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Chapter 11:

Research Needs

Until the southwestern willow flycatcher was proposed for listing as an endangered species in 1993, it was subject to relatively little scientific scrutiny, in part because it is drab, prone to inhabiting dense, wet thickets, and difficult to identify and observe. Consequently, it remained one of the lesser-known of North American birds. Since that time, it has become clear that significant gaps exist in our understanding of its status, distribution, ecology, and management. Recently, many questions about the subspecies have arisen due to controversy over management actions and resulting litigation. New information that addresses these specific questions is essential to effect recovery of the bird. In this chapter we present, in annotated outline form, what we consider to be important areas for further research. This list of research needs is not intended to be exhaustive, and has not been prioritized. Refer to the southwestern willow flycatcher Recovery Plan for research priorities.

Historical and Current Status of Habitat

The greatest threat to the continued existence of the southwestern willow flycatcher is the loss and degradation of its riparian habitat throughout the Southwest (Chapter 4). A better understanding of

the patterns and changes of distribution of riparian habitats will enable a greater understanding of the causes and patterns of population declines in the flycatcher.

- Review historical and archival records (e.g., historical photos, agency management records, military records, journals and diaries) and other literature to assess the historical extent and condition of riparian areas in the Southwest, especially where willow flycatcher populations were known to have existed.
- Document and map the temporal and spatial patterns of habitat loss in the Southwest, and determine the causes of historical habitat loss. Cross-check historical records with paleobotanical data (e.g., pollen, phytolith, macrobotanical analyses, packrat middens).
- Correlate changes in willow flycatcher numbers and distribution to changes in riparian habitats over time.
- Research and document the current distribution and extent of riparian vegetation in the Southwest, to determine (1) the location and amount of currently available habitat, and (2) the types and condition of extant riparian habitat, including micro and macroclimatic condition and landscape context.

Status on the Breeding Ground _____

Although there is a consensus that population levels of the southwestern willow flycatcher have declined in this century, questions remain about its historical range and distribution. The geographic extent of the breeding range of *E. t. extimus* is unclear, particularly where it intergrades with the ranges of *E. t. brewsteri* and *E. t. adastus* (see Fig. 7-1). Sound management and recovery require a better understanding of both the historical and current breeding range as well as the current status of the southwestern subspecies to ensure that efforts target the correct subspecies.

- Analyze museum specimens using morphometric methods to assess (1) species level limits (alder vs. willow flycatchers) among populations, and (2) sub-specific level limits among populations. In particular, efforts should be made to determine whether birds breeding in western Texas, northern New Mexico, southern Colorado, Utah, and Nevada, and at higher elevations in Arizona and New Mexico, are *E. t. extimus*.
- Analyze museum specimens and field captures using genetic methods to assess (1) species level limits among populations, and (2) sub-specific level limits among populations. In particular, efforts should be made to determine whether birds breeding in western Texas, northern New Mexico, southern Colorado, Utah, and Nevada, and at higher elevations in Arizona and New Mexico, are *E. t. extimus*.
- Identify transitional areas between the ranges of *E. traillii* subspecies, using genetics, morphology, and vocalizations.
- Review historical and archival records to document the historical distribution and abundance of willow flycatchers in the Southwest.
- Refine our knowledge of the current distribution and abundance of *E. t. extimus* throughout the Southwest.
- Determine the breeding status of *E. t. extimus* in Mexico using information from surveys.
- Identify and locate suitable riparian habitat not currently occupied by flycatchers, in order to determine the degree of habitat saturation by flycatchers.

Threats to the Southwestern Willow Flycatcher _____

The various threats to the southwestern willow flycatcher, described in Chapter 4, are imperfectly understood. Many must be considered merely potential threats because their actual impacts on flycatchers or their habitats are unknown at this time. A

better understanding of those threats and their interactions with flycatchers and human activities is required to mitigate for the threats effectively. Also, it is critical to understand that many of these threats are interrelated.

Effects of Small Population Size

Populations composed of few individuals are vulnerable to genetic problems, particularly when they exist as fragmented subpopulations. Small populations tend to lose much of their genetic variability through drift, making them less able to adapt to changing environments. In the extreme case, very small populations may be prone to inbreeding depression. Recently, a study of population genetics in southwestern willow flycatchers in Arizona was initiated by the USGS Colorado Plateau Field Station (Paxton et al. 1997). This program should be expanded to the whole range of the flycatcher to address the following genetic questions. Considering the very small size and fragmented distribution of southwestern willow flycatchers, these topics should be considered high priority.

- Characterize the genetic variability and relationships within and among breeding populations.
- Assess the extent of gene flow among populations.
- Determine if inbreeding depression occurs in flycatchers.
- Determine the effective population size (N_e) of *E. t. extimus*.
- Determine whether the 2% observed rate of physical deformity in southwestern willow flycatchers is genetically based, by examining pedigrees of marked birds.
- If warranted, explore tools or techniques to increase genetic variability, e.g., cross-fostering.

Habitat Threats and Considerations

- Quantify habitat characteristics of Willow flycatcher breeding sites across entire range, in terms of (1) patch area and shape, (2) proximity to water, (3) stand age and successional status, (4) vertical structure, (5) plant species composition, (6) landscape matrix, (7) climate and microclimate variables, and (8) topography.
- Characterize 'suitable' breeding habitat and qualitatively describe variation in 'suitable' habitat across range (in more detail than in Sogge et al. 1997).
- Assess why willow flycatchers are absent from potentially suitable native habitats, especially with respect to microclimate.
- Compare placement of nest sites in relationship to substrate availability and in association with other habitat features, such as patch size and stand characteristics.

- Evaluate the impacts of phreatophyte mowing regimes on willow flycatcher habitat suitability.
- Evaluate the direct and downstream effects of sand and gravel operations on hydrology and habitat, using results from the literature or by conducting field studies.
- Evaluate the impacts of beaver on willow flycatcher habitat in the southwest, through a compilation of historical records and an assessment of current beaver distribution in different drainages.

Water Management—Water is a scarce resource in the southwest, and the health of riparian habitats is directly impacted by water management practices. Much remains to be learned about how water management affects riparian vegetation, and how water management can be altered to benefit riparian habitat and the willow flycatcher.

- Compile information on the effects of water management (e.g., dams, diversions, impoundments) on riparian habitat, using sources such as aerial photos and previous studies.
- Compare dammed and undammed drainages with respect to habitat features.
- Evaluate the effects of groundwater withdrawal or pumping on riparian habitat.
- Evaluate the effects of surface water movement (e.g., ditching, irrigation) on riparian habitat.
- Identify management regimes that favor native plant species and natural patterns of succession.
- Evaluate the impacts of dredging and channel bed alterations on riparian habitat.
- Determine how willow flycatchers respond to catastrophic habitat loss (e.g., flooding of Roosevelt Lake, Lake Mead).

Livestock Grazing—Livestock grazing in riparian areas and adjacent uplands has been identified as a major cause of the loss and degradation of riparian habitats. However, because grazing practices can vary considerably in terms of timing, location, and intensity, the effects of different grazing regimes on vegetation and flycatchers are also likely to vary. Livestock grazing remains one of the principle uses of public and private lands within the range of *E. t. extimus*. As a result, management policies that affect grazing are likely to have severe economic and political implications. Robust data on the effects of different grazing regimes on flycatchers and their habitats is essential for effective, intelligent, and defensible management of flycatcher habitat.

- Evaluate the impact of different grazing regimes (timing, livestock density, duration of grazing) on flycatcher ecology, e.g., reproductive success, population size, nest placement, productivity, predator assemblage, cowbird parasitism rates.

- Evaluate the direct and indirect effects of grazing on or adjacent to riparian habitats both occupied and unoccupied by flycatchers.
- Evaluate the effects of livestock grazing in upland habitats adjacent to riparian breeding habitat on flycatchers and their habitat.
- Evaluate the effects of livestock grazing upstream from riparian breeding habitat on flycatchers and their habitat.
- Compare the impact of different grazing regimes on plant community structure, particularly the incidence of native vs. exotic species.
- Determine the effects of livestock grazing on fuel load, and whether such effects impact flycatchers either positively or negatively.
- Use artificial nests to quantify the impacts of trampling and direct disturbance by livestock.

Recreation—Recreational activities tend to be concentrated in riparian areas in the Southwest, and therefore are likely to create significant conflicts with flycatcher conservation (Johnson and Carothers 1982). We currently know little about the direct or indirect effects of recreation on flycatchers.

- Assess the effects of human activity in and around riparian habitats on habitat quality, e.g., effects on vegetation structure, erosion, and introduction of exotics.
- Assess the impacts of human activity in and around riparian habitats on the settlement and productivity of flycatchers, e.g., possible changes in rates of nest abandonment.
- Assess the impacts of the presence and density of roads on flycatcher habitat use and productivity.

Fire—Fire has become an issue of concern in southwestern riparian systems, especially with the recent loss of some occupied willow flycatcher sites. Research on fire may help in the development of management strategies that minimize future losses to burning.

- Summarize the historical role of fire in riparian systems.
- Characterize fire sources and risks.
- Compare fire risks in exotic vs. native stands.
- Determine whether fuel loads present a fire hazard, and if so, determine what tools can be used to effectively reduce fuel loads.
- Determine the short- and long-term response of flycatchers to different types of fire, e.g., catastrophic, prescribed burnings, and patchy fires.
- Determine the effectiveness and ecological ramifications of fire breaks, e.g., do breaks significantly increase fragmentation of riparian habitats.

Exotic Vegetation—Much riparian habitat in the southwest has been invaded by exotic plants, particularly tamarisk. At the same time, many extant

populations of the southwestern willow flycatcher nest in pure or mixed stands of tamarisk, while others breed in other exotic species, such as Russian-olive. A better understanding is needed of the relative quality of exotic plants as willow flycatcher habitat and nest substrate, as well as the potential for restoring native vegetation.

- Compare willow flycatcher nesting success in exotic vs. native plant communities (e.g., tamarisk, Russian-olive, willow, box-elder, oak).
- Compare insect prey abundance and flycatcher foraging efficiency in exotic vs. native plant communities, and in relation to site-specific nesting success and flycatcher abundance.
- Evaluate quality of tamarisk habitat in relation to structure, density, canopy cover, and presence of native species.
- Identify water and land management options that favor native vegetation.
- Evaluate biocontrol of tamarisk in terms of (1) likelihood that native species will return to treated sites, (2) rate of movement of biocontrol insects, (3) responses of target and nontarget plants to biocontrol, (4) control mechanisms and containment procedures for biocontrol insects, and (5) responses of willow flycatchers to vegetation changes resulting from biocontrol.

Habitat Restoration—Because habitat loss constitutes the major threat to the flycatcher, riparian habitat restoration should prove to be a vital tool for recovery efforts. However, riparian restoration efforts have differed in their goals, methodologies, and levels of success. Very few have been conducted specifically to restore wildlife habitat for a particular species. Recently, restored riparian sites in California were colonized by least Bell's vireos (*Vireo bellii pusillus*; Kus 1998), although it remains to be seen whether the sites can persist without management (B. Kus, personal communication). As noted in the discussion on habitat (Chapter 9), not all riparian areas provide suitable habitat for the willow flycatcher. Thus, research is urgently needed to assess the appropriateness and efficacy of restoration techniques for flycatcher recovery.

- Summarize and evaluate results of past restoration efforts.
- Evaluate restoration techniques in terms of their overall efficacy.
- Compare restoration techniques, e.g., “natural” flooding events vs. managed restoration.
- Monitor colonization by willow flycatchers on restored sites with respect to rate and persistence.
- Determine efficacy of restoration projects with respect to colonization by willow flycatchers or population growth rates of willow flycatchers.

- Compare the efficacy of restoration methods for establishing Willow flycatcher populations as a function of distance to existing flycatcher populations.
- Review success of compliance “mitigation” sites in terms of regeneration and flycatcher use.
- Evaluate the efficacy and feasibility of reinstating “natural” hydrological regimes of disturbance and plant succession to willow flycatcher breeding areas.
- Determine whether successful restoration techniques are compatible with ongoing management regimes.
- Evaluate if modifying management practices can promote habitat restoration; review those modifications that have worked in the past and evaluate those not yet tried.

Factors Directly Threatening Flycatchers

Cowbird Parasitism—Some willow flycatcher populations suffer heavy cowbird parasitism, while for others parasitism appears to be a minor problem. Work is needed to determine which factors of landscape, habitat, avian community structure, or land use affect cowbird abundance and parasitism rates. Cowbird control through trapping has been proven to be effective in reducing rates of parasitism in some willow flycatcher populations (e.g., Whitfield and Strong 1995) as well as in populations of other small passerines. The methodology for trapping cowbirds is well established, but it is a labor-intensive and costly strategy. Questions about when, where, how long, and whether to trap must be answered if we are to maximize its effectiveness as a management tool, and to make the best use of scarce management funds.

- Determine if willow flycatchers are a preferred host of cowbirds at particular sites throughout the Southwest, compared to other host species.
- Determine how parasitism rates on willow flycatchers vary with host assemblage and density.
- Because cowbird abundance has been associated with livestock, characterize the relationships between flycatcher parasitism rates, cowbird abundance in feeding and breeding areas, and grazing regimes (e.g., dispersed vs. congregated, upland vs. riparian).
- Evaluate whether cattle dispersion and grazing characteristics are linked to cowbird travel distances between feeding and breeding sites in the Southwest.
- Quantify cowbird abundance throughout the Southwest (e.g., using Breeding Bird Surveys) to determine where areas of high cowbird density overlap with flycatcher breeding sites.

- Establish scientifically-based criteria to either implement or discontinue cowbird trapping in flycatcher breeding habitat.
- Evaluate the effectiveness of cowbird trapping in different habitats and regions by monitoring its effects on flycatcher productivity and population trends over time.
- Compile a list of sites where Animal and Plant Health Inspection Service blackbird control occurs, and evaluate its effects on cowbird numbers.

Because female cowbirds produce at least 30 to 40 eggs per breeding season and parasitize many species (Rothstein et al. 1986), the availability of alternate hosts in a community may affect the risk of parasitism on flycatchers (e.g., Barber and Martin 1997). Therefore, the following research questions need to be addressed:

- How does the relative timing of nesting phenology among species affect parasitism rates in flycatchers?
- How do cowbirds select hosts to parasitize?
- What management actions can reduce parasitism rates?
- How do landscape and structural features of the habitat (e.g., distance to edge, density of cover, vegetation structure, availability of perches) affect rates of cowbird parasitism?
- Determine the impacts of parasitism on juvenile and adult survival in flycatchers.

Predation—Predation may constitute a major threat to the southwestern willow flycatcher. Nest predation has been identified as a major cause of nest failure in most populations studied. Further, the risk of predation may be increasing as riparian habitats are further fragmented by human activities. Yet, because our knowledge of predators and predation on flycatchers is limited to anecdotal accounts, we lack sufficient data to manage predation effectively.

- Identify potential and documented predators on *E. t. extimus* rangewide.
- Identify the temporal and spatial distribution of predators within riparian habitats.
- Characterize predation rates and types relative to landscape and habitat features.
- Summarize geographic and temporal variation in predation patterns.
- Evaluate methods to minimize predation impacts through management.
- Determine the extent of cowbirds as predators on flycatcher eggs and nestlings.

Parasites and Disease—

- Summarize ectoparasite and disease-related information from netting and banding stations.
- Expand data collection of nest and blood parasites.

- Assess the effects of parasitism on willow flycatcher survival and productivity.

Environmental Toxins—Agricultural development in the southwest tends to be concentrated in floodplain areas, suggesting potential threats to the flycatcher and its habitat from associated pesticides, herbicides, and other toxins.

- Investigate the incidence, range, and prevalence of toxins at flycatcher breeding, stopover, and wintering locations.
- Analyze available specimens and nonviable eggs for toxins.
- Analyze other sympatric riparian birds (specimens and nonviable eggs) for toxins.

Winter and Migration _____

Willow flycatchers migrate from their summer breeding areas to winter in the tropics. However, little is known about where they go and what they do once they leave their breeding grounds (see Chapter 5). Gathering such information for this endangered subspecies is hampered by difficulties in identifying non-singing *Empidonax* species in the field, let alone subspecies. Such information is essential, however, because conservation measures on the temperate breeding grounds will be futile if the taxon's requirements are not also met during migration and on the wintering grounds.

- Determine the winter range of *E. t. extimus*, through the use of (1) museum specimens from Mexico and Central America, (2) surveys conducted on potential wintering grounds, and (3) information exchange with colleagues in Latin America.

Once the winter range is identified:

- Characterize habitat use and quality.
- Determine if, and how, winter habitat is at risk.
- Identify key areas for protection.
- Develop methods for protecting habitat and birds.
- Identify factors limiting winter survival of flycatchers, e.g., food, weather, contaminants, habitat loss or degradation, catastrophic events, disease, and predation.

Migration is a critical time for migratory songbirds, especially in terms of energy expenditure and physiological stress. However, migration ecology remains poorly known for most species, including the southwestern willow flycatcher.

- Identify migration corridors, if any, by analyzing existing survey data.
- Determine subspecies patterns in migration routes and timing, if possible.
- Determine sex- and age-specific patterns of migration.

- Determine habitat use and influence of exotic vegetation during migration.
- Evaluate stopover time with respect to habitat quality, bird condition, and food supply.
- Examine condition of migrants as a function of age and in relation to stopover time and subsequent probability of survival.
- Examine the relationship between stopover time and bird condition with the size and degree of patchiness of habitats and other landscape features.

Breeding Biology and Demography

Measures of fecundity and mortality are essential for assessing the health of any population. Much more work is needed to develop a better understanding of the factors that affect nesting success, survival, and dispersal. Many aspects of breeding biology and demography can only be determined by observing individual birds, which requires the use of color-banding.

- Expand the current Arizona banding program to create a coordinated, rangewide program.
- Quantify rates of site fidelity, both within and among years.
- Determine rates of recruitment among different populations.
- Determine the age structure of populations.
- Estimate rates of survivorship for different age classes and among different populations.
- Determine the effects of age on nesting success, yearling and adult survival.
- Identify source and sink populations.
- Estimate rates of immigration and emigration, in terms of (1) distances moved, (2) relationship to patch size and isolation, and (3) source and sink populations.
- Characterize the metapopulation structure of *E.t. extimus*.
- Characterize nesting success in terms of (1) number of nesting attempts per season, (2) fledging success over a season, (3) variation among years and among habitats, and (4) seasonal fecundity using the Pease-Grzybowski model (Pease and Grzybowski 1995).
- Determine the relation between nesting success and (1) arrival time on the breeding grounds, (2) movements within and between years, and (3) any habitat or cowbird manipulations.
- Determine the relation between nesting success and habitat or landscape features listed under habitat threats and considerations.
- Assess the relative impacts of predators versus brood parasites on fecundity.
- Determine the rates and causes of nest desertion.

Behavior

Many aspects of willow flycatcher behavior remain poorly known, but have important implications for monitoring, conservation and management. In particular, a better understanding of the flycatcher's mating system would help to answer questions about effective population size and other consequences of small population size in this subspecies.

- Determine the frequency of extra-pair copulations (by sex) to determine mate fidelity, estimates of male fecundity, and genetic relations within and among populations.
- Assess the parentage of family groups to determine the incidence of extra-pair copulations.
- Assess the relative nesting success of polygynous vs. monogamous pairs.
- Correlate mating strategy (floater vs. territorial male) with arrival time on breeding grounds.
- Correlate mating success with patch size, population size, habitat quality, and distance to source population.
- Determine the presence, size, and age of floaters in relation to population size, quality and range of habitats.
- Use data on the genetics of floaters to assess (1) relatedness to nestlings in broods resulting from extra-pair copulations, and (2) the lifetime reproductive success of floaters.
- Characterize nest defense in willow flycatchers, in terms of (1) whether birds actively defend nests, (2) whether nest defense is successful, and (3) how variable nest defense is with respect to age, sex, habitat, nest site, population size of patch, and the type of predator or intruder.

Food Habits

Many of the details of willow flycatcher food habits remain poorly known. A better understanding of the prey choice and foraging behavior is needed because insect prey abundance may be adversely affected by land use and water management practices, and because food has the potential to limit reproductive success and population growth.

- Characterize the diet of southwestern willow flycatchers through (1) fecal analyses, and (2) by direct observations of foraging birds.
- Quantify food delivered to nests, in terms of frequency of food delivery and differences between sexes and among seasons.
- Identify differences between prey eaten by adults and prey delivered to nestlings, in terms of insect size, type, or palatability.
- Assess foraging efficiency in relation to habitat type (exotic vs. native).

- Determine insect availability and type (taxon or size class) in different habitat types, including exotic vegetation. Identify any variation due to the effects of season or weather.
- Assess the existence and degree of diet overlap with other bird species to identify the potential for interspecific competition.
- Determine if willow flycatcher nest success or population trends vary in relation to food availability.
- Determine if food is limiting within or among years. Potential indicators of food limitation include (1) the frequency of nestling starvation, and (2) adult foraging behavior, as measured by the duration of foraging bouts or the percentage of daily activity spent foraging.

Vocalizations

Recent work has documented singing in females and fledglings (Seutin 1987, Sogge 1997), demonstrating that our knowledge of willow flycatcher vocalizations remains incomplete. Increased research on flycatcher song should be considered a high priority for several reasons. Survey protocols, used for assessing numbers and status of birds within populations, are based on singing. At least two current studies report the possibility that song may vary among regions or subspecies (Travis 1996, J. Sedgwick personal communication).

- Characterize the daily and seasonal patterns of song.
- Quantify the frequency, timing, and intensity of female singing.
- Evaluate female territorial defense by singing or chasing behavior.
- Compare singing behavior between sexes in relation to concealment and height of perch.
- Evaluate the role, intensity, and frequency of song in migrating willow flycatchers relative to resident birds.
- Evaluate the relation between song quality and male quality and nesting success.
- Identify and characterize local and regional dialects in vocalizations, and determine if dialects are related to subspecies or geography.
- Characterize variation in song and singing behavior, through the use of sonographs, (1) in relation to social behavior (e.g., floaters, polygyny), (2) between sexes and age classes, (3) among habitats, nest sites, or proximity to edge, and (4) with respect to cowbird abundance and parasitism rates.

Monitoring and Surveying _____

Most of our knowledge of willow flycatcher status, distribution and reproductive success comes from

survey and nest monitoring programs. These methodologies have been developed for this particular taxon only very recently, and are still evolving. Further work is needed to assess and improve the accuracy and reliability of data collected from survey and monitoring efforts.

- Expand rangewide survey efforts to fill gaps in current knowledge of flycatcher distribution.
- Determine the effectiveness of survey protocol in detecting accurate numbers of willow flycatchers, by comparing different census and nest monitoring results to survey results.
- Determine the optimal number of surveys per site.
- Compile and analyze range- and state-wide survey data to address questions about (1) population trends in time and space, and (2) distributional statistics. If there are declines, determine their causes.
- Develop a systematic population monitoring program using surveys repeated annually.
- Develop a standardized nest-monitoring protocol by coordinating the methodologies, reporting, data management and data analysis of state wildlife agencies and the US Fish and Wildlife Service. These data would be used to analyze regionwide trends and patterns in productivity over time.
- Use winter nest searches to document willow flycatcher breeding at unmonitored sites, or where breeding could not be determined during summer monitoring efforts.
- Assess the impacts of human observers on nesting success.
- Assess the impacts of color bands on willow flycatcher survival and mating success.
- Compare and correlate survey trends with trends in nest success and cowbird densities.
- Monitor habitat response to beaver reintroductions.

Population Viability Analysis _____

In Chapter 7, a population projection model was presented to show possible fates of a hypothetical flycatcher population based on different sets of assumptions about demography. That model was simple and deterministic. The more in-depth process of modeling and analyzing the various deterministic and stochastic forces that determine the fate of a population is called population viability analysis (PVA; Boyce 1992). A PVA can provide quantitative estimates of likely population trajectories under current conditions, as well as test the likely effects of different management actions. Repeated analyses through the species recovery process can provide a gauge of the progress of recovery, and may provide a quantitative criterion for de-listing. However, a PVA model is

data-intensive and its results are only as good as the data used to obtain them. Before any attempt can be made to assess the viability of the southwestern willow flycatcher population, many of the research needs outlined in this chapter need to be accomplished.

- Use the data outlined in previous sections to conduct a population viability analysis, taking into account (1) variation in vital rates among and within populations, (2) stochastic events such as fires and floods, and (3) the spatial distribution of flycatcher populations (metapopulation).
- Based on PVA results, prioritize where management efforts should be focused for (1) sustaining current population, and (2) encouraging species recovery.

Multiple Species Considerations _____

Riparian areas in the Southwest support some of the most diverse and densely populated wildlife communities in North America (Hubbard 1977, Knopf et al. 1988). Many obligate riparian and riverine species in the region are considered threatened, endangered, or sensitive, frequently due to the same factors that have impacted the willow flycatcher. Conservation efforts may be most efficient and cost-effective when they benefit multiple species.

- Identify other sensitive, threatened, or endangered species that share occupancy patterns and distributions with *E.t. extimus* (i.e., a mini-GAP analysis with a riparian focus).
- Evaluate the impacts of flycatcher management on other species, and identify management actions that benefit other sensitive, threatened or endangered species. Develop criteria for rating riparian habitats based on multi-species benefits, or concentrations of threatened or endangered species (to be used to prioritize protection efforts).
- Refer to state Partners in Flight efforts, State Heritage reviews, TNC Bioreserve program, and state-wide GAP analyses, to help prepare sensitive species management plans based on threatened and endangered species priorities.

General Recommendations _____

- Because many occupied flycatcher sites occur on privately-owned lands, more research should be conducted on private lands in collaborative efforts with landowners.
- Encourage more coordinated efforts in research, monitoring, and data sharing.
- Research to date has revealed that many aspects of flycatcher biology vary considerably among sites. Therefore, interpretation of local research

results should take this variation into consideration. Research should be conducted at a broader range of sites to better understand the extent and causes of variation.

Summary _____

The research needs outlined in this chapter demonstrate extensive gaps in our knowledge of many areas of southwestern willow flycatcher biology. It is unlikely there is enough time or funding to accomplish all of these suggested studies, however. Nor are all of the research needs of equal importance for recovering the species. The Recovery Plan for the southwestern willow flycatcher suggests that the top priority areas for research are the distribution, abundance, demography, and limiting factors of flycatcher populations. These baseline data are necessary to provide a knowledge base to begin the recovery process. Topics of secondary priority include assessments of flycatcher habitat and factors that affect habitat, such as dam and water management, grazing, and cowbird management, as well as work on migration and wintering distribution and ecology and subspecific taxonomy.

References _____

- Barber, D. R., and T. E. Martin. 1997. Influence of alternate host densities on Brown-headed Cowbird parasitism rates on Black-capped Vireos. *Condor* 99: 595-604.
- Boyce, M. S. 1992. Population viability analysis. *Annual Review of Ecology and Systematics* 23: 481-506.
- Hubbard, J. P. 1977. Importance of riparian ecosystems: biotic considerations. Pp. 14-18. In: Importance, preservation and management of riparian habitat: a symposium. General Technical Report RM-43 (R.R. Johnson, D.A. Jones, technical coordinators). Fort Collins, Colorado, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Johnson, R. R., and S. W. Carothers. 1982. Eisenhower Consortium Bulletin, 12: Riparian habitats and recreation: Interrelationships and impacts in the Southwest and Rocky Mountain region. Fort Collins, Colorado, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Knopf, F. L., R. R. Johnson, T. Rich, F. B. Samson, and R. C. Szaro. 1988. Conservation of riparian ecosystems in the United States. *Wilson Bulletin* 100: 272-284.
- Kus, B. E. 1998. Use of restored riparian habitat by the endangered least Bell's vireo (*Vireo bellii pusillus*). *Restoration Ecology* 6: 75-82.
- Paxton, E., S. Langridge, and M. K. Sogge. 1997. Banding and population genetics of Southwestern Willow Flycatchers in Arizona: 1997 Summary Report. Flagstaff, USGS Biological Resources Division, Colorado Plateau Field Station, Northern Arizona University.
- Pease, C. M., and J. A. Grzybowski. 1995. Assessing the consequences of brood parasitism and nest predation on seasonal fecundity in passerine birds. *Auk* 112: 343-363.
- Rothstein, S. I., D.A. Yokel, and R. C. Fleischer. 1986. Social dominance, mating and spacing systems, female fecundity, and vocal dialects in captive and free-ranging Brown-headed Cowbirds. *Current Ornithology* 5: 127-185.
- Seutin, G. 1987. Female song in Willow Flycatchers (*Empidonax traillii*). *Auk* 104: 329-330.
- Sogge, M. K. 1997. Primary song by a juvenile Willow Flycatcher. *Journal of Field Ornithology* 68: 630-631.

- Sogge, M. K., R. M. Marshall, S. J. Sferra, and T. J. Tibbitts. 1997. National Park Service Technical Report, NPS/NAUCPRS/NRTR-97/12: A Southwestern Willow Flycatcher Natural History Summary and Survey Protocol.
- Travis, J. R. 1996. Song types of willow flycatchers in New Mexico. Report to New Mexico Department of Game and Fish, Contract No. 95-516-67. Santa Fe.
- Whitfield, M. J., and C. M. Strong. 1995. Bird and Mammal Conservation Program Report, 95-4: A Brown-headed Cowbird control program and monitoring for the Southwestern Willow Flycatcher, South Fork Kern River, California. Sacramento, California Department of Fish and Game.

