GILA WATERSHED

Most of the Gila Watershed lies within Grant and Catron counties of southwestern New Mexico, but several headwater streams are in Sierra County. The lowermost reaches of the Gila River flow through Hidalgo County. The Gila River is the only un-dammed major river in New Mexico. Except for Silver City, which is outside the Gila Watershed, there is no town having more than 500 residents. The population of Grant County is 31,002 (US Census Bureau 2000), of which 10,545 live in Silver City. Catron and Hidalgo counties, in contrast, have substantially fewer residents. In 2000, 3,543 people resided in Catron County and 5,932 lived in Hidalgo County (more than half lived in Lordsburg, which lies outside of the Gila drainage). Reserve, the largest town in Catron County, has 387 residents. Sierra County, in the eastern portion of the watershed, has 13,270 residents, but few of these live within the watershed. Between 1990 and 2000, the population of Catron County grew 38%. Population of Grant County increased 12% and Hidalgo County declined less than 1%. Between 2000 and 2003, the population of all counties in watershed, including Sierra County, declined between 1% (Sierra) and 12% (Hidalgo). In 2000, the per capita income in Grant County was $18,507. Catron County was $13,095 and Hidalgo County was $15,940. Mining, construction, agriculture, and retail trade are among the largest economic activities in Grant County. Almost all economic activity in Catron County is related to agriculture, generating about $14.5 million in 2000. The economy of Hidalgo County was dominated by agriculture contributing $18.3 million in 2000.

Several small reservoirs including Snow, Roberts, Wall, and Bill Evans are present in the Gila Watershed. Snow and Roberts lakes are on US Forest Service lands. Bill Evans Lake is owned by NMDGF with water provided by the Phelps Dodge Corporation. Wall Lake is privately owned. Non-native rainbow trout (*Oncorhynchus mykiss*) and common carp (*Cyprinus carpio*) live in Snow Lake. Rainbow trout and channel catfish (*Ictalurus punctatus*) are found in Lake Roberts, and rainbow trout and largemouth bass (*Micropterus salmoides salmoides*) are in Bill Evans Lake.

Native fishes, if present, are incidental. No native fish depends upon perennial reservoirs within the watershed and there are no Species of Greatest Conservation Need (SGCN) in these reservoirs. There is some potential to stock Gila trout (*Oncorhynchus gilae*) in Snow Lake, once the species has been downlisted from endangered to threatened.

The Gila Watershed in New Mexico is composed of two major streams, the Gila and San Francisco Rivers. Within these streams, perennial marsh/cienega/spring/seep, perennial 1st and 2nd order streams, perennial 3rd and 4th order streams, and perennial 5th order streams were identified as key habitats (Fig. 5-10). Headwaters of both major streams lie at high elevations in the Mogollon Mountains of southeastern Arizona and southwestern New Mexico.

Small, headwater canyon-bound streams are bordered by blue spruce (*Picea pungens*), Douglas-fir (*Pseudotsuga menziezii*), and aspen (*Populus tremuloide*) in high elevation headwaters. As the streams descend and coalesce, ponderosa pine (*Pinus ponderosa*), juniper (*Juniperus* spp.), and piñon (*Pinus* spp.) become the dominant conifers. Stands of willow (*Salix* spp.) are common in moderate gradient reaches. Headwater streams of the Gila join in the Mogollon Mountains to form the river's West, Middle, and East forks. From this junction, the Gila flows westerly and

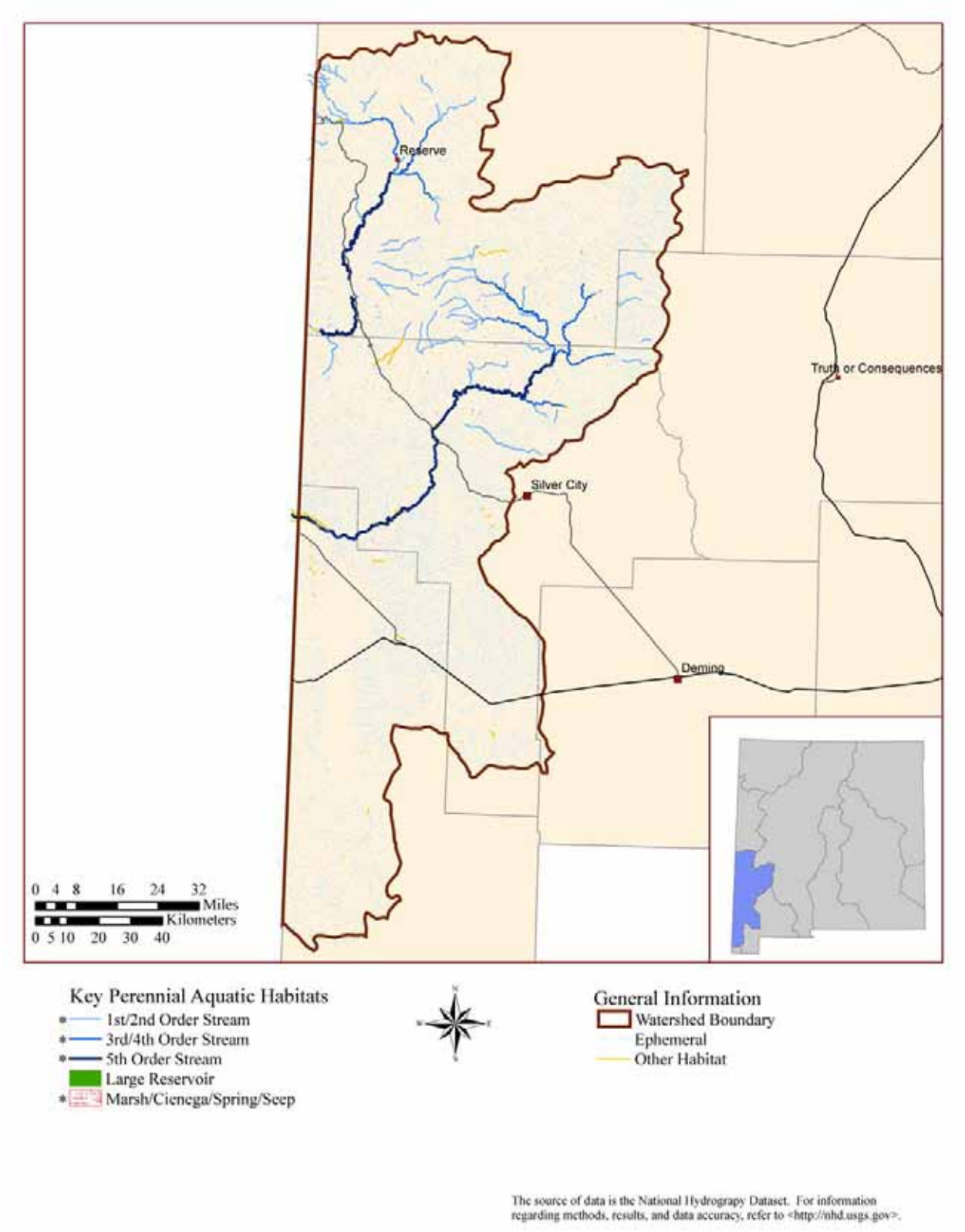

Figure 5-10. Key perennial aquatic habitats in the Gila Watershed in New Mexico. Key habitats are designated with an asterisk (*).

exits the Mogollon Mountains just east of the town of Gila. Along its mountain course, the river is bordered by ponderosa pine, piñon, juniper, cottonwood (*Populus deltoides*), Arizona sycamore (*Platanus wrightii*), boxelder (*Acer negundo*), and Arizona walnut (*Juglans major*). Mountainous portions of the Gila River are almost entirely within lands administered by US Forest Service and substantial portions flow within the Gila and Aldo Leopold wilderness areas. In high elevation streams, non-native brown trout (*Salmo trutta*), and rainbow trout are common.

After exiting the mountains, the Gila flows westerly through the Cliff-Gila Valley to the Arizona border near Virden. Portions of lower Gila River flow through lands administered by US Bureau of Land Management and US Forest Service but most lands are privately owned. The primary land uses along the river in this section is livestock grazing and irrigated cropland. Water is seasonally diverted from the river. An infiltration gallery diverts water to Bill Evans Lake. Rio Grande sucker (*Catostomus plebeius*) is common in Sapillo Creek, a mid-elevation tributary to Gila River. Several non-native fish, such as red shiner (*Cyprinella lutrensis*) and fathead minnow (*Pimephales promelas*) occupy the Cliff-Gila Valley, but none are common.

At the western end of the valley, the river is narrowly confined as it flows through the Middle Box. Non-native black bullhead (*Ameiurus melas*), smallmouth bass (*Micropterus dolomieui*), and channel catfish inhabit mid-elevation streams, and dominate fish assemblages in canyon reaches. Downstream, the Gila River flows across desert grasslands to another constriction, the Lower Box where it crosses desert shrub lands and exits New Mexico. Arizona sycamore, cottonwood, and mesquite (*Prosopis* spp.) are the primary woody vegetation in lower reaches. In this lower reach, channel catfish, flathead catfish (*Pylodictus olivaris*), and red shiner are common.

Species of Greatest Conservation Need

At least 49 SGCN, excluding arthropods other than crustaceans, occur in the Gila Watershed (Table 5-12). Historically, the watershed provided habitat for 11 and perhaps 13 fish species. Today only seven confirmed native species persist in the drainage. Most species (n = 28, 57%) are classified as vulnerable, imperiled, or critically imperiled both statewide and nationally. Fifteen SGCN are classified as nationally secure, but vulnerable, imperiled, or critically imperiled in the state. Conservation status codes (abundance estimates) for each SGCN are provided in Appendix H. Conservation concerns for birds, mammals, amphibians, and reptiles are primarily addressed in the statewide distributed riparian habitats section and/or the discussion of terrestrial habitats in each ecoregion. Additional concerns for molluscs and crustaceans are addressed in the statewide distributed ephemeral habitats and perennial tanks section.

Colorado pikeminnow (*Ptychocheilus lucius*) and razorback sucker (*Xyrauchen texanus*) once occurred in the Gila River in Arizona as far upstream as Safford. Because there were no barriers to their movement upstream, it is presumed both species at least seasonally entered New Mexico. The Gila chub (*Gila intermedia*) formerly inhabited perennial marsh/cienega/spring/seep habitat in the Gila, but no extant perennial marsh/cienega/seep supports the species. Gila topminnows (*Poeciliopsis occidentalis occidentalis*) were noted in the Frisco Hot Springs in the past but were extirpated in the early 1950s (Sublette *et al.* 1990). The Gila trout has also been extirpated from 5th order streams in this watershed.

Table 5-12. Species of Greatest Conservation Need in the Gila Watershed in New Mexico.

Common Name	Perennial			
	Marsh/ Cienega/ Spring/ Seep	1st and 2nd Order Stream	3rd and 4th Order Stream	5th Order Stream
Fish				
Colorado Pikeminnow				?
Desert Sucker		X	X	X
Gila Chub	X	X	X	
Gila Topminnow	E[1]	E	E	
Gila Trout		X	X	E
Headwater Chub			X	
Loach Minnow		X	X	X
Razorback Sucker				?
Roundtail Chub			E	E
Sonora Sucker	X	X	X	X
Spikedace			X	X
Birds[2]				
Eared Grebe	X		X	X
American Bittern	X			
White-Faced Ibis	X			
Northern Pintail	X		X	X
Osprey			X	X
Bald Eagle	X		X	X
Northern Harrier	X			
Common Black-Hawk	X	X	X	X
Peregrine Falcon	X		X	X
Sandhill Crane	X			X
Gila Woodpecker			X	X
Southwestern Willow Flycatcher	X		X	X
Bell's Vireo			X	X
Bank Swallow			X	X
Lucy's Warbler	X		X	X
Yellow Warbler	X	X	X	X
Abert's Towhee	X		X	X
Mammals[2]				
Arizona Shrew	X			
Western Red Bat	X			
Spotted Bat	X			
Allen's Big-Eared Bat	X			
Pocketed Free-Tailed Bat	X			
American Beaver	X	X	X	X
NM Meadow Jumping Mouse	X			
Desert Bighorn Sheep	X			
Amphibians[2]				
Tiger Salamander	X			
Arizona Toad	X	X	X	X
Western Chorus Frog	X	X	X	

Table 5-12 Cont.

Common Name	Perennial: Marsh/ Cienega/ Spring/ Seep	Perennial: 1st and 2nd Order Stream	Perennial: 3rd and 4th Order Stream	Perennial: 5th Order Stream
Amphibians Cont.				
Chiricahua Leopard Frog	X	X	X	X
Northern Leopard Frog	X	X	X	X
Lowland Leopard Frog	X	X		
Reptiles[2]				
Sonoran Mud Turtle	X	X	X	
Mexican Garter Snake	X	X	X	X
Narrowhead Garter Snake		X	X	X
Molluscs[2]				
Gila Pyrg Snail	X	X		
New Mexico Hotspring Pyrg Snail	X			
Blunt Ambersnail	X			
Crustacean[2]				
Sideswimmers / Scuds	X	X	X	X

[1] Species is considered extirpated from habitat type.

[2] Additional conservation concerns for these taxa are addressed in the Statewide Distributed Riparian Habitats, Statewide Distributed Ephemeral Habitats and Perennial Tanks and/or Ecoregion and terrestrial habitat sections.

Perennial Marsh/Cienega/Spring/Seep

Habitat Condition

Historically, extensive cienegas such as Mancos, Duck, and San Simon were present in the middle and lower reaches of the Gila River in New Mexico. Groundwater pumping, livestock grazing, and draining destroyed these habitats. Perennial springs like the East Fork Gila Springs, Alum Spring, and Middle Fork Gila Springs are scattered throughout the watershed. Some are developed and have lost all "natural" attributes while others retain most natural attributes. Many springs and seeps are geothermal. Gila chub formerly inhabited perennial marsh/cienega/ spring/seep habitats in the Gila Watershed, but no extant perennial marsh/cienega/seep now supports the species. Gila topminnows were extirpated in the early 1950s (Sublette *et al.* 1990).

Problems Affecting Habitats or Species

Water Withdrawal
Groundwater pumping and drainage have had significant adverse effects upon perennial marsh/cienega/spring/seep habitats. Drought and the persistence of these practices, will likely result in further loss of this habitat type in the Gila Watershed.

Grazing Practices
Improper grazing practices that reduce long-term plant and animal productivity (Wilson and MacLeod 1991), in combination with ground water pumping and drainage have, in the past, destroyed many Gila cienegas. Unmodified, these practices are likely to result in additional losses.

Non-Native/Invasive Species
Perennial marsh/cienega/spring/seep habitats continue to be vulnerable to modification by invasive plant species. The State Forest and Watershed Health Plan devotes significant planning to the management of non-native invasive phreatophytes (New Mexico Energy, Minerals, and Natural Resources Department 2004). Native fish species in these habitats are most at risk from non-native species encroachment.

Information Gaps

There are numerous information gaps regarding perennial marsh/cienega/spring/seep habitats that impair our ability to make informed conservation decisions.

- There is little known about fish species in spring habitats of the Gila Watershed.
- The interactions between species that rely on this habitat type are largely unknown.
- Data are lacking on re-established topminnow population on Red Rock Wildlife Area.
- The existing environmental conditions or thresholds that limit SGCN populations are unknown.
- Information is lacking regarding the extent to which invasive and non-native species may alter perennial marsh/cienega/spring/seep habitats and limit populations of SGCN.

Research, Survey, and Monitoring Needs

Genetic studies and husbandry practices for Gila topminnow have been investigated in this habitat type (Meffe and Vrijenhoek 1988, Vrijenhoek *et al.* 1985). Additional research or survey needs that would enhance our knowledge of perennial marsh/cienega/spring/seep habitats or associated SGCN are detailed below.

- Research is needed on the biology and taxonomy of Gila chub.
- Current distribution of the Gila chub needs to be quantified.
- Investigate the extent to which land use activities such as livestock grazing timing, intensity, and duration, human development, off-road vehicle use, and invasive or non-native species intrusions that fragment and alter habitats in relation to patch size, edge effect, and use by wildlife. This information is important in understanding how different

land use intensities and frequencies of disturbances affect SGCN in perennial marsh/cienega/spring/seep habitats.

- Investigate hydrologic relationships in perennial marsh/cienega/spring/seeps to provide a better understanding of the physicochemical and hydrologic processes that will allow for sustainable watershed conservation and management practices. This information will help evaluate the affects of extended drought on perennial marsh/cienega/spring/seep habitats and SGCN.

Desired Future Outcomes

Desired future outcomes for perennial marsh/cienega/spring/seep habitats in the Gila Watershed include:

- Perennial marsh/cienega/spring/seep habitats in the Gila Watershed persist in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN and host a variety of land uses with reduced resource use conflicts.

- Native species are re-established in the Gila Watershed.

- There is no net loss of perennial marsh/cienega/spring/seep in the Gila Watershed.

- The final version of the *Gila Topminnow Recovery Plan* (USFWS 1994) is completed and implemented and garners wide public support.

Prioritized Conservation Actions

Approaches for conserving New Mexico's biological diversity at the species or site-specific level are inadequate for long-term conservation of SGCN. Conservation strategies should be ecosystem-based and include public input and support (Galeano-Popp 1996). Monitoring of species and habitat will be employed to evaluate the effectiveness of the conservation actions described below. Those found to be ineffective will be modified in accordance with the principles of adaptive management. Conservation actions, in order of priority, which assist in achieving desired future outcomes, are outlined below.

1. Collaborate with federal and state agencies and affected publics to re-establish perennial cienega habitats along riparian corridors.

2. Work with federal, state, and private agencies and institutions to remove non-native species and restore Gila topminnow in appropriate perennial spring habitats.

3. Work with public and private land managers to develop sustainable livestock production practices on native rangelands around perennial marsh/cienega/spring/seep habitats to reduce spring degradation.

4. Collaborate with federal and state agencies and affected publics to create awareness and understanding of perennial marsh/cienega/spring/seep functions, services, and values.

5. Collaborate with federal and state agencies and affected publics to adopt standardized monitoring and survey methods to track gains and losses of perennial marsh/cienega/spring/seep in the Gila Watershed.

6. Work with federal and state agencies, landowners, research institutions, and universities to design and implement projects that will provide information about SGCN and marsh/cienega/spring/seep habitats outlined in the Research, Survey, and Monitoring Needs section.

7. Collaborate with federal and state agencies and affected publics to implement the recovery plan for the Gila chub.

Perennial 1st and 2nd Order Stream

Habitat Condition

Although most 1st and 2nd order streams in the Gila Watershed are high elevation, several originate at lower elevations. High-elevation streams such as Iron, White, Rawmeat, Langstroth, and Whiskey cascade through narrow canyons and valleys. Cascade pools and cobbled riffles are the main habitat. Riparian vegetation shifts from aspen, spruce, and fir at high elevations to ponderosa, oak, piñon, and juniper at mid elevations. Low-elevation 1st order streams such as Mancos Creek typically begin at a spring source and are bordered by willow and cottonwood. Mancos Creek has continuous surface flows to the Gila River in most years. Flows of other low-elevation small perennial streams, such as Blue Creek, sink into the desert alluvium before reaching the Gila River.

Most high elevation 1st and 2nd order streams flow on lands administered by US Forest Service. From its origins near Aragon, the Tularosa River, a major San Francisco River tributary, is a 1st order stream, but rapidly becomes a 3rd and 4th order stream with the addition of tributaries such as Apache Creek. Most 1st and 2nd order streams in the San Francisco sub-drainage occur at higher elevations along the Mogollon Rim. These steep gradient headwater streams lie mostly within National Forests.

Few headwater streams have continuous surface flow throughout their entire course. Domestic livestock have been removed or precluded from grazing along most headwater streams within West Fork, Middle Fork, and East Fork Gila drainages. Wildfires have burned large portions of the West and Middle forks in recent years and resultant ash flows have diminished or eliminated fish from portions of the affected streams. There are few perennial low elevation, warm water 1st and 2nd order streams in the drainages. Habitat is mainly shallow, sand and gravel bottomed runs. Some are in comparatively good condition, but improper livestock grazing and ground water pumping have seriously modified others. Abandoned mines and associated tailings may affect water quality of some 1st and 2nd order streams.

Non-native rainbow and brown trout are common in mid to high-elevation 1st and 2nd order streams, and red shiner and western mosquitofish (*Gambusia affinis*) are common in low-elevation streams. Currently four native fishes occur in perennial 1st and 2nd order streams in the Gila River and five native fishes currently occur in the San Francisco River subdrainage. Gila trout occupy cold, high-elevation headwater streams of the Gila River subdrainage in the Mogollon and Black Mountain ranges. Speckled dace occupy some cold, headwater streams as well as warm, headwater streams. Longfin dace and desert and Sonora suckers occupy warm water 1st and 2nd order streams.

Problems Affecting Habitats or Species

Grazing Practices
Domestic livestock have been removed or precluded from grazing along most headwaters. However, some 1st and 2nd order streams have been, or continue to be, altered by historic effects of improper grazing practices that increased bank erosion and elevated sediment levels in streams.

Non-Native/Invasive Species
Mid to high-elevation 1st and 2nd order streams have become occupied by non-native rainbow and brown trout. Red shiner and western mosquitofish occur in low elevation streams.

Fire Management
Large portions of West and Middle fork drainages have been burned by wildfire in the past five years. Ash flows associated with these wildfires have diminished or eliminated fish from portions of affected streams.

Information Gaps

There are numerous information gaps that impair our ability to make informed conservation decisions regarding perennial 1st and 2nd order streams.

- Current distribution of the Gila chub in 1st and 2nd order streams is uncertain.
- Long-term effects of wildfire on stream biota, including Gila trout, are unknown.
- Little is known about the relative efficacy of mechanical versus piscicide removal of non-native species for Gila trout restoration.
- Effects of regulated angling on populations of Gila trout are largely unknown.
- Comprehensive spatial data designating the location and area of perennial 1st and 2nd order streams suitable for Gila trout and other SGCN would provide the foundation for monitoring impacts and facilitating risk assessment for species that occupy this habitat.
- Population dynamics and species interactions of mixed assemblages of Gila trout and native cyprinids and catostomids are unclear.

- The existing environmental conditions or thresholds that limit populations of SGCN are unknown.

- Information is lacking regarding the extent to which invasive and non-native species may alter perennial 1st and 2nd order streams and limit populations of SGCN.

Research, Survey, and Monitoring Needs

Currently small streams containing Gila trout are monitored on a regular basis. However, additional research, survey, and monitoring needs in perennial 1st and 2nd order streams are detailed below.

- Investigate the extent to which land use activities such as livestock grazing timing, intensity, and duration, road-building, and invasive or non-native species invasions fragment and alter habitats in relation to patch size, edge effect, and use by wildlife. This information is important in understanding how different land use intensity and frequency of disturbance affects SGCN in perennial 1st and 2nd order streams.

- Investigate hydrologic relationships in perennial 1st and 2nd order streams to provide a better understanding of the physicochemical and hydrologic processes that will allow for sustainable watershed conservation and management practices. This information will help evaluate the effects of extended drought on streams and SGCN.

- Research is needed on the biology and taxonomy of the headwater, roundtail and Gila chubs.

- Research is needed to delineate the current distribution of Gila chub in 1st and 2nd order streams in the Gila Watershed.

- Studies are needed to characterize effects of piscicides on non-target aquatic organisms.

- The effect of regulated angling on populations of Gila trout needs to be characterized.

- Streams suitable for Gila trout restoration should be identified and prioritized.

- Research is needed to characterize population dynamics and species interactions of mixed assemblages of Gila trout and native cyprinids and catostomids.

Desired Future Outcomes

Desired future outcomes for perennial 1st and 2nd order streams in the Gila Watershed include:

- Perennial 1st and 2nd order streams of the Gila Watershed persist in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN and host a variety of land uses with reduced resource use conflicts.

- Viable populations of native species are restored into 1st and 2nd order streams.

- Healthy watershed conditions exist that contribute to natural stream recovery.

Prioritized Conservation Actions

Approaches for conserving New Mexico's biological diversity at the species or site-specific level are inadequate for long-term conservation of SGCN. Conservation strategies should be ecosystem-based and include public input and support (Galeano-Popp 1996). Monitoring of species and habitat will be employed to evaluate the effectiveness of the conservation actions described below. Those found to be ineffective will be modified in accordance with the principles of adaptive management. Conservation actions, in order of priority, which assist in achieving desired future outcomes, are outlined below.

1. Work with US Forest Service and other land managers to ensure that native species in perennial 1st and 2nd order streams are not adversely affected by fire management practices.

2. Collaborate with federal and state agencies and affected publics to control non-native species in perennial 1st and 2nd order stream habitats.

3. Collaborate with federal and state agencies and affected publics to implement the recovery plan for the Gila chub. Implementation of this plan is essential for perpetuation of the species in New Mexico.

4. Work with public and private land managers to develop sustainable livestock production practices on native rangelands around perennial 1st and 2nd order stream to reduce stream degradation.

5. Encourage collaboration among state, federal, NGO's, and private land stewards to assist with current Gila trout restoration.

6. Work with federal and state agencies, private landowners, research institutions, and universities to design and implement projects that will provide information about SGCN and perennial 1st and 2nd order streams outlined in the Research, Survey, and Monitoring Needs section.

7. Collaborate with federal and state agencies and affected publics to create awareness, appreciation, and understanding of perennial 1st and 2nd order stream habitat functions, services, and values.

Perennial 3rd and 4th Order Streams

Habitat Condition

Collectively the West, Middle, and East forks of the Gila River are composed primarily of 3rd and 4th order streams. A few other main stem tributaries, such as Sapillo Creek are 3rd or 4th order streams. Riparian vegetation consists mainly of cottonwood, willow, and boxelder. Aquatic habitat consists of large boulder pools, long moderately deep runs, and short riffles. Fine sediment deposits, a consequence of wildfire induced ash flows, are common in the West and Middle forks of the Gila. Years of improper grazing have contributed to large sediment loads in the East Fork and subsequent armoring of cobble substrata. All native fishes extant in the Gila River occur in 3rd and 4th order streams. The occurrence of Gila trout is limited to the recently renovated upper West Fork of the Gila River.

Problems Affecting Habitats or Species

Transportation Infrastructure
Bridge maintenance and road construction result in channel modifications and disruption of normal streambed dynamics. Continued road maintenance activities have exacerbated problems rather than solved them.

Non-Native/Invasive Species
Invasive species are a concern throughout the drainage. Non-native smallmouth bass, black bullhead, yellow bullhead (*Ameiurus natalis*) are locally common in 3rd and 4th order streams. The most common species in Sapillo Creek is the non-native Rio Grande sucker.

Grazing Practices
The East Fork of the Gila River carries heavy sediment loads from improper grazing practices. This condition may be expected to continue or worsen if improper grazing practices continue without restoration.

Information Gaps

There are numerous information gaps regarding perennial 3rd and 4th order streams that impair our ability to make informed conservation decisions.

- Interactions are unclear between the various native fishes and introduced fishes in perennial 3rd and 4th order streams.
- The response of native and non-native fish to various flow regimes, including channel drying, needs to be known.
- The effects of wildfire induced ash flows on native fish assemblages are largely unknown.

- The response of native fish assemblages to the removal of non-native predators is unclear.

- Little is known on the status of rare fishes, including spikedace and loach minnows in perennial 3rd and 4th order streams.

- The distribution of the headwater, roundtail and Gila chub and their various habitat requirements is uncertain.

- Factors that limit the abundance of native fishes and other SGCN in the Gila River downstream of the Middle Box are unknown.

- The reasons for low density or absence of most native fish species from canyon-bound reaches are unclear.

- Little is known on the reasons for depressed native fish abundance throughout the Gila Watershed for the past 5 years.

- Information is lacking regarding the extent to which invasive and non-native species may alter perennial 3rd and 4th order streams and limit populations of SGCN.

Research, Survey, and Monitoring Needs

There are several research and survey projects that seek to address information gaps in perennial 3rd and 4th order streams. These projects are either underway or have recently been completed. They include: 1) annually monitoring fish assemblages at eight locations to assess species trends and characterize habitat associations, 2) restoration of Gila trout to the upper portion of the West Fork, 3) surveys to identify streams suitable for intensive management of native fishes, 4) evaluating the efficacy of mechanical removal of non-native fishes, 5) identification of potential sites for the construction of barriers to protect extant or restored native fish assemblages, 6) assessment of the effects of ash flows on native fishes, particularly Gila trout, and 7) a study to taxonomically differentiate the three species of chub that occupy the Gila River. Additional research, survey, and monitoring needs in perennial 3rd and 4th order streams are detailed below.

- Thorough surveys are needed to determine the current distribution of the headwater, roundtail and Gila chub.

- Evaluate the relative efficacy of mechanical versus piscicide removal of non-native species for Gila trout restoration.

- Studies are needed to characterize effects of piscicides on non-target aquatic organisms.

- The effects of regulated angling on populations of Gila trout need to be investigated and characterized.

- Streams and relevant renovation suitable for Gila trout should be identified.

- Research is needed to characterize population dynamics and species interactions of mixed assemblages of Gila trout and native cyprinids and catostomids.

- Systematic status surveys for native warm water fishes of the Gila Watershed are needed.

- Investigate the extent to which land use activities such as livestock grazing timing, intensity, and duration, human development, road-building, bridge maintenance, and road construction alter habitats in relation to patch size, edge effect, and use by wildlife. This information is important in understanding how different land use intensity and frequency of disturbance affect SGCN in perennial 3rd and 4th order streams.

- Investigations are needed to characterize life history, biology, and habitat associations of native state and federal unlisted catostomids and cyprinids.

Desired Future Outcomes

Desired future outcomes for perennial 3rd and 4th order streams in the Gila Watershed include:

- Perennial 3rd and 4th order streams persist in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN and host a variety of land uses with reduced resource use conflicts.

- Non-native species are controlled or eliminated.

- Natural flow regimes throughout the basin are maintained.

- Native riparian plant communities are restored and maintained.

- Viable native fish populations are maintained in perennial 3rd and 4th order streams.

Prioritized Conservation Actions

Approaches for conserving New Mexico's biological diversity at the species or site-specific level are inadequate for long-term conservation of SGCN. Conservation strategies should be ecosystem-based and include public input and support (Galeano-Popp 1996). Monitoring of species and habitat will be employed to evaluate the effectiveness of the conservation actions described below. Those found to be ineffective will be modified in accordance with the principles of adaptive management. Conservation actions, in order of priority, which assist in achieving desired future outcomes, are outlined below.

1. Collaborate with federal and state agencies and affected publics to remove non-native species and restore native fish species in perennial 3rd and 4th order stream habitats.

2. Work with federal and state agencies, private landowners, research institutions, and universities to design and implement projects that will provide information about SGCN and perennial 3rd and 4th order streams outlined in the Information Gaps and Research, Survey, and Monitoring Needs section.

3. Collaborate with federal and state agencies and affected publics to formulate conservation actions that gain public support for native fish management and conservation in perennial 3rd and 4th order streams. Actions may include creating public awareness, appreciation, and understanding of perennial 3rd and 4th order stream habitat functions, services, and values.

4. Work with public and private land managers to develop sustainable livestock production practices on native rangelands around perennial 3rd and 4th order streams to reduce stream degradation.

5. Work with federal and state agencies, private landowners, research institutions, and universities to continue fish assemblage monitoring and to identify suitable stream reaches for restoration of native fishes.

6. Work with US Forest Service to develop strategies to reduce the effects of wildfire induced ash flows on native fish assemblages.

7. Collaborate with federal and state agencies and affected publics to implement the recovery plan for the Gila chub. Implementation of this plan is essential for perpetuation of the species in New Mexico.

8. Encourage collaboration among state, federal, NGO's, and private land stewards to assist with current Gila trout restoration efforts.

Perennial 5th Order Streams

Habitat Condition

From the confluence of the East and West forks to the Arizona border, the Gila River is a 5th order stream. Flows are continuous, except during drought when irrigation withdrawals can diminish surface flow to a trickle in portions of the Cliff-Gila Valley. Gila River is the last main stem in New Mexico without a major water development. An infiltration gallery withdraws water from the river to maintain water levels in Bill Evans Reservoir. Livestock grazing is the major land use in the valley and resultant bank degradation is common.

The Nature Conservancy owns several parcels along the river. In the Cliff-Gila Valley, red shiner, channel catfish, and fathead minnow are rarely found. The lower valley is within the US Forest Service's Gila Bird Area. Non-native fish, especially channel catfish and flathead catfish, are common in the Middle and Lower boxes. Downstream of the Middle Box, non-native red shiner, fathead minnow, western mosquitofish, channel catfish, and flathead catfish dominate fish assemblages. The current native fish fauna of the main stem Gila River consists of few

species. Speckled dace were historically rare and are currently absent. Roundtail chub were comparatively common in the past but are now apparently eliminated.

From its confluence with Tularosa River, the San Francisco River is a 5th order stream. For most of its course in New Mexico, the river flows through narrow canyons. In the vicinity of Reserve, Alma, and Pleasanton it flows through desert valleys. Water is diverted for agriculture in the valleys, but the river is seasonally dry only in Alma Valley. Two lowhead diversion dams, one in upper Alma Valley and the second in Pleasanton Valley, fragment riverine habitats. The downstream diversion dam likely contributes to precluding the establishment of non-native channel and flathead catfishes in upper reaches of the river. The US Forest Service administers most lands, but canyon bottoms and valleys are largely privately owned. Improper livestock grazing is the primary land use affecting watershed condition. In some reaches, grazing is quite intense along the river. With the exception of Gila trout, all extant native fishes of San Francisco River occur in the 5th order portion of the river

Problems Affecting Habitats or Species

Water Withdrawal
Water withdrawal for irrigation in the Cliff-Gila Valley, Redrock Valley, and Virden Valley depletes surface flows in the Gila River. In drought years, water withdrawals result in a complete drying of the river channel. Diversion dams in the San Francisco River cause some seasonal drying and habitat fragmentation. The Gila River development free status may be affected by the Arizona Water Settlements Act.

Grazing Practices
Livestock grazing is intense along some reaches of the Gila and San Francisco Rivers. As currently practiced, this exacerbates bank erosion in some areas and elevates sediment levels in streams.

Transportation Infrastructure
In the vicinity of highway bridges, gabion bank retention structures have altered river dynamics and increased problems associated with bank erosion and instability. Projects proposed to restore levees and harden stream banks, particularly in the vicinity of bridges, will cause considerable loss of aquatic habitats by channel incision and increase flood damage to surrounding floodplains and the probability of bridge failure. Removal of woody debris from river channel reduces habitat diversity to the detriment of native fishes.

Fire Management
Ash flows associated with upland wildfires also increase sediment loads in these perennial 5th order streams. Resultant deposition causes loss of interstitial spaces in riffle habitats and may adversely affect invertebrates and native fish assemblages in unknown ways.

Non-Native/Invasive Species
Non-native fish species, particularly centrarchids, ictalurids, and cyprinids have achieved numerical dominance in some reaches of the Gila River. Their potentially overwhelming presence poses serious threats to the persistence of several native fish species.

Information Gaps

There are numerous information gaps regarding perennial 5th order streams that impair our ability to make informed conservation decisions.

- The persistence of roundtail chub in the Gila Watershed in New Mexico is uncertain.
- The distribution of roundtail chub in perennial 5th order streams, and throughout New Mexico, is not fully understood.
- The current status of spikedace and loach minnow in the Gila Watershed is unknown.
- The effects of wildfire induced ash flows on native fish assemblages are poorly understood.
- Little is known about the effects of seasonal channel drying on native fish assemblages.
- The effects of abiotic factors, such as altered flow regime, on the reproductive success and recruitment of native fishes are unknown.
- Effects of range fragmentation on demographics and genetic integrity of native fishes are poorly understood.
- Effects of woody debris removal on occurrence of roundtail chub are unknown in the main stem Gila River.
- We know little about the effects of predation by non-native ictalurids on native fish assemblages.
- Information is lacking regarding the extent to which invasive and non-native species may alter perennial 5th order streams and potentially limit populations of SGCN.
- The reason(s) for the low density of native fish in canyon-bound reaches are unknown.

Research, Survey, and Monitoring Needs

Fish assemblages are annually monitored at eight stations in the Gila and San Francisco river drainages. Data from this effort are used to characterize habitat use, life history, and population trends of resident fishes. Additional research, survey, and monitoring needs in perennial 5th order streams are detailed below.

- Investigations are needed to characterize life history, biology, and habitat associations of native state and federal unlisted catostomids and cyprinids.
- Systematic status surveys of the basin's native warm water fishes are needed.

- Investigate the extent to which land use activities such as livestock grazing timing, intensity, and duration, human development, road-building, bridge maintenance, and road construction alter habitats in relation to patch size, edge effect, and use by wildlife. This information is important in understanding how different land use intensities and disturbance frequencies affect SGCN in perennial 5th order streams.

- Research is needed to quantify the loss of habitat diversity due to the removal of woody debris from the river channel, and the affect on SGCN.

- Determine the efficacy of techniques for artificial propagation of rare fishes that occur in perennial 5th order streams.

- Research is needed to characterize the life history, biology, and habitat needs of SGCN associated with perennial 5th order streams, including the effects of non-native species on native assemblages.

- Conduct research to enhance currently incomplete information of the diverse vertebrate and invertebrate community structures, natural history, and ecological relationships in perennial 5th order streams. Research should focus on factors that are limiting populations of native SGCN in canyon-bound reaches.

Desired Future Outcomes

Desired future outcomes for perennial 5th order streams in the Gila Watershed include:

- Perennial 5th order streams persist in the condition, connectivity, and quantity necessary to sustain viable and resilient populations of resident SGCN and host a variety of land uses with reduced resource use conflicts.

- Non-native species are controlled or eliminated.

- Natural flow regimes throughout the basin are maintained.

- Native riparian plant communities are restored and maintained.

- Viable populations of native fishes are maintained in perennial 5th order streams.

- Cooperative efforts with other state and federal resource agencies and private entities are enhanced and promote the conservation of perennial 5th order stream habitats and their associated SGCN.

Prioritized Conservation Actions

Approaches for conserving New Mexico's biological diversity at the species or site-specific level are inadequate for long-term conservation of SGCN. Conservation strategies should be ecosystem-based and include public input and support (Galeano-Popp 1996). Monitoring of species and habitat will be employed to evaluate the effectiveness of the conservation actions described below. Those found to be ineffective will be modified in accordance with the principles of adaptive management. Conservation actions, in order of priority, which assist in achieving desired future outcomes, are outlined below.

1. Collaborate with federal and state agencies and affected publics to remove non-native species and restore native fish species in perennial 5th order stream habitats.

2. Implement and encourage compliance with strict baitfish regulations in 5th order stream habitats within the Gila Watershed so as to preclude introduction of non-native species.

3. Work with federal and state agencies, private landowners, research institutions, and universities to design and implement projects that will provide information about SGCN and perennial 5th order stream habitats outlined in the Information Gaps and Research, Survey, and Monitoring Needs section.

4. Work with public and private land managers to restore native fish populations that have been eliminated to 5th order stream habitats within the Gila Watershed.

5. Collaborate with federal and state agencies and affected publics to update and implement recommendations in the spikedace and loach minnow recovery plans.

6. Collaborate with federal and state agencies and affected publics to format conservation actions to gain public support for native fish management and conservation in perennial 5th order streams and in the Gila Watershed. Actions may include creating public awareness, appreciation, and understanding of perennial 5th order stream habitat functions, services, and values.

7. Work with public and private land managers to develop sustainable livestock production practices on native rangelands around perennial 5th order stream to reduce stream degradation.

8. Coordinate and cooperate with other state and federal resource agencies, conservation groups, and private land managers in developing and implementing measures to conserve native fish in 5th order stream habitats within the Gila Watershed.

9. Collaborate with federal and state agencies and affected publics to complete and implement the recovery plan for the roundtail chub.