

## PECOS WATERSHED

The Pecos River arises in the Sangre de Cristo Mountains of Mora County, New Mexico. It runs south through San Miguel, Guadalupe, De Baca, Chaves, and Eddy counties in New Mexico before entering Texas. The Pecos Watershed encompasses 1.6 million ac (6,474,970 ha) in New Mexico (US Bureau of Reclamation 2002) and includes a variety of aquatic habitats. Key habitats in the Pecos Watershed include large reservoirs, perennial spring/seep/marsh/cienega, perennial 1<sup>st</sup> and 2<sup>nd</sup> order streams, and perennial 3<sup>rd</sup> and 4<sup>th</sup>, and perennial 5<sup>th</sup> order streams (Fig. 5-12).

Land uses in this watershed consist mainly of rangeland, with some irrigated cropland and pastureland along the Pecos River. Roughly 10% of the industry in the lower Pecos Valley is agriculture (De Baca, Chavez, and Eddy Counties). Primary crops include small grains, alfalfa, and hay. Oil and gas development occurs within the lower Pecos River Valley. Soils range from shallow to moderately deep loams in all parts of the watershed. Along the Pecos River, soils are moderately deep to deep, with moderate to heavy texture.

Las Vegas, Santa Rosa, Fort Sumner, Roswell, Artesia, and Carlsbad are the principal cities within the watershed. The counties in the Pecos Watershed have experienced positive population growth from 1990 – 2000 (New Mexico Economic Development Department 2004), with only De Baca County showing slight declines (-0.5%). Lincoln County had the second highest growth rate in the state (59%) for this period.

### **Species of Greatest Conservation Need**

Fifty-eight Species of Greatest Conservation Need (SGCN), excluding arthropods other than crustaceans, occur in the Pecos Watershed (Table 5-14). Thirty-one of these SGCN (53%) are classified as vulnerable, imperiled, or critically imperiled both statewide and nationally. Only six SGCN (10%) were secure both statewide and nationally. Conservation status codes (abundance estimates) for each SGCN are provided in Appendix H.

Although large reservoirs are not native habitats, several native fish species use them as refuge when water diversions and low water conditions occur elsewhere in the river. For example, the blue sucker (*Cycleptus elongates*) and the gray redbreast (*Moxostoma congestum*) use the reservoirs near Carlsbad. A variety of SGCN, including five native fish species, use marsh/cienega/spring/seep habitats, primarily in the lower Pecos Watershed. Perennial 1<sup>st</sup> and 2<sup>nd</sup> and 3<sup>rd</sup> and 4<sup>th</sup> order streams within the watershed occur in several ecoregions, thus there are both cold and warm water SGCN in these habitat types. Diverse assemblages of SGCN, especially fish species, inhabit the main stem of the Pecos. The New Mexico Department of Game and Fish (NMDGF) have active projects for managing Pecos pupfish (*Cyprinodon pecosensis*) and Rio Grande cutthroat trout (*Oncorhynchus clarki virginalis*). Otherwise, there is little known about the distribution or variability of fish populations in these habitats. 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.

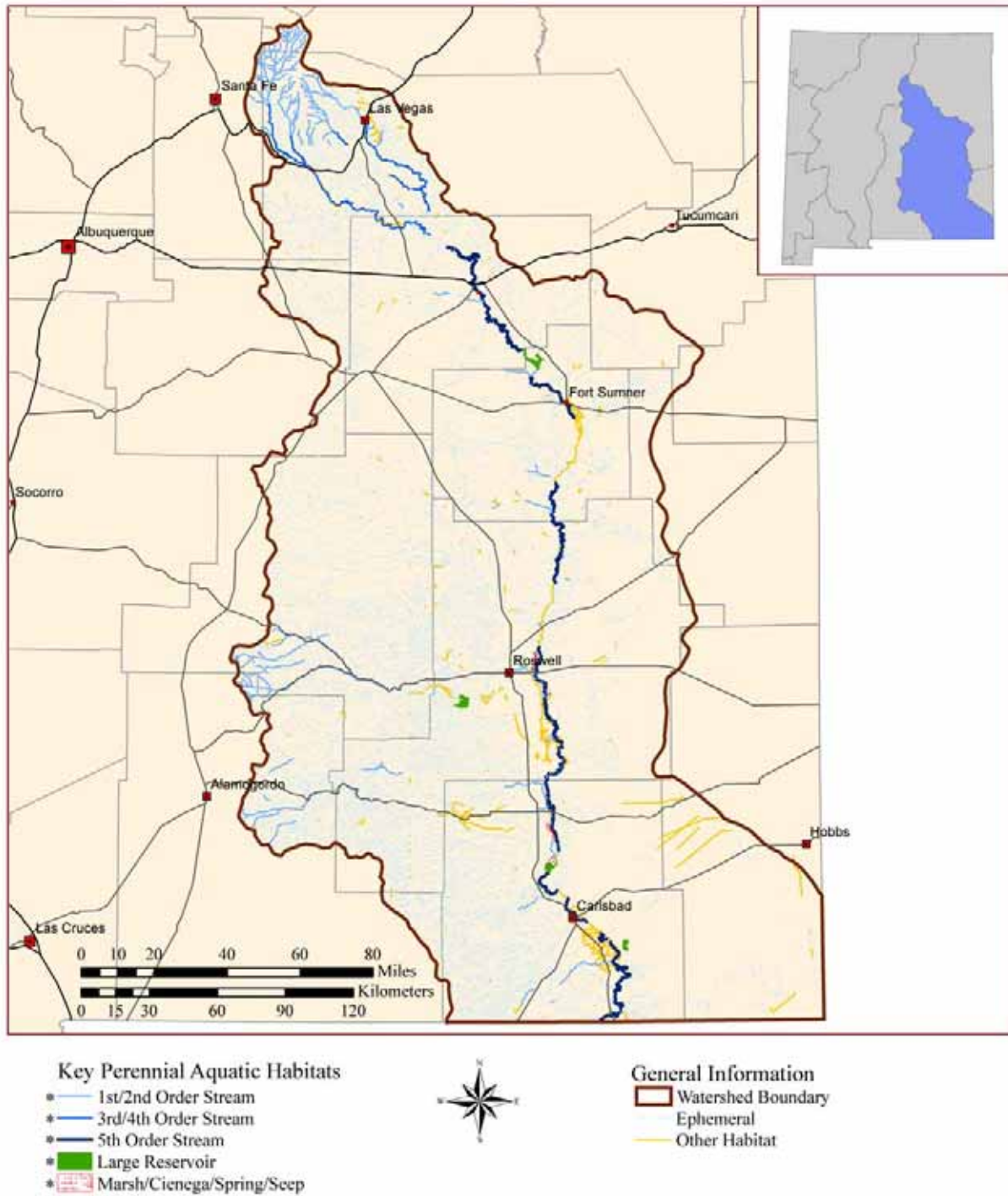


Figure 5-12. Key perennial aquatic habitats in the Pecos Watershed in New Mexico. Key habitats are designated with an asterisk (\*).

Table 5-14. Species of Greatest Conservation Need in the Pecos Watershed in New Mexico.

Common Name	Perennial				
	Large Reservoir	Marsh/Cienega/ Spring/Seep	1 <sup>st</sup> and 2 <sup>nd</sup> Order Stream	3 <sup>rd</sup> and 4 <sup>th</sup> Order Stream	5 <sup>th</sup> Order Stream
<b><i>Fish</i></b>					
Bigscale Logperch	X				X
Blue Catfish	X				X
Blue Sucker	X			X	X
Central Stoneroller			X	X	X
Gray Redhorse	X				X
Greenthroat Darter	X	X	X	X	X
Headwater Catfish				X	X
Mexican Tetra	X	X	X	X	
Pecos Bluntnose Shiner					X
Pecos Gambusia		X	X		
Pecos Pupfish		X	X	X	X
Rainwater Killifish		X	X	X	
Rio Grande Chub			X	X	
Rio Grande Cutthroat Trout			X	X	
Rio Grande Shiner					X
Rio Grande Silvery Minnow					E <sup>1</sup>
Smallmouth Buffalo	X				X
Speckled Chub					X
<b><i>Birds</i><sup>2</sup></b>					
Eared Grebe	X	X		X	X
American Bittern		X			
White-Faced Ibis	X	X			
Northern Pintail	X	X		X	X
Osprey	X			X	X
Bald Eagle	X	X		X	X
Northern Harrier		X			
Common Black-Hawk		X	X	X	X
Peregrine Falcon	X	X		X	X
Sandhill Crane	X	X			X
Snowy Plover	X				X
Interior Least Tern	X			X	X
Southwestern Willow Flycatcher		X		X	X
Bell's Vireo				X	X
Bank Swallow				X	X
Yellow Warbler		X	X	X	X
Painted Bunting				X	X
<b><i>Mammals</i><sup>2</sup></b>					
Pocketed Free-Tailed Bat		X			
American Beaver	X	X	X	X	X
NM Meadow Jumping Mouse		X			
Least Shrew		X			

Table 5-14 Cont.

Common Name	Perennial				
	Large Reservoir	Marsh/Cienega/ Spring/Seep	1 <sup>st</sup> and 2 <sup>nd</sup> Order Stream	3 <sup>rd</sup> and 4 <sup>th</sup> Order Stream	5 <sup>th</sup> Order Stream
<b><i>Amphibian</i><sup>2</sup></b>					
Tiger Salamander		X			
Western Chorus Frog		X	X	X	
Rio Grande Leopard Frog		X		X	X
Plains Leopard Frog		X		X	X
Northern Leopard Frog		X		X	X
<b><i>Reptiles</i><sup>2</sup></b>					
Western River Cooter				X	X
Blotched Water Snake		X		X	X
Arid Land Ribbon Snake		X	X	X	X
<b><i>Molluscs</i><sup>2</sup></b>					
Pecos Assiminea Snail		X			
Texas Liptooth Snail		X			
Blunt Ambersnail		X			
Ovate Vertigo Snail		X			
Blade Vertigo Snail		X			
Wrinkled Marshsnail		X			
Texas Hornshell				X	
Pecos Pyrg Snail		X	X		
Roswell Pyrg Snail		X	X		
Koster's Tryonia Snail		X	X		
<b><i>Crustacean</i><sup>2</sup></b>					
Sideswimmers / Scuds		X	X	X	X

<sup>1</sup> Species is considered extirpated from habitat type.

<sup>2</sup> 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 Large Reservoirs**

#### **Habitat Condition**

Perennial large reservoirs in the Pecos Watershed are under diverse management regimes. The New Mexico State Parks Division administers three of the largest reservoirs in the drainage. Santa Rosa Reservoir is operated primarily for flood control, Sumner Reservoir is managed largely as an irrigation storage facility, and Brantley Reservoir is operated to store water for irrigation and for meeting interstate compact requirements. Water levels, therefore, vary greatly and independently of SGCN habitat needs. These reservoirs can be nearly drained in years of

low run-off. Water levels in the smaller Avalon, Carlsbad Municipal, Six-Mile, and Ten-Mile reservoirs on the Pecos River generally fluctuate less than those of larger reservoirs. These perennial large reservoirs support non-native sport fish and other non-native fishes such as the common carp (*Cyprinus carpio*). Large reservoirs are also popular recreational sites for camping, boating, and angling.

### **Problems Affecting Habitats or Species**

#### *Reservoir Hydrology*

Large reservoirs in the Pecos Watershed are operated to meet human needs. As a result, flood control management and irrigation requirements take precedence. Santa Rosa Reservoir is emptied when large inflows are anticipated. Sumner Reservoir water levels are determined by releases to meet irrigation requirements. Irrigation and interstate compact requirements determine Brantley Reservoir water levels. The extent and frequency of such water level fluctuations directly affect resident fish spawning, cover, and feeding habitats.

#### *Water Quality*

Water quality is a potential problem for SGCN, especially fishes, in large reservoirs in the Pecos Watershed. The New Mexico Environment Department monitors water quality and has identified mercury and petrochemicals as potential problems in reservoirs.

### **Information Gaps**

Information gaps that impair our ability to make informed conservation decisions with respect to perennial large reservoirs and associated SGCN are outlined below.

- Little information is known about the effects of reservoir management strategies on golden algae (*Chrysophyta*) outbreaks.
- The fate of Pecos bluntnose shiner (*Notropis simus pecosensis*) and other pelagic spawning fish displaced into Brantley Reservoir is unknown.
- Relative importance of run-of-river reservoirs (Carlsbad Municipal, Six-Mile and Ten-Mile) for the maintenance of populations of gray redhorse and blue sucker is unknown. This information would assist in conservation activities focused on large reservoirs.
- The relative importance of large reservoirs as sources of undesirable non-native fishes is poorly understood.
- The feasibility of water release modifications to benefit native river fishes, and the sequential affects on large reservoir SGCN, are unknown.
- Little is known about the reasons for the continued rarity of smallmouth buffalo (*Ictiobus bubalus*) in these large reservoirs.

- The existing environmental conditions or thresholds that limit populations of SGCN in large perennial reservoirs are unknown.
- It is unknown the extent to which invasive and non-native species may alter perennial large reservoirs and limit populations of SGCN.
- It is unknown the extent to which degraded water quality may limit SGCN in large reservoirs.

### **Research, Survey, and Monitoring Needs**

NMDGF, New Mexico Environment Department, and New Mexico Department of Health conduct periodic testing for fish contaminants within large reservoirs. Additional research, survey, and monitoring needs that would enhance our ability to make informed conservation decisions regarding large reservoirs and associated SGCN are outlined below.

- Annual sampling and life history studies of fish assemblages in run-of-river reservoirs are needed to provide information about SGCN.
- Determine the occurrence of small native fishes in large perennial reservoirs.
- Determine the relative importance of reservoirs as sources of undesirable non-native fishes, such as sheepshead minnow (*Cyprinodon variegatus*).
- Investigations of water withdrawal relationships in large reservoirs are needed to provide a better understanding of how fluctuating reservoir levels affect spawning fish and nursery habitats. This information will help in designing sustainable watershed conservation and management practices.
- Determine the extent to which invasive and non-native species alter perennial large reservoir habitats and limit populations of SGCN.

### **Desired Future Outcomes**

Desired future outcomes for perennial large reservoirs in the Pecos Watershed include:

- Perennial large reservoirs persist in the condition, connectivity, and quantity necessary to maintain viable and resilient populations of resident SGCN while sustaining land uses with reduced resource use conflicts.
- Recreational opportunities that do not pose significant threat to the persistence of SGCN are optimized at large reservoirs. This may include focusing sport fish management on species that are appropriate for the biotic and abiotic conditions specific to each reservoir.
- Large perennial reservoir operations do not pose significant threat to the persistence of native fish communities and associated SGCN.

- The emigration and impact of non-native fishes from reservoirs into surrounding habitats are minimized.
- SGCN within this habitat are not adversely affected by aquatic nuisance species or other non-native species.

### **Prioritized Conservation Actions**

1. The conservation of New Mexico's biodiversity in perennial large reservoirs will require a variety of conservation actions focused on both native and non-native species and habitat requirements of SGCN. 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.
2. Collaborate with federal and state agencies and affected publics to implement the Draft State Aquatic Nuisance Species Management Plan (currently in development by NMDGF) in perennial large reservoirs of the Pecos Watershed.
3. Work with water management authorities to maintain minimum conservation pools in perennial large reservoirs sufficient to support established sport fisheries, SGCN, and year-round recreational opportunities.
4. Work with public and private land managers to develop strategies to prevent emigration of non-native fishes from reservoirs into surrounding areas and educate anglers on the importance of not relocating live fish to other areas.
5. Collaborate with federal and state agencies and affected publics to create public awareness and understanding of large reservoirs functions, services, and values. Risks posed by undesirable non-native fishes to both sport and native fishes should be emphasized.
6. Collaborate with agencies and affected publics to adopt and encourage compliance with baitfish regulations that preclude introduction of non-native species into large perennial reservoirs.
7. Continue participating with other state and federal agencies in the Conservation Agreement for Pecos Pupfish and in completing development of The Pecos Pupfish Recovery Plan.
8. Establish partnerships with federal, state, and local agencies (Interstate Stream Commission, New Mexico State Parks, New Mexico Environment Department, etc.) to monitor reservoir water quality relative to SGCN.

9. Work with federal and state agencies, private landowners, research institutions, and universities to design and implement projects that will provide information about SGCN and the perennial large reservoirs outlined in the Research, Survey, and Monitoring Needs section.

### **Perennial Spring/Seep/Marsh/Cienega**

#### **Habitat Condition**

The lower Pecos Watershed has an abundance of natural springs and associated lakes. Many of the springs and catchments and associated wetlands in the lower Pecos Watershed are now alkaline but originally supported unique species assemblages. Flood control, groundwater withdrawal, oil and gas development, erosion and invasion of non-native vegetation have adversely affected many of the natural wetlands springs in this watershed, including those of Bottomless Lakes State Park and Bitter Lakes National Wildlife Refuge (BLNWR).

#### **Problems Affecting Habitats or Species**

##### *Non-Native/Invasive Species*

Non-native centrarchids and gambusia have had the greatest impacts on SGCN, especially fish species, occupying perennial spring/seep/marsh/cienega habitats of the Pecos Watershed. Invasive New Zealand mudsnail (*Potamopyrgus antipodarum*), red-rim melania (*Melanoides tuberculatus*), and non-native crayfish are also potential problems.

##### *Habitat Conversion*

Alterations that drain, fill, channelize or impound wetlands compose habitat conversion processes that affect SGCN of marsh/cienega/spring/seep habitats. Capping of springhead sources may likewise permanently alter natural wetland characteristics. Human caused habitat conversion such as excessive groundwater pumping and physical alteration of artesian spring systems has resulted in extirpation of isolated populations of Noel's amphipod (*Gammarus desperatus*) and prosobranch gastropods (gill-breathing snails) in Chavez and Eddy counties.

Habitat essential to the persistence of these taxa in BLNWR burned during the March 2000 Sandhill Fire. Among the most salient fire impacts were the marked post-fire growth of the common reed (*Phragmites australis*), which may account for changes in hydrochemical conditions, stream flow patterns, and the riparian plant community of Bitter Creek (Lang 2005a).

All of the problems associated with human development have the potential to alter perennial marshes, cienegas, springs, and seeps, and thus affect associated SGCN. Excessive groundwater pumping, sewage/septic contamination of water supplies and drought could lead to lower spring levels (US Bureau of Reclamation 2002) that would be detrimental to species occurring in these habitats.

### Information Gaps

- Information gaps that impair our ability to make informed conservation decisions for perennial marshes/cienegas/springs/seeps habitat in the Pecos Watershed are outlined below.
- The status, distribution, abundance and natural history of SGCN, especially Mexican tetra (*Astyanax mexicanus*), greenthroat darter (*Etheostoma lepidum*) and rainwater killifish (*Lucania parva*) are unknown.
- We do not have a current inventory of the species and habitats associated with Bottomless Lakes State Park.
- Little is known of the aquatic macroinvertebrates of perennial spring/seep/marsh/cienega habitats.
- Habitat requirements and life history data are lacking for most invertebrate SGCN of perennial spring/seep/marsh/cienega habitats.
- Little is known about the extent to which human related habitat conversion activities alter or potentially affect perennial spring/seep/marsh/cienega habitats in the Pecos Watershed.

### Research, Survey, and Monitoring Needs

Current research and survey efforts in perennial spring/seep/marsh/cienega habitats in the Pecos Watershed include:

- The transport, fate, and effects of polychlorinated biphenyls (PCBs) in aquatic food webs within Hunter Marsh and Hunter Oxbow of BLNWR.
- The Interstate Stream Commission monitors flow levels from Lea Lake in the Bottomless Lakes State Park.
- The New Mexico Fishery Resources Office has conducted population monitoring on the Pecos River and BLNWR since the mid 1980s. These data provide population trend information on fish communities with emphasis on Pecos pupfish and Pecos gambusia (*Gambusia nobilis*).
- Surveys for gammarid amphipods and prosobranch snails of BLNWR have been conducted since 1995 under a state conservation and recovery plan (NMDGF 2005a).
- Research is ongoing on cryptic species of gammarid amphipods using molecular genetic techniques (Gervasio *et al.* 2004).

- NMDGF is collaborating with Dr. Robert Hershler of the Smithsonian Institution on a phylogenetic study of the Pecos assiminea (*Assiminea pecos*) snail species complex of New Mexico, Texas, and Mexico.
- Additional research, survey, and monitoring needs that would inform our conservation decisions regarding perennial marshes, cienegas, springs, and seeps, and associated SGCN are outlined below.
- Understand the distribution, biology, population stability, and microhabitat use of SGCN that rely on perennial spring/seep/marsh/cienega habitats.
- A comprehensive statewide survey of aquatic macroinvertebrates of perennial spring, seep, marsh, and cienega habitats is needed.
- Investigate the extent to which land use activities fragment and alter perennial spring/seep/marsh/cienega habitats. This information is important in understanding how different land use intensities and frequencies of disturbances affect associated SGCN.

### **Desired Future Outcomes**

Desired future outcomes for perennial marsh/cienega/spring/seep habitats and associated SGCN in the Pecos Watershed include:

- Perennial marsh/cienega/spring/seep habitats 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.
- Natural water levels in marsh, cienega, spring, and seep habitats are maintained sufficiently to sustain associated aquatic SGCN.
- The spread of aquatic non-native or invasive plant and animal species is controlled or minimized to a level that SGCN within this habitat are not adversely affected.

### **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 implement the draft state aquatic nuisance species management plan in perennial marsh/cienega/spring/seep habitats in the Pecos Watershed.

2. Work with federal and state agencies and affected publics to take actions to prevent lowering of groundwater levels, including regulation of groundwater pumping.
3. Coordinate with state and federal land managers and private landowners to protect, restore, conserve, and create perennial marsh/cienega/spring/seep habitats and surrounding natural vegetation.
4. 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 habitats in the Pecos Watershed.
5. Seek partnerships that encourage the removal of harmful non-native species and the prevention of further introductions.
6. Establish partnerships with federal, state, and local agencies such as the Interstate Stream Commission, New Mexico State Parks Division, New Mexico Environment Department, to monitor and maintain water quality relative to SGCN.
7. Work with willing agencies, landowners, and NGO's to implement the conservation and recovery plan for the Pecos assiminea (snail), Noel's amphipod, Koster's springsnail (*Juturnia kosteri*), and Roswell springsnail (*Pyrgulopsis roswellensis*) (NMDGF 2005a).
8. Continue participating with other state and federal agencies in the Conservation Agreement for Pecos Pupfish, including updating the agreement, enforcing baitfish regulations, investigating the efficacy of legal protection for the species, and completing development of the state recovery plan for the Pecos pupfish.
9. Work with federal and state agencies, private landowners, research institutions, and universities to design and implement projects that will provide information about SGCN and the perennial large reservoirs outlined in the Research, Survey, and Monitoring Needs section.

### **Perennial 1<sup>st</sup> and 2<sup>nd</sup> Order Stream**

#### **Habitat Condition**

Headwater streams occurring in the southern Sangre de Cristo Mountains, including the Pecos Wilderness, Capitan and Sacramento Mountains, are mainly under the administration of the US Forest Service and the Mescalero Apache Indian Reservation. These typically shaded streams range from meanders through high mountain meadows to cascading runs down steep canyons. Improper grazing, logging, and roads adversely affect small, high-elevation streams. Generally, habitat quality on publicly administered lands is fair to excellent. Lower elevation 1<sup>st</sup> and 2<sup>nd</sup> order streams in this drainage are mainly ephemeral, but several are perennial. Scattered cottonwood and willow typically border these streams and habitat conditions are diverse.

## Problems Affecting Habitats or Species

### *Modification of Natural Processes*

Improper livestock grazing, road building, improper timber harvest, and mineral extraction can diminish habitat quality. Groundwater pumping reduces surface flow in lower elevation 1<sup>st</sup> and 2<sup>nd</sup> order streams in the watershed (US Bureau of Reclamation 2002).

### *Non-Native/Invasive Species*

Non-native fishes, particularly rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalis*), have been a major factor adversely affecting native Rio Grande cutthroat trout in perennial 1<sup>st</sup> and 2<sup>nd</sup> order streams of the Pecos Watershed.

### *Diseases and Pathogens*

The presence of whirling disease in rainbow trout was confirmed in New Mexico the spring of 1999. Since this confirmation, portions of the San Juan, Rio Grande, Canadian, and Pecos Watersheds in New Mexico have tested positive for *Myxobolus cerebralis* (whirling disease causal agent) (Hansen 2002). Routine testing and remediation procedures have begun in New Mexico's hatcheries and a testing program has been initiated coldwater streams and reservoirs that may have been inadvertently stocked with rainbow trout carrying the disease or infested through transmission by natural or anthropogenic vectors. Very little is known regarding whether the disease exists in Rio Grande cutthroat trout. However, it is likely that if *M. cerebralis* were to spread to Core Conservation Areas for Rio Grande cutthroat trout, the species would be at risk of infection.

## Information Gaps

- Information gaps that limit our ability to make informed conservation decisions for perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats are outlined below.
- Little is known about perennial 1<sup>st</sup> and 2<sup>nd</sup> order streams habitats in lower elevations of the Pecos Watershed and the warm water fish species that occupy these habitats.
- There is little known about the movement of native fish, especially salmonids, between various tributary systems and how the metapopulation concept may apply to the management of these species.
- Data are lacking regarding the distribution and abundance of fish SGCN and the location and condition of perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats.
- It is unknown the extent to which land use activities such as livestock grazing intensity and duration, logging, human development, and road-building, fragment and alter habitats in relation to 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 1<sup>st</sup> and 2<sup>nd</sup> order streams.

- Environmental conditions or thresholds that limit populations of SGCN in perennial 1<sup>st</sup> and 2<sup>nd</sup> order streams are unknown.
- It is unknown the extent to which non-native species are adversely affecting populations of SGCN in perennial 1<sup>st</sup> and 2<sup>nd</sup> order streams.
- The potential and risk for whirling disease to spread among salmonids of perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats is uncertain until investigations into the extent of *M. cerebralis* distribution within the watershed has been completed.

### Research, Survey, and Monitoring Needs

NMDGF and the US Forest Service currently conduct surveys and monitoring of fish and habitats on forest service lands. These survey and monitoring efforts are valuable and need to continue. Additional research, survey, and monitoring needs that would enhance our ability to make informed conservation decisions regarding perennial 1<sup>st</sup> and 2<sup>nd</sup> order streams and associated SGCN are outlined below.

- Determine SGCN distribution, abundance, and biology in lower elevation 1<sup>st</sup> and 2<sup>nd</sup> order streams.
- Ongoing research and survey for aquatic macroinvertebrates found in this habitat type is detailed under our consideration of perennial marsh/cienega/spring/seep habitats. Additional research needs to be conducted on distribution, habitat requirements, and life history for most invertebrate SGCN in perennial 1<sup>st</sup> and 2<sup>nd</sup> order streams habitats.
- Determine the extent to which land use activities fragment and alter perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats in the Pecos Watershed.
- Understand environmental conditions or thresholds that limit populations of SGCN in this habitat.
- There is a need to complete the ongoing investigation into the distribution of *M. cerebralis* to determine the risk of whirling disease to Rio Grande cutthroat trout by this parasite.

### Desired Future Outcomes

Desired future outcomes for perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats and associated SGCN of the Pecos Watershed include:

- Perennial 1<sup>st</sup> and 2<sup>nd</sup> 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.

- Impacts to native species communities by non-natives are negligible and native species have been successfully re-established into previously occupied areas.
- Channel conditions are stabilized with appropriate streamside vegetation and substrates.
- The spread of aquatic nuisance species or other non-native or invasive plant and animal species is controlled or minimized in perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats to a level that SGCN within this habitat are not adversely affected.
- Natural flow regimes are present in perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats and sufficient to sustain 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 to re-establish native fish communities in perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats.
2. Work with land management agencies, private land managers, and the agriculture industry to identify and promote grazing systems on rangelands near perennial 1<sup>st</sup> and 2<sup>nd</sup> order streams that ensure long-term ecological sustainability and integrity and are cost effective for livestock interests.
3. Collaborate with federal and state agencies to reduce the amount of stream degradation by logging and road building.
4. Coordinate with state and federal land managers and private landowners to protect, restore, conserve, and create perennial 1<sup>st</sup> and 2<sup>nd</sup> order streamside habitats, with consideration for natural vegetation.
5. Work with federal and state agencies and affected publics to develop techniques to maintain natural stream flows in perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats. Actions may include evaluating in-stream flow regulations for conservation of aquatic species.
6. Coordinate and cooperate with federal and state agencies and affected publics to implement the draft state aquatic nuisance species management plan (in development by NMDGF) in perennial 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats in the Pecos Watershed.

7. Continue participating with other state and federal agencies in the Conservation Agreement for Pecos Pupfish, including updating the agreement, instituting baitfish regulations, investigating the efficacy of legal protection for the species, and completing development of the *Pecos Pupfish Recovery Plan*.
8. 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 1<sup>st</sup> and 2<sup>nd</sup> order stream habitats outlined in the Information Gaps or Research, Survey, and Monitoring Needs sections.

### **Perennial 3<sup>rd</sup> and 4<sup>th</sup> Order Stream**

#### **Habitat Condition**

Habitat conditions vary considerably among perennial 3<sup>rd</sup> and 4<sup>th</sup> order streams in the Pecos Watershed. Some streams retain considerable integrity while others have been greatly modified by human activities. There are many small impoundments and diversions along these systems used for irrigation, drinking water, and recreation. Many of the low-elevation systems are ephemeral prior to entering the main stem of the Pecos. The Black River provides habitat important to the survival of New Mexico's only remaining native freshwater mussel, the Texas hornshell (*Popenaias popeii*) (Lang 2004). Land use practices, such as excessive clearing of vegetation, improper grazing, and oil and gas development can exacerbate the effects of flooding and sedimentation, while contaminating surface waters. The Delaware River formerly supported several native fish species, including a population of headwater catfish (*Ictalurus lupus*). However, the diversion of all water from the river onto fallow fields has resulted in the loss of all resident stream fishes.

#### **Problems Affecting Habitats or Species**

##### *Modification of Natural Processes*

At higher elevations, almost all 3<sup>rd</sup> and 4<sup>th</sup> order streams have livestock grazing within their watersheds. Timber is harvested and roads constructed to provide access. These activities locally may increase bank erosion and sedimentation and remove riparian vegetation. In lower elevations, water diversion and groundwater pumping diminish surface flows and in some reaches have resulted in complete channel drying (US Bureau of Reclamation 2002). Dams regulate flows and disrupt natural flow regimes. In several places, these streams flow through urbanized areas and receive municipal runoff. Habitat modification caused by flooding and associated sedimentation is known to cause mortality of the Texas hornshell. Lang (2004) details threats to the Texas hornshell.

##### *Non-Native/Invasive Species*

Non-native fish species and bivalves such as the Asian clam (*Corbicula fluminea*) and giant floater (*Pyganodon grandis*) have been established in many of the 3<sup>rd</sup> and 4<sup>th</sup> order Pecos Watershed streams. The potential effects of their presence on associated SGCN are poorly understood.

### *Diseases and Pathogens*

Portions of the San Juan, Rio Grande, Canadian, and Pecos Watersheds in New Mexico have tested positive for *Myxobolus cerebralis* (whirling disease causal agent) (Hansen 2002). Routine testing and remediation procedures have begun in New Mexico's hatcheries and a testing program has been initiated in coldwater streams and reservoirs. These waters may have been contaminated through inadvertent stocking of infected rainbow trout or by natural or anthropogenic vectors. Very little is known regarding whether the disease exists in Rio Grande cutthroat trout. However, it is likely that if *M. cerebralis* were to spread to Core Conservation Areas for Rio Grande cutthroat trout, the species would be at risk of infection.

### **Information Gaps**

Information gaps that limit our ability to make informed conservation decisions for perennial 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats are outlined below.

- Current SGCN distribution and abundance are not well known. This is particularly true on private lands that contain a significant proportion of the perennial 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats within the Pecos Watershed.
- Information is lacking regarding the extent to which invasive and non-native species may alter perennial 3<sup>rd</sup> and 4<sup>th</sup> order streams and limit populations of SGCN.
- The extent is unknown to which land use activities such as livestock grazing, logging, human development, and agriculture alter habitats in relation to connectivity, patch size, edge effect, and use by SGCN. This information is important in understanding how different land use intensities and frequencies of disturbances affect SGCN in perennial 3<sup>rd</sup> and 4<sup>th</sup> order streams.
- The potential and risk for whirling disease to spread among salmonids of 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats is uncertain until investigations into the extent of *M. cerebralis* distribution within the watershed has been completed.

### **Research, Survey, and Monitoring Needs**

NMDGF and the US Forest Service currently conduct surveys and monitoring of fish and habitats on US Forest Service lands. Further, NMDGF is conducting capture-recapture studies to document survivorship of the Texas hornshell relative to variable flood regimes in the Black River. These survey and monitoring efforts are valuable and need to continue. Additional research and survey efforts of the Pecos Watershed that would assist conservation decisions regarding perennial 3<sup>rd</sup> and 4<sup>th</sup> order streams are outlined below.

- Determine the distribution, abundance, and biology of SGCN in perennial 3<sup>rd</sup> and 4<sup>th</sup> order streams. Studies on warm water 3<sup>rd</sup> and 4<sup>th</sup> order stream fishes are especially desirable to document their presence and status.
- Determine habitat use by juvenile mussels and glochidial (mussel larvae) host fish in situ.

- Refine captive aquaculture methods for the Texas hornshell and develop emergency response protocols to salvage mussels in the event of a human-caused or natural catastrophe that could threaten extant populations or population segments.
- Define the extent to which current land use activities fragment and alter perennial 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats.
- Investigate environmental conditions or thresholds that limit populations of SGCN in perennial 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats.
- A genetic study is needed comparing isolated populations of the Texas hornshell in New Mexico and Texas to make decisions regarding the federal listing status of this species.
- There is a need to complete the ongoing investigation into the distribution of *M. cerebralis* to determine the risk of whirling disease to Rio Grande cutthroat trout by this parasite.

### Desired Future Outcomes

Desired future outcomes for perennial 3<sup>rd</sup> and 4<sup>th</sup> order streams and associated SGCN in the Pecos Watershed include:

- Perennial 3<sup>rd</sup> and 4<sup>th</sup> 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.
- Impacts to native species communities by non-natives are negligible. Native species have been successfully re-established into previously occupied areas.
- Stream channel conditions are stabilized with appropriate streamside vegetation and substrates.
- The spread of aquatic nuisance species or other non-native or invasive plant and animal species are controlled or minimized in perennial 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats to a level that SGCN within this habitat are not adversely affected.
- Natural flow regimes are present and maintained for the benefit of SGCN.
- A naturally reproducing population of the Texas hornshell persists in the Black River.

### **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 re-establish native fish communities in perennial 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats.
2. Work with public and private land managers to develop sustainable livestock production practices on native rangelands around perennial 3<sup>rd</sup> and 4<sup>th</sup> order streams to reduce stream degradation.
3. Collaborate with federal and state agencies to reduce the degradation of perennial 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats by logging and road building.
4. Coordinate with state and federal land managers and private landowners to protect, restore, conserve, and create perennial 3<sup>rd</sup> and 4<sup>th</sup> order streamside habitats, with consideration for natural vegetation.
5. Work with federal and state agencies and affected publics to develop techniques to maintain a natural stream flow in perennial 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats. Actions may include evaluating the efficacy of in-stream flow regulations for conservation of SGCN.
6. Initiate a conservation and recovery plan for the Texas hornshell with the cooperation of federal and state agencies and affected publics.
7. Coordinate and cooperate with federal and state agencies and affected publics to implement the *Draft Aquatic Nuisance Species Management Plan*, which includes perennial 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats in the Pecos Watershed, currently being prepared by NMDGF.
8. Continue participating with other state and federal agencies in the *Conservation Agreement for Pecos Pupfish*. This would include updating the agreement, instituting baitfish regulations, investigating the efficacy of legal protection for the species, and completing development of the state recovery plan for Pecos pupfish.
9. 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 3<sup>rd</sup> and 4<sup>th</sup> order stream habitats outlined in the Information Gaps and Research, Survey, and Monitoring Needs sections.

## **Perennial 5<sup>th</sup> Order Stream**

### **Habitat Condition**

The main stem of the Pecos River comprises the 5<sup>th</sup> order stream of this watershed. Upstream of Roswell, it is a meandering, sand-bottomed river bordered by scattered cottonwoods and grasses. Pools occur around stream obstructions, making habitat diversity and quality comparatively high. Except for regulated flows from Sumner Reservoir, irrigation return near Taiban, and dispersed livestock grazing, the Pecos River in this reach is little modified by human activity. Downstream of Roswell to Brantley Reservoir, the river is more constrained and habitat less diverse. Run habitats tend to dominate. Downstream of Brantley Reservoir, four smaller dams impound the river. Between these impoundments, the river is bound by bedrock and habitat varies from large pools to short riffle and cascades. Downstream, dense stands of non-native saltcedar (*Tamarix* spp.) border the river.

### **Problems Affecting Habitat or Species**

#### *Impoundments*

The Pecos River is impounded by several reservoirs starting at Santa Rosa. These main stem reservoirs and irrigation-water release patterns have altered the natural flow regime. Since Sumner Dam was closed in 1937, mean annual discharge of the Pecos River has decreased slightly and peak flows have diminished. During irrigation season, zero-flow days are common in reaches below diversions. Winter discharge from all Pecos River reservoirs is negligible. Spring input and aquifer recharge is presumably responsible for winter flows. In addition to altering flow regimes, reservoirs trap sediments depriving downstream reaches of depositional materials.

#### *Channel Modification*

Most of the lower Pecos Watershed is significantly affected by channel modification due to regulated flows from reservoirs and other diversions. From Sumner Dam to the Fort Sumner Irrigation Diversion the channel has become incised and armored with gravel and cobble (Hoagstrom 2003). From the Fort Sumner Irrigation Diversion to Brantley Reservoir, the Pecos River is shallow and braided, consisting primarily of sandy-bottomed runs and short riffles (Bestgen *et al.* 1989).

#### *Groundwater Pumping*

In the past, groundwater pumping near Roswell lowered the water table and thus diminished the wetted channel in the river (US Bureau of Reclamation 2002). With increased regulation of groundwater pumping, the water table has risen and maintenance of surface flows in the river has improved.

#### *Pollution*

Runoff from livestock feedlots and dairy operations introduces nutrients and numerous contaminants to the river. Petrochemical pollutants reach the river from various refinery operations in the vicinity of Artesia.

### *Non-Native/Invasive Species*

The integrity of Pecos River habitats has been impacted by non-native and invasive species. Non-native fish have been established throughout the system. Salmonids in the upper Pecos River have tested positive for whirling disease. Golden algae (Chrysophyta) blooms have impacted the aquatic communities from Brantley Reservoir downstream into Texas. The non-native Asian clam and giant floater, a freshwater mussel, have been introduced to the Pecos Watershed. The former species occurs in the Pecos River from Santa Rosa downstream to the border with Texas, including 1<sup>st</sup> and 2<sup>nd</sup> order streams, while the latter species is reported from below Brantley Reservoir downstream to Carlsbad (Lang 2004).

Saltcedar is the dominant plant species in the riparian corridor in many areas. Saltcedar is an invasive plant with long taproots that allow it to intercept deep water tables and interfere with natural aquatic systems. This plant disrupts the structure and stability of native plant communities and degrades native wildlife habitat by out-competing native plant species and over-exploiting limited sources of moisture. 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).

### **Information Gaps**

Information gaps that limit our ability to make informed conservation decisions for Pecos River habitats and associated SGCN are outlined below.

- The effects are unknown of agricultural chemicals and petrochemicals on the native fish fauna.
- The current status of headwater catfish and the impacts of hybridization with channel catfish are uncertain.
- Life histories of SGCN, especially fishes, in the Pecos River have not been characterized.
- Long-term effects of periodic channel drying on fish assemblages are unknown.
- Impacts of non-native fishes, such as Arkansas River shiner (*Notropis girardi*) and plains minnow (*Hybognathus placitus*), on native fishes are unknown.
- Factors essential for survival of native large-bodied fishes, such as blue sucker and gray redhorse, in Pecos River are unknown.
- The taxonomic status of gray redhorse and blue sucker is unknown.
- The status of native crayfish (*Procambarus simulans simulans*) in the Pecos Watershed is uncertain.

### **Research, Survey, and Monitoring Needs**

The US Fish and Wildlife Service, New Mexico Fishery Resources Office, and NMDGF conducted six population monitoring trips at 12 -13 sites on the main stem Pecos River between Fort Sumner Reservoir and Brantley Reservoir in 2004. The primary objective was to provide population trend data on Pecos bluntnose shiner, a federally protected species. Other ongoing research and survey efforts include an investigation on the effects of low and interrupted flow to the fish community of the middle Pecos River and a study on the ecology of the blue sucker and gray redhorse in the lower Pecos River. Additional research and survey efforts that would enhance our ability to make informed conservation decisions regarding the Pecos River and associated SGCN are outlined below.

- Characterize the life histories of rare fish in Pecos River.
- The main stem of the Pecos River between the village of Pecos and Santa Rosa Reservoir and downstream of Carlsbad needs to be systematically surveyed to determine distribution and status of SGCN.
- Develop effective methods to diminish or eliminate the sheepshead minnow.
- Determine the current status of the headwater catfish, including genetic surveys to increase our understanding of the impacts of hybridization with channel catfish.
- Identify environmental conditions that limit populations of SGCN in this habitat.
- Long-term effects of periodic channel drying on fish assemblages need to be quantified.
- Evaluate the impact of agricultural chemicals and petrochemicals on native fish fauna, especially SGCN.

### **Desired Future Condition**

Desired future outcomes for the Pecos River and associated SGCN include:

- The Pecos River persists 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.
- Natural flow regimes are maintained throughout the main stem of the Pecos River.
- Water quality parameters in the Pecos River meet or exceed New Mexico water quality standards.
- The spread of aquatic nuisance species or other non-native or invasive plant and animal species are controlled or minimized in the Pecos River to a level that SGCN within this habitat are not adversely affected.

- Extirpated native fishes, such as Rio Grande silvery minnow (*Hybognathus amarus*), are restored and have viable populations in the Pecos River.
- Native crayfish populations persist in the lower Pecos River and its perennial tributaries.

### **Prioritized Conservation Actions**

Prioritized conservation actions for the Pecos River are outlined in several biological assessments (see: <http://www.usbr.gov/>; USFWS *et al.* 2002) and the various recovery plans that are in place for fish species that occupy its main stem. 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. Seek acceptance of in-stream flow regulations for the conservation of aquatic species.
2. Work with federal, state, county, and city agencies and planners and affected publics to develop strategies for a no-net-increase in water development within the Pecos Valley.
3. Collaborate with federal and state agencies and affected publics to remove non-native species and to re-establish native fish communities in the Pecos River.
4. Coordinate with state and federal land managers and private landowners to protect, restore, and conserve Pecos Watershed habitats and streamside vegetation and to limit the degrading effects of anthropogenic activities.
5. Collaborate with federal and state agencies and affected publics to eradicate or control invasive plant species.
6. Work with federal and state agencies, private landowners, research institutions, and universities to design and implement projects that will provide information about Pecos Watershed habitats and associated SGCN outlined in the Problems or Research, Survey, and Monitoring Needs sections.
7. In cooperation with other state and federal agencies, continue participating in the *Conservation Agreement for Pecos Pupfish*. This would include updating the agreement, instituting baitfish regulations, investigating the efficacy of legal protection for the species, and completing development of the *Recovery Plan for Pecos Pupfish*.
8. Work with federal and state agencies and affected publics to develop and implement management plans for rare fishes, such as Rio Grande shiner (*Notropis jemezanus*), speckled chub (*Macrhybopsis aestivalis aestivalis*), blue sucker, and gray redbreast, greenthroat darter, and bigscale logperch (*Percina macrolepida*).