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Supplemental Aquatic Species Report

Forest Plan Revision DEIS

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Preface

The information in this specialist report reflects analysis that was completed prior to and in conjunction with the completion of the Draft Environmental Impact Statement (DEIS) for the revision of the 1987 Coconino National Forest Land Management Plan (the Plan). The primary purpose of specialist reports associated with the DEIS is to provide detailed information to assist in the preparation of the DEIS. As the DEIS was prepared, review-driven edits to the broader DEIS resulted in modifications to some of the information contained in some of the specialist reports. As a result, some reports no longer contain information and analysis that was updated through an interdisciplinary review process and is included in the DEIS in its entirety. This specialist report retains the additional information on the environmental consequences that was not included in the summarized information in the DEIS. However, analysis and information for this resource that is included in its entirety in the DEIS is not duplicated in this report. Efforts have been made to ensure that the retained information in the specialist reports is consistent with the DEIS. If inconsistencies exist between specialist reports and the DEIS, the DEIS should be regarded as the most current, accurate source of analysis.

Contents

Introduction

This specialist report evaluates and discloses the environmental consequences not included in the DEIS on the fish and aquatic species resource that may result from the adoption of a revised land management plan.

Relevant Laws, Regulations, and Policy that Apply

All alternatives are designed to guide the Coconino NF's management activities in meeting all applicable Federal and State laws, regulations, and policies.

National Forest Management Act (NFMA) regulations, adopted in 1982, require that habitat be managed to support viable populations of native and desirable non-native vertebrates within the planning area (36 CFR219.9). USDA regulation 9500-004, adopted in 1983, reinforces the NFMA viability regulation by requiring that habitats on national forests be managed to support viable populations of native and desired non-native plants, fish, and wildlife. For planning purposes, a viable population shall be regarded as one that has the estimated numbers and distribution of reproductive individuals to ensure its continued existence is well distributed in the planning area (36 CFR 219.19). Also, the 1982 planning provisions require that "Forest planning shall provide for diversity of plant and animal communities and tree species consistent with the over-all multiple-use objectives of the planning area" (36 CFR 219.26).

Shown below is a partial list of federal and state laws, executive orders, and Forest direction pertaining to project-specific planning and environmental analysis for this Plan.

- Executive Order (EO) 11644 and EO 11989
- Coconino National Forest Land and Resource Management Plan, 1987 (as amended)
- Endangered Species Act, 1973 (as amended)
- Forest and Rangeland Renewable Resources Planning Act (RPA), 1974 (as amended)
- Forest Service Manual, FSM 2620, 2630, 2670, 2672
- Multiple-Use Sustained-Yield Act of 1960
- National Environmental Policy Act, 1969
- National Forest Management Act, 1976 (as amended); 36 CFR 219.

Assumptions

In the analysis for this resource, the following assumptions have been made:

- The land management plan provides a programmatic framework for future site-specific actions.
- Land management plans do not have direct effects. They do not authorize or mandate any site-specific projects or activities (including ground-disturbing actions).
- Land management plans may have implications, or environmental consequences, of managing the forests under a programmatic framework.
- The plan decisions (desired conditions, objectives, standards, guidelines, management areas, monitoring) will be followed when planning or implementing site-specific projects and activities.
- Law, policy, and regulations will be followed when planning or implementing site-specific projects and activities.

- Monitoring will occur and the land management plan will be amended, as needed.
- We will be funded similar to past budget levels (past 5 years).
- The planning timeframe is 15 years; other timeframes may be analyzed depending on the resource (usually a discussion of anticipated trends into the future).
- The kinds of resource-management activities allowed under the prescriptions are reasonably foreseeable future actions to achieve the goals and objectives. However, the specific location, design, and extent of such activities are generally not known at the time. The decisions are made on a site-specific (project-by-project) basis. Therefore, the discussions should refer to the potential for the effect to occur and are usually only estimates. The effects analyses are to be useful for comparing and evaluating alternatives on a forest-wide basis. It is not intended to be applied directly to specific locations on the Forest.

Revision Topics Addressed in this Analysis

Aquatic species viability on the Coconino National Forest is the primary Revision Topic addressed in this analysis. This process identifies species for which there are substantive risks to maintenance of viable populations to ensure that appropriate habitat management strategies to reduce those risks to acceptable levels are applied where feasible.

Habitat abundance was assessed based on conditions found on national forest land. Habitat distribution, however, was assessed considering the condition of intermixed ownerships and conditions, which may affect the interactions of species among suitable habitat patches on national forest lands.

Guidelines and other management approaches for Coconino NF Rare and Endemic aquatic species are also a focus in this analysis. These species face additional threats simply because of their relatively limited range-wide distribution. They might be easily affected by localized and/or stochastic events, and were noted separately in the SDR regardless of whether or not they were associated with habitat level threats. Due to their limited distribution and potential susceptibility to perturbation, these species can require additional management considerations. Methods used to achieve the priority needs for change that were identified in the CER/AMS and subsequent management reviews could affect Rare and Endemic aquatic species distribution and abundance. The priority needs for change are:

- Update desired conditions and objectives for soil resources
- Integrate management direction for riparian, aquatic, and water resources
- Update desired conditions to reflect the composition, structure, and natural disturbance attributes (such as fire) appropriate for the different ecosystems, and integrate desired conditions across different resource areas
- Address non-native invasive animals (including invertebrates) and grasses
- Ensure plan components address concerns of Threatened, Endangered, and Forest planning species and their habitats
- Acknowledge the importance of habitat connectivity
- Consider strategies to address effects of climate change

Indicators for Coconino planning aquatic species:

- Forest Ranking (F Rank) of each Coconino NF planning aquatic species

- Risk to species viability for each aquatic species/habitat element relation by Forest Plan alternative
- Number of species/habitat relationships rated as of very high, high, and moderately high risk to aquatic species viability for each habitat elements by forest plan revision alternative
- Number of species/habitat relationships rated as of very high, high, and moderately high risk to aquatic species viability for each category of management effect by forest plan revision alternative
- Number of species/habitat relationships rated as of very high, high, and moderately high risk to aquatic species viability for each category of species status by forest plan revision alternative
- Desired Conditions for Coconino NF Rare and Endemic aquatic species and their habitats
- Guidelines for Coconino NF Rare and Endemic aquatic species
- Management Approaches for Coconino NF Rare and Endemic aquatic species and their habitats

Supplemental Information for Affected Environment

Sediment Delivery

Sediment adversely impacts stream fishes directly through: changing fish behavior, altering fish physiology, impairing growth, shifting blood chemistry, inducing gill trauma, reducing disease resistance, increasing egg mortality, and direct mortality of juveniles and adults if sediment levels are high enough (Anderson 1996, Argent and Flebbe 1999, Bisson and Bilby 1982). Sediment indirectly affects fish through behavior modifications including, increased frequency of the cough reflex, avoidance of suspended sediment, reduction in feeding, and temporary disruption of territoriality. The severity of changes in fish behavior is associated with the timing of disturbance, the level of stress, and the importance of the habitat that the fish may be excluded from (Anderson 1996, Bisson and Bilby 1982, Rice et al. 2001). Other indirect effects on stream fishes from sediment can occur by modifications to stream habitat. These changes include: altered channel morphology, loss of spawning habitat, loss of rearing habitat, changes in the food supply (macroinvertebrate assemblage), and decreased over-wintering habitat (Lisle 1989, Miller and Benda 2000, Wood and Armitage 1997).

Sediment exceeding natural background levels can fill pools, silt spawning gravels, decrease channel stability, modify channel morphology, and reduce survival of fry (Lisle 1989; Anderson 1996; Argent and Flebbe 1999; Kolka and Smidt 2004). Increased fine-sediment composition in stream gravel has been linked to decreased fry emergence, decreased juvenile densities, loss of winter carrying capacity, and increased predation of fishes. Increased fine sediment can reduce benthic organism populations and algal production. Survival of incubating salmonids from embryos to emergent fry has been negatively related to the proportion of fine sediment in spawning gravels (Anderson 1996; Wood and Armitage 1997; Rowe and Dean 1998; Shaw and Richardson 2001). Increased fine sediment in stream gravel can reduce intra-gravel water exchange, thereby reducing oxygen concentrations, increasing metabolic waste concentrations, and restricting movements of alevins (Lisle 1989; Platts et al. 1989; Anderson 1996). Survival of embryos is directly related to dissolved oxygen concentration, velocity of intra-gravel water, gravel permeability and gravel size. Increases in fine sediment can also reduce winter carrying

capacity of streams by loss of concealment cover and by increasing the likelihood of predation (Thurow et al. 1997).

Pools that lose volume from sediment (Lisle 1982) support fewer fish, and fish that reside in them may suffer higher mortality (Wood and Armitage 1997; Shaw and Richardson 2001; Kolka and Smidt 2004). Pools and other slow water areas are bioenergetically beneficial because fish can forage in such areas with minimal effort (Rosenfeld and Boss 2001). Pools function as resting habitats for adults, rearing habitats for juveniles, and refugia from natural disturbances (Stoneman and Jones 2000; Keim et al. 2002). On the Coconino National Forest where many species are dependent on intermittent/residual pool systems, the loss of pool habitat due to sedimentation has amplified adverse effects on the species dependent on those pools for survival during drier periods.

Chronic sediment input may lead to increased turbidity. Turbidity has been shown to decrease the reaction distance between fish and their prey (Gradall and Swenson 1982; Barrett et al. 1992; Abrahams and Kattenfeld 1997). High turbidity (>40 NTU) can promote a change in foraging strategies from "lie in wait" to active searching for prey, negatively affecting the ability of fish to feed and limiting growth from increased energy expenditure (Sweka and Hartman 2001a; Sweka and Hartman 2001b).

The following is a list and analysis of current and historic disturbances that occur on the Coconino National Forest affecting erosion and sediment delivery to aquatic systems (Steinke and Renner 2007).

Herbivory: Cattle grazing occurs throughout many perennial streams, riparian areas and some wetlands. High levels of ungulate grazing (both livestock and elk) have been observed to reduce effective vegetative ground cover and riparian vegetation and contribute to accelerated erosion, soil compaction (GTES 1991) and sedimentation to connected perennial waters and reduce or impair water quality. High levels of elk grazing are largely uncontrolled and have been observed in riparian areas and especially in unfenced wetlands and have resulted in similar adverse effects on the vegetation, soil and riparian condition and function. Excessive or poorly timed ungulate grazing in riparian areas can reduce plant and animal diversity and negatively affect riparian habitat and those species that depend on it for their survival. Currently, the Forest does not permit livestock grazing along the Verde River which has resulted in improved riparian condition over the last 10 years. Many other allotments have reduced livestock grazing in perennial streams to hardened areas or to times when grazing pressure does not adversely affect riparian area condition.

Drought: The Forest has experienced several years of drought (roughly since about 1999) with occasional normal levels of seasonal moisture. Reduced precipitation results in reduced upland vegetative growth, reduced surface organic matter and ineffective vegetative ground cover putting the soil at risk of accelerated erosion and sediment delivery to connected streams during storm events. As vegetation dries out, there is increased risk of wildfire spread and subsequent accelerated erosion and watershed degradation.

Perennial stream riparian vegetation is very resilient to drought and has not been shown to be drastically altered during periods of drought. However, riparian vegetation in wetland sites has been observed to dramatically decrease during periods of drought, resulting in less ponded and available water, lower plant composition and ecosystem diversity for those species that rely on it for their survival.

Flooding: Frequent flooding is a natural process and disturbance on the Coconino National Forest, and is generally beneficial to native aquatic biota because substrates are reset, thus reducing embeddedness (level to which gravels and cobbles are covered with fine sediment) and increasing interstitial spaces in substrates, thus improving water flow and oxygen delivery. Flooding may cause localized soil loss, increased sediment movement, and reduced water quality in stream channels if streambanks and floodplains are not well protected with vegetative ground cover. Flash flooding can occur in perennial, intermittent and ephemeral streams, especially in large watersheds where short duration, high intensity storms occur. Maintaining native vegetation described in the Potential Plant Community of the Terrestrial Ecosystem Survey (Miller et al. 1995) provides channel stability, functional riparian areas and good water quality for wildlife and aquatic species.

Wildfire: Riparian areas are not identified as fire-adapted ecosystems but may be in the pathway of wildfires. Since the majority of wildlife species rely on vegetation, food and water supplied by perennial streams, wetlands and riparian areas, it is essential to minimize the destruction that may be caused by adjacent, prescribed or uncontrolled wildfires to these areas.

With the exclusion of wildfire throughout most Potential Natural Vegetation Types (PNVTs) in the last 70 years, fuel loading has increased in woodland and forest PNVTs resulting in high risk of accelerated erosion, loss of soil and vegetative productivity, and sediment transport to connected streams following wildfires in areas with moderate and high erosion hazard on the Forest. High levels of sediment can reduce fishery and aquatic habitat and those species that rely on it for their survival. Over 60% of the Forest (with high proportions in Pinyon-Juniper and Ponderosa Pine PNVTs) is highly departed from historical condition, and poses risk to watershed degradation following wildfires (USDA 2009).

Roads: The effects of roads on aquatic habitat are believed to be widespread at the landscape scale; correlative evidence suggests that roads are likely to influence the frequency, timing, and magnitude of disturbance to aquatic habitat. Increased fine-sediment composition in stream gravel, a common consequence of road-derived sediments entering streams, has been linked to decreased fry emergence, decreased juvenile densities, loss of winter carrying capacity, and increased predation of fishes, and can reduce benthic organism populations and algal production. Roads can act as barriers to migration, lead to water temperature changes, and alter streamflow regimes. Improper culvert placement where roads and streams cross can limit or eliminate fish passage. Roads greatly increase the frequency of landslides, debris flow, and other mass movement. At the landscape scale, increasing road densities and their attendant effects are correlated with declines in the status of some fish species (Gucinski et al. 2001).

Vegetation Treatment and Prescribed Fire: Most effects to aquatic habitat and biota are the result of upland terrestrial changes that result in changes to sediment and water transport in the watershed. The primary negative impacts to aquatic systems and their associated biota from vegetation treatment and prescribed fire come as indirect effects. These indirect effects include increased sediment, loss of riparian vegetation, altered macroinvertebrate assemblages, lowering of groundwater tables and decreased perennial flows, increased stream temperature, larger peak flows, stock tank impacts, and changes in channel form (Bisson et al. 2003, Swank et al. 1989).

Sedimentation and erosion are natural processes and ecosystems have evolved to handle the natural background levels and the episodic events of fire (Bisson et al. 2003). However, when

land management activities alter the natural levels in a watershed, deleterious effects to the habitat and biota can occur; this can be compounded when a system's natural resiliency has been degraded by past activities, such as fire suppression, drought, road building, grazing, etc. Vegetation management can contribute to the deterioration of soil stability and porosity, increasing erosion and compaction. These factors can lead to increased sedimentation into streams and changes in the hydroperiod.

Watershed hydroperiod can be altered by vegetation removal and fire through the loss of soil productivity, and increased soil compaction. Reductions in soil productivity can limit the vegetation potential resulting in decreased precipitation that is taken up by plants. Increased soil compaction decreases the amount of water infiltration into the soil. Both of these factors compound to lead to higher surface runoff and higher flood pulses in stream channels (Swank et al. 1989, Ziemer et al. 1991). The erosive energy of floods can cause stream channel downcutting or incision, causing water to drain from floodplains into the channel resulting in lower ground water tables (Agee and Skinner 2005, Lertzman et al. 1998, Ziemer et al. 1991). This results in a narrowing or loss of riparian vegetation since it is left in drier soils. Additionally, with less water entering upslope and riparian soils less water is available to provide late season flows. Therefore, the higher flows during precipitation events are often followed by low or no flow during drier weather periods (Rinne and Miller 2006).

The effects of hydroperiod alterations listed above can result in deleterious effects to aquatic biota. Lower water tables that reduce or eliminate riparian vegetation affect macroinvertebrate communities. Streamside vegetation provides both allochthonous (produced outside stream system) and autochthonous (produced within stream ecosystem) food sources for macroinvertebrates and the quantity and quality of these inputs plays a critical role in regulating the macroinvertebrate assemblage that is present in the system (Gregory et al. 1991). In turn, macroinvertebrates are a primary food source for aquatic vertebrates (icthyofauna and herptefauna) and alterations to the food web at the lower levels will have repercussions to these higher-level consumers. Additionally, riparian plant communities with rooted plants retard streambank erosion, filter sediments out of the water, build and stabilize streambanks and streambeds, and provide shade and nutrients for aquatic species. Healthy riparian areas act as sponges during high water periods and raise water tables, maintaining streamwater during dry seasons, resulting in more flow throughout the year (Elmore and Kauffman 1994, Kauffman et al. 1997). The loss of riparian vegetation, therefore, can result in a negative feedback loop where conditions continue to break down until active management is undertaken to repair or retard degraded areas.

Invasive Species

Without question, the single most important factor causing the present decline and elimination of native fish in the southwestern region of the North America is the introduction of non-native fish. Over 100 non-native fish species have been introduced onto Coconino National Forest lands alone. Many have become established, and most are piscivorous, feeding on all lifestages of native fish. Habitat alteration, combined with accidental, illegal, and intentional introduction of non-native fish and invertebrate species (e.g. northern crayfish, bullfrogs) has enabled non-native species to reduce or replace the native aquatic fauna (including macroinvertebrates) in most of the perennial streams and tributaries in the American Southwest, including the Coconino National Forest (documented and reviewed by Minckley 1973, Minckley and Deacon 1991, Minckley 1993, Marsh and Pacey 2005, Minckley and Marsh 2009, and others).

To a limited extent, the Forest can control the spread and establishment of invasive plants and animals. For animals, this category includes invasive and nonnative species such as crayfish, other nonnative invertebrates, and nonnative fish and reptiles. The Forest is constrained because: spread of invasive plants and animals can occur via factors the Forest does not control (animals, wind, and water); control of populations may be under the jurisdiction of other agencies; and successful establishment is influenced by many factors including native species lacking defense mechanisms for nonnative organisms. Invasive species influence and can significantly disrupt the composition and structure of ecosystems as well as natural processes.

Nonnative parasites were inadvertently introduced into the region via introductions of nonnative fishes (Hoffman and Schubert 1984). Some of these parasites (e.g., *Lernaea cyprinacea* and *Bothriocephalus acheilognathi*) are generalists and have parasitized many of the Southwest's native fish species (James 1968; Mpoame and Rinne 1983; Heckmann et al. 1987, 1987; Brouder and Hoffnagle 1997; Robinson et al 1998). Native fishes may be particularly susceptible to introduced parasites.

In order to prevent extirpation of many native fish, the Coconino National Forest can protect the habitat of native aquatic species, and also coordinate with the Arizona Game and Fish Department to restore, protect, reintroduce, re-establish, and secure the native aquatic fauna of the Forest.

Supplemental Environmental Consequences and Cumulative Effects

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carry out any project or activity. Because the land management plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions), there can be no direct effects. However, there may be implications, or long-term environmental consequences, of managing the forests under this programmatic framework.

Supplemental Environmental Consequences

Indirect Effects

Foreseeable actions that occur on Forest Service lands include current and future livestock grazing through management of allotment permits, ungulate grazing, fuels reduction projects, forest thinning, and watershed improvement projects. However, these actions are planned to improve soil and water conditions above current conditions and have mitigation measures and best management practices designed to mitigate any short-term impacts to habitat that may occur from project implementation.

Livestock grazing can contribute to increased sedimentation into aquatic systems and thus affect TES aquatic species, planning species, and macroinvertebrates (EI) (see Affected Environment: Sedimentation). Range analyses for permit reauthorization strive to minimize these effects. Range projects on the forest Schedule of Proposed Actions (SOPA) that may impact aquatic resources on the CNF include reauthorization of the Buckhorn, Walker Basin, and Apache-Maid allotments as well as continued livestock grazing through existing grazing permits.

Fuels reduction and forest thinning projects can contribute to effects on aquatic species and their habitat (see Affected Environment: Sedimentation: Vegetation Treatment and Prescribed Fires). Although the effects of fuels reduction and thinning projects are mitigated to reduce the effects on species and their habitat, they still result in modification of vegetation which can increase soil exposure and result in increased erosion and sedimentation to aquatic systems. Fuels reduction projects on the SOPA include the: Clint's Forest Restoration Project, Munds Park Fuels Reduction, and Hart Prairie Fuels Reduction and Forest Health Project.

The Mogollon Rim Ranger District has completed the final environmental assessment (USDA 2006) and has signed a Decision Notice and Finding of No Significant Impact (DN/FONSI) to implement portions of Alternative 5 of the East Clear Creek Watershed Health Improvement Project. All proposed actions occur within the Mogollon Rim Ranger District of the Coconino National Forest, Coconino County, Arizona. Specifically, the Mogollon Rim Ranger District is proposing to) restore understory and overstory vegetative health and diversity; 2) reduce the potential for stand-replacing wildfire; 3) restore soils, meadow systems; and riparian areas; and 4) reduce the effects of roads on riparian areas and threatened, endangered and sensitive species habitat. This project will improve aquatic habitat by restoring riparian areas, and will reduce sediment and ash flow into aquatic systems through the above forest restoration activities. This project will benefit Little Colorado spinedace, Little Colorado sucker, bluehead sucker, and roundtail chub habitat through reductions in sedimentation, which is detrimental to all aquatic species (see Affected Environment: Sedimentation).

Four national forests are actively engaged in a collaborative, landscape-scale initiative designed to restore fire-adapted ecosystems in the Southwestern Region. Those forests are the Kaibab, Coconino, Apache-Sitgreaves and Tonto. Together with a diverse group of stakeholders, the four forests are working to collaboratively plan and carry out landscape-scale restoration of ponderosa pine forests in northern Arizona. The overall goal of the Four Forest Restoration Initiative (4FRI) is to create landscape-scale restoration approaches that will provide for fuels reduction, forest health, and wildlife and plant diversity. A key objective is doing this while creating sustainable ecosystems and industries in the long term. On the Coconino, these activities will benefit aquatic species by reducing the danger of stand-replacing wildfire, which produces excessive sedimentation into springs and streams (see Affected Environment: Sedimentation: Vegetation Treatment and Prescribed Fires).

Construction projects that occur within stream flood plains can result in direct trampling of aquatic organisms, and erosion and increased sedimentation into aquatic systems. Although the effects of these projects are mitigated to reduce effects on aquatic species and their habitat, some direct trampling, erosion and sedimentation to aquatic systems may occur and impact aquatic TES species and macroinvertebrates. Construction projects on the SOPA that will likely contribute some sediment to aquatic systems include the Houston Draw Aquatic Organism Passage Project, the Tobias/Flynn Road Access Project, and the West Fork Oak Creek Bridge Replacement Project. The impacts of these projects are expected to be avoided or minimized by application of best management practices and short term, if any direct impacts occur.

Recreation management can also have impacts on aquatic resources. The Fossil Creek Wild and Scenic River Comprehensive River Management Plan Project will likely result in the construction of developed or designation of dispersed camping sites and associated access routes and parking

areas. This project will close some roads that are causing resource damage, and will develop and designate trails or other access areas. These activities are likely to result in short-term (1 to 5 years) increases of sedimentation into Fossil Creek due to construction activities and this would impact its aquatic TES species and macroinvertebrates (planning and EI species; see Affected Environment: Sedimentation). In the long-term (1 to 5 years after implementation) this project is expected to reduce erosion rates and sedimentation to Fossil Creek below current levels.

Supplemental Information for Cumulative Effects

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Because the land management plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions), there can be no direct effects. However, there may be implications, or long-term environmental consequences, of managing the forests under this programmatic framework.

Past actions that are relevant to fisheries and aquatic biota are described below for all alternatives. The cumulative effects analysis area for aquatics resources is the 5th code watersheds that contain perennial waters within the Coconino NF. This cumulative effects analysis does not attempt to quantify the effects of past human actions by adding up all prior actions on an action-by-action basis. In order to understand the contribution of past actions to the cumulative effects of the proposed action and alternatives, this analysis relies on current environmental conditions as a proxy for the impacts of past actions. This is because existing conditions reflect the aggregate impact of all prior human actions and natural events that are difficult to quantify and that have affected the environment and might contribute to cumulative effects.

Reasonable foreseeable actions that can affect fisheries and aquatic biota include actions that occur in the watersheds on private lands. Actions that take place on private lands are difficult to quantify but include water withdrawals, urbanization, agricultural practices, and introduction and spread of nonnative species.

Unauthorized and unmanaged dispersed recreation, while not continuous across the Forest like grazing or across large areas like fuels reduction and thinning projects, can result in adverse impacts to aquatic species and their habitat. Social trails, social roads, dispersed camping areas, and the use of these by the public can increase sedimentation into aquatic systems. As a result, these activities can impact aquatic TES species and macroinvertebrates.

The impacts of non-native species introductions cannot be understated. This includes the introduction of over 100 nonnative fish into the Southwest, introduction of invertebrates (particularly crayfish) and other aquatic invasive invertebrate species (e.g. quagga and zebra mussel), and the introduction of aquatic invasive plant species (e.g. *Arundo*). Documentation of the negative impacts of nonnative fish introductions comprises an extensive body of literature, much of which has been effectively summarized in books (Minkley 1973; Minckley and Deacon 1991; Minckley and Marsh 2009; and references within these publications) and in review articles (Marsh and Pacey 2005, and references therein). Currently, all native fishes in Arizona and 80 percent of native fishes in the Southwest are on either State or Federal protection lists (USDI 2010). The primary causal factor for extinction of native fishes in the Southwest is directly related to the introduction of nonnative fish (Miller et al 1989).

Population growth in the area within and surrounding the forest is expected to continue. Residential home and commercial development would continue in the watersheds on private lands and have various impacts to watershed integrity. Impacts would be greatest in those hydrologic 5th Codes with higher amount of private land ownership such as Cherry Creek-Verde River and Rio de Flag. Demand for outdoor recreation is also expected to grow concurrently with increasing population with more visitor use of the forest.

Off-forest water uses are having some effect to streamflows on the forest, especially to the Verde River, and are expected to have a greater impact with increasing population and groundwater demands in watersheds that cover the forest. Impacts would be greatest in those subbasins with higher amount of private land ownership such as Cherry Creek-Verde River and Rio de Flag. Currently, the City of Prescott has a water right of 2,700 acre feet per year from Del Rio Springs (Prescott NF), near the headwaters of the Verde River. In addition, the Arizona Groundwater Transportation Act (A.R.S. 45-555), contains an exemption for the city of Prescott allowing them to transfer between 8,000 and 14,000 acre-feet per year from the Big Chino aquifer. The city of Prescott has purchased land in the Big Chino basin and is in the planning stages of construction of a pipeline for water transfer to the city. The city has also purchased lands with water rights in the area with the intent of retiring about 3,600 acre-feet per year of water as potential mitigation for the water transfer. Potential impacts from groundwater withdrawals in the Big Chino aquifer include reduction in river flow levels in the upper Verde River. This will have a negative impact on native aquatic fauna on the Coconino NF.

The Apache-Sitgreaves National Forest is evaluating Leonard Canyon on the Coconino and Sitgreaves National Forests as a potential wilderness area. The area was not burned in the recent Wallow fire and it is therefore assumed that this area may be part of an alternative in their Draft EIS. If the Apache-Sitgreaves National Forest chooses to recommend the Leonard Canyon Potential wilderness Area for Congressional Designation, the Coconino would need to manage the area to preserve its wilderness character and other restrictions in the Forest Plan. This would be more restrictive than any of the alternatives considered by the Coconino National Forest in terms of mechanized and motorized uses. It would contribute additional wilderness acres to provide for those recreation experiences.

Other land uses such as livestock grazing, mining, and vegetation treatments is occurring across the watersheds on federal, state, private, and tribal lands. Management actions on federal and state lands follow law, policy, and other management direction to minimize impacts to aquatic ecosystems. Actions on private lands completed with federal or state dollars are also required to complete environmental assessment on impacts to species and their habitats.

Looking forward, there is general agreement among climate modelers that by the end of the 21st century, the Southwest is likely to experience the following conditions from climate change (USDA 2010):

- Temperature increases of five to eight degrees Fahrenheit (or about 0.5°F/decade on average)
- An increase in the number of hot days, with summer heat waves lasting two weeks or longer
- Warmer winters and reduced snowpack, and a later monsoonal season
- A five percent drop in precipitation in most of Arizona and New Mexico
- An increase in extreme flood events following an overall increase in tropical storms

The current plan does not recognize the potential impacts from climate change. Guidance for addressing this issue is contained in *Navigating the Climate Change Performance Scorecard* (USDA 2011) and would need to be integrated into the current plan. The extent of this effort is unknown, but would involve an amendment to the monitoring section of the plan. The result would be that increased effort would be needed to adapt management practices to respond to changes brought on by increased temperatures, longer heat waves, and reduced precipitation.

All Alternatives

Cumulative effects from all activities would have similar consequences across alternatives. Impacts from population growth, land development, and increased water use on private lands would have the greatest future impacts to aquatic ecosystems on the forest. Management direction provided in all alternatives would maintain or improve aquatic ecosystems on the forest. Implementation of native fish improvement projects on the forest would have the greatest benefit to species viability.

These goals and strategies are consistent with and complimentary to strategies identified in Arizona's Comprehensive Wildlife Conservation Strategy, as well as the State Wildlife Action Plan (AGFD 2012). These plans both emphasize sustainability, a return to historic (reference) conditions and are based on the principles of best science, best management practices, and adaptive management with measurable goals objectives, strategies and approaches.

The net effect of these planning efforts, when combined with the preferred alternative is expected to be a beneficial one for wildlife by providing for better coordination across the landscape and perpetuating the habitat conditions necessary to insure for species viability into the future.

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