensity ground fires would sweep through the grassy undergrowth one or more times per decade (Covington et al. 1997). Stein et al. (1992) suggest that fires in the ponderosa pine stands of northern Arizona may have spread frequently into small, intermittently flowing creeks dominated by arroyo willow *(S. lasiolepis*). However, these small intermittent streams with narrow riparian zones typically do not provide suitable flycatcher habitat. Those with flycatcher habitat tend to have wet meadows, beaver ponds, and willow groves. Being along larger, perennial streams, these sites probably burned infrequently. During very dry years, if the vegetation was sufficiently stressed, the riparian meadows and willow stands may have burned. More often, fires would stop at the edge of the wet riparian zone as was observed by DeBenedetti and Parsons (1979) in the Sierra Nevada. Fire frequency data are lacking for shrub willow sites known to support southwestern willow flycatchers, but charcoal layering suggests a fire frequency of once every 250 to 300 years for some wet meadows in the Sierra Nevada (Chang 1996).

Most shrub willow species, including Geyer willow and arroyo willow, are able to resprout after low to moderate-intensity fires that kill only the aboveground plant parts. Low to moderate-intensity fires thus can maintain the willow patches in an early successional state, and also create habitat for particular animal species. The post-burn resprouts of many willows have a high growth rate and are preferentially foraged upon by elk (Stein et al. 1992; Leege 1979). Patchy fires may create mosaics of shrub stands with different canopy heights and stem densities. High-intensity fires, however, can burn deeply into the soils and kill the willow roots, thereby eliminating the possibility of basal sprouting. Stein et al. (1992) suggest that the vigorous post-fire resprouting ability of arroyo willow may be an adaptation to frequent fire; although it is equally plausible that resprout ability evolved as a response to flood damage.

Many willow species regenerate by seed after floods. Fires also can create seed beds for some willows, if they expose mineral soils at the appropriate time of the year (Zasada and Viereck 1975, Zedler and Scheid 1988, Uchytil 1989). Opportunities for seedling establishing after a fire decrease quickly as the mineral soils become vegetated by herbaceous species (Densmore and Zasada 1983). In some cases, fires or beavers may create the disturbance needed to allow the willows to encroach into areas dominated by perennial grasses, sedges, rushes, and other herbs (Cottrell 1995).

C. Recent Changes to Fire Regimes in Riparian Zones

1. Low and Mid-Elevation Habitats: Fire Increases.

There have been two distinct trends with respect to changes in riparian zone disturbance regimes. Foremost, there has been a shift from a flood-dominated to a fire-dominated disturbance regime on many of the cottonwood-willow rivers that historically supported large populations of southwestern willow flycatchers. Increases in fire size or frequency have been observed for the lower Colorado and Bill Williams rivers (Busch 1995), Rio Grande (Stuever 1997), Gila River (Turner 1974), and Owens River (Brothers 1984). Along the lower Colorado and Bill Williams, over a third of the riparian forests studied burned over a recent 12-year period (Busch 1995). The increased prevalence of fire on these rivers is due primarily to an increase in the abundance of dry, fine-fuels and secondarily to an increase in ignition sources.

Several interrelated factors have contributed to the increase in flammable fuel load. First, and perhaps foremost, is flood suppression. Flood flows are very large relative to base flows in unregulated rivers of the semi-arid Southwest. Large floods can scour extensive areas, clearing away live and dead vegetation and redistributing it in a patchy nature on the flood plain. Willows and other pioneer species quickly revegetate the scoured areas, replacing older, senescent stands with stands of young, 'green' wood. Small to moderate floods frequently remove litter and woody debris from the flood plain surfaces and disperse them into aquatic environments. Floods also increase the patchiness of the vegetation, thereby creating natural fire breaks between stands of riparian habitat. The net effect of this natural flood regime is to 'fire-proof' riparian habitats (Ellis et al. 1998). When floods are suppressed, litter cover and dead biomass accumulate; vegetation can increase in extent, density, senescence, and homogeneity; and fuels become more continuous. On the flood-suppressed Bill Williams River and portions of the Colorado River, riparian vegetation (most of which is fire-prone tamarisk; *Tamarix ramosissima*) has increased in density since dam construction (Turner and Karpiscak 1980, Shafroth 1999), setting the stage for frequent, intense, and large fires. Indeed, most of the rivers with documented fire increases are flow-regulated.

Dewatering of rivers also increases the frequency and intensity of fires by increasing the flammability of the vegetation. Reduced base flows, lowered water tables, and less frequent inundation all can cause plants to lose water content, and cause mortality of stems or whole plants. Stress-related accumulation of dead and senescent woody material is a primary factor contributing to the fire increase on the Lower Colorado (Busch 1995, Busch and Smith 1995). Dewatering also facilitates the replacement of broad-leaved riparian vegetation by more drought-tolerant, and often more flammable, vegetation such as tamarisk (Smith et al. 1998).

Loss of beavers has altered local hydrology, vegetation composition and possibly fire patterns. Beaver activities help to expand areas of shallow ground water and hydrophytic vegetation, and generally create a more heterogeneous flood plain (Apple 1985). This can create natural fire breaks and provide refugia from fire effects, especially where beaver activity results in extensive areas of marsh, wetland, and open water habitats. Beaver were extirpated from many Southwest rivers in the 1800s (Tellman et al. 1997), perhaps contributing to increased flammability of riparian vegetation.

Replacement of native vegetation by exotic plant species, many of which are highly flammable, also has contributed to riparian fire increase. Tamarisk, giant reed (*Arundo donax)*, and annual grasses such as red brome *(Bromus rubens)* all are highly flammable. The spread of many of these exotics is due partly to the same changes in stream flow regimes that render the riparian areas more flammable, making it difficult to disentangle the effects of the exotic species from the effects of management factors that have enhanced their spread (see Appendix H). Nevertheless, we will focus discussion on tamarisk because it is such a key factor in the flood-to-fire regime shift.

Tamarisk plants have many stems and high rates of stem mortality, resulting in an accumulation of dense, dry dead branches. Large amounts of litter - including dead branches and the small, needle-like leaves - are caught in the branches elevated above the ground surface, enhancing its flammability. Fallen leaves of the native broadleaf trees decay quickly relative to tamarisk, thus reducing the relative fuel loading. Based on studies conducted along the Rio Grande (Ellis et al. 1998), there is some evidence that tamarisks produce less litter than cottonwood stands, though this does not mean that tamarisk stands are therefore less fire prone.

When the fire-prone characteristics of tamarisk are coupled with conditions brought about by flood suppression, fires become inevitable in the tamarisk forests. Rosenberg et al. (1991) stated that "Saltcedar is deciduous and, without floods, large amounts of leaf litter accumulate. Therefore, after 10 or more years fires almost become a certainty, especially during the hot and dry summer months." Faber and Watson (1989) suggested that fires become a real hazard when the stands reach 15 to 20 years of age. Anderson et al. (1977) noted that 21 of the 25 tamarisk stands they studied along the lower Colorado River had burned in the prior 15 years. Weisenborn (1996) calculated a fire return interval of about once every 34 years for tamarisk stands along the Colorado River.

When dense tamarisk stands burn, the fires are often intense and fast moving, characteristics that have led to substantial acreages of burned riparian habitat along the Lower Colorado River (Table 1; note that Table 1 data are reported in acres, not hectares). During just three years, recent fires burned a total of 1,000 ha of the 6,200 ha of occupied or potentially suitable willow flycatcher habitat that existed along the Lower Colorado River in 1998 (U.S. Bureau of Reclamation 1999a). Altered fire regimes also have played a role in reducing the amount of cottonwood-willow vegetation on the Lower Colorado River from approximately 36,000 ha (based on 1938 aerial photography with appropriate adjustments: U.S. Bureau of Reclamation 1999a) to the current extent of less than 6,500 ha.

Although fire hazard is greatest with the combination of flood suppression, water stress, and tamarisk presence, tamarisk stands on free-flowing perennial rivers also can burn. Some of the tamarisk stands on the San Pedro River, for example, have large numbers of dead stems (Stromberg 1998) and occasionally ignite. In June 1996, a fire burned along the lower San Pedro River in a stand of cottonwood-willow with an understory of tamarisk (Paxton et al. 1996). The fire was primarily carried by the understory tamarisk, but almost all cottonwoods in the burned area were killed. The patchiness of the forest stands along the free-flowing San Pedro presumably results in smaller fire sizes than on flood-suppressed rivers.

Other human actions have increased the frequency of accidental and intentional fires. Turner (1974) describes the intentional setting of fires by ranchers to clear tamarisk thickets to allow access by cattle. More common, though, are accidental fires caused by campfires, cigarettes, automobile sparks, agricultural burning, and “kids-with-matches.” Riparian areas on military bases or ranges may also be at risk to frequent fires due to use of explosive ordinance, military vehicle traffic, or other ignition sources. Brothers (1984) attributed increased fire along the Owens River to increased use of the riparian zones by campers and fishermen in the past 30 years. Some managers recognize a '4th of July fire syndrome', due to the prevalence of riparian fires started by fireworks. According to Wiesenborn (1996), "Wildfires are an increasingly common occurrence in saltcedar along the lower Colorado River, partly the result of increasing population densities along the river's shorelines." In fact, John Swett (pers. comm.; U.S. Bureau of Reclamation, Boulder City, Nevada) reports that 95% of fires along the Lower Colorado River are human caused. Fires also can be started by homeless people or transients, especially along rivers near urban areas where dense riparian vegetation provides relatively attractive sheltering sites (see Appendix M).

Another factor that may be contributing to riparian fire increase is an increase in fires in the desert uplands. As is true for Sonoran riparian cottonwood-willow forests, fire has become a 'new' disturbance in the Sonoran and Mojave Desert during the past century (Brown and Minnich 1986). Dry, fine fuel-loads, as well as ignition rates, have increased in these deserts. Livestock grazing has contributed to the establishment of grazing-adapted, exotic annual plants which carry fire more readily than native annuals (Brooks 1995). The dense stands of exotic annuals that develop in wet, El-Nino years create opportunities for spread of fire in these non fire-adapted communities far in excess than would have been produced by native riparian plant species during similar El-Nino events. Fires also have become more frequent in other upland vegetation types, such as California chaparral. Extensive urban development in southern California has increased the ignition sources from cars, cigarettes, and other sources, thus providing more opportunities for upland fires to spread into riparian corridors.

2. Low and Mid-Elevation Habitats: Fire Decreases.

We speculate that fire has become less frequent along rivers that historically flowed through grassland or savannah habitats, given the documented declines in fire frequency in these upland habitats (MacPherson 1997). In addition to direct fire suppression, many of the grassland and savannah habitats have been replaced by less flammable vegetation types such as shrublands. There is some evidence that these changes have influenced the adjoining riparian cottonwood-willow-mixed broadleaf forests. For example, the upper reaches of the San Pedro River historically were vegetated primarily by marshland and sacaton grass, with fewer stands of riparian trees than today. Recurrent fire probably favored the herbaceous vegetation types. In the mid 1800s, for example, Leach (1858, in Davis 1982) describes a fire along the San Pedro River that destroyed "large quantities of Cottonwood, Ash, and willow timber with which the banks of the river were densely overgrown", but says that three weeks later "the Sacaton grass had grown up and covered the entire valley with a beautiful carpet of verdure". Only recently and only locally has fire returned as an ecological force to the San Pedro uplands, due to cessation of grazing and subsequent recovery of the grassy-fuel load (Krueper 1992). As a result, several fires have spread into the older riparian forests in the past decade. The fires are carried into the riparian corridor by the seasonally dry understory of perennial grasses and forbs, and have killed several patches of cottonwood and willow trees. In other areas throughout the range of the southwestern willow flycatcher, desert grasslands have been so degraded that they have reached a new stable state composed of shrublands and small trees; thus precluding the return of the historical upland fire regime.

There is other anecdotal evidence that fires have become less frequent at some mid-elevation sites. In some areas, fires may have decreased in frequency because Native Americans no longer set fires to improve hunting success. In others, ranchers no longer are setting fires to increase access and improve forage for cattle (Boukidis 1993). Part of the reason for the decline in prescribed burning is the difficulty in obtaining permission from the permitting agencies, as well as risks to the increasing number and distribution of rural homes.

3. High-Elevation Habitats.

There is little hard evidence that fire regimes of the high elevation wet meadows and willow shrublands have changed. In some of the adjacent upland conifer forests, including the *P. ponderosa* forests, fires have become less frequent but more intense. Heavy livestock grazing has eliminated the fine fuel load that historically contributed to frequent low-intensity fires in some of the forest types (Belsky and Blumenthal 1997). Active fire suppression has allowed for the accumulation of high fuel loads (i.e., very dense stands of young conifer trees) that results in very high fire intensities when the forest do burn (Covington et al. 1997). These changes may have altered fire patterns in the associated riparian zones. With higher intensity, the fires may be more likely to penetrate into the riparian corridor. Additionally, catastrophic fires can trigger catastrophic flooding events, which in turn can destroy wetlands or eliminate populations of some wetland plants (Hendrickson and Minckley 1984, Bowers and McLaughlin 1996); but at the same time create opportunities for establishment of disturbance-dependent species such as willows.

D. Impacts on Southwestern Willow Flycatcher

1. Low and Mid-Elevation Habitats: Fire Increases

The willow flycatcher is a bird that lives in a dynamic habitat. Suitable nesting patches historically underwent frequent loss and replacement due to flood disturbance. When assessing the impacts of fire regime change on the flycatcher, we must compare the population dynamics of the birds between flood-disturbance and fire-disturbance scenarios. Although there are some similarities, there also are substantial differences in the ways in which fires and floods influence the bird and its habitat. We stress the management implications of one similarity: because fires and floods both periodically cause localized habitat loss, the total numbers of individual flycatchers and of flycatcher populations need to be sufficiently large to buffer the species from these habitat losses. This requires that riparian habitat patches be sufficiently abundant and distributed appropriately throughout the birds' range to allow for post-disturbance recolonization.

Historically, most floods that were large enough to scour and remove nesting trees and shrubs from the Sonoran Desert rivers occurred in winter, spring, late summer or fall, but rarely in the early summer period coincident with the flycatcher breeding season. Thus, despite the floods, nest sites had a high probability of remaining intact throughout the breeding season. Riparian fires, however, tend to burn during the summer breeding season and thus can cause direct loss of nests and young. Some nesting flycatchers may move to other, unburned habitat to re-nest, but the resultant delayed breeding and use of alternative habitat may lower their overall seasonal breeding success. For example, the 13 willow flycatcher pairs breeding in the area burned by the San Pedro PZ Ranch fire in June 1996 abandoned the site (Paxton et al. 1996). Their subsequent reproductive success, if they had renested in the same year, probably would have been reduced because willow flycatcher clutch size is significantly reduced each time a flycatcher renests within a season (Holcomb 1974). Although some willow flycatchers returned to unburned portions of the PZ Ranch site during subsequent years, the population there continued to decline over time through 1999, when only a single unpaired male remained (Arizona Game and Fish Dept., unpubl.

data).

We do not know how many flycatchers are affected directly by burns in any given year. The number may be large given the dominance of tamarisk along rivers in the desert southwest and the prevalence of fires in this vegetation type. In 1998, for example, a major fire along the lower Colorado River destroyed large portions of dense tamarisk habitat at Topock Marsh. Approximately 100 ha of suitable flycatcher habitat was consumed in the blaze (of a total 1,200 ha burn), though effective fire suppression kept the fire out of known occupied habitat that supported over a dozen territories, and thus no known flycatcher nests were destroyed (U.S. Fish and Wildlife Service 1998). However, the potential for loss in such situations is high.

Fires at any time of the year can affect breeding success by causing changes in vegetation structure and composition. The structural characteristics of post-disturbance riparian vegetation and suitability as flycatcher habitat differ substantially between floods and fires. Floods, unlike fires, trigger primary succession along alluvial desert rivers. By scouring sediment from aggraded floodplains, creating new channels, redistributing sediment, recharging aquifers, and moistening sediments, floods create opportunities for seed-based regeneration of cottonwoods and willows, and create a mosaic of age classes in the flood plain. Natural flood regimes provide a mechanism for the continued development of habitat patches with suitable nesting structure. Fires, in contrast, do not cause these same geomorphic, hydrologic, and vegetational changes.

Fires cause directional change in the composition of the riparian stand, and trigger secondary successional processes. Along the lower Colorado and Bill Williams rivers, fires have contributed to the replacement of many native species including Fremont cottonwood, quail bush (*Atriplex lentiformis*), and salt bush (*Atriplex* spp.), by tamarisk (Anderson et al. 1977, Higgins 1981, Busch 1995, Shafroth 1999). Tamarisks can be killed by very hot or frequent fires, but generally resprout from the root crown in as little as a few days after the fire (Faber and Watson 1989, Hoddenbach 1990). Horton (1977) found that "fire burning through a saltcedar stand will not kill the shrubs, as they tend to sprout vigorously unless they are growing under stress. Then as many as half of the shrubs may not survive." Although some native species, including honey mesquite and Goodding willow, also resprout after fire, the development of a fire-cycle triggered by the dominance of tamarisk ultimately can result in the loss of these species. Anderson et al. (1977) noted that "with the initiation of a burn cycle, the dominance of an area by saltcedar becomes successively more complete." The native shrub arrow-weed (*Pluchea sericea*) also is favored by frequent fire, and thus tall forests of Fremont cottonwood, Goodding willow, and mesquite along the Colorado River have been replaced by short shrublands of arrowweed and tamarisk. Along the Owens River, fires may be favoring the shrubs narrowleaf-willow (also known as coyote willow; *Salix exigua*) and rabbitbrush (*Chrysothamnus nauseosus*) over Fremont cottonwood and Goodding willow trees (Brothers 1984).

Flycatcher breeding success can be impaired for several years after a fire. The extent and duration of the impairment varies with many factors including the size and severity of the fire, rate of vegetation regrowth, and post-fire changes in vegetation structure and insect community structure and productivity. Post-fire regrowth of tamarisk can be quite rapid if site conditions are favorable, with resprouts growing to 4 m high in a year after burning (Horton 1977). In other cases, over a decade may be required for the resprouted tamarisks and/or willows to attain the requisite structure for flycatcher breeding (Paxton et al. 1996).

The following case study illustrates the complexity of the post-fire response. In March 1997, an agricultural brush-pile fire on land adjacent to Escalante State Wildlife Area, Colorado escaped control and burned through the small patch of flycatcher habitat on the area (Owen and Sogge 1997). The habitat burned during the non-breeding season when flycatchers were not present, and approximately 95% of the known breeding area burned. Subsequently, the number of flycatchers present in 1997 (six territories) was lower than during 1996 (10 territories). Three territories within the burned area retained approximately 50-60% willow coverage and were occupied by breeding pairs. The other three territories were in completely burned habitat (much of which was previously tamarisk), and two of these three territories were only occupied by unpaired males. By 1998, resprouting willow and tamarisk vegetation provided dense habitat in the burned area, but only five territories were found (Sogge unpubl. data). Thus, although flycatchers occupied the site after the burn, it presumably reduced the local population size and lowered the overall breeding success.

Southwestern willow flycatchers breed in dense, tall, and typically older tamarisk patches at many sites in the Southwest (see Appendix D). We do not yet know if tamarisk patches can reach a state of maturity or decadence in which they would lose their suitability as flycatcher breeding habitat. This could theoretically occur if the tamarisk plants undergo senescence, become decadent, and lose vigor (and thus live-foliage density). This question has significant ramifications in terms of the sustainability of currently occupied sites, and for the future suitability, availability, and distribution of substantial amounts of flycatcher habitat. This important issue deserves future research attention.

If tamarisk stands can "age" beyond suitability for flycatchers, such conditions would require the absence of disturbance factors such as fire or floods. In these situations, small fires may be beneficial by allowing for development of younger stands. Fires may perpetuate a mosaic of size classes, in the absence of other disturbances. Thus, it is theoretically possible to use fire as a tool to manage for key structural types in saltcedar (Anderson et al. 1977) if research determines that older structural types are not suitable for flycatchers or that a mix of saltcedar successional stages is superior for flycatchers. However, older stands of dense tamarisk may be so fire-prone that it is impossible to keep a fire "small enough" to serve as an effective tool that does not destroy an entire riparian area.

Overall, many questions need to be answered regarding tamarisk and fire management. If fires are going to persist as the dominant disturbance factor on some rivers, we need to define more explicitly the tamarisk structural types and age ranges that are preferred by the flycatchers. More research is needed in general on relationships between riparian stand age and flycatcher habitat suitability (Farley et al. 1994). We also need to know the response of tamarisk to repeated burning. How long can tamarisk survive under a frequent-burn scenario? Will the resprouted plants die at the end of some fixed natural life span, or does burning reconfigure them to a juvenile state? More research also is needed to determine how post-fire forest stands differ from post-flood stands in terms of insect food base, or other habitat suitability factors.

2. Low and Mid-Elevation Habitats: Fire Decreases

As we noted earlier, fires have returned as an ecological force along some rivers, including the upper San Pedro, that are bordered in the uplands by fire-adapted vegetation types. We anticipate that the restoration of the fire regime in this reach will reduce the abundance of cottonwood-willow forests, particularly on the highest (and thus most surface-dry) flood plains. Fire-related losses of these habitat patches need to be countered by restoring riparian habitat to other sites throughout the flycatchers' range. Because there are other rare species that depend on the fire-adapted riparian vegetation types, we advocate a multi-species approach to riparian ecosystem management.

3. High-Elevation Habitats

We are not aware of published evidence that fire regime changes have had either positive or negative effects on the flycatcher in high elevation habitats. Mature stands of willows grow in some meadows in the Sierra Nevada. While fire may be a tool to rejuvenate willows in these situations, the ecological processes that lead to the stands natural presence and persistence are unknown (Valentine, pers. obs.). In some high-elevation willow habitats (e.g., the Alpine site in the White Mountains of Arizona), intentional removal of beavers dried the site substantially, contributing to reduced water ponding, conversion of perennial stream flow to intermittent, restriction of the flow to the narrow creek channel, and declines in the extent and density of willows (Langridge and Sogge 1997). Drier herbaceous and shrub vegetation, essentially pasture-like in nature, can surround the remaining willow patches where willow flycatchers still breed. These changes in vegetation and hydrology have the potential of increasing fire frequency, and are another topic that warrants research attention.

E. What Can Be Done

There are many actions that could be taken, and that are being undertaken at various riparian sites, to restore appropriate disturbance regimes. Some of these actions, such as restoring flood flows, fall in the category of "ecological restoration" approaches because the intent is to restore habitat by restoring desired physical processes. Others, such as clearing woody debris, fall in the "active intervention" category. Some actions focus on prevention of fires (e.g., reducing ignition sources, reducing the abundance of flammable fuel loads) while others focus on extinguishing fires once they have started. Some actions are long-term with regard to implementation and benefits. Others can be carried out more quickly, often at smaller scales, and result in relatively rapid reduction in fire risk and impacts. Some of the actions could be undertaken in adjacent uplands, where fires have become a new disturbance, to reduce probabilities of spread of upland fires to riparian corridors.

In this section, we discuss some of the caveats, constraints, and benefits of several action-items with respect to willow flycatcher habitat quality. Our primary focus is cottonwood-willow habitats (now cottonwood-willow-tamarisk), the type that has undergone the greatest change in disturbance regime.

1. Fire Risk Evaluation and Planning

* *Fire risk and management plans.* As a first step in reducing the risk and effects of fire, land owners or managers should develop a fire plan for all current flycatcher breeding sites, and for sites where flycatcher-related riparian restoration is planned. This can be accomplished quickly and with relatively little cost, and yet can yield great rewards in minimizing or avoiding loss of occupied habitat. This was the case for the 1998 fire that occurred at the Topock Marsh site along the Colorado River – advance risk-evaluation and response planning played a key role in preventing the destruction of active flycatcher nests and important breeding habitat. Fire control efforts involved on-the-ground "flycatcher advisors", working with the fire team to identify and protect occupied willow flycatcher habitat. The suppression tactics would have been different if fire crews were not aware that the flycatchers were present, and the fire would likely have burned occupied willow flycatcher habitat. This involvement of the willow flycatcher resource advisors was critical, and they will provide assistance on any future fires at the site.

Other fire-suppression planning for flycatchers has occurred. The Bureau of Reclamation distributed 10,000 brochures on the dangers of wildfire along the Lower Colorado River to local federal and state land management offices. Management agencies along the Lower Colorado River have developed cooperative strategies for fire response. In the BLM Lower Colorado Fire Management Plan, protection of riparian habitat is given suppression priority second only to human life and property. The BLM and USFWS prohibit campfires on their lands along the Colorado River from May 1 through September 30 from Davis Dam to Mexico.

A comprehensive fire evaluation and response plan (hereafter referred to as the fire plan) should have several components including:

(a) evaluation of the degree of fire threat for that particular site. This section of the fire plan involves consideration of vegetation composition and structure, hydrologic conditions, patch morphology/structure, historical and recent fire regime, assessment of the fire risks posed by land-use management (e.g., livestock grazing, fire suppression) on-site and adjacent to flycatcher habitat, and potential sources of ignition (especially with regard to intensive human use) as well as identifying entities that contribute to control of fireworks risks.

(b) identification of short-term preventative actions that will be taken to reduce the risk of fire. This section of the fire plan could include many of the recommendations made later in this appendix, such as reduction of ignition sources (e.g., recreational use management, signage), efforts to produce less flammable conditions (e.g., development of 'wet' fire breaks, periodic inundation to moisten the soils and litter, modifying grazing to achieve reduced flammability), encouraging fireworks regulating entities to eliminate or restrict sales and use areas, etc.

(c) direction for quick response for fire suppression. This section of the fire plan should be very detailed and identify flycatcher breeding locations, prioritize areas for protection, locate access points, provide important site contacts (including the management agency and the USFWS), etc. The plan should be developed in conjunction with local fire management agencies, and periodically updated (at least biennially). Updates should be reviewed with the associated fire management agencies so that firefighters know about the management plan *before* a fire actually threatens a site.

(d) post-fire remediation/restoration. This section of the fire plan should have a goal of enhancing the recovery of desired vegetation that is suitable for breeding flycatchers, and should take advantage of the vegetation-clearing role of the fire. Remediation plans will, of course, vary from site to site depending on site potentials and logistic considerations. For example, at some sites the flood plain surface could be cut and lowered closer to the water table, flood irrigated and seeded with desired species. At other sites, it may be possible to excavate channels and then revegetate their margins. Some areas may simply need planting of the desired species without undertaking any earth moving activities.

(e) identification of long-range efforts to reduce risk of fire. This section of the fire plan can include reducing ignition sources (e.g., educational efforts), producing less flammable conditions by restoring more natural hydrologic and ecologic conditions (e.g., release of flood pulses, increase of ground water levels, restoration of willow, cottonwoods and other native species; release of beavers), etc.

(f) development of long-term monitoring of conditions in the riparian zone and watershed that maintain flood regimes and reduce fire susceptibility. This section of the fire plan should consider efforts such as monitoring regional water use patterns; water level trends in the regional and flood plain aquifers; fire-related recreational activities; and fuels loading.

2. Ecological Approaches to Reducing Risk

**Restore flood flows.* Flood pulses can be restored by breaching dams or releasing prescribed flows from dams. Both approaches can serve to reduce fire frequency and size in the short-term by scouring flammable fuel loads and moistening the vegetation and in the long-term by selecting for less flammable vegetation types. This ecological approach has tremendous value in that it addresses the root causes behind the shift in the nature of the disturbance regime. To be most effective, flood pulse restoration should be part of an overall restoration plan that will allow for ongoing establishment and survivorship of the native tree and shrub species that constitute flycatcher habitat (see Appendices I, J, and K).

Ideally, floods should be released in a fashion that mimics the natural flow regime. Water or power demands, or physical characteristics of the dam structure itself, may constrain the size or frequency of flood releases. To reduce fire size and frequency, floods should be sufficiently large to scour and remove accumulated forest floor debris and moisten the surface soils and tree bases. Based on flood recurrence intervals calculated for free-flowing rivers (Stromberg et al. 1991), an approximate frequency for such floods is once every two to five years. Larger floods that remove dead branches and scour patches of forest should be released, at longer intervals, to further reduce fuel loads and allow for successional regeneration processes. Where river channels below dams have become entrenched, there may be a need to mechanically grade and lower the adjacent flood plains and/or to raise the channel, to allow the flood plain surfaces to be inundated by smaller flood flows. Site-specific hydrologic and ecologic studies should be conducted to determine specific flood frequencies and magnitudes. Hydrography information for the reach in question can be calculated from upstream gauging or other hydrological information to guide prescriptions on flood size, frequency, and timing (see Appendices I and J).

* *Restore ground water and base flows.* Restoration of water availability also is an ecologically-based approach that will aid willow flycatchers not only by reducing fire risks but by improving habitat quality in other ways. Depth to ground water should be sufficiently shallow to restore or maintain native cottonwood-willow forests in non-water stressed condition (i.e., no lower than 3 m below the flood plain surface for mature forests and within 0.5 to 1 m of the flood plain for younger forests measured during the peak water-demand periods). Hypothetically, shallow depth to ground water also might allow tamarisk stands to be more fire resistant than if water is deeper because they maintain higher internal water content. Such high water tables may also allow native cottonwoods and willows to outcompete tamarisk. If a stream has become intermittent, perennial surface flows should be restored. In lieu of restoring the natural hydrology (the preferable option), other actions to improve plant water content and raise water tables could be undertaken such as flood irrigation, sprinklers, or agricultural tail water.

* *Reintroduce beavers*. By locally raising water tables, creating ponds, and increasing the extent of marshy, wetland vegetation (Parker et al. 1985, Johnston and Naiman 1987, Naiman et al. 1988), beavers may reduce fire size or frequency at a site. By promoting these habitat conditions, beavers appear to generally enhance site quality for flycatchers (Albert 1999). Apple (1985) showed that introduction of beaver into deteriorated or deteriorating riparian habitats lead to substantial improvements in 3 years. Subirrigated meadows formed where the channel formerly was downcutting into a gully-cut channel and "full riparian recovery was underway." Beavers have recolonized many riparian sites on their own, and they will likely spread (through natural dispersal or human intervention) into additional sites in the future.

There are several issues that must be considered before releasing beavers as a habitat restoration tool. The site should be assessed to ensure that there is an adequate food base of preferred foods, and to ensure that the natural successional dynamics are in place that will allow these plant species to regenerate over time. Otherwise, beaver foraging can reduce habitat quality by reducing densities of wetland herbs and riparian trees and shrubs below replacement levels. For example, in very small riparian patches, beaver might render the site unsuitable for breeding flycatchers by girdling or cutting down too many trees and shrubs. Arizona Game & Fish (unpubl. data) observed this event at the Tavasci Marsh flycatcher breeding site in the Verde Valley. There, beaver activity lead to a 50 percent loss of dominant large willows that dramatically reduced the live foliage. Subsequently, willow flycatchers did not nest at the site. However, these short-term losses in habitat quality may be offset by long-term improvements. Beaver habitat suitability analysis models (e.g., Allen 1982) should be consulted to determine if a site is likely to support beavers.

Another potential complication in using beavers for flycatcher habitat improvement is that beavers were not historically present in some parts of the Southwest (e.g., Southern California). There, introduction of beaver could violate proscriptions against introduction of new species. Furthermore, the hydrological conditions created by beaver activity (especially perennial ponds) could provide favorable conditions for unwanted species, such as the introduced bullfrog (*Rana catesbeiana*), at the expense of locally rare or endangered fish or amphibians. However, beavers are already so widespread in Southern California that it may be acceptable to consider them as vital agents in the functioning of riparian areas. In general, additional site- and context-specific research is needed about the role of beavers in creating and maintaining suitable willow flycatcher breeding habitat, and any ecological ramification or trade-offs of such actions.

* *Exclude livestock or follow proper utilization rates.* Livestock grazing is one of the factors that can cause drying of riparian sites and that can favor flammable exotic species such as tamarisk and red brome (see Appendices G and H). Many of these exotics are more flammable than the native species they replace. There is no guarantee that simple removal of livestock or reduction to more appropriate utilization rates will allow the native species to recover. Exotics can remain dominant for decades after a stressor, or factor that enabled their establishment, is removed. For example, Harris (1967 in Krebs 1972; 313) noted that the invasive cheatgrass (*Bromus tectorum*) is very resistant to displacement by native perennial grasses. In Washington, native wheatgrass (*Agropyron* sp) was not able to invade the *Bromus* stands even after 30-40 years of protection from fire and grazing. Further, some exotics may not even require the stressor to gain dominance in a community. Mensing and Byrne (1999) assert that red-stem filaree (*Erodium cicutarium*) was introduced to the West Coast of North America in the feed imported to support livestock of the first Spanish mission. However, its dispersal exceeded the spread of livestock from the mission, suggesting that the species was pre-adapted to the Mediterranean climates of the West coast. Therefore, simple removal of a stressor may not be adequate to recover native flora. However, removal of

the stressor, when coupled with other restoration measures such as seeding or soil manipulations (see Appendix H) may be necessary to hasten the recovery to a less flammable community type. Where the consequences of fire are high due to fine fuel loads, livestock grazing might be used as a tool to reduce the risks (Boukidis 1993, Chang 1996).

* *Use sustainable agricultural practices.* We need to address all of the factors that are causing riparian habitats to be more flammable. Some agricultural practices, for example, amplify the amount of salt and its delivery into rivers, in some cases favoring tamarisk and other exotics over willows and other native species. Increase in salinity is one subtle factor that can give tamarisks a competitive edge over willows (see Appendix H). Shifts towards more efficient use of water and less reliance on applications of fertilizers would help to reduce salt loads. Flood plains and watersheds should be managed in such a way as to keep salinity levels within the tolerance ranges of the native plant species.

3. Physical Manipulation of Fuel Loads

* *Manually/mechanically reduce fuel loads.* On heavily regulated rivers where natural flood regimes will not be restored, we must regularly intervene to actively manage the fire disturbance regime. One type of intervention involves clearing the 'fine woody debris' such as litter and dead branches, from dense stands of flammable vegetation, such as tamarisk. This also could entail clearing the duff of annual grasses from forest understories. These actions may reduce the intensity of fires and ease suppression, but are likely very time-intensive and could reduce site suitability. Such actions should be carefully planned, and adopted as part of a larger plan only after the benefits and costs are assessed to avoid causing more harm than good with respect to habitat quality. For example, it may be necessary to develop access roads to remove the fuel loads. The resulting fragmentation and opening of the vegetation may reduce quality of the flycatcher habitat or provide an avenue of ingress for threats to habitat or the species.

There has been little, if any, experimentation with fuel reduction in riparian habitats (especially tamarisk), and there are no standard guidelines on how best to accomplish this. Therefore, riparian fuel reduction actions should be considered as experimental, and initially conducted only in unoccupied habitats until the success and ramifications are better understood. Efficacy of these actions as a fire management tool, and effects on bird habitat quality, should be tested in a scientifically explicit, controlled fashion.

* *Dry fire breaks.* This approach, in some respects, is related to the one above. Here, the goal is to reduce the spread of fires by clearing all of the vegetation from swaths of land. Because of concerns over fragmentation of flycatcher breeding habitat, including the potential for providing increased human access to and into breeding sites,

fire breaks are not a preferred choice at most flycatcher sites. In addition, the effectiveness of firebreaks in dense willow and saltcedar willow flycatcher habitat is questionable. For example, the Topock Marsh fire of July 1998 jumped an existing firebreak. West (1996) indicated that fire breaks should be at least 100 feet (ca. 30 meters) wide, which would remove a substantial amount of habitat and greatly fragment a site. Furthermore, there is anecdotal evidence that flames from fires in dense tamarisk can travel across even 100 m wide bare strips, thus restricting the utility of fire breaks at tamarisk sites. In occupied or suitable flycatcher habitat, creation of wide fire breaks might render the habitat unsuitable. Situations where dry fire breaks may be effective include:

- along grass-edged roadways. Mowing or clearing dry vegetation along roadways may reduce fire ignition and spread from discarded matches and cigarettes.
- where large areas of fire-prone vegetation, unsuitable for flycatcher breeding, separate a breeding site from potential ignition sources or high-frequency fire areas. A wide fire break, far from the flycatcher breeding patch, could prevent or slow fire from spreading into the occupied patch.
- between agricultural “burn areas” and flycatcher sites, to prevent brush-pile fires from spreading into breeding sites.

Additional research is needed on the potential values, effectiveness, and ramifications of creating fire breaks in riparian habitats. Such research should first be conducted only in unoccupied sites.

* *Create wet fire breaks*. As an alternative to creating 'dry' fire breaks, 'wet' fire breaks could be created along heavily managed rivers by developing channels and restoring strips of less flammable vegetation along their margins. In dense, wide tamarisk stands, channels could be excavated to the level of the water table, or provide a water source directly into the channel. Site conditions adjacent to the channel would need to be assessed to determine what vegetation types could survive. If the soil is not too salty and if water tables are relatively stable, willows and cottonwoods could be restored (though this may require active establishment and maintenance). Another option is to plant marsh species such as cattails and bulrush. The channel and adjacent vegetation would have to be relatively wide (30 m to 100 m) to be an effective fire break. Potential ancillary benefits of this approach include increasing availability of flycatcher nest sites, enhancing the amount of water (an important habitat parameter) on-site, and increasing the productivity of the insect food base. Another benefit is that the presence of surface water can provide another source of water to be used for suppression purposes. However, even wet fire breaks have the potential to fragment habitat and provide increased access to flycatcher breeding sites, and should be approached with the same cautions noted for dry fire breaks (above).

* *Burning issues: Implement controlled burns.* There may be benefits to the use of prescribed fire in

riparian areas, from the perspective of flycatcher habitat. In older tamarisk stands, fire might create a mosaic of patches in different age classes and structural classes, which may provide for long-term maintenance of tamarisk at the site. It may also decrease the chance that an accidental fire will burn large areas and homogenize the landscape. However, these are theoretical benefits, and some fire experts consider dense tamarisk habitat a poor choice for controlled burns. Tamarisk is highly flammable (observers of some recent fires describe tamarisk plants as literally “exploding” in succession as the fire swept through stands) and there is a high risk of losing control of the burn (Kerpez and Smith 1987). In some cases, though, such as after rains or floods, managers were unable to ignite the tamarisk (Jorgensen 1996, West 1996). To better manage the controlled burns in tamarisk stands, one may wish to limit efforts to the rainy season, inundate the stand before burning, or reduce the fuel loads mechanically before burning. These possibilities warrant further research. Until then, however, controlled burns should be avoided in occupied habitat (or where the fire could spread to occupied sites), and considered only as experimental management techniques if dealing with suitable unoccupied habitat.

4. Public Education and People-Management

* *Reduce recreational fires.* In occupied habitat and in large buffer strips surrounding the occupied habitat, fires and fire-prone recreation uses should be prohibited during high fire-risk periods. In areas with suitable but unoccupied habitat, manage the numbers and/or distribution of recreationists to concentrate them into locations where fire suppression efforts can be more effectively deployed (and thus habitat loss minimized). Some areas may need to be closed to recreational use during high-risk periods, such as 4th of July weekends or drought periods. Additional patrolling by enforcement personnel would help to enforce restrictions.

* *Educate recreationists.* Brochures, signs, and other interpretive materials should be developed to educate river and riparian recreationists about the ecological roles of fires and floods, and the potential dangers of accidental fires. As noted above, such a program has been initiated by the U.S. Bureau of Reclamation along the Lower Colorado River. In the long-term, this should help to reduce accidental fires and garner public support for the implementation of ecological restoration approaches.

5. Reactive Measures: Fire Suppression

* *Suppress fires.* Fires in occupied habitat and adjacent buffer zones should be rapidly suppressed. As part of each breeding site’s Fire Evaluation and Management Plan (described above), maps of occupied habitat and buffer zones should be updated at frequent intervals, and the maps made available to local fire commanders to aid in active suppression process. “Ok-to-burn” areas should be identified based on site-specific analysis of the size, structure and composition of the riparian habitat throughout the management area, the recent fire history in the area,

and the ease of extinguishing the fire once it has moved beyond the area targeted for burning.

F. When and Where to Apply Measures

Table 2 lists the suite of actions that should be taken to restore an appropriate disturbance regime for the southwestern willow flycatcher. We classify the actions based on the quality and occupancy of the habitat. The actions in Table 2 apply to low and middle-elevation riparian forests that have undergone shifts from flood to fire disturbance regimes.

For all riparian community types throughout the flycatcher's range, including those at low, middle and high elevations, we need more information on the fire regime and ecological effects of fire. As noted above, all occupied sites, even those at high elevations, should undergo a fire risk evaluation and development of a fire plan.

G. Literature Cited

Please see Recovery Plan Section VI.

Table 1. Recent fire history along the Lower Colorado River, Arizona and California (Source: U.S. Bureau of Reclamation 1997, 1998, and 1999).

Reporting period	Number of fires	Number of fires in known occupied willow flycatcher sites	Total acres burned (range/fire)	Total acres of potential or suitable willow flycatcher habitat burned
October 1996 - July 1997	8	2	431 (.1 - 158.0)	306*
October 1997 – August 1998	5	1	3238 (3.1 -2925.0)	2303
September 1998 – September 1999	27	0	1119 (.1 - 158.0)	7
October 1996 – September 1999	40	1	4776	2506

* best estimate, based on limited data

Table 2. Suggested actions for reducing and eliminating the risk and impacts of fire in southwestern willow flycatcher potential breeding habitat. These actions pertain primarily to low and middle elevation riparian forest types, which have undergone recent shifts from flood to fire disturbance regimes. Note, however, that fire risk and management plans should be developed for all occupied breeding sites.

Action	Occupancy and Condition Status of Habitat Patch		
	Occupied	Unoccupied but Suitable	Targeted for Restoration
Planning and Suppression			
Develop Fire Risk and Management Plan	Yes	Yes, if goal is occupancy	Yes
Develop Fire Remediation Plan	Yes	Yes, if goal is occupancy	Yes
Suppress Fire if it Occurs	Yes	Yes, if goal is occupancy	Possibly, if fire incompatible with restoration effort
Ecological Approaches			
Restore or maintain flood flows	Yes	Yes	Yes
Restore or maintain perennial surface flows and shallow ground water	Yes	Yes	Yes
Reintroduce Beaver	Yes, if site conditions are favorable	Yes, if site conditions are favorable	Yes, if site conditions are favorable
Manage livestock (exclude or proper utilization rates)	Yes	Yes	Yes
Use sustainable agricultural practices	Yes	Yes	Yes
Intervention: fuel load management			
Manually or mechanically reduce fuel loads	No	Experimentally	Experimentally
Create dry fire breaks	Not in habitat, possibly nearby	Not in habitat, possibly nearby	Not in habitat, possibly nearby
Create wet fire breaks	Not in habitat, possibly nearby	Experimentally	Possibly, as part of site design
Controlled burns	Not in habitat, possibly nearby	Experimentally	Experimentally
Education and People Management			
Public outreach and education	Yes	Yes	Yes
Manage activities or restrict access in high risk areas	Yes	Yes	Yes

Appendix M.

Potential Recreation Impacts on Southwestern Willow Flycatchers and Their Habitat

A. Introduction

When conservation ethics and outdoor recreation were evolving, they were initially thought of as mutually beneficial. Recreation activities were considered compatible with the environment, especially when compared to timber harvesting, mining, development, and grazing (Knight and Gutzwiller 1995). Recreation demands on riparian areas may have been the single most important factor in motivating management agencies to reduce consumptive use in flood plains (Johnson and Carothers 1982). However, as recreation activities increase and persist over time, the damage they sometimes cause can no longer be ignored. Conservation ethics and outdoor recreation are often in conflict, requiring recreation management (Flather and Cordell 1995). Some experts believe the primary natural resource management issue for this century will revolve around conflicts between recreation and wildlife (Knight and Gutzwiller 1995).

Some subspecies of the willow flycatcher *(Empidonax traillii*) are known to be suburban nesters, breeding along roads and freeways and in areas of low to moderate recreation use. Although the southwestern subspecies *(Empidonax traillii extimus*) does not occur as a suburban nester, it may be more likely to persist in suitable habitat adjacent to recreation than some other endangered species. For example, unlike a species like the bald eagle (*Haliaeetus leucocephalus*), which has a large home range and is often sensitive to human proximity during the breeding season, the flycatcher has a small home range and does not appear to be overly sensitive to low level human activity outside of its' breeding patch.

Although there is little evidence of direct impacts on southwestern willow flycatchers or their habitat, the projection of recreation use into the future is cause for concern. Increasing human populations, coupled with the attraction of limited riparian areas for recreation, make willow flycatcher habitat a vulnerable resource.

To truly understand the breadth of the potential impacts, we must first acknowledge that recreation is a growing and economically profitable business that produces outdoor experiences for the public. The recreation industry, which includes the government, caters to users by providing hiking trails, campgrounds, picnic areas, resorts, marinas, and stocked rivers. These amenities allow visitors diverse experiences such as hiking, camping, motorboating, whitewater rafting, kayaking, and sportfishing. Visitors patronize the recreation industry by purchasing equipment, food, fuel, lodging, permits, and commercial tours.

Despite the fact that their cumulative activities can degrade riparian habitat, recreationists are important advocates for riparian conservation. As individuals or organized groups, they support habitat acquisition, review management plans, and generate funds. Recognizing the unintentional negative impacts recreation can bring about, user groups provide stewardship by sponsoring riparian clean-up, trail maintenance, restoration, monitoring, and education programs. In other words, it is important to recognize that recreation users can have positive impacts.

B. Current and Future Recreation Use

As the Southwest becomes increasingly urbanized, there will be greater demand to escape to natural environments. Population growth during 2000 to 2025 is expected to increase from 48,161,345 to 68,692,000 people for Arizona, California, Colorado, Nevada, New Mexico, and Utah combined. This is an increase of an additional 30% (U.S. Census Bureau 2001). These trends clearly indicate impacts are likely to escalate in the absence of recreation planning.

The growth in recreation activity from 1983 to 1995 exceeded growth of population, based on National Recreation Surveys (Cordell et al. 1999). Birding, hiking, backpacking, downhill skiing, and primitive camping were the five fastest growing activities in the country in terms of percentage change in number of participants between 1983 and 1995. Outdoor recreation activities involve more than 25% of the country's population.

Based on analyses of public recreation visitor surveys (Table 1), significant increases in future recreation activities will likely result in increased use of formerly undisturbed or lightly disturbed areas. People will increasingly enter wildland areas in search of a more natural and less crowded experience (Flather and Cordell 1995).

Table 1. Projected indices of growth in recreation trips between years 2000 and 2040 in the United States. The baseline index for all activities was set at 100 for the year 1987. These projections assume that recent trends in facility development, access, and services for outdoor recreation will continue into the future. This table was adapted from Flather and Cordell (1995).

	Projected Participation Index by Year				
Activities	2000	2010	2020	2030	2040
Day hiking	123	144	168	198	229
Bicycling	124	146	170	197	218
Developed camping	120	138	158	178	195
Horseback riding	114	125	135	144	149
Primitive camping	108	115	122	130	134
Off-road vehicle use	104	108	112	118	121
Nature study	99	101	103	107	108
Rafting	123	151	182	229	267
Canoeing/ Kayaking	113	126	138	153	163
Swimming	108	118	128	140	152
Motorboating	107	114	122	131	138

C. Recreation Use in Riparian Areas

Riparian areas already receive disproportionately high recreation use in the arid Southwest, when compared with other habitats. Not surprisingly, riparian areas near cities receive greater use than those farther away from development (Turner 1983). The demand for recreation in riparian areas will continue to increase in proportion to increasing human populations.

Impacts can be even more devastating in the Southwest, where riparian habitat tends to be more linear, narrow, and dissimilar to adjacent habitat than in other parts of the country. Where there is no buffer between adjacent habitats, impacts are more significant.

1. Examples of High Use Recreation in Southwestern Riparian Habitat

To illustrate the magnitude of public demand for recreation, we provide two examples of intensive use currently challenging managers.

Typical holiday use on the Imperial National Wildlife Refuge, along the lower Colorado River in southern Arizona, was estimated for Memorial Day, 1999. A 30-mile stretch of river from Martinez Lake north to Cibola National Wildlife Refuge was estimated to be inhabited by at least 2,790 people and their 951 boats and personal watercraft (e.g., jetskis). More than half of this use was concentrated on a sandbar nicknamed "zoo island," with an estimated 1,550 users and their 523 boats and personal watercraft. Nearby Cibola National Wildlife Refuge receives less recreation pressure while Havasu National Wildlife Refuge has 2-3 times as many recreation users as Imperial National Wildlife Refuge (J. Record pers. comm.).

The 135-mile Lake Mead National Recreation Area, on the border of Arizona and Nevada, receives over 200,000 visitors on a summer holiday weekend. A summer holiday weekend day averages 5,385 boats and personal watercraft (J. Holland pers. comm.). Activities include swimming, camping, waterskiing, fishing, hiking, and use of personal watercraft. Almost half of the overnight visitors camp along the shoreline (Grafe and Holland 1997). Most recreation occurs on the lakes or along shoreline habitat, currently unsuitable for nesting willow flycatchers (J. Holland pers. comm., K. Turner pers. comm.).

D. Types of Recreation Impacts

1. Overview

Wildlife can be affected by recreation in a variety of ways: 1) direct mortality, 2) indirect mortality, 3) lowered productivity, 4) reduced use of habitat, 5) reduced use of preferred habitat, and 6) aberrant behavior/stress that in turn results in reduced reproductive or survival rates (Purdy et al. 1987). These impacts are not easily measured and different species may not react to them the same way. A review of nonconsumptive recreation impacts on wildlife was conducted, using results of 166 journal articles on the subject (Boyle and Samson 1985, DeLong and Schmidt in prep). Although this review did not quantify the type or intensity of impact, negative effects on birds were detected in 77 of these studies (Table 3). Table 4 lists the kinds of recreation impacts in riparian habitat in the southwestern United States.

Table 3. Number of citations in 166 journal articles on "nonconsumptive" outdoor recreation impacts on North American wildlife. Birds were the most common subject of study (61%), followed by mammals (42%), and herpetofauna (4%) respectively (Boyle and Samson 1985, DeLong and Schmidt in prep).

	Impact on birds			Impact on mammals			Impact on herpetofauna		
Type of recreation	+	-	0	+	-	0	+	-	0
Hiking and camping	4	17	6	5	24	4			
Boating		25	9		1	2		1	
Wildlife observation and photography		19	2	1	5	4			
Off-road wheeled vehicle use		7	2		5	2		7	1
Swimming and shore recreation		6	2						
Spelunking					8				
Rock climbing		2	3		1	1			
Snowmobiles		1	1	1	7	3			
Total	4	77	25	7	51	16	0	8	1

"+" = positive impact, "-" = negative impact, "0" = no impact or unknown impact

Table 4. Recreation impacts in riparian habitat in the southwestern United States. Adapted from Cole and Landres (1995).

Loss of surface soil horizons

Soil compaction

Altered soil moisture and temperature

Altered soil microbiota

Habitat fragmentation

Reduced dead woody debris (fuelwood gathering)

Altered plant species composition

Altered foliage height diversity

Reduced plant density/cover

Lack of plant regeneration

Erosion

Increased sedimentation/turbidity of water

Altered organic matter content of water

Altered water chemistry

Altered flow regimes

Pollution (air and water)

Increased risk of accidental fire

Increased trash

Increased human waste and diseases

Increased feral and pet dogs and cats (exotic predators)

Increased native predators, scavengers, brown-headed cowbirds (*Molothrus ater*)

Displacement of wildlife by facilities, roads and trails, human presence and noise disturbance

2. Fire Risk

As the number of recreation users increases, so does the probability of an accidental fire. Over 95% of fires on the lower Colorado River are caused by recreation users (J. Swett pers. comm.) (see Appendix L). This high cause-and-effect factor greatly increases the cumulative impacts of recreation on the environment. If recreation use is to persist, fire risk can be reduced by confining campfires to certain locations, using fire boxes, restricting campfires during high fire danger conditions, or prohibiting campfires. In some cases, fires may be fairly inevitable, but even in these cases, the amount of damage can still be reduced with proper planning. The risk of damage can be managed as much as possible with current fire response plans, operable equipment, and available personnel.

3. Frequency, Intensity, Location, and Type of Use

Although there are few cases where outdoor recreation caused direct major impacts, such as outright willow flycatcher habitat destruction, indirect effects should not be underestimated. Actions that affect the behavior, survival, reproduction, and distribution of wildlife may be as damaging as direct impacts (Cole and Landres 1995). Animals displaced by recreation are less likely to survive and reproduce where habitat is unfamiliar or inferior (Gutzwiller 1995).

The potential for the recreational activity to produce negative impacts depends on the frequency, intensity, location, and type of use. For example, a hiking trail placed outside of suitable habitat is less likely to impact willow flycatchers than a trail and campground placed within suitable habitat. A trail that receives daily use is likely to result in greater habitat damage and impacts to local wildlife than one that receives occasional use. As the frequency and intensity of use increase we can expect to see increases in multiple trailing, soil compaction, vegetation loss, erosion, trash and human waste, pollution, scavengers, predators, brown-headed cowbirds (*Molothrus ater*), noise disturbance, and development of physical facilities like parking lots (Boyle and Samson 1985, Tellman et al.1997, Monz 1998).

Infrequent, but unpredictable recreation without pattern can be just as or more damaging than frequent, predictable use. Activities with pattern, such as hiking on established trails, may cause birds to nest away from a frequently used area. Activities without pattern, such as target shooting, fishing, picnicking, or wildlife observation, can create more of an impact per event. Because these kinds of recreation are often conducted off established trails, they are more likely to startle nesting birds or damage habitat.

4. Habitat Impacts

Unlike direct recreation impacts on wildlife, impacts on soils and vegetation are easier to measure and are well documented. Changes in the structure, density, and composition of vegetation can occur from recreation induced soil compaction and erosion (Lutz 1945, Harper et al. 1965, Dotzenko et al. 1967, Hopkins and Patrick 1969, Merriam and Smith 1974, Snyder et al. 1976, Manning 1979, Webb 1983, Cole 1986, Hammitt and Cole 1987, Briggs 1992, Briggs 1996, Cole and Spildie 1998, Deluca et al. 1998, Monz 1998). Macroporosity, water infiltration rates, and available nutrients are reduced once soil is compacted (Harper et al. 1965, Frissell and Duncan 1965, Settergren and Cole 1970, Young and Gilmore 1976, Cole 1986). Activities contributing to these changes include hiking, horseback riding, off-road vehicle use, camping, recreational shooting, and day use (Willard and Marr 1970, Manning 1979, Briggs 1996, Cole and Spildie 1998). Off-road vehicles can produce noticeable changes in the environment after just one pass (Webb 1983) and can cause runoff to be nearly eight times greater than in an undisturbed area (Snyder et al. 1976).

Current recreation may be preventing suitable flycatcher breeding habitat from developing where trampling and soil compaction are impeding regeneration. Trails, campgrounds, and facilities can fragment habitat to the point where it cannot become suitable. Where vegetation is sparse, even light use can prevent further development of dense lower stratas which are important to willow flycatchers. Cottonwood and willow often establish on open, unvegetated sand or gravel bars, which are also attractive to off-road vehicle users (Turner 1983, Stromberg 1997).

Increased water turbidity, bank erosion, water pollution, noise disturbance, and overwater movement resulting from watersports like swimming, tubing, fishing, and boating reduce suitability of habitat (Tellman et al. 1997).

5. Increase in Predators, Scavengers, and Nest Parasites

Where humans appear, an entourage of other animals causing disturbance soon follow (Ward et al.1973, Aune 1981). Unleashed dogs chasing wildlife, barking, and digging up animal burrows can cause as much or more disturbance as their owners. Food and garbage left behind by recreation users attract scavengers, predators, and nest parasites including feral cats and dogs, jays, common ravens (*Corvus corax*), great-tailed grackles (*Quiscalus mexicanus*), brown-headed cowbirds, skunks, ringtails (*Bassariscus astutus*), lizards, rodents, and squirrels (Aitchison 1977, Foin et al.1977, Carothers et al. 1979).

Horses can attract brown-headed cowbirds and potential predators, especially if a stable or corral is near the riparian area. The combination of an increase in brown-headed cowbirds and predators can significantly reduce willow flycatcher nest success (see Appendix F).

6. Decline in Bird Species Diversity and Richness

Birds disturbed during the breeding season may abandon nests or young, especially if eggs have not yet hatched, resulting in reproductive failure. Recreation can also alter parental attentiveness that increases predation risk, disrupts feeding patterns, or exposes the young to adverse environmental stress (Speight 1973, Gotmark 1992, Knight and Cole 1995).

Recreation can reduce environmental structure and complexity, which causes a decline in species diversity and richness (Hammitt and Cole 1987). Vegetation changes in and near campgrounds can cause bird species diversity to shift to more common and generalist species, while rarer and specialist species such as the willow flycatcher decline (Aitchison 1977, Guth 1978). Reduced shrub and tree densities, woody debris, and litter depth in campgrounds cause ground, shrub, and small tree nesters to decline (Blakesley and Reese 1988). Changes in vegetation at or near campgrounds result in loss of lower vegetation strata and regeneration, both important components to willow flycatcher habitat.

Day use can reduce the density of breeding birds. Park visitor activities (primarily pedestrians and cyclists) negatively affected breeding bird densities for 8 of 13 species in a study in the Netherlands (van der Zande et al. 1984). In a different study on the effects of shoreline recreation (boaters, cyclists, walkers, moped riders), 11 of 12 bird species were less abundant in areas of high vs. low use. The lower abundances were associated with between 8 and 37 simultaneous visitors per hectare (van der Zande and Vos 1984, Knight and Cole 1995).

Passerine abundance was strongly positively correlated with the volume of willows in a study in Oregon (Taylor 1986). However, results at one site were contrary to this trend. It had a low relative abundance of birds compared to the amount of vegetation. A large number of campers extensively used the riverbanks during May. Willow flycatchers were absent from this campground site, but were present at a number of other noncampground sites in this study.

E. Examples of Effective Long-term Recreation Management on other Endangered Species

Where heavy recreation use occurs, intervention has proven to be successful in reducing negative impacts to some wildlife species. Although expensive and time consuming, this may be the only alternative enabling recreation to co-exist with some wildlife species. The bald eagle breeding population has persisted near the Phoenix metropolitan area for the last 22 years primarily through the efforts of an active management program. Seasonal closures near nest sites, combined with around-the-clock monitoring help reduce impacts. This multi-agency program provides funding for a coordinator and seasonal "nestwatchers." During two bald eagle breeding seasons, 13,999 human activities and nearly 4,000 gunshots were recorded within 3/4 mile of 13 nests along major rivers in central Arizona (Arizona Game and Fish Department in prep.). Season-long nestwatchers help increase bald eagle nesting success by educating the public and guiding activity away from nests. With the increasing growth of communities in central Arizona and accompanying recreation, the future of the bald eagle breeding population is dependent on intensive management.

In New Mexico, conflicts between recreational mountain climbers and nesting peregrine falcons were eliminated by educating climbers and enforcing strict seasonal closure of climbing routes at nesting cliffs (S. Williams pers. comm.).

F. Current Recreation Use in Occupied Willow Flycatcher Habitat

The impact of current recreation use on occupied willow flycatcher habitat can be evaluated from two perspectives: 1) displacement and 2) effects on the existing population. We focus on the latter and what we can do as managers to protect birds and habitat, recognizing that some displacement of willow flycatchers by recreation activities and associated facilities may have already occurred. We identify the recreation impacts and management challenges at these sites.

1. San Luis Rey River, California

Nesting willow flycatchers occur in a day use area on the Cleveland National Forest along the San Luis Rey River, California. As with many recreation use sites, some nesting habitat was probably physically displaced by the parking lot and foot bridge. This area receives light use during the week, but heavy use on summer weekends, usually after mid-morning. Fortunately, most of the human use occurs later in the morning than the peak period for willow flycatcher activity. Much of the habitat is protected from direct human contact because a large proportion of the nests are placed in the naturally thick and thorny shrub layer or higher in the trees (W. Haas pers. comm., K. Winter pers. comm., Kus et al. 1999). However, recreationists did impact this site. One of 13 nest failures in 1999 was caused by human disturbance. The branch supporting a nest was cut (Kus et al. 1999). Recreation use can also potentially impact this site through accidental fire, increased predation by predators and scavengers attracted to trash cans, and increased use by anglers after stocking trucks empty fish into the river (W. Haas pers. comm.).

2. Kern River, California

The South Fork Wildlife Area supports a significant willow flycatcher population that is patrolled by Sequoia National Forest staff. When Lake Isabella rises, boaters and users of personal watercraft have access adjacent to the nesting habitat. A five mile-per-hour speed limit is enforced on Lake Isabella to control disturbance to nesting birds. Willow flycatchers are also nesting along a trail near the Kern River Preserve headquarters office. California Audubon closes this trail during the breeding season (M. Whitfield pers. comm.).

3. Mill Creek, San Bernardino National Forest, California

Nesting willow flycatchers occur at the Thurman Flats picnic area along Mill Creek on the San Bernardino National Forest, California. The willow flycatchers nest in the blackberry (*Rubus ursinus*) understory and in white alder trees (*Alnus rhombifolia*). The primary impacts to these nests are 1) disturbance by blackberry pickers and 2) predation by common ravens (*Corvus corax*), western scrub-jays (*Aphelocoma californica*) and Steller's jays (*Cyanocitta stelleri*):

1) The lush tangle of blackberries that would ordinarily protect nests from off-trail hiking attracts fruit pickers. The San Bernardino National Forest provides a weekend employee to monitor activities at this site and educate users during the blackberry season. In addition, part of the site is closed during the nesting season. Flagging is used to mark the perimeter and closure signs are placed around the nesting habitat informing users that this is a sensitive wildlife area.

2) Ravens and jays may have increased at this site, attracted to the picnic area and adjacent communities of

Forest Falls and Mountain Home. Some nests at this site have failed because of predation from jays or ravens (S. Loe pers. comm.).

4. Grand Canyon, Arizona

The Colorado River in the Grand Canyon is a popular rafting destination for 20,000 people each year (R.V. Ward pers. comm.). The National Park Service closed access to beaches adjacent to habitat where willow flycatchers were found during the breeding season, in an attempt to minimize disturbance. Tour companies and private permit holders were informed of the closures prior to beginning their river trips. Some of these beaches had been regularly used by commercial rafting companies, private kayakers and rafters, and backpackers (Tibbitts and Johnson 1999). Although closing beaches has not yet resulted in an increase in willow flycatchers at these sites, it demonstrates a significant positive action an agency initiated to protect this bird. Within the last few years, that policy changed because willow flycatchers did not reoccupy some previously occupied sites. Beaches are now closed only after willow flycatchers are found. For example, the beach at river mile 50.5 was closed after surveyors found willow flycatchers at the beginning of the 1999 field season. All commercial and private groups are required to check in with the Lees Ferry Ranger Station at the beginning of each trip. Each group is given current information on the status of nesting willow flycatchers and beach closures prior to each trip (R.V. Ward pers. comm.).

5. Hassayampa River Preserve, Arizona

Willow flycatchers have nested near a popular hiking trail at The Arizona Nature Conservancy's Hassayampa River Preserve for several years. The Nature Conservancy closes the trail during the nesting season to minimize disturbance to the willow flycatchers. In 1999, this trail remained closed during the nesting season as a protective measure even though no willow flycatchers were documented from surveys. Nesting probably did occur locally, because juvenile willow flycatchers were caught in mist nets in late July (M. Rigney pers. comm.).

6. Roosevelt Lake, Tonto National Forest, Arizona

Two willow flycatcher breeding populations at the inflows to Roosevelt Lake are managed by the Tonto National Forest. Disturbance from boaters is minimal, because they primarily use the lake area away from the currently occupied breeding populations. However, this area is heavily used by visitors from nearby Phoenix and the potential for recreation conflicts is significant. The Forest Service maintains a vehicle and fire closure at these sites, with perimeter fencing and signs. These closures substantially reduce the potential disturbance caused by off-road vehicles, day use, and camping (C. Woods pers. comm.). One newly occupied area outside the current closure is threatened by impacts from anglers and campers, with increased trailing and fire risk from campfires. Additional measures may be taken to reduce risk in this new area.

7. San Pedro River Preserve, Arizona

The San Pedro River Preserve, managed by The Nature Conservancy, was established to protect southwestern willow flycatcher habitat. Patrolling and maintaining the perimeter fence to prevent off-road vehicle and cattle trespass have been the most effective ways of protecting habitat and promoting regeneration.

G. Management Recommendations

Managing recreation can be accomplished by altering visitor behavior to minimize impacts. Recreation user control ranges from complete restriction to some acceptable level of use (Moore 1989, Briggs 1996). This can be accomplished in a number of ways, including requiring permits, collecting user fees, limiting number of visitors, constraining visitor access or activities, instituting zoning or periodic closures, and limiting the frequency and duration of use (Cullen 1985, Purdy et al. 1987, Klein et al. 1995, DeLong and Schmidt in prep). We provide the following management guidelines to reduce recreation impacts on southwestern willow flycatchers and their habitat:

1. Provide protected areas.

Keep campsites and heavily used day use areas away from areas to be developed or maintained for flycatchers. Ensure protected areas are large enough to encompass breeding, foraging, and post-fledging habitat. Discourage unauthorized off-road vehicle use in riparian habitat with fencing or physical barriers.

Direct vehicles, boating, swimming, tubing, and fishing away from unoccupied and occupied suitable habitat, especially during the breeding season, where impacts are likely to negatively impact habitat or flycatcher behavior. Where potentially suitable habitat has been identified as future southwestern willow flycatcher habitat, these activities should be minimized to allow habitat to develop.

2. Reduce impacts from recreationists by promoting stewardship, educating users and maintenance workers, reducing unpredictable activities, reducing motorboat impacts, providing visual barriers, and reducing noise disturbance. Examples of how this can be accomplished are provided below:

Promote stewardship

Encourage individual recreationists and user groups to support riparian conservation, review management plans, and generate funds. Support their efforts to sponsor riparian clean-up, trail maintenance, field trips, on-site monitors, and development and distribution of interpretive materials.

Educate users and maintenance workers

Sponsor programs and post signs that educate users about the value of riparian habitat to sensitive species. Clearly mark trails, campgrounds, and revegetation areas. Educate equestrians, boaters, and tubers about the value of overhanging branches to nesting birds. Encourage them to avoid trimming overhanging branches. Discourage campers and day users from feeding birds, to prevent increases in jays, ravens, and cowbirds.

Reduce negative impacts of annual or periodic maintenance

Ensure all facilities and grounds workers conduct activities compatible with protecting riparian habitat and species. Conduct annual or periodic maintenance outside the breeding season.

Reduce unpredictable activities

Design wildlife recreation activities that are predictable for wildlife (DeLong and Schmidt in prep). For example, provide well-marked trails or boardwalks to a) encourage controlled and predictable use, and b) discourage off-trail hiking and creation of alternate routes.

Reduce motorboat impacts

Reduce rapid overwater movement and loud noise, such as wake and noise from motorboats through speed limits and designated use areas (DeLong and Schmidt in prep).

Provide visual barriers

Increase distance between disturbance and wildlife or provide visual barriers (DeLong and Schmidt in prep). Provide a natural vegetation buffer in day use areas and along trails.

Reduce noise disturbance

Minimize noise disturbance near southwestern willow flycatcher breeding habitat. Birds are sensitive to vibration, which occurs with low-frequency noise (Bowles 1995). Such efforts include rerouting trails and day use areas away from occupied habitat, controlling the number of visitors, relocating designated shooting areas, and discouraging the use of electronic equipment (radios, “boom boxes”) and off-road vehicles near breeding locations.

3. Confine camping areas.

Evaluate whether confining camping to a small concentrated number of campsites is less detrimental to wildlife and habitat than dispersal over a wide area. Institute fire bans when danger is high or where habitat is vulnerable, e.g., areas dominated by tamarisk (*Tamarix* spp.) See Appendix L for further guidelines. If campfires are authorized, confine them to fire boxes. Limit or prohibit fuel wood collecting in riparian areas.

4. Ensure fire plans are current, operable, and enforced.

Ensure fire fighting equipment and personnel are available.

5. Restore habitat impacted by recreation.

Where needed, post signs that explain the importance of habitat restoration, fence habitat, and/or temporarily close trails and use areas (Craig 1977). Because restoration of recovering habitat can be impeded by recreation, it is important to evaluate its potential for success before forging ahead with a project. For example, in a study of 27 riparian restoration projects, recreation was at least partly responsible for ecological deterioration of two sites and impeding recovery efforts at two other sites (Briggs 1992, Briggs 1996).

6. Place designated recreation shooting areas away from riparian areas.

Designated shooting areas used for target practice should be located away from riparian areas to minimize physical destruction of habitat and noise disturbance.

7. Minimize attractants to scavengers, predators, and brown-headed cowbirds.

Where recreation users congregate, provide adequate waste facilities (covered trash receptacles, restrooms) and regular collection service. Place horse stables away from suitable and occupied habitat. Avoid use of bird seed feeders that use cowbird preferred seeds such as millet.

8. Provide on-site monitors and enforcement where recreation conflicts exist.

Where potential recreation conflicts exist and total closure is not practical, provide on-site monitors to educate users and control use. Increase surveillance and/or impose fines for habitat disturbance or damage.

H. Personal Communication

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Kent Turner. Lake Mead National Recreation Area. Boulder City, Nevada.

R.V. Ward. Grand Canyon National Park. Flagstaff, Arizona.

Mary Whitfield. Kern River Research Center. Weldon, California.

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Craig Woods. Tonto National Forest. Roosevelt, Arizona.

I. Literature Cited

Please see Recovery Plan Section VI.

Note: The Tribal Working Group of the Southwestern Willow Flycatcher Recovery Team developed the following issue paper for purposes of identifying issues relative to recovery of the flycatcher on Tribal lands, promoting a more thorough understanding of these issues and potential resolutions, and engaging the Service in a collaborative approach to recovery. As such, the ideas and opinions expressed herein are those of the Tribal Working Group, and are not necessarily representative of the views of the Service or the Department of the Interior.

Appendix N.

Tribal Perspectives on Southwestern Willow Flycatcher Management and the Endangered Species Act

A. Introduction

To speak with one voice for all the Indian Tribes in the Southwest Region that have a stake in willow flycatcher management and the recovery of endangered species is not possible. There are probably as many approaches to this issue as there are Tribes. It is possible that many Tribes, beyond disagreeing with the notion of acceptance of and cooperation with the Endangered Species Act (ESA), would be hesitant to even participate in this dialogue. Therefore, this paper in no way intends to speak for every Tribe in the United States or even the Southwest Region. Instead, the ideas presented here represent a consensus among some Tribes that believe there is room for dialogue with the U.S. Fish and Wildlife Service on ways of improving the Federal/Tribal relationship as it relates to endangered species management. While many of the problems surrounding this issue remain extremely sensitive and contentious, some Tribes have established the basis for a new type of relationship with the Service, based on mutual respect for each other’s goals, and the desire to move beyond a structured legal relationship to a more problem-solving approach.

B. Background

Before we explore aspects of willow flycatcher recovery, it is important to provide some background on the Endangered Species Act as it relates to Tribal interests. Before this is possible, however, some history of the Federal/Tribal affiliation is necessary. This relationship is built on the foundations of several principles which have been refined through many court decisions and the directives of several Presidential administrations. By far, the most important and pervasive of these are concepts are Tribal Sovereignty and Trust Responsibility.

Tribal Sovereignty

The inherent sovereignty of Indian Tribes and nations has long been recognized by the United States Government and has been reiterated extensively in recent years within the context of natural resource management. As sovereign nations, Tribes and Tribal lands are not subject to the same public laws which govern other lands within the United States, either public or private. It has been legally well-established that inherent in the establishment of a reservation is the right of Indians to hunt and fish on reservation lands free from state regulation. Cases such as the Menominee Tribe v. The United States (1968), Washington v. Passenger Vessel Association (1979), New Mexico v. Mescalero Apache Tribe (1983), Arapahoe Tribe v. Hodel (1990), and Minnesota v. Mille Lacs Band of Chippewa Indians (1999), have cemented this precept. Some of these rights are based on treaty rights, but many follow from the mere establishment of a reservation and the rights inherent therein. Congress can, if it specifies, deny a hunting or fishing treaty right, as it did when it prohibited Indians from hunting eagles under the Eagle Protection Act. Absent this clear congressional intent, however, hunting and fishing rights are not extinguished and may even be upheld for off-reservation lands (including both public and private land) where a Tribe has a strong enough treaty claim. This concept was established by United States v. Winans (1905). In general, however, Congress has not used its authority extensively to regulate Indian hunting and fishing and the matter has been left to Tribal regulation.

Although Congress does have authority to restrict some Tribal wildlife practices, it is unclear whether or not the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (the two agencies responsible for enforcing the Act) have authority to enforce the ESA on Tribal land, as there has never been a court case which has specifically tested the issue. At the heart of the matter is the question of what was Congress' intent when it established the ESA. The ESA does not specifically mention Tribes, and other court cases have upheld the concept that, unless Tribal treaty and other rights are specifically abnegated by an act of Congress or a particular piece of legislation, that they remain in force. In the case that came the closest to testing this question, United States v. Dion, a Tribal member was convicted of taking a bald eagle for ceremonial use. The statute under which the case was prosecuted, however, was not the ESA, but the Eagle Protection Act. The ESA question was left unanswered.

Given this ambiguity (not to mention the potential for costly and lengthy litigation), many Tribal leaders and natural resource managers would just as soon work out these conflicts with cooperative agreements with Federal and State officials, rather than in the courts.

All of the above is not to imply that Indian Tribes are unwilling to work with the ESA or even see it as a burden. In fact, some Tribes would like the ESA to apply on Tribal land, and application of the Act has brought benefit to some Tribes, especially in regard to protection of dwindling fish stocks in the Pacific Northwest and the Great Lakes region. For example, the Pyramid Lake Paiute Tribe in Nevada and other entities used the ESA to achieve listing of the cui-ui fish in Pyramid Lake, and to protect water resources and reduce diversions from the Truckee River. In the Pacific Northwest off-reservation treaty fishing rights are often protected by mandatory conservation measures which are backed with the strong arm of the ESA.

All this legal maneuvering, of course, does little to help endangered species themselves. Consequently, a dialogue has arisen between some Tribes and the Fish and Wildlife Service about whether it is possible to set aside differences over interpretation of the ESA and other laws and instead concentrate on cooperative policies that can be adopted to help endangered species and their habitat.

Trust Responsibility

While it has been well-established that Indian Tribes in the United States are sovereign nations, the U.S. is legally required to act as caretaker for Indian interests, including the protection of the health, welfare, and land resources of Indian people. In other words, Indian land and resources are held "in trust" by the U.S. Government, a policy known as the government's trust responsibility. In managing trust lands or assisting Tribes to do so the Government must act for the exclusive benefit of Tribes, and ensure that Indian reservations are protected and used for the purposes for which they are intended: to provide for the physical, economic, social, and spiritual well-being of Tribes. Reservations were not set aside as parks, critical habitat for endangered species, or even, for that matter, for protection of wildlife, except as this will directly benefit the Tribe for which the reservation was created. Tribal lands do harbor some of the most wild and scenic places on the continent and Tribal lands in many cases harbor far greater biological diversity than the surrounding public or private land. Nevertheless, reservation lands are primarily the ***home*** to the people who live and work there and were created for the safe haven, ecological, social, and economic benefit of the Indian people.

The interaction of the concepts and practices of Tribal sovereignty and trust responsibility are often complex and occasionally contradictory as Tribes and the government struggle to protect Indian interests while at the same time allowing Tribes as much leeway as possible to manage their own affairs.

In the matter of natural resource or wildlife law several other Executive Branch administrative directives also bear directly on the relationship of the U.S. Fish and Wildlife Service and other Interior Department Agencies to Tribes:

Secretarial Order 3175 (November 8, 1993) and Interior Departmental Manual 512 DM 2.

These documents require all Interior Department agencies to identify potential effects from their activities on Indian trust resources and to have meaningful consultation with Tribes where Department activities effect Tribal resources, either directly or indirectly. This Order also directs Interior Agencies to remove procedural impediments to working effectively with Tribal governments, to consult with Tribes on a government-to-government basis where trust resources are affected, and to identify potential effects on Indian trust resources of Department plans, projects, programs, and activities.

Presidential Memorandum of April 29, 1994.

This document reminds all Executive Branch Departments and Agencies of the government-to-government relationship between Indian Tribes and the United States and requires these Departments to consult with Tribal governments to the greatest extent practicable prior to taking actions that affect Tribal governments; to assess the impact of Federal activities on Tribal trust resources; and to ensure Tribal rights and concerns are taken into account during plan development and program implementation.

The Native American Policy of the U.S. Fish and Wildlife Service, June 28, 1994.

This policy reiterates the government-to-government relationship and establishes a framework for joint projects and formal agreements. It also directs the Service to assist Tribes in identifying Federal and non-Federal funding sources for wildlife management activities, and provides a framework for the Service to give technical assistance to Tribes, where requested. While the Service has been helpful to Tribes from a technical standpoint, many Tribes feel that funding has been hard to get. The "Partners for Fish and Wildlife" program has provided some funds, but these are often for small-scale projects.

Secretarial Order 3206, June 5, 1997.

This is perhaps the most far-reaching of the Executive Branch Directives and has been very well-received by most Tribes. It also has potentially the greatest impact on how Tribes and the Federal government manage endangered species. While some have suggested that the Secretarial Order gives Tribes the rights to manage endangered species on their own land, this is far from true. The Order specifically states that it "shall not be construed to grant, expand, create, or diminish any legally enforceable rights, benefits, or trust responsibilities . . . under existing law." and it "does not preempt or modify the [Service's] statutory authorities." It actually re-acknowledges the trust and treaty responsibilities of the U.S. Government and instructs Federal agencies to "be sensitive to Indian culture, religion, and spirituality", the basis for which often relies on the use of natural resources. It also reminds Interior Departments that Indian lands are not subject to the same controls as Federal public lands; instructs them to recognize that Tribes are the appropriate governmental entities to manage their lands and resources; and instructs them to support Tribal measures that preclude the need for conservation restrictions. At the same time, the Order strives to harmonize Tribal concerns and interests about the ESA with Federal mandates to enforce it; and it allows for Tribes to develop their own conservation plans for listed species that are more responsive to Tribal needs.

Executive Order No. 13084, May 14, 1998.

This Presidential Order instructs all executive branch agencies to establish a process whereby elected officials and other representatives of Indian Tribal governments may provide meaningful and timely input in the development of regulatory policies on matters that significantly or uniquely affect their communities. Interestingly, it also instructs agencies, to the extent practicable and permitted by law, to consider any application by a Tribal government for a waiver of statutory or regulatory requirements with a general view toward increasing opportunities for flexible policy approaches. This opportunity for administrative flexibility has the potential to play a key role in how the Service implements endangered species recovery on Tribal land.

C. Tribal Concerns About the Endangered Species Act

Because Indian Tribes as Federal trustees are so dependent on Federal funding, a wide array of activities on Indian lands can trigger Section 7 consultation -- many more so than on private land where the Federal presence and the connection to Federal activities is not so extensive. Approvals for nearly every type of development project require Federal procedure or consultation of one sort or another. While the intent of these regulations is to protect Indian resources, the occasional side effect can be an excessive bureaucracy which slows even the most benign types of projects.

In recent years many Indian Tribes in the United States have become wary of the intent of the Endangered Species Act and the manner in which it is applied on Tribal lands. Many Tribes feel that they have been far better land stewards than the vast majority of private land owners and even some Federal land management agencies, and consequently have a higher proportion of endangered species on their land. In addition, most Indian reservations are far less “developed” (i.e., have a higher proportion of rangelands, forests, or de facto wilderness) than surrounding private or public land. This means that Tribal lands have the potential to act as a safe haven for some endangered or rare species which are driven off surrounding private land as it is developed. Tribes feel that they have been penalized for this good stewardship by having restrictions placed on development activities, and being told what they can and cannot do on their own land, which is viewed as a direct affront to Tribal sovereignty. While Tribes want to keep vast areas of resource use on their reservations, they don’t want to be penalized for not having “urbanized” yet.

A more far-reaching concern of Tribes is the use of some species for religious, cultural, or ceremonial purposes. Considerable conflict has arisen in the past about Indian use of eagles and eagle feathers. Some of the cases have ended up in Federal courts and even the U.S. Supreme Court. Nearly all Indian Tribes in the United States revere bald and golden eagles and use the birds’ feathers or other parts in ceremonies or dances. The fact that this bird has become endangered has led to severe restrictions on its take. Currently individual Tribal members must apply to the Service through the National Eagle Repository to obtain eagle carcasses and feathers, a process which can take as long as 3-4 years. While many Tribal members understand the need for this process, many view it as a direct affront to religious freedom and feel frustrated by the delays entailed in applying for an eagle.

While some latitude has in the past been given to Tribes to take such species, any take may be considered a violation of the ESA, The Migratory Bird Treaty Act, The Lacey Act, or other Federal or state wildlife laws. Again, court cases have led to conflicting interpretations about under what circumstances a Tribe or an individual Tribal member can “take” a species for cultural or religious purposes, and what types of permits are needed. Some Tribes are working cooperatively with the Service to permit some of these activities.

Within the context of the ESA, previous endangered species recovery plans have done a poor job of integrating Tribal concerns. While some Tribes were included at the level of “stakeholders” or “interested parties”, their participation, comments, or suggestions carried no more weight than if they were a large private land owner in the region. For example, the Tulalip Tribes of the Northwest have charged that they were largely ignored in the Section 7 consultation during a major Habitat Conservation Plan. Several other Tribes in the Southwest were shocked to find that critical habitat for the Mexican Spotted Owl had been designated on Tribal land without prior consultation. Tribal leaders and land managers from one Tribe found out by reading about it in the Federal Register. Critical habitat for the Rio Grande silvery minnow was also declared on Pueblo Indian land in New Mexico, over the objections of Tribal leaders. Many other instances exist where Tribes were inadequately brought into the process of Section 7 consultation, despite the fact that species recovery plans had the potential for major impacts to Tribal resources, particularly water rights. For example, recovery plans for endangered San Juan River and Colorado River fishes were driven by court-ordered deadlines which did not leave time for adequate consultation with Tribes. Many instances such as these could easily have been better handled simply through better communication, and many Tribes hope to alleviate some of these misunderstandings through increased cooperation.

1. Endangered Species and Tribal Water Rights

Tribes are watching closely to determine whether or not species recovery means a change in the status of water rights, water availability, and water use. Like many private land owners, Tribes make active use of the region’s critical water supplies for farming, ranching, drinking water, and recreation. In a region where water is depended upon by so many entities, battles over who controls how much water are inevitable. Many Tribes along the Rio Grande are already involved in issues surrounding another endangered species, the Rio Grande silvery minnow, and while they are generally supportive of protection for the minnow, they are wary of shouldering a large share of the burden for this species’ recovery.

For Tribes, the issue of recovery of many riparian species and talk of protection of riparian habitat is inextricably linked to water rights. In all but a few instances in the Southwest, Indian water rights are senior to those of nearly all other users, dating back at least to the date of the establishment or U.S. Government recognition of a Tribe’s reservation (many Tribes justifiably believe that their water rights extend much further back than this). These water rights are generally “Federal reserve water rights” meaning when Indian reservations were created, although water rights were not specifically addressed, it was clearly the intent to include them, because any establishment of a reservation without concurrent rights to its water would have been ridiculously unfair, since the reservations were created for the “beneficial use” of the Indian people. This concept is referred to as the “Winters

Doctrine" and is one of the cornerstones of Indian Water Law. Recently, this doctrine has been affirmed to apply to both surface and ground water.

In some cases due to lack of funding or the very slow water rights process, the rights in a basin or a river have been adjudicated or otherwise fully determined. Despite this, water development has gone on apace, with dams, diversions, and other uses. When the water rights in an area are finally determined, it is quite likely in most cases that Tribes will have rights senior to all other users. In other cases the water rights have already been adjudicated, though Tribes for whatever reason (normally lack of capital) have not made full use of their water rights.

In addition -- and this is the key point -- these water rights are not subject to forfeiture due to non-use, and thus may be exercised at any time in the future, while still retaining their senior priority. This becomes problematic, however, when a watercourse is already fully appropriated and further water use has been deemed to jeopardize a listed species. This is a very difficult question: how to protect species while at the same time preserving water rights. The issue is especially nettlesome to Tribes since, in most cases, it was not Indian appropriation of water that has led to loss of habitat and listed species jeopardy. Now that the species are declining and restrictions are being put on water use, Tribes are wary of not being able to fully exercise their water rights. Tribes become very uncomfortable with the assumption that, by exercising a Federal reserve water right, they are going to jeopardize a threatened or endangered species.

2. Federal/Tribal Cooperation on Endangered Species

The diversity of opinion about Federal/Tribal relations has led to a contentious history of differing interpretations over Federal/Tribal resource jurisdiction. Nevertheless, the Service and many Tribes have expressed a willingness to work together on endangered species issues. Some Tribes in the Southwest region are optimistic that, beginning with this willow flycatcher recovery plan, the Service and affected Tribes can begin to move in a new direction. Within the last few years, many Tribes have gained considerable natural resource management expertise and this experience is being recognized by the Service and other Federal agencies. Doors are being opened for Tribal participation on a broader level among agencies such as the Bureau of Reclamation and the Environmental Protection Agency, and many Federal agencies are hiring Native American Liaisons or offering entire Tribal programs. The intent of the above-listed Federal directives is to establish policies whereby input from concerned Tribes can become a regular and critical part of resource planning initiatives, and to cement the process for Tribal participation. Tribes welcome these changes and are beginning to take full advantage of them.

Some Tribes have moved forward in an effort to establish new parameters to the way Indian Tribes and the Service interact. The White Mountain Apache Tribe and the Pueblo of Zuni have established "Statements of Relationship" (SORs) with the Service. These documents set up a framework by which the Service and the Tribe could, while recognizing differences of opinion or interpretation, work through problems toward a common goal of promoting biodiversity and healthy ecosystems. The SORs reaffirm Tribal sovereignty, while recognizing the Service's technical expertise and the ability to assist the Tribe with complex management issues. This has become possible in part because Tribes have increased their technical capabilities and infrastructure, but also because a new framework for open dialogue has been developing whereby Tribes feel that many of the issues they have been long advocating are being taken seriously. Central to this approach is the Service's use of some of its administrative flexibility to work with Tribes to come up with mutually satisfactory solutions to seemingly intransigent wildlife and resource issues.

One example is the Pueblo of Zuni's recent initiative to alleviate the wait for eagle feathers for Tribal members by constructing the only Native American-owned eagle aviary in the country. With the close cooperation and assistance of the Service and several private foundations, Zuni has received permits and constructed a facility to care for non-releasable (e.g., from permanent injuries or due to human imprinting) bald and golden eagles. The molted feathers from these birds are distributed to Tribal members, and the Tribe is looking into expanding the facility to include a captive breeding facility. This is a good example of how the Service used some of its administrative flexibility to assist the Tribe in adopting a unique and innovative solution to a vexing problem.

Tribes have also been lobbying for more of a voice in endangered species recovery. When the initial steps were taken toward a recovery plan of the southwestern willow flycatcher, some Tribes expressed dismay at the relatively low level of Tribal involvement. Initially, Tribes were grouped with other "stakeholders" (numbering in the many hundreds). Tribes believed that their voices were being unduly diluted, given the large amount of flycatcher habitat on Tribal land. Under Secretarial Order 3206, Tribes have considerable authority to begin to manage endangered species on Indian land. Under the auspices of Tribal sovereignty, each individual Tribe had more endangered species management authority than, say, the individual states that were involved in the process. If a Tribe is unhappy with the process, it can opt not to participate and develop its own plan. In deciding whether or not to sign on to this process, most Tribes need to ask what benefits it could provide them.

Given the tentative nature with which Tribal leaders and land managers have approached endangered species issues, there were several reasons why the southwestern willow flycatcher recovery gives us cause for optimism. The goal of the recovery process, of course, is not only higher populations of this particular bird, but improved riparian areas in general. For many Tribes in the Southwest, the rivers and streams that cross their land provide critical areas for plant and animal collection, recreation, and cultural and religious use. Tribes see riparian protection as an excellent long-term goal. In only a few generations Tribes have seen these areas severely degraded, mainly from human induced changes, some of these changes have unquestionably provided benefits to Tribes, but many of which Tribes had no say in implementing. To restore riparian and wetland habitat and to improve these critical ecosystems is a goal that all Tribes in the region can support.

D. Where Do We Go From Here?

The current climate presents opportunities for significant improvement over what has been a contentious history. The Service and other Interior agencies have considerable administrative flexibility to work cooperatively with Tribes and more actively seek their input and guidance when dealing with endangered species and other region-wide initiatives. Some of the Executive Directives instruct agencies to use this flexibility. It should be remembered that even if a project or consultation may not appear to affect a Tribe's resources, there may be aspects of the situation which are not immediately apparent (such as off-reservation treaty rights, water rights, or the presence of traditional cultural properties that may give a Tribe a stake in the management of certain resources).

The Service has taken great strides to achieve concrete results. Tribes applaud the appointment of several Tribal members to serve as "Native American Liaisons" within the Service, and the creation of Interior Department directives which are favorable to a more cooperative environment. Tribes have also been offered more meaningful participation on regional planning initiatives all over the country, from the operations of the Glen Canyon Dam, to recovery of Northwest salmon stocks and dozens of other issues.

1. Suggestions for Meaningful Tribal Participation

In order to further the blossoming cooperation between Tribes and the Service, the following suggestions are offered:

1. Increased Communication. Many of the past problems outlined in this paper could be avoided with open, honest communication, which may necessitate a massive re-structuring in which way consultation is carried out. Tribes must be kept involved at a meaningful level and treated as equal partners. This does not mean informing Tribes post-facto about management or listing plans that have already been developed. Tribes need to be involved in the earliest stages of planning. Differences in the capabilities of Tribes present challenges to this type of cooperation. Some Tribes already have well-developed natural resource departments but many do not; the rates of communication within a Tribe may work at a different rate than in the Federal government, and adequate time for full consultation must be planned. This is already being done by some Interior Agencies which have used their administrative flexibility to allow Tribes to participate at a higher level than in previous years.

2. Remove Disincentives for Conservation. Vast areas of Tribal land have remained deliberately undeveloped and provide considerable habitat for both endangered and common species. Tribes and other land owners should not be penalized for having maintained good habitat, which might harbor a listed species, or providing improved habitat which brings willow flycatchers or other listed species onto their land. On June 17, 1999 the Fish and Wildlife Service issued its "Safe Harbors" policy, which is gaining

recognition within the Service as a way to encourage private land owners and Indian Tribes to restore and protect wildlife habitat without fearing the repercussions of having endangered species use that habitat. “Safe Harbors” works with Tribes (or other non-Federal land owner) to develop a “time zero baseline” which determines (1) the current population level of a listed species on a particular piece of property; and (2) how long it might take to improve the habitat to provide a net conservation benefit to the species. The Service assures the land owner that, at the end of that time they can, if they wish, return the land to the state in which it was at time zero (the baseline) without worrying that they may be altering habitat for a listed species that may have since moved onto their land. In other words, they will not be penalized under the ESA for any habitat destruction as long as it is at least as good as it was at time zero.

3. Protect Tribal Water Rights. Any discussion of water resources and any recovery plans which dictate or imply a change in water use should be done taking full account of Tribal water rights and water resources. Specifically, when developing an “environmental baseline” by which to gauge the status or trends in a species’ population, Tribal reserved water rights (even those not yet developed) need to be factored in. Where a species is affected by a Federal water project, the courts have held that the projects must be consistent with the protection of senior Indian water rights. Before Indian water rights are affected, junior users should bear the brunt of the restrictions. Before *any* users are affected, however, detailed and thorough consideration should be given to water conservation measures which would make more water available to all users. However, given the lengthy and complicated nature of water rights negotiations or adjudication, parties should not let unresolved water rights issues hold up conservation planning.

4. Do Not Declare Critical Habitat on Tribal Land Without Consent. Even with consent, before critical habitat is declared, the impacts of this designation on Tribal economies and natural resource management operations should be evaluated. If an alternative to critical habitat designation would be equally effective in preserving and recovering a species, this alternative should be implemented in lieu of critical habitat designation on Tribal lands.

Where designations of critical habitat are essential and where Tribes want to fully participate in the recovery process, one approach might be for the Service, in cooperation with Tribal biologists, to designate a target of a certain amount of habitat which should be maintained in a certain condition, and then let the Tribe decide which areas to protect. In other words, the Service and a Tribe could agree on a “big circle” of potential range or habitat for a species, and within this big circle, identify a set amount of habitat targeted for a certain condition. For example, for a riparian species, the Service and the Tribe might agree that 2 miles of stream on a reach of 8 miles needs to have stable banks, vegetation at ***x*** feet high, and an average canopy cover of ***y*** percent. It would then be up to the Tribe to identify the areas it wishes to manage towards these conditions.

5. Provide Funding. Some Tribes have well-developed natural resource management departments which have made considerable strides in rehabilitating riparian areas and wetlands. Some of these projects have received national recognition and praise. However, this work is technically complex and very expensive. The Fish and Wildlife Service should, through every mechanism available, seek funding for Tribal initiatives which foster the recovery of the willow flycatcher. Recovery is a Federal responsibility and the Federal government has an obligation, since it is they who list species, to assist Tribal and State governments seek funding and assistance for recovery. Both Secretarial Order 3206 and the U.S. Fish and Wildlife Service's Native American Policy direct the Service to seek funding for Indian projects. Tribes, of course, should also seek their own sources of funding which will complement Federal sources.

6. Continue implementing Secretarial Order 3206. This directive was very positive in defining the Tribal/Federal relationship over endangered and sensitive species and should be upheld and referred to as a positive model for open dialogue.

7. Respect for Cultural Values. Many Tribal religious, social, and cultural beliefs are based on the concept of reverence for the earth and all its creatures. In conducting business with Tribes and in dealing with Tribes, land managers from Federal and State agencies should be aware of and sensitive to these values. In addition, many Tribal cultural practices use wildlife in a way to which the Service may not be accustomed. Where they impact wildlife, either endangered or common, care must be taken in discussing alterations of any cultural practices. These values may often be at odds with Federal concepts of conservation.

8. Manage for multiple uses. While caring for and protecting the environment is paramount to Tribal land managers, most Tribes want control over the way they use their own land, and this often means more than one use for the land. Woven into the culture are activities such as hunting, fishing, ranching, farming, and collecting which are just as much a part of the value systems and way of life as environmental protection. As stated above, many Tribes feel that they have been unfairly treated by laws such as the ESA which have allowed extensive development on non-Indian lands, leaving Tribal lands as a refuge for rare and endangered species, which are now illegal to make economic use of. Tribes are not in favor of developing land which will lead to the loss of species or the depaupering of the biological diversity on their lands; yet

some development is necessary in order for Tribes to maintain sovereignty and a level of economic independence which even begins to approach that of the non-Indian society in the United States.

9. Confidentiality of Tribal information. All Tribes have serious concerns about what will happen with any information that is gathered concerning the location and numbers of endangered species, habitat, or water quantities. Unfortunately, this often acts as a large stumbling block which inhibits Federal-Tribal cooperation. Tribes need to be assured that information collected during the course of research, inventories, or other management activities will not be subject to disclosure to the general public. This is definitely true for information which the Tribe gathers on its own, but also includes information which may be gathered when public employees and resources are involved. The issue goes far beyond natural resource management, and the confidentiality of information is a cornerstone of a Tribe's sovereignty, self-governance, and spiritual and religious power. This will no doubt be a very difficult precept to implement. Recent case law, such as a 9th Circuit Court decision involving the Klamath Tribes (1999) have held that if any Federal employees, such as Fish and Wildlife Service personnel, were involved in a project, the public has a right to petition for disclosure of information. Ultimately the Tribes had to turn over sensitive information for public review despite initial assurances from the Service that would not have to do so. The Service, apparently, did not have the power on its own to provide that assurance.

2. Specific Recommendations for Implementing Willow Flycatcher Recovery

While the above recommendations speak to implementing the ESA on Tribal lands in general, we have several more specific recommendations for implementing willow flycatcher recovery.

1. A Tribal representative should be placed on the willow flycatcher technical team as a liaison or voting member. While the technical team at present represents the best ecologists in the fields of willow flycatcher ecology, riparian systems, grazing, and other biological aspects of recovery, there may be some points of view or aspects of the physical recovery process that are not represented on the team. Many Tribes working with flycatchers on their land have natural resource specialists who can be brought up to speed on many of the crucial issues concerning the recovery process, and can add significantly to the recovery discussion. Having a representative with Tribal interests in the forefront will also alleviate some of the discomfort Tribes feel in dealing directly with the Service. Thereafter Tribes can work directly with the Technical Subgroup as an extension of the Regional Director.

2. Tribal natural resource personnel should be fully trained in the willow flycatcher survey protocol and

should devote significant personnel to planning and implementing surveys. This may present a significant change in direction for some Tribal wildlife departments, and some Tribes may not have sufficient resources to carry out surveys. In that case, Tribes should seek the assistance of either the Bureau of Indian Affairs or the Fish and Wildlife Service in carrying out surveys. Like states, many Tribes rely on big game as a source of revenue to fund their operations. A shift toward non-game wildlife management might mean allocating resources toward species which will raise no revenue for the Tribe. Nevertheless, if Tribes want to be viewed as equal partners in this process, they need to allocate technical and financial resources to non-game programs, including willow flycatcher monitoring and management.

3. Information collected by Tribes should remain in the custody of Tribes, but Tribes will share summaries of the information, or provide Service or Technical Team personnel access to files on Tribal land with the understanding that the files or photocopies will not be released. This may be difficult in cases where Tribes need to have outside agencies such as the Service perform the surveys. This is a very sensitive issue and potentially one which could lead Tribes away from cooperating in flycatcher surveys, which would work against the conservation of the resource and recovery of the flycatcher. Written agreements should be made with the Service concerning the collection and storage of data.

4. If a Tribe has a riparian restoration plan or is thinking about developing one, it should strongly consider implementing a Safe Harbors Agreement with the Service.

5. The Service, at the request of Tribes, should offer to do an assessment of Tribal riparian habitat, to delineate which areas are likely to provide the best habitat. Perhaps an even better approach would be to provide direct funding to Tribes to enable them to carry out this type of evaluation on their own (under the technical guidance of the Service). Tribes realize that the Service, like many Federal agencies, is under a tight budget. However, Tribes cannot reasonably be expected to take on the additional burden of endangered species management or willow flycatcher habitat assessments without additional funds.

6. Include suggestions for region-wide water conservation in any recovery plan. Protection of endangered species does not always automatically mean a total abandonment of all forms of development or severe impacts to Tribal and non-Tribal water rights. If species can be protected through conservation measures, this is always preferable to other alternatives and there may be relatively little change in the way sustainable development is carried out. In the case of riparian obligate species such as the flycatcher, water conservation could play a big role in assuring that Tribes and other private land owners can continue to use

water to their advantage while still offering a means of protection to listed species.

7. For their part, Tribes should be as open as possible and as committed as practicable to the recovery process. This may mean divulging information or allowing Federal land managers onto Tribal land so an evaluation of populations or habitat can be conducted.

We believe that if the above recommendations are implemented, they will go a long way toward alleviating Tribal concerns, and will allow Tribes to willingly participate at a level which has heretofore not been achieved. Given the positive atmosphere that is emerging in the Service and among many Tribal leaders and resource managers, now is the time to form the foundations of a solid cooperative working relationship. This will only serve to foster increased conservation, a healthier environment, and more harmonious Federal/Tribal relationships.

Appendix O.

Summary of Comments on the Draft Recovery Plan

On June 6, 2001, the USFWS published in the Federal Register (66 FR 30477) an announcement of the availability of the draft Southwestern Willow Flycatcher Recovery Plan, and opened a 120-day comment period. The comment period was subsequently reopened for a period of 60 days extending through December 10, 2001 (66 FR 51683). More than 500 copies of the Recovery Plan were directly distributed to Federal and State agencies, private interests, and Congressional members in New Mexico, Arizona, California, Utah, Colorado, Nevada, and Texas, as well as more than 200 Implementation Subgroup members. The draft Recovery Plan was also available on a USFWS Southwest Region website.

Responses to 87 significant issues identified in comments received by the USFWS are included in this appendix. The USFWS appreciates the interest expressed and the information shared by the commenting parties; many comments led to changes in the draft Recovery Plan. The USFWS hopes that the final Recovery Plan reflects the high degree of collaboration and cooperation that has shaped this planning effort over the last five years.

<u>Issue #1</u>

Comment: The Services policy states a recovery plan delineates, justifies, and schedules the research and management actions necessary to support recovery of the species. Much of the rationale in the draft Recovery Plan fails to show a clear relationship between the task and flycatcher recovery. Some tasks are derived from appendices that acknowledge that many recommended actions may not be appropriate for all situations, but this is not adequately reflected in the Recovery Plan portion of the draft Plan, where tasks are described as universal goals.

Response: The Recovery Plan has been revised in response to this comment.

The approach of the “issue papers” provided in the Plan’s appendices is described on pages 2 and 3 of the Introduction. The appendices provide a broad background of information, full analysis of the threat or management issues, and in some cases, specific justification for the recovery strategy/action used in the body of the Plan. In some cases, an appendix contains information that is useful for understanding the context of a threat to flycatcher recovery, but may not be directly applicable to management recommendations.

The Plan has been revised to bring forward important information from the appendices into the Recovery Plan in order to describe the rationale for specific recovery actions/tasks. A summary of the nine categories of Recovery Actions is provided in the Executive Summary (page vi). The details of the Recovery Actions are presented in the Stepdown Outline of Recovery Actions (Section IV.D.) and Narrative Outline for Recovery Actions Chapter IV Recovery (Section IV.E.). These two sections have been revised in response to this comment to include better descriptions, examples, and more specific information. Also, Section IV.F., “Minimization of Threats to the Southwestern Willow Flycatcher Through Implementation of Recovery Actions”, has been added to specifically associate recovery actions with the factors which led to the flycatcher being listed.

<u>Issue #2</u>

Comment: In order to use the best scientific and commercial data available, consider reports completed by Jones and Stokes in 2000 and 2001 on operation of Isabella Dam along the Kern River in California before completing the final Recovery Plan.

Response: The Plan has been revised in response to this comment.

The reports on the operation of Isabella Dam completed by Jones and Stokes have been reviewed by the Technical Team and included in the list of literature used to formulate the final Recovery Plan.

Issue #3

Comment: The draft Plan has only briefly addressed the introduction of biological control for salt cedar.

Response: Yes, while biological control of salt cedar is only briefly addressed in the Recovery Plan, strategies for management of exotic plant species are provided in detail. Biological control of saltcedar is addressed in Appendix H, "Exotic Plant Species in Riparian Ecosystems of the U.S. Southwest" (page H-17). Appendix H explains that biological control is a complex form of management that is being tested as a method to reduce tamarisk (saltcedar). Widespread biological control is not recommended due to the potential for unfavorable results as described in Appendix H, page H-17, and the Recovery Plan provides recovery actions in the Sections IV.D. and IV.E. for the management of exotic plant species (recovery action 1.1.3.2.). The Recovery Plan specifies that biological control be considered on a site-specific basis only if significant information on impacts is known and if it can be factored into an overall management scheme that addresses underlying reasons for the decline of riparian vegetation. Future revisions to the Recovery Plan will reflect new findings concerning this type of management.

Issue #4

Comment: The Implementation Schedule in the draft Plan does not adequately reflect costs for any changes in water or livestock management, or other recovery actions such as development of habitat for delisting, sediment augmentation, modification of dam rules, etc., nor does it provide any description for how costs were derived.

Response: See revised Implementation Schedule, Section V., page 144.

Issue #5

Comment: The manner displaying costs in the Implementation Schedule is inconsistent with requirements of the ESA which requires recovery plans to show the costs of recovery. The implementation schedule needs to be expanded to show the full cost of recovery through 2030.

Response: See revised Implementation Schedule, Section V., page 144.

Issue #6

Comment: Establish a single target parasitism percentage for when cowbird trapping should be initiated, rather than a range (20 to 30%). A range of percentages makes it more difficult for managers to make a decision on when to trap and regulatory agencies to remain consistent. We realize that there will always be exceptions to every target number, but those should be dealt with in the text, not by giving managers a range of numbers.

Response: The Recovery Plan has been revised in response to this comment. In Sections IV.D. and IV.E., Stepdown and Narrative Outline item 3.1.1.3. has been changed to provide additional clarity. Also, new text has been added to Appendix F, "Cowbird Management and the Southwestern Willow Flycatcher: Impacts and Recommendations for Management", which provides justification for maintaining a range. The USFWS emphasizes that recommendations in a Recovery Plan that provide the roadmap for recovery of an entire subspecies may differ from the determination that a project may adversely affect a breeding pair of flycatchers, or the need to reduce and minimize effects associated with a project evaluated under the Endangered Species Act.

Issue #7

Comment: Because cowbird parasitism has inhibited the reproductive success of the flycatcher, reduced population levels, and contributed to the endangerment of the species, the statement that cowbird parasitism does not necessarily have critical or even significant effects on a given flycatcher population appears to be contradictory. In any case, recently reported cowbird parasitism rates ranging up to 66 percent at several important nesting locales suggest significant, if not critical, parasitism impacts at those locales.

Response: There is no contradiction here. Cowbird parasitism has contributed to the endangerment of the flycatcher and caused adverse effects to individual breeding attempts, but depending on a variety of factors, the presence of cowbird parasitism may not always have an effect on local flycatcher populations(see Section II., page 28, 39 to 41, and also Appendix F). The Recovery Plan recognizes that some flycatcher populations are heavily impacted by cowbird parasitism and advocates control in these cases. But the Plan also advocates an adaptive management approach in order to avoid a one size fits all strategy that dictates inflexible policies to managers and potentially waste recovery funds and efforts that would be more efficacious if directed to other actions. The text in Section II. has been modified to more clearly explain that cowbird parasitism is a potential impediment to recovery, and depending on many factors, the effects of parasitism to the overall population can (but not always) be slight.

Issue #8

Comment: What is the basis for the statement that cowbird parasitism rates of 20 to 30 percent have barely detectable levels on host recruitment (presumably of flycatchers)? How would it be possible that flycatchers would be unaffected (from recruitment and fitness standpoints) if they produced no or reduced numbers of young from up to 30 percent of all nests?

Response: As summarized in Appendix F in the subsection titled "Host Defenses Against Cowbird Parasitism", there is a consensus among recent researchers that the traditional practice of assessing avian productivity on a per nest basis is misleading because it inflates the apparent impacts of factors such as brood parasitism and nest predation. Instead, it is now widely accepted that impacts on avian productivity need to be assessed from a per female breeder perspective. Once this is done, it becomes evident that something like a 30% parasitism rate is likely to translate to a 15% or less reduction in host reproductive output due to desertion or depredation of a nest followed by renesting. However, any measurable reduction in nest productivity should not be construed as one that is insignificant or discountable. For further information, please consult the references listed in Appendix F. In terms of fitness effects other than reduced numbers of young, such as effects of parasitism on adult viability, Sedgewick and Iko's (1999) exceptionally detailed and data rich study found that parasitism had no clear detrimental effects on flycatcher viability, as discussed in Appendix F.

Issue #9

Comment: The statement says that cowbird control should be considered only after impacts exceed certain levels. What are those levels? Given the precarious status of the flycatcher and our incomplete understanding of the means and measures necessary to recover individual populations or the species as a whole, we suggest that there currently is no acceptable level of impacts to the species. In contrast to the recommendations in the draft plan, we contend the available information strongly suggest that the breeding productivity of the species should be maximized wherever possible and not compromised during and after studies that will almost invariably reveal, if cowbirds are present, that brood parasitism by cowbirds has reduced the breeding success of the test population of flycatchers.

Response: Section IV.E., Narrative Outline of Recovery Actions in the Recovery Plan has a detailed explanation of the levels that should trigger consideration of cowbird control efforts for overall recovery of the flycatcher, as does Appendix F. In agreement with the comment, the Recovery Plan argues that maximizing flycatcher breeding success needs to be a major goal, but it also acknowledges the need for adaptive management, which means that actions other than, or in addition to, cowbird control, will often be most effective in achieving recovery. The Recovery

Plan acknowledges that cowbird control is a useful tool because it is a threat that is easily remedied (unlike nest predation and habitat loss). When considering overall recovery of the flycatcher, relative ease of a recovery action should not be the primary reason for taking action.

Issue #10

Comment: The draft Plan recommends that cowbird control should be stopped after a local willow flycatcher population reaches a large size. Please define a large size.

Response: The Recovery Plan has been revised to provide clarification of this issue. The Recovery Plan now states that cowbird control should be discontinued when the flycatcher population has doubled to tripled in size from when cowbird control began, as long as the absolute number of pairs is equal to or exceeding 25 (page F-31). Research (test cases) are needed to determine the extent to which enlarged populations experience significantly reduced rates of parasitism.

Issue #11

Comment: It is the understanding that critical habitat for the flycatcher will be reassessed based on recent court decisions. The critical habitat section should remove opinions on the designation of critical habitat, update the facts surrounding recent court cases, and include the Technical Teams recommendations for critical habitat designation.

Response: The Recovery Plan has been revised in response to this comment. It should be recognized that although the Technical Subgroup has developed a roadmap for recovery by delineating recovery and management units and recognizing important areas within those units for conservation of the species, it is not the Technical Subgroup's responsibility to designate critical habitat.

Issue #12

Comment: On page 43 of the draft Plan, the statement that in recent years, several of the few larger populations have been impacted...by inundation by impounded water (Lake Mead and Lake Isabella) is incomplete and inaccurate. The statement is not supported by any reference to any scientific data. A review of the entire record indicates that any site specific adverse impacts of short duration are counter-balanced by positive impacts of increased riparian acreage and maintenance of existing habitat within the reservoir. The Plan should consider the entire record of data when discussing impacts of routine reservoir operations.

Response: The USFWS recognizes these reservoirs have contained habitat that flycatchers use. In fact, many large populations of flycatchers exist within the water storage space at Lake Isabella, Lake Mead, and Roosevelt Lake. However, dam operations can, have, or will result in reduced suitability and/or complete loss of habitat through inundation or dessication. The broader perspective on dam operations is that dams can alter hydrological regimes and impede transport of sediment, impacting downstream riparian vegetation quality, quantity, and species. This change in vegetation results in conditions that often do not favor development, maintenance, and recycling of native flycatcher habitat (Section II, page 34 and Appendices H and I). Rather, downstream habitat quality is changed to contain more exotic vegetation, which also increases the frequency of fires. Therefore, while dams and the operations of dams can create flycatcher habitat within the area where water is stored, these situations are more vulnerable to inundation and dessication, less persistent, and tend to decrease the amount and quality of available flycatcher habitat downstream. In fact, dams and dam operations can help create the undesirable condition where the only available flycatcher habitat on a stream is contained within the storage space of the reservoir (e.g., Salt River/Roosevelt Lake; however, note that Roosevelt Lake is not the only area where flycatcher habitat can develop within the Roosevelt Management Unit). Although large flycatcher populations do occupy habitat within the storage space of reservoirs, they may not be as numerous or as persistent as those that occupied miles of pre-dammed rivers with fewer anthropogenic stressors.

Issue #13

Comment: The draft Plan treats dams and reservoirs generically, which results in over generalizations that need to be replaced with specifics or deleted. These generalization imply that if these measures are not carried out, there will not be favorable results for recovery of the flycatcher.

Response: The Recovery Plan does not give dam/reservoir-specific information due to the large number and diversity of dams and reservoirs within the range of the southwestern willow flycatcher. Management for dams will differ according to dam size and structure, flow levels, operating rules, and other considerations. In recognition of the comment, the water-related recovery actions in the Section V., Implementation Schedule, have been revised (actions 1.1.2.1.1–1.1.2.1.9.). Based on the new schedule, location-specific information will be obtained during the next five years. This information will help target dams and reservoir operations that may be modified to benefit flycatcher habitat within the legal and economic constraints under which they operate.

Issue #14

Comment: The statement that dam operating rules should be changed to treat rivers as landscapes and ecosystems should be revised to reflect what is meant. Existing dam operations do treat rivers as landscapes and ecosystems.

Response: The Plan has been revised and Stepdown and Narrative Outline item 1.1.2.1.1. has been described in more detail in response to this comment.

Issue #15

Comment: The Plan discusses major changes to river operations in order to accomplish its goals. There is no discussion of how such changes are to be accomplished within existing laws of the Colorado River and treaties with Mexico. It is not appropriate to include these recommendations in the Plan unless the Service has determined how such changes can be accomplished.

Response: The Recovery Plan has been revised in response to this comment. In order to investigate feasibility of modifying dam operations for the benefit of the flycatcher and its habitat, the Recovery Tasks/Actions, Stepdown and Narrative Outline, and Implementation Schedule have been restructured. The current scheme recommends that the responsible entities investigate and identify those dams and reservoirs where it is legally, economically, and logistically feasible to modify operational changes for the benefit of the flycatcher. Furthermore, those who participate in the Recovery Plan and Recovery Tasks/Actions are never expected, nor required, to violate laws or international treaties. Note that this Recovery Plan is intended to provide guidance for the recovery of the flycatcher, and is not a regulatory document.

Issue #16

Comment: The Plan references the Law of the River regarding the Colorado River. This is the only specific reference in the Plan to the legal framework within which dams are operated. However, even this information is not well integrated into the narrative discussion of dam operations. Further, there is not discussion of the influence of state law, flood control criteria, energy production considerations or surface water rights on the operation of other reservoirs within the Plan area like those located on the Salt and Verde rivers. We suggest that you investigate more fully the specific discretionary authority of the operating entity if you intend to include a description of truly feasible site-specific management actions.

Response: The Recovery Plan has been revised in response to this comment. See response to Issues 13, 14, and 15.

Issue #17

Comment: Because of channelization and channel incisement on the lower Colorado River, even very large releases above downstream demand cannot achieve overbank flooding and inundation of even portions of the historic floodplain. While conceptually, it may be possible to remove/relocate bankline and high levees along discrete portions of the lower Colorado River, the greater challenge is channel incisement due to earlier channelization projects, construction of training structures, banklines and levees. It is physically impossible (short of extremely large flood control releases) to facilitate overbank flooding naturally. It will require significant and costly structural modifications and water diversion in order to wet the floodplain periodically.

Response: The Recovery Plan has been revised to address this issue, see Section IV.E., actions 1.1.2.1.1.-1.1.2.1.9.

Issue #18

Comment: In the draft Plan, modifying dam operations to have spike flows in winter time (page 99, line 7) to benefit flycatcher habitat is in conflict with page 108 section 1.1.3.2.2.2 and recovery of endangered native fish species.

Response: The Recovery Plan has been revised in response to this comment. The draft Plan mistakenly recommended spike flows in the winter, when it should have indicated flows that are consistent with the natural hydrograph.

Issue #19

Comment: The boundary line for southwestern willow flycatcher subspecies bisects the southern portion of the state of California, Nevada, Utah, and Colorado. The boundary represents an integrated area where both species may co-exist. It appears that there is a question as to a definitive boundary for the southwestern willow flycatcher. The draft Plan proposes to impose restrictions on this birds habitat without having scientifically sound data of the actual boundaries.

Response: A precise boundary between subspecies is not currently known, given (a) potential integradation between subspecies, and (b) limited survey effort in much of boundary area. However, the boundaries as drawn in the Plan are based on the best available published and unpublished data (Section II, B). Recent studies have helped refine the northern boundary of the southwestern willow flycatcher's range through the collection of blood from breeding willow flycatchers and subsequent genetic comparison and analysis (Paxton 2000). As a result of this information, two Management Units in Utah and Colorado described in the draft Plan (Dolores and Sevier) were removed from the breeding range of southwestern willow flycatcher. Findings from future research may continue to modify the boundary.

Issue #20

Comment: Identify cut-off dates for historical versus contemporary records. This is crucial to determining, and defending, recovery goals and objectives.

Response: The Plan has been revised to now explain that "contemporary investigations" of flycatcher territories in Arizona are post-1990 (Section II, page 8). Note that recovery goals for the southwestern willow flycatcher are not dependent on historical records, historical abundance of habitat, or historical populations. Rather, they are based upon the current potential of habitat, and an abundance and distribution that assures long-term persistence throughout its range. In other words, the recovery goals are not established to maximize the number of birds or achieve historical pre-European settlement population levels.

Issue #21

Comment: A recommendation on page 109 in the draft Plan states that tamarisk in occupied flycatcher habitat not be removed. However, tamarisk is an exotic species. Tom Dudley, University of California, indicated in a personal conversation that tamarisk habitat as producing 0.82 fledgling per nest and therefore was not producing a sustaining population. It would seem the position of managing tamarisk should be rethought to allow removal of the tamarisk and replace it with the more productive native willows and cottonwood vegetation where the water regime permits such conversion.

Response: The Recovery Plan discusses exotic vegetation management in Section IV.E., actions 1.1.2.2 and 1.1.3.2, and also in Appendix H. The Recovery Plan describes methods and conditions for removal of tamarisk and restoration of native vegetation. Specifically, item 1.1.3.2 discusses and recommends use of native plants for revegetation, developing exotic vegetation management plans, and most importantly, advocates reducing the conditions that allow exotic plants to thrive.

The Plan is very explicit by recommending against removal of tamarisk if underlying factors are not understood and management across landscapes is not coordinated, as the probability that re-establishment of exotic plants will occur is high. The Plan describes the fact that flycatchers can and often do nest successfully in tamarisk (Section II, page 13 and14) and recommends that tamarisk be retained in areas where flycatchers are breeding (Section IV.E., action 1.1.3.2.5.1., page 119).

There are as yet, no firm data that southwestern willow flycatchers nesting in tamarisk produce less young than those in native habitats, or that populations breeding in tamarisk are less self-sustaining than those in natives (Section II, pages 11-15). Sferra et al. (2000) compiled the nesting success of 84% of the 2008 nests documented primarily between 1993 and 1999, and some from 2000. Nest productivity in tamarisk-dominated sites is 23% to 54%, which is similar to native willow-dominated sites. Tamarisk nest success averaged 45% in New Mexico and 54% in Arizona, indicating that tamarisk nests are at least as successful as nests in other substrates. Therefore, until such data are available, the Plan’s approach to tamarisk/saltcedar removal is reasonable.

Issue #22

Comment: What is the definition of potential and occupied flycatcher habitat and the difference between potential and suitable willow flycatcher habitat?

Response: The Recovery Plan has been revised to clarify the definitions, differences, and importance of these stages of flycatcher habitat to its survival and recovery in Section II, pages 15 to 19 and Appendix D, Southwestern Willow Flycatcher Habitat.

Issue #23

Comment: Little emphasis is placed on suitable and potential, restorable and/or recovering southwestern willow flycatcher habitat. Also, little emphasis is placed on tributaries or drainages outside the rivers main stem. The document is almost entirely focused on existing occupied flycatcher habitat and makes little or no effort to deal with managing other areas for recovery of the species.

Response: The primary recovery task is to increase and improve currently suitable and potentially suitable habitat (Stepdown and Narrative Outline item 1, page 96 and 106). Every item underneath this heading is directed toward protecting, enhancing, restoring, managing, and cooperating in the management of these habitats.

A section to the Recovery Plan was added on describing the importance of unoccupied suitable habitat and potentially suitable habitat (Section II, page 17). Here, the Plan describes that these different stages of flycatcher habitat are essential for flycatcher survival and recovery because flycatcher habitat is dynamic and ephemeral in nature. As a result, all flycatcher breeding habitat begins as potential habitat, grows into suitability, and then becomes occupied by nesting flycatchers.

Additionally, as directed by the Endangered Species Act, the purpose of this Plan is to conserve the ecosystems upon which the southwestern willow flycatcher depends. The flycatcher depends upon one of the most critically endangered habitats in North America: southwestern riparian ecosystems. As a result, this Plan takes an Ecosystem and Watershed Approach to flycatcher recovery (Section I, page 2).

The Plan discusses that the health of riparian ecosystems and development, maintenance, and regeneration of flycatcher nesting habitat depends on appropriate management of uplands, headwaters, and tributaries, as well as the main stem of river reaches. All of these landscape components are inter-related. As a result, nesting habitat is only a small portion of the larger landscape that needs to be considered when developing management plans, recovery actions, biological assessments for section 7 consultations with the USFWS, or other documents defining management areas or goals for flycatcher recovery (Section II, page 16). Also note that discussion and separate guidance is developed for upland grazing in Appendix G.

Issue #24

Comment: The definition of potential southwestern willow flycatcher habitat used in the draft recovery plan may be too broad to be practical. Using this definition, almost all riparian areas would be considered potential habitat. We suggest using the definition from the Forest Service Region 3 Grazing Criteria, August 1998, page 50, as something more useful [see comments for full definition]. Further discussion of potential habitat on page 16 of the draft recovery plan would dovetail with this definition. The Forest Service definition should be reworded to make it more palatable, definable, and useable for the biologists.

Response: The Recovery Plan has been revised to clarify the definition of potential habitat, and while the description is not identical to that of the National Forests in the Southwest, it retains a similar concept (Section II, pages 15 to 19 and Appendix D, Southwestern Willow Flycatcher Habitat).

Issue #25

Comment: Nesting habitat size requirements must be defined in more specific terms. There seems to be a definite width and length combination providing the seclusion, security, and territory protection needed for successfully breeding flycatchers. Mojave County states that “many biologists in the Grand Canyon National Park no longer classify the long narrow strips of riverbank vegetation as nesting habitat although an occasional nest will be found there” but that BLM wildlife biologists “identify willow strip vegetation along a dry wash as nesting habitat.” BLM’s decision has serious ramifications upon surrounding land management with the restrictive practices required.

Response: The Plan has been revised to respond to this comment (Section II., page 17, Patch Size and Shape, Section II., page 80 and 81, and Appendix D). The riparian patches used by breeding flycatchers vary in size and shape. They may be relatively dense, linear, contiguous stands or irregularly-shaped mosaics of dense vegetation with open areas. Southwestern willow flycatchers nest in patches as small as 0.1 ha (0.25 ac) along the Rio Grande, and as large as 70 (175 ac) in the upper Gila River in New Mexico. Based upon patch size values given in publications and agency reports, mean size of flycatcher breeding sites supporting 10 or more flycatcher territories is 24.9 ha (61.5 ac) (SE =5.7 ha; range =1.4 to 72 ha; 95% confidence interval for mean=12.9 to 37.1; n= 17 patches).

Issue #26

Comment: The position on saltcedar removal needs to be perfectly clear to managers. Removing it, even when it may not be appropriate, is still the prevalent action in S. Nevada among land managers.

Response: The plan has been revised in response to this comment. Recovery tasks listed under Stepdown and Narrative Outline item 1.1.3.2 provides explicit direction for managing and/or removing saltcedar and other types of exotic vegetation. Appendix H discusses the current understanding of exotics in riparian areas specific to the flycatcher. Condition B (page H-19) presents pertinent assessment questions, actions, and case studies to be used by managers. In addition, the Service acknowledges that there may be reasons unrelated to the flycatcher for removing exotics.

Stepdown and Narrative Outline item 1.1.3.2.5.1 is clear in its recommendation to not remove tamarisk in occupied flycatcher habitat and where appropriate, in suitable but unoccupied habitat. Item 1.1.3.2.6 recommends only removing suitable exotic vegetation if: 1) underlying causes for dominance of exotics have been addressed; 2) there is evidence that the exotic species will be replaced be vegetation of higher functional value; and 3) the action is part of an overall restoration plan.

Issue #27

Comment: If parasitism rates of 20-30% have barely detectable effects, how does it make a difference if it is exceeded in more than one year? What rates are needed to create a detectable effect on the species? And how are these rates derived? More study is definitely needed in this area before a true trapping program is developed.

Response: Despite the lack of evidence for increases in flycatcher breeding populations after cowbird trapping, there are cogent reasons to continue this management approach because 1) control does increase the numbers of flycatchers being produced and these increased numbers may result in emigrants to other populations; 2) one can not invalidate the hypothesis that populations that have not increased after cowbird control would have been extirpated without control; 3) whether cowbird control increases local flycatcher populations may vary geographically so it is worth continuing the program to fully assess the efficacy of this approach. The 20-30% range reflects the best judgement of the technical team members familiar with passerine breeding biology. Because many flycatcher populations are small and subject to stochasticity, even moderate rates of parasitism such as 30% could have large effects, by for example, affecting all individuals, within a population that are left unaffected by other threats such as nest predation. Therefore, such rates could lead to local extirpations and affect, metapopulation dynamics. The presentation of the 20-30% range is followed by an extensive discussion of additional factors that managers and regulators should read. This discussion stresses that each site needs to be treated individually and explicit wording to that effect has been added.

Issue #28

Comment: There is inherent conflict between the current state of riparian areas and the proposed management of exotic species. Many riparian areas are populated by thick stands of tamarisk. The Service, in previous publications, has called for removal of tamarisk, but now, because the flycatcher uses it, implies that some plants should not be removed. There is no clear directive and land managers are hard pressed to know what to do.

Response: The USFWS supports restoration of riparian areas to native vegetation (see section IV.E; action 1.1.3.2.3.). In the particular case of the flycatcher, a species that uses tamarisk for breeding habitat, consideration of where and how restoration occurs is needed. As a consequence, this Recovery Plan calls for a coordinated, temporally-staged approach to removal of tamarisk (see section IV.E.; action 1.1.3.2.6.). The endangered status of the flycatcher necessitates maintaining current structure of occupied breeding habitats and suitable unoccupied habitats, regardless of species composition (see section IV.E.; action 1.1.3.2.5.).

Issue #29

Comment: The Recovery Plan needs to better address the overall perception by the general public that tamarisk is good for the flycatcher and be upfront in explaining this dilemma to agencies and the general public.

Response: The Recovery Plan has been adapted in response to this comment (refer to expanded discussion in Section II.C., page 13, *Habitats Dominated by Exotic Plants*, and Section II.J., page 33, ***Reasons for Listing and Current Threats***).

Issue #30

Comment: The Habitat Restoration Appendix describes 5 mitigation goals. Numbers 3 through 5 (remove exotics and restore natives, restore a more natural flood regime, and attaining a self sustaining ecosystem) may be appropriate for a white paper, but turning suggested guidelines and goals into explicit recovery tasks for the flycatcher is not authorized under the ESA.

Response: This Recovery Plan is intended to provide guidance for the recovery of the flycatcher, and is not a regulatory document. The mitigation goals listed in the Habitat Restoration Appendix are intended to guide mitigation projects that involve the flycatcher. Numbers 3-5 are based on the current understanding of significant threats to the species, and are significant issues that are addressed throughout the plan.

Issue #31

Comment: The fundamental and pervasive defect of the Plan is the failure to distinguish between species recovery as properly within the scope of section 4 (f), and maximum ecosystem protection, a goal of section 2 but not the focus of recovery plans. By asserting that the purpose of the Plan is to conserve flycatcher ecosystems, rather than the species itself, the Service concedes the legal deficiency of the document and reveals the fundamental reasons that the measures it calls for are too broad and burdensome and outside the scope of ESA.

Response: Conserving flycatcher ecosystems to the extent that the southwestern willow flycatcher is considered recovered may or may not result in maximum ecosystem protection. The Recovery Plan has been revised in response to this comment to further clarify the focus on riparian systems relevant to the southwestern willow flycatcher (see Section I.B).

Issue #32

Comment: Will 40 percent use by cattle of current years growth ever allow a willow to attain a height great enough for quality flycatcher habitat?

Response: As Appendix G discusses at length the fact that percent utilization of woody vegetation has important consequences for flycatcher habitat quality. Although some willow species may be able to survive with high utilization rates (Lammon 1994/pg. G-7), this does not ensure that woody vegetation is able to attain a structure that is suitable for flycatchers. With appropriate monitoring, as called for in the grazing guidance detailed in Section IV.E., actions 1.1.3.1.1.1.-1.1.3.1.1.4., and 6.4.1., and in Appendix G, Table 2 and page G-28, woody vegetation utilization should not approach, let alone exceed, 40% percent, because livestock would be moved when herbaceous utilization reached 35%. The 40% woody vegetation utilization figure is based on the best science currently available – but this may change in the future as this level is evaluated based on monitoring.

Issue #33

Comment: The Plan states there should be no livestock grazing in occupied flycatcher habitat until research in comparable unoccupied habitats demonstrates no adverse impacts from grazing. Sufficient information exists to identify acceptable use levels in most, if not all, currently-grazed areas such that flycatcher needs can be met while not entirely disrupting the grazing industry. Moreover, where research into impacts of grazing is needed, the grazing pressure in the experimental area should be managed to yield results that will be useful in structuring acceptable use levels on the control site. The text as written provides no such guidance.

Response: The Recovery Plan allows for conservative grazing in the non-growing season in occupied habitats, as long as average utilization does not exceed 35% of palatable, perennial grasses and grass-like plants in uplands and riparian habitats, the extent of alterable stream banks showing damage from livestock use do not exceed 10%, and woody utilization does not exceed 40% on average (Appendix G, Table 2, page G-27). The Recovery Plan supports documentation of grazing practices and further research on grazing schemes (Section IV.E., actions 1.1.3.1.1.2–1.1.3.1.1.4., and 6.4, and Appendix G, page G-23), and advocates an adaptive management approach. The Recovery Plan will be revised with new information on compatible grazing schemes as it becomes available, assuming the additional data and analyses exist in 5 years.

Issue #34

Comment: The Plan is inadequate because the Service did not meet the statutory requirements of Congress nor the regulatory requirements of the Agency, due to not basing the plan on adequately sound data on grazing. The Plan admits that information linking management of livestock grazing effects to the flycatcher remain to be researched. The Plan also goes against statute, by elevating single use over multiple use, which is required by statute.

Response:

The Recovery Plan is based upon the best available science and information. The Recovery Plan emphasizes multiple use, as it includes recommendations for a variety of activities, including grazing, recreation, and water use. The Plan is based on the best available data on grazing (see Appendix G). The Recovery Plan allows for conservative grazing, and acknowledges the need for flexibility interpreting the grazing guidelines based on location-specific conditions. If a particular grazing system coincides with improved southwestern willow flycatcher habitat (e.g., the grazing system is not preventing regeneration of woody and herbaceous riparian vegetation), then that particular grazing system should be allowed to continue provided it is appropriately monitored and documented (Appendix G, page G-25). Additionally, the Plan recommends studies on grazing so that information can be gained and used to assess the compatibility of grazing with flycatcher recovery. Also see previous response.

Issue #35

Comment: The livestock grazing discussion and management would benefit from the addition, development, and implementation of watershed wide management plans. Poor conditions on the adjacent and upstream uplands could exacerbate catastrophic floods and wipe out local gains in riparian habitat recovery.

Response: The Recovery Plan has been revised in response to this comment to incorporate upland areas in the grazing recommendations given in Appendix G, Table 2. The Recovery Plan does not preclude Management Units from working together to craft watershed-scale management plans.

<u>Issue #36</u>

Comment: After much discussion in the issue paper and the beginning of this document, why are upland conditions ignored? Upland conditions and utilization by livestock should have guidelines similar to riparian areas. The proposed utilization standards for occupied habitat seem more appropriate for upland areas than for riparian areas.

Response: The plan has been revised in response to this comment. Upland conditions have been incorporated into the grazing guidelines given in Appendix G, Table 2, as well as in the text of Section IV.E., Narrative Outline of Recovery Actions. Beyond conservative grazing, sufficient scientific information on upland habitat does not exist from which to develop more specific guidelines relevant to flycatchers. Due to the significant variability in upland habitats, guidelines are difficult to recommend and will need to be assessed on a site by site basis.

<u>Issue #37</u>

Comment: Average utilization levels of 35% on herbaceous vegetation and 40% on woody vegetation is <u>not</u> conservative grazing, particularly when dealing with listed species habitat and recovery. Instead, it may rank as moderate to high levels based on the type of vegetation present. If you are grazing in the dormant season, there should be almost no use on woody vegetation; 40% use during the dormant season would seem to represent unexpectedly high use during the nongrowing season. Grazing at these levels are likely to significantly alter overall cover density at lower levels of the canopy.

Response: Available science supports the grazing guidelines given in the Recovery Plan as “conservative” over the variety of riparian systems across the range of flycatcher habitat. Wetter and drier areas will be differentially impacted by grazing. One area (i.e., Tonto National Forest) cannot be the basis for all guidelines. However, data from the Tonto has been assessed and is discussed in Appendix G, and the plan calls for new science/research to further our knowledge base. In addition, the Recovery Plan also recommends vegetation/habitat monitoring. Areas of poor habitat quality (= low forage availability) should not be grazed (Appendix G, pages 23, 28). If 35% utilization of herbaceous vegetation is reached, livestock should be removed from the area and the 40% woody utilization level will likely not be attained. The guidelines will be revised if new information suggests that this strategy is in error. Other relevant changes to the Recovery Plan include establishing maximum bank alteration levels, and clarification of “dormant” season (see Appendix G).

<u>Issue #38</u>

Comment: Livestock use in the riparian areas at the recommended levels, even in dormant season, can affect understory density of vegetation. Allowing these levels in warm, dry winters, will cause extremely high use and are likely to result in bank damage (stream channel alteration) and expose channels to alteration or loss during the peak spring runoff season. More conservative use levels are needed and bank alteration limits should also be established.

Response: The Recovery Plan has been revised in response to this comment. The USFWS reviewed additional data and the published literature on range management and incorporated a threshold for stream bank condition into the grazing guidelines (Fleming et al. 2001; see Appendix G, Table 2).

Issue #39

Comment: What constitutes the dormant season (leaf drop to bud break)? Dormant season means a lot of things to a lot of people.

Response: Definitions of growing season and non-growing season have been added to Appendix G, Table 2 (page G-27). Growing season is defined as bud break to leaf drop for cottonwood and willow species. The non-growing (i.e., dormant) season is defined as leaf drop to bud break for cottonwood and willow species.

Issue #40

Comment: Standards for stubble height should be an option for measuring riparian use. Determining percent use is often difficult for various riparian grasses/grass-like plants because of variability in plant height, site productivity and other factors.

Response: The plan has been revised to discuss stubble height for measuring riparian use (Appendix G). Unfortunately, sufficient available science in riparian areas of flycatcher habitat does not exist upon which to base stubble height recommendations in this Recovery Plan. What we do know is that Mosley et al. (1997) suggested the following guidelines for stubble heights in riparian systems in Idaho: 1) stubble height of 3 to 4 inches for sedges, tufted hairgrass, and similar species following the growing season; 2) two inches for Kentucky bluegrass; 3) four to 6 inches for large bunchgrasses; and 4) utilization of riparian shrubs should not exceed 50 to 60% during the growing season. However, some researchers caution against recommendations that call for a uniform level of utilization or stubble height to maintain riparian attributes because these recommendations ignore the inherent complexity of riparian systems (Green and Kauffman 1995).

Issue #41

Comment: The use of the word habitat appears in several different forms. Mixing the different definitions leads to confusion. Consistent definitions of habitat are important since downlisting criteria calls for protection of double the amount of habitat required to support the target number of flycatchers. Until the term habitat is scientifically defined and consistently used, it will be impossible to implement the Plan.

Response: The Recovery Plan has been revised in response to this comment to clarify the definitions of habitat used in the plan (see Section II.C.). Habitat requirements/characteristics are discussed in Section II.C., Habitat Characteristics. The Recovery Plan States (page 11): "...general unifying characteristics of flycatcher habitat can be identified. Regardless of the plant species composition or height, occupied sites usually consist of dense vegetation in the patch interior, or an aggregate of dense patches interspersed with openings. In most cases this dense vegetation occurs within the first 3-4 m (10-13 ft) above ground. These dense patches are often interspersed with small openings, open water, or shorter/sparser vegetation, creating a mosaic that is not uniformly dense. In almost all cases, slow-moving or still surface water and /or saturated soil is present at or near breeding sites during wet or non-drought years."

Issue #42

Comment: Agricultural lands with suitable flycatcher habitat and future potential habitat are somewhat overlooked in the Recovery Plan. In southern Nevada, irrigation practices are many times conducive to creating habitats for flycatchers and this resource has been undervalued. The document needs to better assess the value of agricultural lands as breeding flycatcher habitat and relate this to the overall recovery of the flycatcher. Agricultural lands operated for their traditional uses under certain constraints may provide significant benefits to adjacent flycatcher habitats as well.

Response: See section IV.E.; action 1.1.2.2.1.

Issue #43

Comment: The Recovery Plan needs to emphasize opportunities for creation of additional breeding habitat over a short period of time. For example, there are willow habitats in Nevada which have recently become established over a 5 year period and have successful nesting flycatchers within that 5 year period. The ability of southwestern river systems to provide a matrix of individually small and short-lived habitat patches which contribute to a larger habitat complex that has both connectivity and appropriate overall structural availability should not be overlooked.

Response: The Recovery Plan (pg. 17) recognizes that potential habitats that are not currently suitable will be essential for flycatcher recovery, because they are the areas from which new suitable habitat develops as existing suitable sites are lost or degraded; in a dynamic riparian system, all suitable habitat starts as potential habitat. Furthermore, potential habitats are the areas where changes in management practices are most likely to create suitable habitat. Not only must suitable habitat always be present for long-term survival of the flycatcher, but additional acreage of suitable habitat must develop to achieve full recovery. See also Section IV.A.; page 75.

Issue #44

Comment: The Recovery Team should consider using existing technology and information to develop a habitat-predictor model for the range of the flycatcher to estimate the amount of current available habitat, help direct survey efforts, and possibly identify areas needing habitat rehabilitation. A model of this type had been developed by the Mexican spotted owl Recovery Team and GIS experts, as has undergone field-testing and several revisions.

Response: Basic research to identify and predict flycatcher habitat at a variety of spatial and ecological scales, using standard vegetative measurement techniques as well as remote sensing and GIS, is recommended in the Recovery Plan. Such projects have been initiated by the AGFD, which developed and successively tested a predictive model for flycatcher breeding territory at low-elevation reservoir inflows in Arizona. The next step is to adapt the AGFD modeling approach to other parts of the flycatcher's range, recognizing that the variability in flycatcher breeding habitats (e.g., native and exotic vegetation; differing plant species; low and high elevation; large and small patches) may require a series of related but somewhat differing habitat models. The Recovery Plan supports and encourages the continuation and expansion of such habitat modeling efforts, as part of the tasks described in Section IV.E.; actions 6.1.1. and 6.1.2.

Issue #45

Comment: The minimum list of responsible entities shown in the Implementation Schedule has no reasonable basis. The assignment of specific tasks that have not agreed to undertake those tasks and have no responsibility to do so is a clear indication that the Plan is arbitrary and capricious and should not be used unless binding agreements exist. The minimum list of responsible entities includes entities who have made no commitments to perform or fund any of the tasks contemplated by the draft plan. The ESA does not authorize the Service to use Recovery Plans to enlist non-federal parties to a species recovery program. Recovery is the responsibility of the federal government, not stakeholders.

Response: Recovery tasks were developed by the Recovery Team with input from stakeholders, including Federal and State agencies, industry groups, conservation organizations, academic institutions, and others. As recovery plans are not regulatory documents, parties on the “Minimum List of Potential Partners”in Section V., Implementation Schedule, are not committed by law to undertake recommended recovery actions. These partners are identified due to their potential to implement recovery actions, if they so choose. Federal agencies do have general responsibilities to listed species.

Issue #46

Comment: Unless recovery actions are made site-specific it is highly questionable that many of the actions listed, such as modify dam operating rules should be given a priority 1 status. Priority 1's are those that MUST be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future. Any priority 1 must be justified in the narrative outline as necessary to prevent extinction. As currently written, most of the tasks in 1.1.2 and 1.1.3 are not justified.

Response: The Recovery Plan has been revised to allow managers to identify site-specific opportunities (see Section IV.E.; 1.2.1.1.-- 1.1.2.1.9.); priority numbers have also been revised (see Section V., Implementation Schedule).

Issue #47

Comment: The 3:1 ratio of acquired habitat to lost habitat needs some additional supporting rationale that agencies/groups can use.

Response: See response to following comment.

Issue #48

Comment: The Plan indicates that potential habitat should be replaced at a 3:1 ratio. Potential habitat is neither occupied nor suitable for use by flycatchers because it lacks in some critical component. This is not habitat. We do not believe the Service has the authority to regulate potential habitat.

Response: Recovery plans are non-regulatory documents; therefore the USFWS is not regulating potential habitat for the southwestern willow flycatcher with the Recovery Plan. The discussion of potential habitat and its importance to the flycatcher has been expanded within the Recovery Plan (see section II.C.2.; page 15). Regarding the suggested habitat replacement ratio, refer to the expanded discussion under “Measures to Minimize Take and Offset Impacts” on page 83.

Issue #49

Comment: Research and removal of exotic species should be maintained as items that should be used to offset the loss of flycatcher habitat.

Response: Research and removal of exotic species are potentially significant recovery actions (see Section IV.E.; 1.1.3.2.6., and 6.1-6.12.3.), but do not compensate for loss of habitat. As the Recovery Plan states (see Section II.J.; page 33), loss and modification of habitat is one of the primary causes for the endangered status of the southwestern willow flycatcher.

Issue #50

Comment: Habitat should be replaced or permanently protected within the same Management Unit. Allowing replacement or protection of habitat that cannot be used by the affected population will lead to a decline of that metapopulation.

Response: The USFWS agrees that habitat should be replaced or permanently protected within the same Management Unit (see Section IV.B.; page 83); however, to increase flexibility in plan implementation, the downlisting criteria allow for small departures within Management Units (see Section IV.B.; page 78-79).

Issue #51

Comment: The Service should ensure that the Plan includes a description of the actual factors which led to the flycatcher being listed as endangered, as described in section 4(a)(1) of the ESA. The objective measurable criteria in a recovery plan are intended to establish goals which, when met, address each of the factors which led to the listing and can lead to the de-listing of the species.

Response: The plan has been revised in response to this comment. See Section II.J.; page 33, "Reasons for Listing and Current Threats", and also Section IV.F.; page 138, "Minimization of Threats to the Southwestern Willow Flycatcher Through Implementation of Recovery Actions".

Issue #52

Comment: In some cases, the discussion of recovery of riparian habitats, found in the appendices, has been substituted for flycatcher recovery. The Plan correctly states the purpose is to conserve the ecosystems on which flycatchers depend. However, the purpose appears to have been modified to that of conserving riparian habitat in the Southwest regardless of the probability of benefitting flycatchers. On page 2 of the Plan it is stated, the Plan ..seeks in part to protect, re-establish, mimic, and/or mitigate for the loss of natural processes that establish, maintain, and recycle riparian ecosystems. In many cases this goal may be necessary for recovery, but it is highly questionable that this should be a goal in itself.

Response: The purpose of the Recovery Plan is to recommend actions that can be implemented in riparian habitats relevant to the flycatcher. The Recovery Plan has been revised to clarify this intent (see Section I.B; page 2).

Issue # 53

Comment: The Population Viability Analysis (PVA) is speculative and should be deleted. Caveats in the PVA itself indicate that it should not be used to determine number of territories per site for target goals, or other such statements. If the PVA is to be included, then full disclosure of its faults at the beginning of the PVA section is necessary, and followed throughout. Also, replace the summary of the PVA in the appendices with the author=s actual literature so that other people can interpret the results for themselves.

Response: The Recovery Plan has been revised in response to this comment (see Section IV.A.4.; page 73). The Recovery Plan explicitly recognizes that the demographic analysis might not be applicable across the entire range of the flycatcher. The incidence function analysis, based on data from 143 sites, was helpful in formulating the Recovery Plan's strategy (e.g., reclassification and delisting criteria) for achieving a population level and an amount and distribution of habitat sufficient to provide for the long-term persistence of metapopulations.

Issue #54

Comment: An appropriate Plan addresses each of the factors that served as the basis for listing and discusses 1) site-specific management and 2) objective and measurable criteria under which the species can be removed from protection of the ESA. The Plan fails to satisfy these items.

Response: Section II.J.; page 33 addresses each of the factors that served as the basis for listing. This Recovery Plan provides a strategy to characterize flycatcher populations, structure recovery goals, and facilitate effective recovery actions that should closely parallel the physical, biological, and logistical realities on the ground. Recommendations for specific sites where recovery actions should be focused is provided in Section IV., Table 10. The down- and delisting criteria provided in the Recovery Plan are both objective and measurable, and provide for a population level and an amount and distribution of habitat sufficient to provide for the long-term persistence of metapopulations. Flexibility provided by the downlisting criteria is intended to allow local managers opportunities to apply their knowledge to meet goals, possibly in areas the USFWS cannot identify or may not foresee.

Issue #55

Comment: Values for existing number of territories were based on survey data for all breeding sites known to have been occupied for at least one year between 1993 and 1999. Why is it not also the criteria for determining the number of territories for reclassification; occupancy at least once over a five year period?

Response: The Recovery Plan has been updated to include 2000 and 2001 survey data. Values for current number of known territories are based on the most recent available survey data for all breeding sites known to be occupied for at least one year between 1993 and 2001 (see Section IV., Table 9). The recovery strategy outlined in Section IV.A. and B. builds on this number of territories to attain a population level and an amount and distribution of habitat sufficient to provide for the long-term persistence of metapopulations. An effective monitoring protocol has yet to be developed for determining when down- and delisting criteria have been met. We do not yet know how and to what extent populations fluctuate, or how often monitoring must take place to satisfactorily estimate population size. This is one reason the USFWS intends to amend the Recovery Plan in 5 years, and proposes recovery action 6.7.4. “Develop methodologies, which can be site-specific if necessary, for determining year-to-year trends in population sizes at breeding sites”.

Issue #56

Comment: Using cumulative total for estimate of known territories overestimates the number of known territories. It needs to be made clear that recovery goals are not based on cumulative totals.

Response: The estimates for known number of territories and minimum number of territories for reclassification (see Section IV.B., Table 9) are not cumulative estimates. Values for current number of known territories are based on the most recent available survey data for all breeding sites known to be occupied for at least one year between 1993 and 2001.

Issue #57

Comment: The narrative at the top of Table 12 should be restated in the main text of the document and highlighted as a recovery action, i.e. recovery efforts need not focus only on reaches identified. In addition to focusing on occupied habitat, there should be substantial effort to promote the protection of watersheds, such as tributaries to main stems, and to move potential, restorable and/or recovering riparian areas toward suitability.

Response: Table 12 is now Table 10 in the Recovery Plan. Refer to Section II.C.2., pages 15-17, and Section IV.B.2., page 80.

Issue #58

Comment: Additionally, the list of reaches for recovery efforts presented in Table 12 seems woefully incomplete. The table should include rivers or reaches with small populations, existing populations, or no populations. We see no reason why this list should not be as comprehensive as possible.

Response: Table 12 is now Table 10 in the Recovery Plan, and has been revised in response to this comment. Table 10 now includes a more extensive list of suggested reaches.

Issue #59

Comment: It is not clear whether recovery goals include breeding flycatchers on Tribal Lands. The document needs to clarify whether the population targets for down- or delisting include or exclude Tribal lands.

Response: Some Tribes are currently participating with the USFWS in assessing flycatcher numbers on Tribal lands. In these instances, the Tribal information is included in the numbers of existing territories in a Management Unit; continued participation of these Tribes is factored into the numbers needed for reclassification (see Section IV.B.2., Table 9). If additional Tribes choose to participate in the flycatcher recovery effort, data from survey and monitoring efforts will also likely count towards achieving the numeric recovery goals.

Issue #60

Comment: Research shows that flycatchers are much more mobile than previously thought, which is relevant to whether satisfying population goals for Management Units should be a prerequisite to downlist or delist the species. The population goals should be more geographically flexible to take into account greater movement from season to season, while still allowing for genetic diversity rangewide.

Response: The down- and delisting criteria provide sufficient flexibility by allowing an individual Management Unit to meet 80% (criteria set A), or 50% (criteria set B), of its minimum population target, as long as the Recovery Unit attains the overall population goal.

Issue #61

Comment: No specific information in the Plan describes how population goals were set other than using a 25 territory minimum, and feasible management actions. No supporting data or rationale other than according to model results are provided for the 25 territory target or the 15 km distance between sites.

Response: The Recovery Plan has been revised in response to this comment. Refer to Section IV.A.4., page 73.

Issue #62

Comment: Dispersal of flycatchers have been documented in excess of 200 km. The Plan also describes that flycatchers in excess of the minimum required for each management unit are considered potential colonizers to other units, implying the birds can move from one unit to another and sometimes significant distances. Moving from one unit to another, considering the birds great migration distance, must be considered not only possible, but probable. In light of this new information on flycatcher movements, we question the feasibility of and need for maintaining minimum populations in each unit simultaneously.

Response: See response to Issue #64.

Issue #63

Comment: There has been no demonstration that 3900 individuals are necessary to allow a proper functioning metapopulation. There has been no appropriate discussion on metapopulations or numbers of individuals required to establish each (or any) metapopulation of flycatchers.

Response: See expanded discussion in Section IV.A.4. and IV.A.5.

Issue #64

Comment: The little Colorado River is placed with the Lower Colorado Recovery Unit, while the lower Gila River is situated in the Gila Recovery Unit. Consider switching these streams into different Recovery Units. Although the Little Colorado River does eventually flow into the mainstem Colorado in the Grand Canyon, it is much closer both in distance and in ecology to some of the Gila River Management Units, especially the San Francisco Management Unit. The lower Gila is separated from the rest of the Gila by a long stretch of dry riverbed whereas it's a short distance to its confluence with the mainstem Colorado near Yuma in the Lower Colorado Recovery Unit.

Response: In response to this comment and information provided by the Lower Colorado River Implementation Subgroup, the lower Gila River near its confluence with the Lower Colorado River has been assigned to the Lower Colorado River Recovery Unit (see Section IV.A.1.). No change in the Little Colorado's inclusion in the Lower Colorado River Recovery Unit was made at this time.

Issue #65

Comment: Most if not all of the existing flycatchers and flycatcher habitat is found within the conservation space at Roosevelt. The Team should recognize there is little or no compensation habitat within the Roosevelt Management Unit. Given the lack of available flycatcher habitat, the population goals should be drastically reduced or not be a prerequisite for reclassification or delisting. The Service should specify where and how there is habitat for 40 to 50 pairs in the Roosevelt Management Unit.

Response: Given our current level of understanding, the USFWS believes that a target of 50 territories in the Roosevelt Management Unit is achievable, and necessary to attain a population level and an amount and distribution of habitat sufficient to provide for the long-term persistence of the metapopulation within the Gila Recovery Unit. If this proves to be in error, the USFWS will modify the target, as appropriate, in future revisions of the Recovery Plan. Within the Roosevelt Management Unit, the USFWS believes there is enough potentially suitable habitat outside of the conservation space of Roosevelt Lake to achieve the population target of 50 territories.

Issue #66

Comment: The Roosevelt Management Unit numbers should be increased. There is much more potential for habitat restoration at Roosevelt Lake than the current goal indicates. Even if the lake reached capacity, there would be enough fringe habitat to contain as many as 50 territories. The current goal does nothing to encourage habitat improvement projects above the lakes new conservation pool. Such suggestions are in line with the Plan's conclusions to maintain existing populations as the highest priority.

Response: The Recovery Plan does not seek to maximize flycatcher numbers in habitats. The strategy used in the Plan calls for increasing population numbers that will serve the metapopulation in that recovery unit. See also response to Issue #69.

Issue #67

Comment: There are concerns that the Plan singles out the Roosevelt Management Unit for additional review of recovery goals in another 5 years. Because the Roosevelt Unit is singled out as a moving target, it creates a climate of uncertainty in the regulated community. We urge this to be removed from the Plan.

Response: The Roosevelt Management Unit was not singled out as a moving target, but rather was assessed, as all Management Units were, for potential habitat that could provide for metapopulation stability and persistence in the future. The USFWS believes there is enough potentially suitable habitat outside of the conservation space of Roosevelt Lake to achieve the population target of 50 territories.

Issue #68

Comment: Camp Pendleton hosts 25% of the flycatcher territories in the San Diego Management Unit. The population's stability is evidence of effective Marine Corps stewardship. On the other hand, the lack of expansion into available habitat on the Base suggests that the population targets for the San Diego Management Unit are not realistic.

Response: The USFWS believes that the amount of potentially suitable habitat within the San Diego Management Unit will support the minimum population target of 125. The known number of territories for this Management Unit is 101 (see Section IV.B., Table 9, page 84).

Issue #69

Comment: The plan fails to acknowledge numerous documented observations and breeding information for willow flycatcher (now being considered southwestern) in the San Luis Valley Management Unit. Recent blood chemistry and DNA work done on birds from the Alamosa National Wildlife Refuge concluded that the birds in the Upper Rio Grande most closely resemble southwestern willow flycatcher and should be treated as such (Paxton 2000). Paxton (2000) presents many locations of the southwestern willow flycatcher in the San Luis Valley Management Unit that have heretofore been discounted or overlooked. The literature search done by Owen and Sogge (1997) for the San Luis Valley Management Unit was inadequate and failed to do a thorough examination of all the existing data in the San Luis Valley Management Unit. There is considerable evidence by numerous observations by amateur and professional birders/biologists that cannot be discounted nor overlooked.

Response: The Recovery Plan references the results of Paxton 2000 (indicating that the San Luis Valley flycatchers show the genetic characteristics of *extimus)* as justification for inclusion of these birds within the range of *extimus*. The current southwestern willow flycatcher population data for the San Luis Valley is not based on Owen and Sogge (1997); rather, it is from Sogge et al. (2002) , which reports current (1993 - 2001) breeding sites as recognized by the USFWS and/or the wildlife agency of the state in which they occur. This is necessary because detections of other species of willow flycatchers (e.g., *E.t. adastus* and *brewsteri*) are common and widely distributed throughout the southwest as they migrate northward during the early portions of the breeding season. Sogge et al. (2002) coordinated closely with Federal and State wildlife agencies during data compilation efforts in order to avoid erroneously reporting migrant detections as breeding individuals, which would inaccurately inflate abundance estimates for *E.t. extimus*. Furthermore, during 2002, the authors of Sogge et al. (2002) met with amateur and professional biologists in the San Luis Valley to review existing information on the current status and distribution of the flycatcher, and trained over 20 biologists to conduct additional flycatcher surveys in that region; any new information arising from these surveys will be included in future Recovery Plan updates.

Issue #70

Comment: Recovery goals for the flycatcher in the middle Rio Grande are unrealistic because they appear to be inconsistent with current management practices for protection and enhancement of habitat for the silvery minnow, land management agencies are actively engaged in removing exotic saltcedar and Russian Olive to save water for the minnow.

Response: The recovery goals for the flycatcher are consistent with current management for the silvery minnow, as the plan provides for removal of exotics in certain circumstances. Continued coordination between and within agencies is vital.

The most extensive project ever undertaken to investigate water savings by tamarisk removal is the U.S. Geological Survey's multi-year, multi-million dollar project on the Gila River below Safford. The results of that project are the most closely controlled scientific investigation in the literature. The results are available in U.S. Geological Survey Professional Papers 655A through 655J. The project extended over a 10-year period, and included precipitation, groundwater well, surface water discharge, and individual plant data to produce a highly detailed water budget that showed the amount of water saved was within the error envelop of the measurements and no more. The savings of removing tamarisk are lost because of the replacement surface (i.e., a bare surface loses a great deal of water through evaporation, and other plants use high amounts of water as well). The USGS project was designed to address this issue – to conduct a rigid controlled experiment where as many variables as possible could be accounted for.

Issue #71

Comment: The Virgin Management Unit could be managed to increase flycatcher territories to a minimum of 100 territories. The Virgin River flows approximately 80 km from Littlefield, Arizona, to its confluence with Lake Mead. This entire stretch of the Virgin River is an active floodplain that creates and alters habitat on an annual basis. A land or water rights acquisition program could ensure ample in-stream flows to accomplish this goal.

Response: The Recovery Plan has been revised in response to these comments (see Section IV.B., Table 9).

Issue #72

Comment: The Bill Williams Management Unit includes areas below and above Alamo Dam. Current known territories are listed at 25, with the majority of them found above Alamo Dam. Increased survey efforts have found additional pairs below Alamo Dam on the Bill Williams River National Wildlife Refuge. The minimum number of territories listed for reclassification is 75. However, reaching this number will depend on the potential acquisition of Planet Ranch from the City of Scottsdale. If this acquisition goes through, then the minimum territories may increase to 100.

Response: The Recovery Plan has been revised in response to this comment (see Section IV.B., Table 9).

Issue #73

Comment: The Pahranagat Valley has the potential to increase the number of flycatcher territories to a minimum of 50 territories. Past survey efforts were limited to mainly native plant dominated habitat on Pahranagat National Wildlife Refuge. Surveys were not conducted within exotic plant dominated habitats on the refuge and limited surveys were conducted on privately owned parcels within the valley. The opportunity for habitat acquisition is limited within the Pahranagat Valley due to political restraints; however, some opportunity for purchase of conservation easements or habitat restoration on private and state lands does exist. The potential for habitat restoration exists on Pahranagat National Wildlife Refuge.

Response: The Recovery Plan has been revised in response to this comment (see Section IV.B., Table 9).

Issue #74

Comment: The minimum number of territories for reclassification should be adjusted slightly for the Lower Colorado Recovery Unit. Specifically, the Hoover to Parker Management Unit has much less potential habitat (based on floodplain characteristics) than the Parker to Mexico Management Unit. Opportunities for habitat expansion are much more limited geographically in the Hoover to Parker reach than from Parker to Mexico. The Hoover to Parker reach is dominated by canyons that have been flooded to form lakes; the Mohave Valley represents the main opportunity for habitat expansion. Much of the Mohave Valley is within the Havasu National Wildlife Refuge, dominated by Topock Marsh. The Colorado River is heavily channelized through the Mohave Valley and groundwater is deep below the land surface, limiting opportunities for habitat management. Based on the proportions of floodplain in the two reaches, target numbers of territories for reclassification should be redistributed.

Response: The Recovery Plan has been revised in response to this comment (see Section IV.B., Table 9). After careful consideration of information provided by the Lower Colorado River Implementation Subgroup, no changes to the population goal for the Parker to Southerly International Border Management Unit were made at this time. The USFWS believes there is enough potentially suitable habitat within the Management Unit to support the minimum population target.

Issue #75

Comment: If the target 150 territories is met from Parker to Mexico Management Unit, it can only happen through a large-scale land acquisition and restoration program. Several sites within this reach could be used for habitat restoration. The Cibola Valley Irrigation and Drainage District, Palo Verde Irrigation District, and over 2000 acres of BLM administered agricultural leases offer the best opportunities for land acquisition and restoration. The Colorado River Indian Tribes have partnered on riparian restoration projects in the past and may want to be involved in this effort. Cibola NWR and Imperial NWR are located within this reach and the Service should participate in habitat restoration; however, funding opportunities will be limited. It may be possible to meet this ambitious goal but only through large-scale active restoration projects.

Response: The USFWS agrees that the goal is ambitious, but achievable. See also the response to Issue #78 which pertains to this Management Unit.

Issue #76

Comment: Along the Rio Grande in Texas, two management units (Pecos and Texas Rio Grande) have a question mark regarding minimum number of territories for reclassification. Does this mean no territories are expected? If territories are expected, will they be added to the Rio Grande's total, or subtracted from other units?

Response: After further assessment of these two Management Units, the minimum population targets were set at zero (see Section IV.B., Table 9, page 84).

Issue #77

Comment: To meet overall recovery objectives in the Plan, it is not necessary to have viable populations of flycatchers in every Recovery Unit, rangewide. Long-term persistence can be attained by the presence of functioning metapopulations in only some of the Recovery Units. Relaxing the standards for down and de-listing to either a portion of the target population, or preferably, to only a fraction of the Recovery Units would make recovery more achievable without significantly decreasing the probability of long-term persistence.

Response: The plan has been revised to include a criteria set B for downlisting (see Section IV.B., page 78), to provide further flexibility for plan implementation.

Issue #78

Comment: It is not clear whether the Service is requiring that all Management Units meet their respective minimum numbers before reclassification can occur or whether reclassification is being proposed on a unit by unit basis.

Response: Each Recovery Unit must meet its respective minimum population goal, with flexibility provided for Management Units contained therein. Downlisting and delisting will occur when all Recovery Units meet and maintain their population and habitat targets.

Issue #79

Comment: The goal that all management units must achieve and continuously maintain their minimum population goals wrongly assumes that the condition and quantity of flycatcher habitat will remain static over time. Riparian habitats are subject to cyclical and sudden declines and increases. Populations within management units can and are quite likely to vary significantly. Management and development pressures will vary in management units, hydrology of a management unit may impede recovery.

Response: The Recovery Plan takes into account the fact that habitat condition and quality will change over time (see Section II.C.2., page 17, "The Importance of Unoccupied Suitable Habitat and Potentially Suitable Habitat"). Flexibility has been built into the plan to allow for the dynamic nature of riparian habitat (see Section IV.B.).

Issue #80

Comment: The downlisting criteria require achieving 80 percent of the population objectives, and maintaining them for five consecutive years, in all six Recovery Units before downlisting is triggered. Conservation partners vary widely from one unit to another, those in one or more units who failed to act or to achieve success would penalize those in another who aggressively and successfully pursued recovery.

Response: The Recovery Plan has been revised in response to this comment. A second downlisting criterion has been added to increase the implementation flexibility of the plan (see Section IV.B.2.).

Issue #81

Comment: An insufficient case has been made to warrant treating Recovery Units as isolated populations that are separate, unique metapopulations with non-linked objectives. Thus, we believe the Service must offer another objective that would enable downlisting if 80 percent of the overall objective were accomplished in a lesser number of Recovery Units. We believe that achieving 80 percent of the rangewide objective in 3, or perhaps 4, of the units would be an appropriate trigger for downlisting.

Response: The Recovery Plan has been revised in response to this comment. A new downlisting criterion has been developed as a way to increase the flexibility plan implementation (see Section IV.B.2.).

Issue #82

Comment: The concept that de-listing criteria should focus on security of protected and created/restored habitats to accommodate and support target population numbers achieved in downlisting is a good one and represents a valid approach to accomplishing overall recovery. While certain recovery units may present challenges in meeting the projected habitat conservation targets, other units may actually be quite conservative. We would be most supportive of a recovery objective that is population-based (i.e., breeding pair based), when it is demonstrable that the species is clear of jeopardy because enough pairs are breeding to support a healthy metapopulation. We would support that approach more readily than one that unduly focuses on achievement of projected targets in all units before recovery is declarable.

Response: The recovery strategy recommended in the Recovery Plan is population based (i.e., recovery criteria of 1,950 territories) and habitat based (i.e., spatial distribution). The population targets establish a distribution and abundance of flycatchers that minimizes the distance between populations, connects isolated sites to other breeding populations, and increases population sizes to achieve metapopulation stability (see Section IV.A.4., page 73).

Issue #83

Comment: The general criteria for management agreements necessary for delisting are poorly defined, highly subjective, and thus probably impossible to achieve. No definition is provided for the word protected or how much area must be protected. No criteria is provided to indicate which areas are critical to metapopulation stability, or what a network of conservation areas is that would support recovery.

Response: The Recovery Plan has been revised in response to these comments. Examples of management agreements may be found in Section IV.B.2., page 79; Table 10 has been expanded to identify areas where recovery efforts should be focused; and the delisting criteria in Section IV.B.2., pages 81-82, “Removal from the Federal Endangered Species List”, provide a measurable context for how much area must be protected for the benefit of breeding flycatchers.

Issue #84

Comment: We are unable to find the scientific justification or rationale for the delisting criterion that the amount of suitable breeding habitat be double that necessary to support the target number of flycatchers within each Management Unit under the criteria for threatened status. Do we know how much habitat this will require in each Management Unit? If so, is it feasible to restore enough habitat to accomplish recovery? If these parameters are not currently known, is it possible to determine how much habitat is necessary to accomplish recovery and how much habitat needs to be created? If the answers to any of the above questions are not known, we recommend that focused research directed at providing said answers should be a high-priority recovery action. Such research may be a prerequisite for the establishment of realistic recovery criteria.

Response: The Recovery Plan has been revised to address these comments (see Section IV.B.2., page 80). The USFWS believes it is feasible to restore enough habitat to accomplish the recovery goal.

Issue #85

Comment: The recovery objectives and criteria do not even mention the statutory listing factors which must be addressed.

Response: The Recovery Plan has been revised in response to this comment (see Section IV.F., page 138).

Issue #86

Comment: The Plan fails to set forth management actions on a site-specific basis as is required by the ESA. A recovery plan must, to the maximum extent practicable incorporate site specific management actions necessary for the conservation and survival of the flycatcher. The Service already has extensive documentation on operation of dams on the lower Colorado River and Salt River. We believe that each dam and river system is unique in terms of what actions the Service may be able to implement to aid in recovery of the flycatcher. Any proposed modifications to dam operating rules or dam operations should be accurately described and separately identified.

Response: The Recovery Plan has been revised in response to this comment. To obtain information on site-specific management actions that will aid the flycatcher, the plan now calls for the development of feasibility plans for the modification of dam and reservoir operations in flycatcher habitat. These studies will identify site-specific management actions that are legally, economically, and logistically feasible to implement (refer to Section V., page 143, actions 1.1.2.1.1.– 1.1.2.1.9.).

Issue #87

Comment: The Service should include in the Plan suggestions for meaningful Tribal participation offered by the Tribal Working Group in fulfilling the Federal Governments trust responsibility to Indian Tribes as outlined in Secretarial Order 3206.

Response: The Recovery Plan has been revised in response to this comment (see Section IV.E., Narrative Outline for Recovery Actions, actions 1.3.1. – 1.3.6., and Section V., actions 1.3.1.– 1.3.6.).