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April 14, 2006

Cons. # 2-22-03-F-171

Memorandum

To: Area Manager, Albuquerque Area Office, Bureau of Reclamation, Albuquerque, New Mexico

From: Acting Field Supervisor, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico

Subject: Biological Opinion for the Bureau of Reclamation's Proposed Pecos River Dam Operations

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (BO) on the effects of the Bureau of Reclamation's (Reclamation) proposed Pecos River dam operations from the date of this opinion through summer 2006 (October 31, 2006) or until Reclamation implements a new operation defined in a Record of Decision, whichever occurs first, on the Pecos bluntnose shiner (*Notropis simus pecosensis*) (shiner) and its designated critical habitat and the interior least tern (*Sterna antillarum athalassos*) (tern) in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). The Service received Reclamation's transmittal memo requesting formal consultation and the biological assessment (BA) for Pecos River water operations on December 13, 2002, and received supplemental information on January 10, January 30, May 20, and May 23, 2003. On December 19, 2005, the Service received Reclamation's transmittal memo to amend the BA, and received supplemental information to the final amended BA on December 23, 2005, January 19, February 14, February 15, February 23, February 28, March 7, and March 8, and April 7, 2006.

The current BO does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. USDI Fish and Wildlife Service (CIV No. 03-35279) to complete the following analysis with respect to critical habitat. This consultation analyzes the effects of the action and its relationship to the function and conservation role of shiner critical habitat to determine whether the current proposal destroys or adversely modifies critical habitat. This document and the relevant analyses from our June 18, 2003, BO represents our biological opinion for the shiner and its designated critical habitat in accordance with section 7 of the Act.

The Service determined that Reclamation provided information necessary to reinitiate the formal consultation, as outlined in the regulations governing interagency consultation (50 CFR § 402.14). All information required for consultation was either included with your original 2002 BA, was provided in subsequent memorandums and meetings, or was otherwise accessible for our consideration and reference. You determined that the proposed operations on the Pecos River "may affect, is likely to adversely affect" the shiner and its critical habitat. You also determined that the proposed action "may affect, is likely to adversely affect" the tern. A complete administrative record of this consultation is on file in the Service's New Mexico Ecological Services Field Office (NMESFO).

CONSULTATION HISTORY

Reclamation initiated formal consultation with the Service in 1991 to address operations on the Pecos River (Reclamation 1991). The consultation concluded in August 1991 with the issuance of a biological opinion (BO) (Cons. #2-22-91-F-198). In that BO (Service 1991), the Service found that the timing of releases of water from upstream storage facilities (large blocks of water for expedient delivery down the channel followed by extensive drying of the river channel) was likely to jeopardize the continued existence of the shiner. A Reasonable and Prudent Alternative (RPA) was successfully formulated by the Service and accepted by Reclamation that removed the likelihood of jeopardy to the shiner. The Service also found that implementation of the RPA removed the likelihood of take. Therefore, no incidental take for the shiner was provided in the BO.

Formal consultation with the Service was requested by the U.S. Army Corps of Engineers (Corps) in April 1992 concerning operations of Santa Rosa Dam and Reservoir and the potential of that operation to mobilize and transport environmental contaminants to downstream habitats occupied by the endangered shiner and the tern. The BO issued for that consultation (Cons. #2-22-92-F-240) found that the Corps' ongoing and proposed operations of Santa Rosa Dam were likely to jeopardize the continued existence of the shiner and adversely modify its designated critical habitat on the Pecos River. An RPA was developed by the Service and accepted by the Corps to remove the likelihood of jeopardy/adverse modification.

With implementation of the RPA, the Service did not anticipate that continued operation of Santa Rosa Dam and Reservoir would result in incidental take of the shiner. Accordingly, no incidental take was authorized.

On December 8, 2005, an interagency meeting was held that included ornithologists and biologists from the New Mexico Department of Game and Fish, Reclamation, Bitter Lake National Wildlife Refuge, and the New Mexico Ecological Services Field Office (NMESFO) to discuss the current status of terns in the Pecos River Basin and opportunities to create additional breeding habitat for terns at Brantley Reservoir. The group requested Reclamation to obtain data on historic water levels at Brantley Reservoir during the May through August tern breeding season to help determine which elevations within the storage space of Brantley Reservoir would be suitable for habitat creation. A site visit would also occur prior to the 2006 tern breeding season to view the operating pool of the reservoir and the 2004 tern nesting area location, and locate potential areas for habitat creation above the operation pool.

On January 5, 2006, subsequent to receiving Reclamation's amendment, NMESFO staff met with Reclamation to request additional information for this consultation. Reclamation was requested to provide the historic dates when block releases were received at Brantley Reservoir during the tern breeding season. There was also discussion about predictive information available on the number and timing of upstream block releases, and about the salt cedar clearing that was conducted on the shoreline of Brantley Reservoir in the vicinity of the 2004 tern nesting area. On January 19, 2006, NMESFO received a supplement to the amendment to the biological assessment for Pecos River Water Operations that addressed these additional requests for information on issues related to the terns at Brantley Reservoir.

BIOLOGICAL OPINION

I. Description of the Proposed Action

Reclamation's proposed action is storing and releasing water. The activities of Fort Sumner Irrigation District (FSID) are not part of the proposed action. Reclamation cannot store natural flow water that FSID is entitled to receive under its senior State water rights permit. Reclamation will not store any natural inflow that is needed to target a downstream objective of avoiding river intermittency (defined as 0 to 5 cubic feet per second (cfs)) as stated below. Therefore, Reclamation will only store natural flow water when such storage is allowed by State permit and when it is not needed to avoid intermittency. Reclamation's proposed action includes operating Sumner Dam in a manner that not only seeks to avoid jeopardizing the shiner, but also to conserve and protect the species under section 7(a)(1).

Consistent with these goals, Reclamation proposes the following:

A) Criteria for Diverting Water to Storage

1) Water needed to satisfy FSID's senior water right cannot be stored at Sumner or Santa Rosa Reservoirs.

2) When FSID requests water, as allowed under its water right, water needed to meet the downstream target of avoiding river intermittency will not be stored at Sumner or Santa Rosa Reservoirs if there is water available under the two-week flow calculation.

3) At all other times than those listed above, water will not be stored at Sumner or Santa Rosa Reservoirs if there is water available on a real-time basis as determined at the Puerto de Luna gage (PDL), and that water is needed to meet the downstream target of avoiding river intermittency.

B) Releasing Water from Storage

1) Releasing stored water for the beneficial purpose of irrigation in CID in a manner that does not constitute a wasteful use due to excessive losses through seepage and evaporation.

2) Manage the block release schedule from Sumner Reservoir to alleviate any river intermittency.

3) Targeting a minimum of 14 days between block releases from Sumner Reservoir.

C) Supplemental Water

There are two major criteria associated with Reclamation's Pecos River operations that supplement river base flows and avoid river intermittency. These are: a) Reclamation will not store water if it is needed downstream for shiner flows, and b) Reclamation will utilize its flexibilities to make block releases in a manner that will help avoid intermittency. For example, Reclamation will schedule block releases that will meet irrigation demand and will also alleviate the lowest of river flows. River intermittency has not occurred historically when the April 1 upstream reservoir storage has been at existing levels (Figure 3). The available water storage in 2006 is greater than 80,000 acre-feet (af) in both Santa Rosa and Sumner Reservoirs, whereas in 2002 through 2004 the available storage was less than 40,000 af. The relatively high storage in the upstream reservoirs this year provides more flexibility to manage block releases for shiners. In addition, Reclamation has and is undertaking numerous proactive supplemental water activities.

Reclamation first entered into a lease agreement with FSID in 2000 which provided for land fallowing. The current agreement, executed in 2002 and expiring in 2007, has resulted in an average of 930 acres (ac) of fallowed land over the past four years, which represents 15 percent of the average of the historically irrigated acreage of 6,100 ac. The 12 percent currently leased will therefore result in an estimated 12 cfs bypassed water for the shiner when the diversion is 100 cfs. Under optimal conditions this is anticipated to provide approximately 5 cfs at the Acme gage.

Additionally, Reclamation has established a fish conservation pool in Sumner and Santa Rosa Reservoirs, through a permit obtained from the New Mexico State Engineer. The Fish Conservation Pool is water stored in one or more reservoirs that is set aside to aid in the conservation of the shiner. The purpose of the water is to help maintain a continuous river. Five hundred acre-feet of Carlsbad Project water is stored in Sumner and/or Santa Rosa Reservoirs and replaced with 375 af pumped into Brantley Reservoir from wells located at Seven Rivers. Depending upon antecedent conditions and the amount of water released, approximately 1 to 6 cfs of the released water arrives at the Acme gage. The stored water can then be released downstream at any time of the year to maintain instream flows and avoid intermittency. Reclamation will pursue expanding the conservation pool into a water banking concept which would supply additional water from Sumner or Santa Rosa Reservoirs at critical times to avoid intermittency and protect designated shiner critical habitat. Reclamation has already begun discussions of this option with irrigation districts and the State.

Since 2001, Reclamation has fallowed land leases with a variety of Pecos River water users totaling approximately 4,280 af, some with direct diversion water rights, and other with artesian well water rights. Additionally, one fallowed land lease for 1,180 af provides for delivery of water pumped from artesian wells directly to the Pecos River through a pipeline. This water is exchanged for surface water released upstream to provide instream flows to the critical habitat.

Reclamation provided supplemental information on March 8, 2006, in an electronic message to modify their proposed action to include the following:

1. "ESA 7(a)(1) activities that will be implemented to avoid river intermittency.
2. Coordination with the U.S. Fish and Wildlife Service and the New Mexico Department of Game and Fish to capture and hold Pecos bluntnose shiner in facilities at Dexter National Fish Hatchery."

With the existing upstream reservoir storage being greater than twice the three previous years and the activities described above (i.e., fish conservation pool and bypass flows), including managing block release schedules, Reclamation has sufficient resources to avoid river intermittency. In addition, if efforts to obtain lease agreements and groundwater exchange are successful there will be more flexibility to manage water operations and maintain continuous flows.

Reclamation is also proposing to fund and assist in the capture and holding of shiner in refugia. The refugia would provide a second shiner population should any unforeseen circumstances (e.g., disease, parasites) impact the wild population. It would also provide an opportunity to refine handling or develop propagation methodologies for shiners in captivity should future conditions warrant the need to expand the refugial population. The NMFRO would coordinate with the NMESFO the collection and transfer of approximately 250 shiners to the Dexter National Fish Hatchery and approximately 250 to the NMFRO. Using experienced crews supervised by the NMFRO, healthy shiners would be collected in spring 2006 when water quality (e.g., water temperature) is optimal and transferred to the Dexter facility and the NMFRO. Dexter and NMFRO would provide care and handling to maximize the survival of the translocated fish.

As part of the proposed action described in the amendment, Reclamation will continue to: 1) Monitor endangered terns to estimate the population size, nesting activity, and identify threats to the colony; 2) coordinate with the New Mexico Department of Game and Fish, New Mexico State Parks, and Eddy County officials to help prevent public access to the colony; 3) erect signs to restrict public access to the area; 4) discuss water management options with the Carlsbad Irrigation District to avoid flooding nests; and 5) informally consult with NMESFO on Reclamation's actions and the tern colony.

II. Status of the Species/Critical Habitat

A. Species/Critical Habitat Description

Pecos Bluntnose Shiner

Description of the Species
Historically, bluntnose shiner, *Notropis simus* (Cope), was found in main channel habitats of the Rio Grande, Rio Chama, and Pecos River, New Mexico and Texas (Cope and Yarrow 1875, Evermann and Kendall 1894, Koster 1957, Chernoff et al. 1982, Hatch et al. 1985, Bestgen and Platania 1990). The total range of the species, based on collected specimens, was 827 river miles (mi) (1,332 kilometers [km]) (C. Hoagstrom, Service, pers. comm. 2002). Concern for the species began in the 1970's, when it was listed as endangered by the American Fisheries Society (Deacon et al. 1979, Williams et al. 1989), and by the Texas Organization for Endangered Species (Anonymous 1987). Concern proved valid for the Rio Grande subspecies (*Notropis simus simus*) which was last collected in 1964 and determined to be extinct during the 1970's (Chernoff et al. 1982, Williams et al. 1985, Miller et al. 1989, Bestgen and Platania 1990, Sublette et al. 1990, Hubbs et al. 1991). As a result, the Pecos River subspecies (*Notropis simus pecosensis* Gilbert and Chernoff), was given formal protection by the state of New Mexico in 1976 (listed as endangered, Group 2) and the state of Texas in 1987 (chapter 68 of the Texas Parks and Wildlife Code). In 1987, the shiner was listed as threatened with critical habitat by the Service (1987).

The shiner is a true minnow (family Cyprinidae) in the genus *Notropis* (Chernoff et al. 1982), and the subgenus *Alburnops* (Etnier and Starnes 1993). Members of the genus *Notropis* are commonly referred to as 'the true shiners' (Jenkins and Burkhead 1994). The shiner shares the typical characteristics of the genus in that they do not have a frenum (a bridge of skin-covered tissue binding snout to the upper lip) and lack a barbel (a slender fleshy protuberance, found on lip, jaw, or elsewhere on the head of some fishes) (Sublette et al. 1990, Jenkins and Burkhead 1994). Members of the subgenus *Alburnops* lack bright breeding coloration, are found in big rivers, have small tubercles on dorsal surfaces of the head, and have pectoral fin rays 1 or 2 through 7 to 9 (Chernoff et al. 1982). The shiner is distinguished from other members of the subgenus *Alburnops* because it commonly possesses as many as 9 anal rays (soft, segmented support structures in the anal fin) (Chernoff et al. 1982, Sublette et al. 1990).

The shiner is a relatively small, moderately deep-bodied minnow, rarely exceeding 3.1 inches (in) (80 mm) total length (TL) (Propst 1999). It has a deep, spindle-shaped silvery body and a fairly large mouth that is overhung by a bluntly rounded snout and a large subterminal mouth. The fish is pallid gray to greenish brown dorsally and whitish ventrally. A wide silvery lateral stripe extends from the pectoral girdle to the base of the caudal fin. Pelvic and anal fins lack pigmentation, dorsal and pectoral fins have small black flecks along the fin rays, and the caudal fin is variably pigmented. Adult shiners do not exhibit sexual dimorphism except during the reproductive period, when the female's abdomen becomes noticeably distended and males develop fine tubercles on the head and pectoral fin rays.

The historic range of the shiner in the Pecos River was 392 river mi (631 km) from Santa Rosa, New Mexico to the New Mexico-Texas border (Delaware River confluence). At the time of listing (1987), the shiner was confined to the mainstem Pecos River from the town of Fort Sumner to Major Johnson Springs, New Mexico (roughly 202 river mi, 325 km) (Hatch et al. 1985, Service 1987). In the 2003 biological opinion (Service 2003a), the range of the shiner was described as from Old Fort Sumner State Park to Brantley Reservoir (194 mi, 318 km), or about 23 percent of the historical range of the species. For purposes of surveys and habitat considerations, the Pecos River from Sumner Dam to Brantley Reservoir was divided into three reaches. The first is the Tailwater reach, which extends from Sumner Dam to the confluence of the Pecos River and Taiban Creek. The second is the Rangelands reach, which extends from Taiban Creek to the Middle Tract of the Bitter Lake National Wildlife Refuge (BLNWRMT). The third reach is from the BLNWRMT to Brantley Reservoir. These reaches will be used throughout the remainder of this biological opinion to describe the condition of the shiner and its habitat.

In the 2003 biological opinion (Service 2003a), the river reach from the FSID Diversion Dam to Bitter Lake National Wildlife Refuge Middle Tract (BLNWRMT) (110 mi, 177 km) was considered the "stronghold" for the shiner, and comprised 13 percent of the historic range of the species (C. Hoagstrom, Service, pers. comm. 2002). This "stronghold" encompassed a portion of the Tailwater reach and all of the Rangelands reach. This reach was considered a stronghold because habitat availability and suitability was the best within the overall range, all size classes of shiner were found, and population numbers were relatively stable (Hoagstrom 2003).

Based on current information presented by Reclamation (Reclamation 2005a) and the NMFRO (Service 2003b), the occupied range of the shiner is more likely defined by the reach of the Pecos River between Taiban Creek and Brantley Reservoir (Rangelands and Farmlands reaches). The reach from the FSID Diversion Dam to Taiban Creek (which includes the reach from Old Fort Sumner State Park to Taiban Creek contained in the Tailwaters reach) does not currently support suitable habitat for the shiner (Hoagstrom 2003). Shiners have not been found in the reach above Taiban Creek since 1999 (S. Davenport, Service, electronic message, 2006a) even though there are no apparent barriers limiting shiner access to this area. Controlled flows, sediment scouring that resulted in channel armoring, and other factors, including the spread of non-native salt cedar are the likely mechanisms for the loss of suitable habitat in this portion of the river. This change in boundary, eliminating the approximately 5 mi (8 km) section between the Old Fort Sumner State Park and Taiban Creek, reduces the occupied range to 186 mi (298 km). The 94 mi (151 km) "stronghold" reach considered in the 2003 biological opinion should also be modified to extend from Taiban Creek to the BLNWRMT, a reduction of 5 mi (8 km) and is defined by the boundary of the Rangelands reach. This does not substantially change the percentage of the historic range currently occupied by the shiner from the 2003 biological opinion.

Critical Habitat

Shiner critical habitat is divided into 2 separate reaches (Service 2003a, Figure 1) and includes a 64 mi (103 km) reach (upper critical habitat) extending from 0.6 mi (1 km) upstream from the confluence of Taiban Creek (river mi 668.9) downstream to the Crockett Draw confluence (river mi 610.4). Only 64 mi (93 km) of the Rangeland reach is included in the upper critical habitat reach. The Rangeland reach continues downstream for an additional 36 mi (58 km). The lower critical habitat reach is 37 mi (60 km) from Hagerman to Artesia (Service 1987). This portion of the critical habitat is located in the Farmlands reach. These two areas were chosen for critical habitat designation because both sections contained permanent flow and had relatively abundant, self-perpetuating populations of shiner. However, these two areas vary greatly in their habitat characteristics. The upper critical habitat has a wide sandy river channel with only moderately incised banks, and provides habitat suitable for all age classes. The lower critical habitat is deeply incised, has a narrow channel, and has a compacted bed (Tashjian 1993). Although the lower critical habitat has permanent flow, the habitat is less suitable for shiners and only smaller size classes are common in this reach (Hatch et al. 1985, Brooks et al. 1991). Survey data indicate that most of the shiners in the Farmlands reach, including the lower critical habitat unit are young-of-the-year (YOY) and juveniles that may be washed into the area from the upstream Rangelands reach (Service 2003a) and the ability of this area to support self-sustaining populations of the shiner over the long-term is uncertain.

At the time of critical habitat designation, the 114 mi (184 km) portion of the Pecos River between the two critical habitat reaches was subject to frequent drying and therefore was not designated. However, when flow is maintained in this area, as it was between 1991 and 2001, this area contains excellent habitat and supports large numbers of shiners (Hoagstrom 1997, 1999, 2000). The lower 36 mi (58 km) of the Rangelands reach is located in this area and the provision of water provides important habitat to support the shiner population. Flows of 35 cfs at the Acme gage during the winter season (November through February) were also provided in this reach through the requirements of the 2003 biological opinion to ensure maintenance of these habitats in the Rangelands reach. The Pecos River between the two areas of critical habitat is acknowledged as an important component of recovery for the shiner.

Primary constituent elements of the critical habitat are clean, permanent water; a main river channel with sandy substrate; and low water velocity (Service 1987). At the time of listing, sporadic water flow in the river was identified as the greatest threat to the shiner and its habitat. Water diversions, ground and river water pumping, and water storage had reduced the amount of water in the channel and altered the hydrograph with which the shiner evolved. Although block releases maintain the current channel morphology (Tetra Tech 2003), since the construction of Sumner Dam, the peak flow that can be released is much less than the historical peak flows (U.S. Geological Survey historical surface flow data). The altered hydrograph encourages the proliferation of non-native vegetation, such as salt cedar, which armors the banks and causes channel narrowing. Channel narrowing increases water velocity, reduces backwater areas, and leads to the removal of fine sediments such as sand. Consequently, in areas dominated by salt cedar, the habitat becomes less suitable or unsuitable for shiners. Lack of permanent flow and an altered hydrograph continue to be the greatest threats to the shiner and its habitat.

B. Life History

Habitat

Typical of other members of the subgenus *Alburnops* (Etnier and Starnes, 1993), the shiner inhabits big rivers (Chernoff et al. 1982, Bestgen and Platania 1990). It has survived only within perennial stretches of the middle Pecos River, New Mexico (Hatch et al. 1985, Service 1987). In conjunction with perennial flow, the shiner is found in wide river channels with a shifting sand-bed and erosive banks (Tashjian 1993, 1994, 1995, 1997; Hoagstrom 2000, 2001, 2002). The highly erosive bed and banks allow channel configurations to change in response to flow events (Tashjian 1997, Tetra Tech 2000).

Flood inflows from numerous uncontrolled tributaries contribute to favorable river channel conditions in the Pecos River in the Rangelands reach. Although flood flows from uncontrolled tributaries occur too infrequently to maintain a wide channel, the combination of sediment and floodwater inflows are important for the maintenance of a sand-bed. Throughout the remainder of the historic bluntnose shiner range, closely spaced impoundments that control floods and block sediment transport have virtually eliminated these features (Lawson 1925, Lane 1934, Woodson and Martin 1965, Lagasse 1980, Hufstetler and Johnson 1993, Collier et al. 1996).

Although the shiner is found in the deeply incised lower river stretch that constitutes the Farmlands reach, the population there is dominated by small YOY (Hatch et al. 1985, Brooks et al. 1991, Brooks et al. 1994, Brooks and Allan 1995, Service 2003b), Hoagstrom et al. 1995, Hoagstrom 1997, 1999, 2000, 2001). Lack of growth, reduced survival, and reduced recruitment in this reach is attributed to poor habitat conditions related to the narrow, incised river channel and silt-armored bed. The predominance of YOY shiner in this reach is explained by periodic downstream displacement of eggs, larvae, and small juveniles (Brooks and Allan 1995, Hoagstrom et al. 1995, 1997, 1999, 2000; Platania and Altenbach 1998).

Velocity and Depth Preference

A habitat preference study was conducted from 1992 to 1999, to determine the effects of dam operations and variable flows on habitat availability. Velocity association varies with shiner size; larger fish are found in higher velocities (Hoagstrom 1997, 1999, 2000, 2002). Adults most frequently utilize velocities between 0.33 and 1.4 feet/second (ft/s) (10 and 42 centimeters/s [cm/s]). These velocities are typically found in open-water runs, riffles, and shallow pools (Hoagstrom 2002). Juveniles most frequently utilize velocities between 0.03 and 0.91 ft/s (1.0 and 28 cm/s), which are most commonly associated with shoreline areas (Hoagstrom 2002). Larvae presumably utilize backwater habitats with negligible velocity, relatively high water temperature, and high water clarity (Platania and Altenbach 1998). Thus, a range of velocities is necessary to support all shiner life stages.

Adult shiners most frequently utilize depths between 5.1 and 13 in (13 and 34 cm) (Hoagstrom, 2002). Juvenile shiners utilize a variety of depths from 2 to 17 in (6 to 42 cm) (Hoagstrom 2002). Such depths are generally associated with run, riffle, and shallow pool habitat. Use of a variety of depths may be caused by the need to avoid high velocity areas. However, shallow, low-velocity habitat may be most favorable (Platania and Altenbach 1998). Depths used most often by larvae are unknown.

The habitat preference study found that habitat availability varied between study sites (Hoagstrom 1999, 2000, 2002). Suitable depths and velocities were least abundant in the Farmlands reach (Hoagstrom 2002). The uniformity of the channel creates nearly constant depths and velocities across the channel at a given discharge. This lack of variability at all flows and lack of shallow depths and low velocity areas at high discharge, greatly reduces the suitability of habitat in this lower reach. In the Rangelands reach between the Taiban Creek confluence and Gasline, the wide, mobile, sand-bed channel meanders from side to side. Because a variety of depths and velocities are present over a wide range of discharges, the availability of suitable habitat is much greater in this reach.

Additional information on habitat availability and use by shiners was provided by Kehmeier et al. (2004) (as cited in Reclamation 2005a). This study evaluated mesohabitat use and availability in the Rangelands reach. Shiners were found to use parallel and perpendicular plunge habitats having moderate velocities and depths. Run and flat-water areas were avoided. Based on volumetric calculations, the authors concluded that the availability of the preferred plunge habitats was less altered by low flows than other types. This information is relevant to the ability of the Rangelands reach to provide sufficient habitat to support shiner populations at varying flow levels. It is important to consider the amount of habitat present at all flow levels, particularly to ensure the amount is adequate to support the desired population levels. Additional review of this information will be important in evaluating changes in future management proposed by Reclamation.

Reproduction (Spawning)
The shiner is a member of the pelagic spawning minnow guild found in large plains rivers (Platania 1995a, Platania and Altenbach 1998). These minnows release non-adhesive, semi-buoyant eggs (Platania and Altenbach 1998). Because these minnow inhabit large sand bed rivers where the substrate is constantly moving, semi-buoyant eggs are a unique adaptation to prevent burial (and subsequent suffocation) and abrasion by the sand (Bestgen et al. 1989). Shiners begin spawning as one-year-olds, once they reach 1.6 in (41 mm) standard length (SL) (Hatch 1982). The spawning season extends from late April through September, with the primary period occurring from June to August (Platania 1993, 1995a). Throughout the reproductive season, spawning is associated with substantial increases in discharge, including flash floods and block releases of water (Platania 1993, S. Platania, University of New Mexico, pers. comm. 2002).

Fecundity varies among individuals. Platania (1993) found that females released an average of 370 eggs with each spawning event and spawn multiple times during the spawning season. Eggs hatch in 24 to 48 hours (Platania 1993). Because the eggs are semi-buoyant, they are carried downstream in the current (Platania 1993, 1995a, Platania and Altenbach 1998). Newly-hatched larvae float downstream for another 2 to 4 days. During this time, blood circulation begins, the yolk sac is absorbed, and the swim bladder, mouth, and fins develop (Moore 1944, Bottrell 1964, Sliger 1967, Platania 1993). As the larvae drift, they "swim up", a behavior in which they repeat a cycle of swimming towards the surface perpendicular to the current, sink to the bottom, and upon touching substrate, propel themselves back toward the surface (Platania 1993). This behavior allows larvae to remain within the water column and avoid burial by mobile substrate (Platania and Altenbach 1998). Small juveniles are also susceptible to downstream displacement (Harvey 1987), but are better able to seek low-velocity habitats. Channel conditions that reduce downstream displacement and provide low-velocity habitats are favorable for successful shiner recruitment.

Historically the Pecos River had low, erosive banks, large inputs of sediment from tributaries, and uncontrolled floods. However, downstream displacement of eggs and larvae was minimal because flood peaks were of short duration and backwaters and other low velocity habitat remained abundant at high discharge (Dudley and Platania 1999). In contrast, transport of water in block releases that are part of the current water operation strategy sustains high flows for many days instead of several hours (Dudley and Platania 1999). In addition, where the channel is narrow and incised, backwaters and other low velocity areas are much reduced. Block releases of water stimulate the shiner to spawn (S. Platania, University of New Mexico, pers. comm. 2002), but the eggs, larvae, and small juveniles are then displaced downstream because of the lack of low velocity habitats and the sustained high discharge. Massive downstream displacement from the Rangelands reach accounts for population fluctuation in the deeply incised Farmlands reach (Brooks et al. 1994, Brooks and Allan 1995, Hoagstrom et al. 1995, Hoagstrom 1997, 1999, 2000; Platania and Altenbach 1998). Eggs, larvae, and small juveniles that are transported to Brantley Reservoir likely perish (Dudley and Platania 1999). Some shiner eggs or larvae may be able to pass through Brantley Dam, as indicated by the detection of young shiners below the dam in 2003 (Service 2003b). The ability of these shiners to survive and spawn in this area is unknown.

Food Habits

A short intestine, large terminal mouth, silvery peritoneum, and pointed, hooked pharyngeal teeth indicate that the shiner is carnivorous (Hubbs and Cooper 1936, Bestgen and Platania 1990). Although Platania (1993) found both animal and vegetable matter within shiner intestines, it is possible that vegetation is ingested incidental to prey capture. It is uncertain whether vegetation can be digested in such a short intestine (Hubbs and Cooper 1936, Marshall 1947). Young shiners likely consume zooplankton primarily, while shiners of increasing size rely upon terrestrial and aquatic insects (Platania 1993, Propst 1999). In a cursory analysis of 655 shiner stomachs, Platania (1993) found terrestrial insects (ants and wasps), aquatic invertebrates (mainly dipteran fly larvae and pupae), larval fish, and plant seeds (salt cedar). Other studies have also documented *Notropis* species consuming seeds during winter (Minckley 1963, Whitaker 1977) and it could be that shiners are primarily carnivorous, but utilize less favorable forage such as seeds when animal prey is scarce or that they indiscriminately ingest anything that is of the appropriate size.

The shiner diet is indicative of drift foraging (a feeding strategy where individuals wait in a favorable position and capture potential food items as they float by) (Starrett 1950, Griffith 1974, Mendelson 1975). Drift foragers depend upon frequent delivery of food to offset the energy required to maintain a position in the current (Fausch and White 1981). Water velocity must be adequate to deliver drift (Mundie 1969, Chapman and Bjornn 1969) but low velocity refugia where the fish can rest within striking distance of target items is also necessary (Fausch and White 1981, Fausch 1984). Habitat structure that creates adjacent areas of high and low velocity (e.g., bank projections, debris, bedforms) may be important for shiner feeding. Alluvial bed forms may be the most abundant form of habitat structure in sand-bed rivers (Cross 1967) and these bedforms require a certain velocity for formation and maintenance (Simons and Richardson

1962, Task Force on Bed Forms in Alluvial Channels 1966). Thus, foraging shiners rely upon flow both for delivering food items and for maintaining favorable habitat.

Age and Growth

First year and second year individuals are predominate in the shiner population, comprising 97 percent of captures. Third year individuals are much less prevalent (Hatch et al. 1985). First year individuals grow rapidly, reaching 26 to 30 mm SL within 60 days (S. Platania, University of New Mexico pers. comm. 2002). Hatch et al. (1985) reported that age-0 (first year) shiners ranged from 0.75 to 1.3 in (19.0 to 32.5 mm) SL, age-1 (second year) individuals ranged from1.28 to 1.77 in (32.6 to 45.0 mm) SL, and that age-2 (third year) individuals ranged from 1.77 to 2.22 in (45.1 to 56.5 mm) SL.

Mean length of the shiners is significantly different between the Rangeland reach (Taiban Creek confluence down to BLNWRMT) and the Farmlands reach (downstream of the BLNWRMT). In the Rangelands reach the mean length of shiners is 1.3 in (34.2 mm), with a standard deviation (SD) of 0.36 in (9.3 mm) (N=7,477). Downstream the mean length is 0.91 in (23.2 mm) with a SD of 0.28 in (7.1 mm) (N=8,876) (C. Hoagstrom, Service, pers. comm. 2002). Most likely the difference in size is related to habitat quality (the downstream Farmlands reach provides less suitable habitat for the growth and survival of the shiner) and the influx of small shiners into this lower reach during high flows including those caused by block releases from Sumner Dam.

Data from 1992 to 1999 (years of high precipitation and experimental base-flow supplementation) suggest that favorable flow conditions produced larger shiners (Hoagstrom 2001). Numerous individuals captured during that period were larger than previously recorded. Abundance of record-length shiners peaked between April and July 1999 when the 16 largest shiners, ranging in size from 2.58 to 3.01 in (65.5 to 76.4 mm) SL were captured (C. Hoagstrom, Service, pers. comm. 2002). Twenty-five percent of the longest shiners caught over an 11-year period (1992 to 2002) were caught in 1999. The longest individual captured in 1999 was 3 in SL (76.4 mm). This specimen was 0.4 in (11.2 mm) longer than any other shiner caught during the 10-year study, 0.3 in (7.5 mm) longer than the longest reported by Platania (1993), 0.8 in (19.9 mm) longer than any reported by Hatch (1982), and 0.9 in (23 mm) longer than the longest from the historical record (Chernoff et al. 1982). Dryer weather has prevailed since 1999, and shiners greater than 2.4 in (60.0 mm) SL have again become uncommon (C. Hoagstrom, Service, pers. comm. 2002). Dry conditions from 2002-2004 likely contributed to the shift in the size of individual shiners back near pre-1992 conditions. Size data from 2005 are not yet available.

Competition and Predation

Non-native fish species, including the plains minnow (*Hybognathus placitus*) and the Arkansas River shiner (*Notropis girardi*) are now established members of the Pecos River fish community. They are also part of the guild defined as broadcast spawners to which the shiner belongs (Platania 1995a). Members of this guild spawn during high flow events in the Pecos River and have semi-buoyant eggs that are distributed downstream to colonize new areas (Bestgen et al. 1989). As a result of the non-native introductions, interspecific competition may be a factor in the reduction in shiner abundance and distribution. Young fishes of these species that also use low velocity backwater areas may compete directly with young shiner for space and food (if food is limited); however, competitive interactions among Pecos River fishes have not been studied.

Juvenile and adult shiners generally occupy flowing water of low depth (see Velocity and Depth Section). At the same time, flowing water is important for supplying food and creating habitat structure (see Food Habits). Thus, a significant reduction of velocity impacts feeding position and food availability. Under such circumstances, shiners are forced to occupy habitats with lower velocity and more variable depth, but these habitats are commonly occupied by other fish species (Hoagstrom 1999, 2000). At low discharge, competition for space and forage is likely increased (Hoagstrom 1999). Concentration of species is most severe during intermittency because fishes must congregate in remnant pools. In such cases, it is likely that fishes that commonly inhabit still and stagnant waters (e.g., red shiner [*Cyprinella lutrensis*], western mosquitofish [*Gambusia affinis*]) gain a competitive advantage over fluvial species (Cross 1967, Summerfelt and Minckley, 1969). In addition, without flows to deliver food items, species dependent upon drift, such as the shiner, are at a disadvantage (Mundie 1969).

Large-bodied piscivorous fishes in the Pecos River are uncommon in currently occupied shiner habitat between the Taiban Creek confluence and Brantley Reservoir (Hoagstrom 2000, Larson and Propst 2000). This is primarily because the majority of available habitat is shallow. High turbidity likely inhibits sight-oriented predators such as the sunfishes (Centrarchidae). Predators that occupy the most suitable shiner habitat include the native longnose gar (*Lepisosteus osseus*), flathead catfish (*Pylodictis olivaris*), and green sunfish (*Lepomis cyanellus*), and the non-native channel catfish (*Ictalurus punctatus*), white bass (*Morone chrysops*), and spotted bass (*Micropterus punctulatus*) (Larson and Propst, 2000, C. Hoagstrom, Service, pers. comm. 2002). When captured during surveys, the majority of these predators have been small (Larson and Propst 2000, Valdez et al. 2003). Thus, low abundance and small size suggest fish predation is not a major threat to the shiner (Larson and Propst 2000). However, the impacts of predaceous fishes within intermittent pools have not been studied and it is possible that they feed on shiners (Larson and Propst 2000). With the increase in intermittent flow days in 2002-2003 (number intermittent days: 2002 [53 days] and 2003 [47 days]) there may have been an increased risk of predation on shiners caught in pools. The reduction in intermittent flow days in 2004 to eight days, and none in 2005, reduced that risk of predation. By maintaining continuous flow in 2006, the degree of risk from predation should continue to be reduced.

Aerial and terrestrial piscivores may also threaten the shiner. Although neither group appears especially abundant along the Pecos River (C. Hoagstrom, Service, pers. comm. 2002), many piscivorous birds are seasonally found at BLNWRMT and piscivorous mammals and reptiles are present along the river. Least terns are known to prey on shiner species in other rivers (Wilson et al. 1993, Schweitzer and Leslie 1996), but this has not been documented on the Pecos River. As with piscivorous fishes, impacts of non-aquatic predators (e.g. racoons, skunks, coyotes) on the shiner are likely most significant during surface flow intermittence, when fishes are confined and crowded in shallow water (Larimore et al. 1959).

C. Population Dynamics

Based on seine collections (0.12 in, 3.0 mm mesh), shiner population structure is bimodal (two distinct length classes) from May through August (Hoagstrom 2003). The smaller size class includes YOY and juveniles; the larger size class, adults. In the spring (January through April) the population is unimodal (one size class) as first year individuals complete a growth spurt and third year individuals decline in abundance (Hoagstrom 2003). Large juveniles and adults dominate the population at this time. Young-of-the-year present in May and June are not collected with the seine because they are small enough to pass through the mesh.

Within the Pecos River, two population trends are exhibited. In the Rangelands reach, all age groups are present and adults dominate the population. In contrast, in the Farmlands reach, adults are rare and YOY dominate (Hatch et al. 1985, Brooks et al. 1991, Brooks and Allan 1995, Service 2003b, Hoagstrom et al. 1995, Hoagstrom 1997, 1999, 2000, 2001). In the upstream Rangelands reach, fish community composition was found to be stable among years and seasons (Hoagstrom 2000). Shiner abundance varied among years, but was relatively stable within years (seasonally) (Hoagstrom 2000, 2001). In contrast, downstream in the Farmlands reach fish community composition was unstable among years and seasons and shiner abundance fluctuated widely both within and among years (Hoagstrom 2000, 2001). This relationship held true for both reaches through 2001. In 2002, relative abundance of shiners in both the upstream and downstream reaches declined precipitously beginning in the second trimester (May-August) survey period (Fagan 2006). There was some rebound in early 2003, but by the end of that year, relative abundance, shiners as a percentage of the shiner guild, and density were at or near 1992 levels (Service 2003b, Fagan 2006).

Early studies showed that shiners avoid (or perish within) areas subjected to frequent surface flow intermittence (Hatch et al. 1985, Brooks et al. 1991). Subsequent studies found that shiners proliferated in areas that were formerly intermittent when they remained perennially wet (e.g. the middle reach of the Pecos River between the two critical habitat segments) (Hoagstrom 1997, 1999, 2000, 2001). Favorable flow conditions between 1992 and 1999 corresponded with increased shiner density in the middle reach (Hoagstrom 2000, 2001) and large individual size (see Age and Growth).

In 1992, New Mexico Fishery Resources Office (NMFRO) began a 5-year study on the shiner and its habitat. This study was extended beyond the original 5-years and is ongoing. Research on the shiner population has continued, resulting in a 13-year record of population trends (data analyzed from 1992-2004). From February 1992 through August 2002, 803 fish collections were made, capturing 19,525 shiners (density = 0.09 shiner/m^2) (C. Hoagstrom, Service, pers. comm. 2002). In 2003-2004 an additional 105 fish collections were made with 81 of those containing the shiner. Over the 13-year period, only 23 shiners have been caught in the Tailwaters reach. Although at the time of listing (1987) shiners were relatively common from the FSID Diversion Dam down to Taiban Creek, they have become more rare in this part of the river and now are infrequently collected (Hoagstrom 2003). The remainder of this discussion will focus on the Rangelands and Farmlands reaches that remain occupied by the shiner. The Tailwaters reach will not be discussed further.

Between 1992 and 2001, shiner density increased from the January-April sampling period to the

May-August sampling period in seven of the 10 years in the Rangelands reach (Figure 4). In those years (1995-1997) where declines were observed between the first and second trimesters, these declines were small and populations had increased by the end of the third trimester. In 2002, the decline between these same two trimesters was 75 percent over the pervious sampling period. Not only is it unusual to see a decline between these two sampling periods but the magnitude of decline seen in 2002 is much greater than has been recorded before. Two factors contribute to the decline. First, there were two periods of stream drying between May and August 2002, which led to the death of shiners (D. Propst NMDGF, pers.comm. 2002). Second, because stream flow was low during the January-April 2002 sampling period, fish were concentrated and much easier to capture. The very high density recorded in January-April may be in part an artifact of sampling during low flows. However, flows were also low during the May-Aug collection. Ease of capture may in part explain the high density values seen in 2001 as well.

In 2003, shiner density was considerably higher in the January-April period in the Rangelands reach than at the end of 2002, but did not significantly change between January-April and May-August. Densities dropped to 1992 levels by the last sampling period (Fagan 2006). High capture rates in the first two sampling periods may relate to the same issues as in the discussion about 2002 captures.

In 2004, January-April shiner densities remained near 1992 starting levels in the Rangelands reach and remained considerably below 2003 levels for the May-August period and were at very low levels at the end of 2004. While 2004 had fewer days of no-flow at the Acme gage than in 2003 (8 days versus 44), the lingering effects of the low 2003 population numbers to provide for the breeding population in 2004 may have been a factor in continued low levels. In Figure 4, notice the pattern in 1992-1995 where populations were generally low. Several years of good flows were needed before the population densities increased significantly. It is also important to consider the manner in which flows move through the system. Shiners spawn in response to sudden peaks in flow. Optimal years may then be those with the necessary peaks that also have sufficient base flows to ensure that nursery habitat exists and eggs and larvae are retained in areas of good habitat. Years with a steady flow may not provide the appropriate cues for spawning. Years with very high spikes and very low baseflows may have significant movement of eggs and larvae out of good habitat areas, thus potentially reducing survival.

The relative abundance of shiners in the fish community in the Rangelands reach showed a gradual increase over time, especially between 1995 and 2002 (Figure 5). This indicates that shiners became a more abundant component of the fish community over time, reaching a high of 25.6 percent in the January-April 2002, sampling period. The overall trend was likely the result of high precipitation and experimental base-flow supplementation until 2000. The precipitous drop in the May-August 2002 sampling period may indicate that shiners are more susceptible to drying conditions than are other species in the fish community. For instance, red shiners typically occur in harsh, unpredictable environments with temperature extremes and episodes of low oxygen, floods, and drought (Matthews et al. 2001). Data from NMFRO and Valdez et al. (2003) indicate that the percent abundance of shiner decreased to about 5 percent of the shiner guild in October 2002 while the percent abundance of red shiner markedly increased. In 2003, relative abundance of shiners increased somewhat over the lows seen in 2002 in the first two trimesters, and then decreased significantly to 1992 levels. Data from 2004 show further declines in shiner relative abundance and density (Fagan 2006). Data from the first two trimesters in 2005 again showed declines when compared to the comparable trimesters in 2004(Fishery Resources Office 2006). Based on the first two trimesters in 2005, values river-wide are the lowest recorded since monitoring began in 1992 (Fishery Resources Office 2006).

Shiner relative abundance and density in the Farmlands reach have not shown any distinct trends over the last 13 years (Figures 6 and 7). Both measures have been highly variable over this time frame. Similar to the Rangelands reach, shiner density increased in 2001. This is likely due to increased sampling efficiency because of low flows (C. Hoagstrom, Service, pers. comm. 2002). Both density and relative abundance declined precipitously in late 2002 through 2003 with no appreciable recovery in 2004. Although shiner density has shown sporadic increases, it is nearly always followed by a decrease in the Farmlands reach. There has been a decreasing trend in shiner density or relative abundance in the Farmlands reach.

Population fluctuation in the Farmlands reach is largely attributable to Sumner Dam operations (Hoagstrom 1997, 1999, 2000). After block releases of water (> 15 days in duration) numerous shiner eggs, larvae, and juveniles are displaced downstream (Hoagstrom 1997, 1999, 2000). For example, after a long block release in 1995 (32 days greater than 500 cfs, 14.2 m^3/s), shiner density at the Brantley Reservoir inflow was very high (73 shiners/ft^2, 6.8 shiners/m^2). These fish were all very small (0.6 in, 15.2 mm). Unfortunately, the high number of shiners is not sustained in the Farmlands reach, and shiner abundance is normally low during winter and spring (less than 1.1 shiners/ft^2, 0.1 shiners/m^2) (Hoagstrom 2000). Inability of the shiner to sustain high densities in the Farmlands is the result of low survival, growth, and recruitment attributed to poor habitat conditions (see Velocity and Depth Preference and Reproduction sections).

D. Status of Species and Distribution

The historic trend in shiner abundance indicates a decline since the 1940s (Hatch et al. 1985, Brooks et al. 1991, Propst 1999). For example, Koster (1957) collected 818 shiners on September 3, 1944, at the U.S. Highway 70 Bridge (University of New Mexico Museum of Southwestern Biology records). In comparison, at the same site between 1992 and 1999, the NMFRO collected a total of 815 shiners in 39 trips (Hoagstrom 2000). In pre-1950 collections shiner represented 37.5 percent of the shiner guild (Platania 1995b) but never reached that level subsequently (Platania 1995b, Hoagstrom 2003). Collections between 1986 and 1990 indicate a further decline in abundance and a reduction in range, although the species still existed within the designated critical habitat reaches (Brooks et al. 1991). Brooks et al. (1991) found that the shiner comprised 3.7 percent of the total number of all shiners collected (5 species) from the Pecos River during 1990, compared to 22.4 percent for all collections prior to 1980 (4 species).

From 1992 to 1999 shiner status improved substantially compared to 1991 (Brooks et al. 1991, 1993, Brooks and Allan 1995, Hoagstrom et al. 1995, Hoagstrom 1997, 1999, 2000, 2001). This was due to the combined effects of increased snowpack and spring runoff, frequent local precipitation, and experimental Sumner Dam operations, all of which contributed to sustaining perennial flows from Sumner Dam to Brantley Reservoir (Hoagstrom 1999, 2000). These years included base-flow supplementation and a 15-day maximum peak flow restriction on storage transport release duration. However, 2002 was a very dry year with extensive river drying (49 days) and it appears to have impacted the shiner population. In 2003 and 2004, there were 44 and 8 days intermittency, respectively. No intermittency was recorded in 2005. Preliminary data for the last trimester sampling in 2005 indicate a slight increase in either density or relative abundance of shiners over the last trimester of 2004 (S. Davenport, Service, electronic message, 2006b).

From the long-term population surveys that have been conducted in the Rangelands reach, it appears that the prolonged and extensive intermittency that occurred in 2002 and 2003 had a negative impact on the shiner population. Both the relative abundance and shiner density dropped precipitously in the Rangelands reach, where the habitat is the best (Figures 4 and 5). As previously described, shiner density had been showing an overall upward trend until the May-August and September-December 2002 sampling dates (Fagan 2006). Although more limited in scope, work conducted by Valdez et al. (2003) from May to October, 2002, showed the same pattern. Density of shiner at the 3 sites sampled showed marked declines in the October sampling period. Likewise, the relative abundance of shiner at the three sites declined (as calculated from data presented in Valdez et al. 2003). Information from 2004 sampling by the Service indicates that density, relative abundance, and percentage of shiners in the shiner guild were very low at or near the lowest levels since 1992 (Fagan 2006) (Figures 8 and 9).

Although shiner density was greater in 2001 than a decade ago, the extensive intermittency in 2002 through 2003 may have substantially reduced the number of shiners available for breeding in 2004. In the 1990s, shiner numbers increased over a 5-year period (1991 to 1996) largely due to favorable flow conditions and absence of river intermittency. Drought conditions have reduced flows and increased river drying. Because the shiner has a short life span (3 years), extended drought conditions and subsequent river drying has severely reduced the shiner population. Recruitment to the adult population in 2002-2004 may have been low (as reflected in the density figures for 2003-2005), limiting the ability of population to react to the less severe conditions in 2004 and improved conditions in 2005.

E. Analysis of the Species/Critical Habitat Likely to be Affected

The shiner has undergone significant population declines and range contraction in the last 65 years (Service 2003a). It is now restricted to about 186 mi (298 km) from Taiban Creek to Brantley Reservoir. The decline is the result of various alterations to the Pecos River, most notably the diversion of water for irrigation and the storage of water in impoundments. Channel drying was recorded at the Acme gage in 1989 (22 days), 1990 (32 days), 1991 (15 days), 2001 (5 days), 2002 (49 days), 2003 (44 days), 2004 (8 days), and no days in 2005 (USGS stream gage data for Acme gage).

The shiner population is unlikely to expand its distribution because Santa Rosa and Sumner Reservoirs, FSID Diversion Dam, and Brantley Reservoir fragment river habitat and prevent upstream and downstream migration and colonization. Low base flows and river intermittency also limit movement of the shiner. These conditions persist to the present time. Although the portion of the river in the Tailwaters reach between Taiban Creek upstream to the FSID Diversion Dam (17 mi, 27 km) is almost always wet, shiners do not colonize this area, most likely because the habitat is not suitable (Hoagstrom 2003). The suitability of this area for shiners has not improved since 2003. Brantley Reservoir is a sink for millions of drifting shiner eggs and larvae and prevents downstream colonization (Dudley and Platania 1999); however, some shiners were found below Brantley Reservoir in 2003 (Service 2003b). The survival of these individuals is uncertain, and the habitat between Brantley Reservoir and Avalon Reservoir may not be suitable for persistence of a self-sustaining population. The possibility of naturally increasing the range of the shiner appears remote.

River channel degradation has also impacted the range of the shiner. River channels below dams often become more stable as a consequence of an altered hydrograph (Polzin and Rood 2000, Shields et al. 2000). Exacerbating this effect is the presence of salt cedar. Salt cedar was first observed near Lake McMillan in 1914 and its range expanded quickly thereafter (Thomas 1959). Encroachment of salt cedar has narrowed the river channel, especially in the lower critical habitat, leading to a degradation of shiner habitat. Artificial channel geometry was created between BLNWRMT and McMillan Reservoir through channelization efforts that were exacerbated by salt cedar invasion and reservoir operations (Corps 1999). At the same time, bed sediments were scoured from the Tailwaters reach between Sumner Dam and Taiban Creek confluence, leaving a gravel-armored channel (Tetra Tech Inc. 2000). The only reach that has retained an active river channel is the Rangelands reach between Taiban Creek confluence and BLNWRMT, but channel width and bed mobility progressively decrease downstream into the Farmlands reach (Tashjian 1993, 1994, 1995, 1997; Tetra Tech Inc. 2000). These habitat conditions may have been affected by the low flows in 2002-2003; however, the extent and permanency of such effects is unknown. Higher flows in late 2004-2005 may have eliminated further adverse effects.

Decreased peak flows and extended peak flows for block water releases by Reclamation have altered the natural hydrograph, to which the shiner is best adapted (Cross et al. 1985). There is increasing interest in oil and gas development near the Pecos River and in its flood plain (S. Belinda, BLM, pers. com. 2003). This development could lead to more roads, pipelines, and potential sources of pollution into the Pecos River. Sediment entrapment in upstream and tributary reservoirs limits the amount of sediment available for the development of habitat (Sherrard and Erskine 1991).

Interior Least Tern

Species Description

Least terns are the smallest members of the subfamily Sterninae and family Laridae of the order Charadriiformes, measuring approximately 9 in long with a wing span of 20 in. The least tern is recognized as a distinct species of tern, and the interior least tern as a subspecies, based on studies of vocalizations and behavior (American Ornithologists' Union 1957, 1983; Johnson et al. 1998). Three subspecies of least tern nest in the United States. The California least tern

(*Sterna a. brownii*) nests from Baja California to the San Francisco Bay; the interior least tern (*Sterna a. athalassos*) nests along the major tributaries throughout the interior U.S. from Montana to Texas and New Mexico to Louisiana; and the eastern least tern (*Sterna a. antillarum*) nests along the coast from Texas to Maine. Breeding plumage of terns consists of a black cap, white forehead, throat and underside with a pale gray back and wings, and black-tipped yellow-orange bill. In flight, the tern is distinguished by the long, black outermost wing feathers and the short, deeply forked tail. First-year birds have a dark bill, a dark gray eye stripe, and a dusky brown cap.

Historic and Current Range-wide Distribution

Terns are long-distance migrants that breed in North America and winter in South America. Terns historically bred along the Mississippi, Missouri, Arkansas, Red, Rio Grande, and Ohio River systems (Coues 1874, Youngworth 1930, 1931; American Ornithologists' Union 1957, Hardy 1957, Burroughs 1961, Anderson 1971, Ducey 1981). The range extended from Texas to Montana and from eastern Colorado and New Mexico to southern Indiana. This tern continues to breed in most of its historic breeding range, although its distribution is generally restricted to river segments that have not been heavily altered from historic conditions (U.S. Fish and Wildlife Service 1990). It breeds along the lower Mississippi River from approximately Cairo, Illinois, south to Vicksburg, Mississippi (U.S. Fish and Wildlife Service 1990). In the Great Plains, it breeds along: (1) The Missouri River and many of its major tributaries in Montana, North Dakota, South Dakota, Nebraska, and Kansas; (2) the Arkansas River in Oklahoma and Arkansas; (3) the Cimarron and Canadian Rivers in Oklahoma and Texas; and (4) the Red River and Rio Grande in Texas (U.S. Fish and Wildlife Service 1990). Current wintering areas of the interior least tern remain unknown (U.S. Fish and Wildlife Service 1990). Least terns of unknown subspecies are found during the winter along the Central American coast and the northern coast of South America from Venezuela to northeastern Brazil (U.S. Fish and Wildlife Service 1990).

Life History

Reproductive Biology. Terns are present at breeding sites for 4 to 5 months, arriving from late April to early June (Youngworth 1930, Hardy 1957, Wycoff 1960, Faanes 1983, Wilson 1984, U.S. Fish and Wildlife Service 1987). Predators and other intruders are dive-bombed by adults. Courtship can occur either at the nest site or some distance away (Tomkins 1959). It includes aerial displays involving pursuit and maneuvers, culminating in a fish transfer on the ground between two courting birds. Other courtship behaviors include nest scraping, copulation and a variety of postures and vocalizations (Hardy 1957, Wolk 1974, Ducey 1981). The nest is a shallow, inconspicuous depression in an open sandy area, gravelly patch, or exposed flat. Small stones, twigs, pieces of wood and debris usually lie near the nest. Terns nest in colonies as small as a single pair to over 100 pairs, and nests can be as close as a few feet apart or widely scattered up to hundreds of feet (Ducey 1988, Anderson 1983, Hardy 1957, Kirsch 1990, Smith and Renken 1990, Stiles 1939). Terns usually lay two to three eggs (Anderson 1983; Faanes 1983; Hardy 1957; Kirsch 1987, 1988, 1989; Sweet 1985, Smith 1985) and may renest if their nest is destroyed. Incubation generally lasts 20 to 25 days, but has ranged from 17 to 28 days (Moser

1940, Hardy 1957, Faanes 1983, Schwalbach 1988). Although the female does most of the incubation and brooding, both adults participate. Chick color varies from white to tan with black spots or streaks across back and top of head. Tern chicks hatch within 1 day of each other and stay near the nest bowl for several days. Chicks are fed small minnow-like fish until they fledge at around 20 days. Recently fledged chicks are inefficient predators and continue to receive food from adults for several weeks. Fledglings may disperse from natal colonies within 3 weeks of fledging. Departure from colonies by both adults and fledglings varies, but is usually complete by early September (Bent 1921, Stiles 1939, Hardy 1957).

Growth and Longevity. Young terns are slightly precocial and are brooded for about 6 days after hatching. At that time, they are mature enough to disperse from the nest on the ground. Chicks are able to fly by about 20 days after hatching, but do not become competent at fishing until after migrating from the breeding grounds in fall (Hardy 1957, Tomkins 1959, Massey 1972, 1974). Therefore, they depend on parental care for a short time after they have become strong fliers. Record longevity for a least tern is 24 years (Klimiewicz and Futcher 1989).

Movements/Dispersal Patterns. Annual and seasonal movements of terns between breeding sites are poorly understood, but are known to occur frequently over significant distances and may occur quickly based on abrupt changes in habitat conditions. Breeding site fidelity is affected by the ephemeral nature of the tern's riverine environment, which prevents some sites from being used in successive years. Localized shifts observed in tern distribution likely result from the interplay of several related ecological factors, including the presence of suitable sandbars, the existence of favorable water conditions during the nesting season, and the availability of food (Hardy 1957). Changes in the microhabitat and social structure within breeding areas often leads to birds changing sites if suitable habitat of higher quality is available elsewhere (Prindiville 1986).

Food and Habitat Requirements. Terns are piscivorous, feeding on small fish in shallow waters of rivers, streams, and lakes (U.S. Fish and Wildlife Service 1990). Moseley (1976) believed terns to be opportunistic feeders, exploiting any fish within a certain size range. Fishing behavior involves hovering and shallow dives over standing or flowing water.

The terns' physical habitat requirements include lack of vegetative cover (Dirks 1990, Ziewitz et al. 1992), open expanses of sand or pebble beach within the river channel or reservoir shoreline, and proximity to stable food sources (Faanes 1983, Dugger 1997, Adolf 1998). The riverine nesting areas of terns are sparsely vegetated sand and gravel bars within a wide unobstructed river channel, or salt flats along lake shorelines. Nesting locations usually are at the higher elevations and away from the water's edge because nesting starts when the river flows are high and small amounts of sand are exposed. The size of nesting areas depends on water levels and the extent of associated sandbars. The Lower Mississippi River is very wide and carries a tremendous volume of water and sand. Sandbars form annually, are washed away, and shift position. Many sandbars are over 3.2 km long and 1.2 km wide. Nest sites are often several hundred meters from the water (Rumancik 1987, 1988). Thus, nesting areas usually are several hundred hectares in size.

Sandbar geophysiology and associated hydrology are integral components of suitable habitat. Bacon (1996) found channel bars chosen for nesting sites by least terns on the Yellowstone River were exposed above river level longer throughout the breeding season than non-nesting habitats. Similarly, Smith and Renken (1991) found that tern colonies along the lower Mississippi River were located on sand islands and sandbars that differed from unused sand islands by the length of time sites were continuously exposed above the river. Most nest colonies on the Yellowstone occurred in a section of the river where channel sinuosity began to increase. Terns prefer sites that are well-drained and well back from the water line. Terns usually nest on sites totally devoid of vegetation, but if present, vegetation is usually located well away from the colony (Hardy 1957, Anderson 1983, Rumancik 1985, Smith and Shepard 1985). Terns also nests in dike fields along the Mississippi River (Smith and Stuckey 1988, Smith and Renken 1990); at sand and gravel pits (Kirsch 1987-89); ash disposal areas of power plants (Wilson 1984, Johnson 1987, Dinsmore and Dinsmore 1988); along the shores of reservoirs (Chase and Loeffler 1978, Neck and Riskind 1981, Boyd 1987, Schwalbach 1988); and at other manmade sites (Shomo 1988). It is unknown to what extent those alternative habitats have replaced productive natural habitat.

Foraging habitat for terns includes side channels, sloughs, tributaries, shallow-water habitats adjacent to sand islands and the main channel (Dugger 1997). To successfully reproduce, productive foraging habitat must be located within a short distance of a colony (Dugger 1997). For example, terns in Nebraska generally were observed foraging within 328 ft (100 m) of the colony (Faanes 1983). Armbruster (1986) recommends that feeding areas for terns be present within 1,312 ft (400 m) of the nesting colony.

Range-wide Population Status and Trends

Over the past century, the number of terns has fluctuated. During the late 1800s, terns declined in numbers due to harvesting for the millinery trade. After the Migratory Bird Treaty Act was passed in 1916 to make commercial harvest illegal, tern numbers increased until the mid-1900s, when alterations of natural hydrologic patterns and urban and industrial development of shorelines led to further population declines. The interior least tern was listed as endangered on June 27, 1985 (50 FR 21784-21792), primarily due to widespread, human-caused stabilization of its normally dynamic riverine habitat. Since the taxonomic status of the interior least tern was not resolved in 1985, the interior population was defined as any least tern nesting more than 50 km from the coast, and this population was listed as endangered independent of taxonomic status (U.S. Fish and Wildlife Service 1985). Barren sandbars, the tern's preferred nesting habitat, were once a common feature of the Mississippi, Missouri, Arkansas, Ohio, Red, Rio Grande, Platte, and other river systems of the central United States. Sandbars are not stable features of the natural river landscape, but are formed, enlarged, eroded, moved, or destroyed, depending on the dynamic forces of the river. Widespread stabilization of major rivers for navigation, hydropower, irrigation, and flood control significantly impaired the dynamic nature of riverine processes (Smith and Stucky 1988). Reduced flooding prevents scouring of sandy islands and shores, allowing vegetation to grow and making the habitat unsuitable for nesting terns. Many of the remaining sandbars became unsuitable for nesting because of vegetation encroachment, or were low and subject to frequent inundation. River channelization, gravel mining and human-related disturbance (i.e., foot traffic, unleashed pets, swimmers, canoeists and off-road vehicles) also contributed to the decline of this subspecies. Indirect disturbance of tern colonies can result in temporary abandonment of nests (Burger 1981), exposing adults to aerial predation and eggs and chicks to predation and inclement environmental conditions. All of these habitat changes resulted in declines in numbers and distribution of terns that led to its listing as endangered in 1985.

Kirsch and Sidle (1999) compiled tern population data from 1984 to1995 to assess the range-wide status of the population. Breeding population estimates were compiled for 35 local areas. Large population increases occurred along the middle and lower Mississippi River where approximately 52 to 79 percent of terns nest. The Platte River in Nebraska contained the second largest number of terns (6.2 to 13.6 percent). Two stretches of the Missouri River in North Dakota, South Dakota and Nebraska; Salt Plains National Wildlife Refuge in Oklahoma; Cimarron and Canadian Rivers in Oklahoma; and Falcon Reservoir on the Rio Grande in Texas all typically provided habitat for more than 100 terns annually (Kirsch and Sidle 1999).

The 1995 tern count numbered approximately 8,800 terns in 1995, and exceeded the range-wide delisting numerical recovery objective of 7,000 terns. However, the mean number of terns in 12 of 19 local areas designated in the tern recovery plan (U.S. Fish and Wildlife Service 1990) did not reach corresponding recovery objectives for delisting. These recovery criteria include assuring that essential habitat is protected by removal of current threats and habitat enhancement, establishing agreed-upon management plans, and attaining a population of 7,000 birds at the following levels:

1. Adult birds in the Missouri River system will increase to 2,100 and remain stable for 10 years.
2. Current numbers of adult birds (2,200 to 2,500) on the Lower Mississippi River will remain stable for 10 years.
3. Adult birds in the Arkansas River system will increase to 1,600 and remain stable for 10 years.
4. Adult birds in the Red River system will increase to 300 and remain stable for 10 years.
5. Current number of adult birds in the Rio Grande system (500) will remain stable for 10 years, essential breeding habitat will be protected, enhanced and restored, and terns will be distributed along the Rio Grande and Pecos Rivers.

Overall tern population trends from 1986 to 1995 were positive. However, this positive trend was primarily due to increases in numbers of terns on the lower Mississippi River (Kirsch and Sidle 1999). Annual increase for the entire tern population was approximately 9 percent. When data from the lower Mississippi River was excluded, the annual increase was 2.4 percent (Kirsch and Sidle 1999). Two areas, near the Missouri River in Iowa and Optima National Wildlife Refuge in Oklahoma, had significant negative trends from 1986 to 1995.

During a recent 2005 range-wide tern survey, 4,515 river mi, 12 reservoirs, 61 sand pits, and over 14,000 ac of salt flats were covered (Lott 2006). A total of 17,587 terns were counted in association with 491 different colonies. Terns were detected on 63 out of 74 survey segments.

A majority of adult terns were counted on rivers (89.9 percent), with much smaller numbers at sand pits (3.7 percent), reservoirs (2.7 percent), salt flats (2.1 percent), industrial sites (1.5 percent), and roof-tops (0.3 percent). Similarly, most colony sites were on rivers (82.5 percent) with fewer colonies occurring on reservoirs (6.8 percent), sand pits (6.0 percent), salt flats (2.5 percent), industrial sites (1.8 percent), and roof-tops (0.4 percent). Just over 62 percent of all adult terns were counted on the Lower Mississippi River (10,960 birds on over 770 river mi). Four additional river systems accounted for 33.9 percent of the remaining terns, with 12.1 percent on the Arkansas River system, 10.4 percent on the Red River system, 7.1 percent on the Missouri River system, and 4.3 percent on the Platte River system. Lesser numbers of terns were counted on the Ohio River system at natural, created, and industrial sites along the Ohio and Wabash Rivers (1.5 percent); on urban, industrial, and reservoir sites within the Trinity River system in Texas (1.5 percent); at reservoirs along the Rio Grande/Pecos river system in New Mexico and Texas (0.8 percent), or elsewhere (0.5 percent). Although nearly 63 percent of all individual adult terns were counted on the Mississippi River, the Mississippi River accounted for only 17.9 percent of all colony sites. A higher percentage of all colony sites were reported for the Arkansas (25.9 percent), Red (25.5 percent), and Missouri (19.1 percent) river systems. Less than 7 percent of all colonies were detected on the Platte River and just over 2 percent were on the Ohio and tributaries. Average colony sizes for terns were generally small, between 4 and 29 birds per colony). A strong exception to this rule was the Mississippi River, where average colony size was 119 birds and a single colony had 700 birds. The maximum colony size at any location other than the Mississippi was 130 birds at the mouth of the Canadian River at Eufaula Lake (Lott 2006).

Status and Trends in the Rio Grande/Pecos River System. In 2005, 138 terns were counted at three locations on the Pecos River (nesting on barren alkali "flats" at Bitter Lake National Wildlife Refuge, roosting but not breeding at Brantley Lake State Park in New Mexico, and at Imperial Reservoir in Texas) and at a single reservoir on the Rio Grande (Amistad National Recreation Area) (Lott 2006). Terns are not known to nest on sandbars on either the Rio Grande or the Pecos River. During the 2005 census, water levels at Falcon Reservoir, a historically important nesting area for terns, were high and all tern nesting habitat was presumed to be under water. Therefore, surveys of Falcon Reservoir were not conducted (Lott 2006). Historically, terns have nested at six reservoirs on the Rio Grande/Pecos River system and a single reservoir (O.C. Fischer) on the nearby North Concho River (Kasner et al. 2005). Habitat conditions at Lake Casa Blanca on the Rio Grande and O.C. Fischer Reservoir on the North Concho River may have declined to a point where terns would no longer nest, and no terns were recorded during the census at either of these locations (Lott 2006). The 2005 count of 85 terns at Amistad Reservoir is below average, compared to counts between 1999 and 2004. Large numbers of terns were counted at Falcon Reservoir in the late 1980s and early 1990s. However, habitat conditions have declined since then, and it is unclear how many terns still nest there (Lott 2006). The last time that all major reservoirs were surveyed for this system was in 1989, where 482 birds were present. It is unclear whether numbers have actually declined from this total to the 138 reported during the 2005 census, or if this low number reflects the lack of survey data from Falcon Reservoir (Lott 2006).

Factors Affecting the Species Range-wide

Habitat Loss and Degradation. Remnants of tern habitat remain distributed across much of the species' historic range, although at much reduced levels. Beach habitats are increasingly used for human recreation and residential development; river sandbars have been eliminated by channelization, water diversions, impoundments, and by changes in vegetation resulting from controlled water flow below dams. Alternatively, agricultural fields, parking lots, and flat, graveled roof tops are providing occasional opportunistic nesting sites. In Nebraska, where the central Platte River no longer provides suitable habitat because of upstream diversion, terns are nesting at commercial sand and gravel pits within 0.9 mi (1.5 km) of the Platte (Sidle and Kirsch 1993). In Iowa, terns have nested on fly ash effluent at power plants (Huser 1996).

Channelization, irrigation, construction of reservoirs and pools, and managed river flows have contributed to the elimination of much of the tern's sandbar nesting habitat by engineering wide, braided rivers into a single, narrow channel (Funk and Robinson 1974, Hallberg et al. 1979, Sandheinrich and Atchison 1986). Reservoir storage and irrigation depletions of flows responsible for scouring sandbars has resulted in encroachment of vegetation onto sandbars along many rivers, further reducing tern nesting habitat (Eschner et al. 1981, Currier et al. 1985, O'Brien and Currier 1987, Stinnett et al. 1987, Lyons and Randle 1988, Sidle et al. 1989). In addition, river main stem reservoirs now trap much of the sediment load resulting in less aggradation and more degradation of the river bed, reducing formation of suitable sandbar nesting habitat. With the loss of much tern nesting habitat, predation has become a significant factor affecting tern productivity in many locations (Massey and Atwood 1979, Jenks-Jay 1982).

Human Disturbance. Human disturbance affects tern productivity in many locations (Massey and Atwood 1979, Goodrich 1982, Burger 1984, Dryer and Dryer 1985, Schwalbach et al. 1986, Dirks and Higgins 1988, Schwalbach 1988, Mayer and Dryer 1990). Many rivers have become the focus of recreational activities, and the currently reduced quantity of sandbars has become a recreational counterpart to coastal beaches. Human presence reduces reproductive success (Mayer and Dryer 1988, Smith and Renken 1990). Domestic pet disturbance and trampling by grazing cattle are other factors that have contributed to population decline.

Pollution and Contaminants. Pollutants entering waterways within and upstream of tern breeding areas can negatively impact water quality and fish populations in nearby foraging areas. Strip mining, urban and industrial pollutants, and sediments from non-point sources can all degrade water quality and fish habitat, thereby impacting small fish on which terns depend (Wilbur 1974, Erwin 1983). In addition, because terns are relatively high on the food chain, they can accumulate contaminants that can render eggs infertile or otherwise affect reproduction and chick survival (U.S. Fish and Wildlife Service 1983, Dryer and Dryer 1985). Mercury residues have been found in terns from the Cheyenne River watershed in South Dakota. Organochlorines have been found in terns in South Carolina and California (U.S. Fish and Wildlife Service 1983). Elevated selenium and organochlorine concentrations were found in tern eggs collected on the Missouri River in South Dakota (Ruelle 1991). Allen and Blackford (1997) found 81 percent of 104 least tern eggs collected from the Missouri River exceeded the selenium concentration currently considered safe for avian reproductive success.

III. Environmental Baseline

The Acme gage occurs below upper critical habitat and is in the reach of river that provides excellent shiner habitat when the river is flowing. It is also in the reach of river that often goes intermittent. Annual mean runoff at the Acme gage is an indicator flow through this important reach of river. The annual mean stream flow for water years 2000, 2001, 2002, and 2003 at the Acme gage has been 173 cfs, 92.4 cfs, 71.9 cfs, and 51.0, respectively (viewed at http://waterdata.usgs.gov/nm/nwis/rt on February 7, 2006). The 2003 mean is the lowest for the period of record (1938-2003), with the 2002 mean being the 4th lowest on record. The lowest annual mean recorded prior to 2003 was in 1964 (56.5 cfs). The low annual mean runoff is reflected in the number of days of intermittency that occurred at Acme; 49 and 44 days in 2002 and 2003, respectively. Conditions were less severe in 2004, with only 8 dry days. Monthly mean stream flows at the Acme gage for the first nine months of 2004 showed some increase over 2003; with very high flows from spring rains and summer storms in August having the most effect on the increase in mean monthly flows.

In 2003, Reclamation attempted to sustain flows in the Rangelands reach during the irrigation season, and provide 35 cfs at the Acme gage during the winter season. Intermittency in the Rangelands reach occurred between Taiban and Acme on 44 days. During the winter season, flows at the Acme gage averaged 35 cfs, with 12 days in the record having a daily mean flow of less than 26 cfs (the lower target of flows described in the 2003 biological opinion) and 12 days when the mean was over 41 cfs (the upper target of flows) (USGS stream gage data for Acme gage, November 1, 2002 to February 28, 2003).

In 2004, intermittency occurred 8 days. Reclamation released water from the Fish Conservation Pool in Sumner Reservoir to limit the extent of the intermittency. Flows reconnected due to flood inflows prior to the released water reaching the affected area (Reclamation 2005b). During the winter season, flows at the Acme gage averaged 27 cfs, with 48 days recorded below 26 cfs and six above 41 cfs (USGS Streamgage Data for Acme gage, November 1, 2003-February 29, 2004). The majority of days below 26 cfs were in November and early December of 2003. The days above 41 cfs were all at the end of February.

In 2005, there were no days of intermittency. During the winter season (November 1, 2004-February 28, 2005) flows at the Acme gage averaged 38 cfs. During the irrigation season (March 1-October 31, 2005) flows averaged 137 cfs, and during the 2006 winter season (November 1, 2005-February 21, 2006) flows averaged 175 cfs. This increase in average flow was due to the sale of water by CID to ISC and delivery of 34,000 af to Texas.

As of April 1, 2006, the snowpack in the Pecos River Basin is at 11 percent of average, with year to date precipitation at 37 percent. The National Resources Conservation Service indicates that the basin is on track to be drier than the very dry years of 2000 and 2002 (http://www.wcc.nrcs.usda.gov/water/snow/bor2.pl?state=nm&year=2006&month=2&format=text, viewed April 11, 2006). The current snowpack in the Upper Pecos River Basin is the worst in more than 50 years and inflow to Santa Rosa reservoir is expected to be 9 percent of normal (http://www.srh.noaa.gov/data/ABQ/ESABQ, viewed April 11, 2006).

Water storage in the Pecos River Basin reservoirs as of April 10, 2006, totaled 115,342 af (data from http://www.spa.usace.army.mil/wc/adbb/pecrt.htm.) with storage in Santa Rosa Reservoir at 65,542 af, Sumner at 18,500 af, Brantley at 30,000 af, and Avalon at 1,300 af.

Based on collections, the known range of the shiner included the mainstem Pecos River from Santa Rosa, New Mexico, to the New Mexico-Texas border (Chernoff et al. 1982), but it is likely the species occurred upstream to the Pecos River-Gallinas River confluence and downstream to, at least, Live-Oak Creek confluence (near Sheffield, Texas) because the Pecos River had similar characteristics throughout (Pope 1854, Newell 1891, Freeman and Mathers 1911, Dearen 1996). These characteristics included perennial flow, a wide-erosive river channel, and shifting sand-beds (Newell 1891, Fisher 1906, Freeman and Mathers 1911, Thomas 1959, Hufstetler and Johnson 1993, Dearen 1996). The reason the full extent of the historical shiner range is not well defined is that historical fish collections were few and collectors sampled the river at easily accessible localities such as bridge crossings and villages (Sublette et al. 1990).

Development of irrigated agriculture began in the early 1850s with acequia diversions from headwater reaches of the mainstem Pecos River and tributaries (U.S. National Resources Planning Board 1942). Large-scale diversion and impoundment of the mainstem Pecos River began in the 1880's (U.S. National Resources Planning Board 1942), while groundwater pumping became widespread after 1900 (Lingle and Linford 1961). By 1940, when systematic fish collections were initiated, Pecos River hydrology and geomorphology were already dramatically changed (Grover et al. 1922, U.S. National Resources Planning Board 1942, President's Water Resources Policy Commission 1950, Campbell 1958, Thomas 1959, Grozier et al. 1966, Ashworth 1990, Hufstetler and Johnson 1993). The response of Pecos River fishes to early human developments is unknown, but it is significant that the majority of native species were decimated in areas directly impacted by irrigation projects, such as the Pecos River between Carlsbad, New Mexico and Girvin, Texas (Campbell 1958). The same pattern has been documented in other sand bed streams (Arkansas and Cimarron rivers) (Cross et al. 1985). Native fishes have survived best in reaches with fewer direct impacts, such as the Pecos River between Taiban Creek and Salt Creek confluences (Hoagstrom 2000).

Currently, six dams (Santa Rosa, Sumner, FSID Diversion Dam, Brantley, Avalon, and Black River) largely control the flow of the Pecos River in New Mexico (Figure 1). The uppermost dam, Santa Rosa (completed in 1980), is operated by the Corps for flood control and irrigation. Sumner and Brantley dams are operated by Reclamation primarily for irrigation purposes and secondarily for flood control. Sumner Dam was built in 1937 and is 55 mi (88 km) downstream from the Santa Rosa Dam. The FSID Diversion Dam is located 14 mi (23 km) downstream of Sumner Dam and was completed in 1951. Brantley Dam was completed in 1989 and is 225 mi (360 km) downstream of Sumner Dam. Brantley Dam replaced McMillan Dam, which was completed in 1893.

The construction of the dams and human activities has had many adverse effects on the Pecos River ecosystem over the last 100 years. Santa Rosa and Sumner Dams trap sediment needed for shiner habitat development and alter the downstream flow regime (Collier et al. 1996). When these effects are combined with the depletion of groundwater, diversion of Pecos River flows, capture of sediment by tributary dams, water pollution, and salt cedar colonization, the result is large scale changes to the Pecos River hydrograph and shiner habitat. The Pecos River downstream of Roswell has become highly incised, and is poor habitat for the shiner (Tashjian 1995, Hoagstrom 2002). The reach from Sumner Dam to the FSID Diversion Dam has become incised and armored with gravel and cobble (Hoagstrom 2003). This substrate does not provide the sand/silt habitat that the shiner prefers (Tashjian 1993, 1994, 1995, 1997; Hoagstrom 2000, 2001, 2002).

Up to 100 cfs (2.8 m^3/s) is diverted by FSID at the diversion dam for delivery to agricultural fields from March 1 through October 31. Water can also be diverted for two, eight-day periods during the winter; however, recently, this diversion has been made in the two weeks prior to the irrigation season (i.e., February 15 to March 1). Fort Sumner Irrigation District has no storage rights in the upstream reservoirs, but is entitled to water rights that predate Sumner Dam construction (1937). The water entitlement is based on a calculation made by the OSE from flow data collected every two weeks throughout the irrigation season. Reclamation releases water from Sumner Dam for FSID and the water travels 14 mi (23 km) downstream to the FSID Diversion Dam. The water is diverted into a main canal which is 15 mi (24 km) long and then into smaller lateral canals. The system also includes a drain canal which collects seepage and runoff from the fields and carries these return flows back to the Pecos River near the confluence of Taiban Creek. The return flows to the Pecos River may be up to half of the amount diverted, but were less than 20 cfs (0.6 m^3/s) in 2002. A pumpback system, located at the lower end of the irrigation canal, pumps from 10 to 15 cfs (0.28 to 0.42 m^3/s) from the main return canal back into lateral canals. A new pump which can pump 2-3 cfs more than the old pump has further reduced the amount of water returning to the river (G. Dean, Reclamation, pers.comm. 2002). Operation of this pump continued through the 2003-2006 period.

The Pecos Bluntnose Shiner Recovery Plan stated that the operation of Sumner Dam had significantly altered flow regimes in the upper Pecos River (Service 1992). During the period 1913 to 1935, prior to dam operation, flows were never less than 1 cfs (0.03 m^3/s) at the Sumner Dam Gage. For the period after dam operation began, 1937 to 1990, flows less than 1 cfs (0.03 m^3/s) occurred an average of 55 days per year. After Sumner Dam was completed, it prevented all movement between the shiner population above and below the dam. Shiners were last collected above Sumner Dam in 1963 (Platania and Altenbach 1998).

The effect of upstream water storage and diversion on the downstream reaches of the Pecos River was to virtually eliminate floods (Table 1), eliminate winter inflows (Table 2), and reduce summer inflows (Table 3). These Tables and the implications for the shiner and its habitat are described in detail below.

The maximum release capacity of Sumner Dam is 1,400 cfs (40 m^3/s). Prior to the completion of Sumner Dam, flows greater than 1,400 cfs (40 m^3/s) occurred an average of 7 days per year and the lowest annual peak mean daily discharge was 2,020 cfs (57 m^3/s) (Table 1). By comparison, only two of 18 post-Sumner Dam years had mean daily discharge greater than 1,400 cfs (40 m^3/s) for an average of 1 day per year. The maximum mean daily discharge in the pre-Sumner

Dam years was 26,200 cfs (740 m^3/s) while the maximum of the 18 post-Sumner Dam years was 1,980 cfs (56 m^3/s). This maximum was less than the lowest annual peak of the pre-dam period. Reduced peak discharge has caused the channel to become narrower, less braided, and to have less complex fish habitat (Tashjian 1993, 1994, 1995, 1997; Hoagstrom 2000, 2001, 2002).

Table 1. Summary of change in frequency and magnitude of flows > 1400 ft^3/s (maximum Sumner Dam release) at the Pecos River Below Sumner Dam Gage. The Fort Sumner gage represents inflow into the Pecos bluntnose shiner range. The pre-Dam summary was completed using mean daily discharge data for the 18 calendar years with complete records. The post-Dam summary was completed using the calendar years 1962 through 1979 (18 years). This period was chosen because it represented flow conditions after the 1950s drought, pre-Santa Rosa Dam, and pre-1980s and 1990s wet years. In other words, this 18-year period was the most 'normal' for the post-Sumner Dam period.

Period	Days	Days > 1400 ft^3/s	Mean Days per Year > 1400 ft^3/s	Years With Flows > 1400 ft^3/s	Maximum Discharge (ft^3/s)
Pre-Dam	6574	128	7.1	18	26200
Post-Dam	6574	18	1.0	2	1980

Before the construction of Sumner Dam, mean daily discharge in the non-irrigation season (winter), was 97 cfs (3 m^3/s) with a minimum flow of 41 cfs (1.2 m^3/s) (Table 2). After the dam was built (1962 to 1979), mean daily discharge in the winter was 6 cfs (0.2 m^3/s), a reduction of 94 percent. The storage of winter season base flows in Sumner Reservoir reduced the amount of water and habitat available to the shiner. Since 1998/1999, the winter season operation of Sumner Dam has been modified to divert water to storage only when not required to meet downstream flow targets at the Acme gage. Reclamation bypasses flows in the winter to target approximately 35 cfs at the Acme gage. Typically, 5 to 10 cfs is bypassed in November to supplement natural flows in the river. By February or March about 25 to 30 cfs is bypassed, depending on the natural flows. Flows coming into Sumner greater than the amounts bypassed to supplement natural flows are stored (Reclamation 2002). This operation has continued in 2006.

Table 2. Summary of winter flows (i.e., flows reported for the typical FSID non-irrigation season, 1 November to 14 February) at the Pecos River Below Sumner Dam Gage. The Fort Sumner gage represents inflow into the Pecos bluntnose shiner range. The pre-Dam summary was completed using mean daily discharge data from the 18 calendar years having complete flow records. The post-Dam summary was completed using the calendar years 1962 through 1979 (18 years). This period was chosen because it represented flow conditions after the1950s drought, pre-Santa Rosa Dam, and pre-1980s and 1990s wet years. In other words, this 18-year period was the most 'normal' for the post-Sumner Dam period.

Period	Days	Mean ft^3/s	Minimum ft^3/s	Maximum ft^3/s
Pre-Dam	1908	97.3	41	265
Post-Dam	1908	6.0	0	99

During the irrigation season (March 1 to October 31), prior to Sumner Dam, the mean daily discharge flows exceeded 100 cfs (2.8 m^3/s) 147 days per year compared to 69 days per year after the completion of Sumner Dam (Table 3). Discharge adequate to overflow (greater than 100 cfs [2.8 m^3/s]) the FSID Diversion Dam during the irrigation season was recorded more than twice as often in the years prior to Sumner Dam, than in the post-Dam period. Overflow of the FSID Diversion Dam was less frequent and of greater magnitude after Sumner Dam was built because of block releases of water from Sumner Dam. Before November 1998, all water available above FSID's 100 cfs (2.8 m^3/s) requirement was stored in Sumner. Since 1999, the Sumner Dam operations have been modified to bypass water that is available above FSID's 100 cfs (2.8 m^3/s) requirement in an attempt to keep the water flowing in the reach from Sumner Dam down to the Acme gage. In 2002, water was bypassed on fewer than 5 days during the irrigation season. In 2003, releases out of Sumner Dam were over 100 cfs for 13 days in June, which was followed by a high spike release from June 18-30. Flows during the rest of the irrigation season were below 100 cfs. In 2004, there was an eight day spike in March, flows of 98-109 cfs through late April to mid-June, and a second spike flow in late September. Otherwise, releases were below 100 cfs (USGS Streamflow Data for Below Sumner Dam Gage). Data for 2005 are not available, but information from Reclamation indicates that bypass flows were available during 2005 (Reclamation 2005b).

Table 3. Summary of flows at the Pecos River Below Sumner Dam Gage during the FSID irrigation season (March through October). The pre-Dam summary was completed using mean daily discharge data for the 18 calendar years with complete records. The post-Dam summary was completed using the calendar years 1962 through 1979 (18 years). This period was chosen because it represented flow conditions post 1950's drought, pre-Santa Rosa Dam, and pre-1980's and 1990's wet years. In other words, this 18-year period was the most 'normal' for the post-Sumner Dam period. Since FSID can divert a maximum 100 ft^3/s, it was assumed that flows >100 ft^3/s overflowed downstream. Mean overflow for each period was calculated solely for the days in which overflow presumably occurred (discharge >100 ft^3/s).

Period	Days	Days > 100 ft^3/s	Mean Days per Year > 100 ft^3/s	Mean Overflow (ft^3/s)
Pre-Dam	4666	2649	147.2	355.7
Post-Dam	4666	1238	68.8	594.2

Dams have many downstream effects on the physical and biological components of a stream ecosystem (Williams and Wolman 1984). Some of these effects include a change in water temperature, a reduction in lateral channel migration, channel scouring, blockage of fish passage, channel narrowing, changes in the riparian community, diminished peak flows, changes in the timing of high and low flows, and a loss of connectivity between the river and its flood plain (e.g., Sherrard and Erskine 1991, Power et al. 1996, Kondolf 1997, Friedman et al. 1998, Polzin and Rood 2000, Collier et al. 1996, Shields et al. 2000). To our knowledge temperature studies on the Pecos River have not been conducted and it is not known how the temperature regime below Sumner dam may be different from the historical temperature regimes. However, the other downstream effects have been noted. In particular, Sumner Dam has reduced sediment inflows from the upper basin, caused channel scour from the dam to the Taiban Creek confluence, and eliminated large floods. Large floods are an important component of riverine ecosystems because they maintain channel width and complexity, limit colonization of non-native vegetation, maintain native riparian vegetation, recharge the alluvial aquifer, increase nutrient cycling, and maintain the connection between the aquatic and riparian ecosystems (Ward and Stanford 1995, Schiemer 1995, Power 1996, Shafroth 1999). Sumner Dam blocks fish passage fragmenting the Pecos River and preventing shiners from migrating upstream. Shiners have been extirpated above Sumner Dam (none collected since 1963).

Reclamation diverts water to storage at Sumner Reservoir for the Carlsbad Project and then releases the stored water for the CID. The release of water occurs in "blocks" where large amounts of water (usually a minimum of 1,000 cfs [28 m^3/s]) are released over a short period of time. Blocks of water are used because less water is lost to evaporation and groundwater seepage during transport. Sumner Dam block releases occurred between one and four times per year from 1990 to 2001 (not including the years in which block releases were modified for hydrologic studies). The average annual number of block releases per year was 2.6. The block release durations ranged from 7 to 30 days, with an average of 15.7 days. Since 1999, the Sumner Dam irrigation season operations have been modified to: 1) limit the block release duration to a maximum of 15 days; and 2) limit block release timing and frequency. There was one block release in 2003, two in 2004, three in 2005, and one so far in 2006.

Although block releases are maintaining channel width, peak flows are now much lower than they were before Sumner Dam was built (Table 1). Biological consequences of diminished peak flows can include changes in the riparian vegetation (Polzin and Rood 2000), aquatic macroinvertebrate species composition (Sheldon et al. 2002), nutrient exchange processes (Schiemer 1995), and shorter food webs (Power et al. 1996). These changes could have an indirect effect on the fish community including the shiner. However, these complex ecosystem interactions have not been investigated on the Pecos River. Given the relatively short duration of this BO, there are no anticipated impacts to channel width.

The range of the shiner was reduced by inundation of Major Johnson Springs in 1988 and declines have occurred upstream of the Taiban Creek confluence (Hoagstrom 2000, 2003) in the Tailwaters reach. Restrictions on the duration of block releases and institution of base-flow bypass have benefited the shiner population at times, but have not reduced the primary threat to the species (intermittency). Bypass flows are most commonly available during the non-irrigation season (November through February), but intermittent flows are most frequent during irrigation season (USGS historical surface flow data).

Block releases that have occurred during the spawning season from May through September have rapidly transported semi-buoyant shiner eggs and larvae into Brantley Reservoir. The eggs require water velocity to remain suspended in the water column. In the reservoir, the eggs sink to the bottom and likely perish when they are covered with sediments and suffocate or are eaten by predators. Larval fish are likely eaten by predatory fish. Eggs and larvae drift downstream for a total of 3 to 5 days; the distance they travel depends on the rate of egg and larvae development and water velocity (Platania and Altenbach 1998). Assuming a drift rate of 1.8 mi/h (3 km/h), the eggs and larvae could be transported 176 to 220 mi (284 to 354 km) in 4 to 5 days. Swifter currents and a more uniform channel would carry the eggs and larvae a greater distance. Block releases exceeding 65 days per year result in the transport of many age-0 shiners into the Farmlands reach (Hoagstrom 2002). The effect on size class distribution is not as pronounced when the total is less than 65 days per year.

The provision of low flows from bypasses and other supplemental water does not intrinsically provide for the cues (rising water levels) needed to initiate spawning in the shiner. Without these cues provided naturally (by seasonal monsoon inflows) or through management (some level of spike flow), spawning may occur at reduced levels. Similarly, very high long duration flows associated with block releases made during the spawning period are likely to, while triggering spawning responses, also remove a significant percentage of eggs and larvae out of the favorable habitat reach of the Rangelands, and into the less suitable Farmlands reach or to Brantley Reservoir. Block releases that occur during the spawning season from May through September have a direct effect on the shiner by rapidly transporting their semi-buoyant eggs and larvae into Brantley Reservoir (Dudley and Platania 1999). The eggs and larvae die in the reservoir from predation and lack of appropriate habitat. Although eggs and larvae are lost into Brantley Reservoir during natural flood events, the number is less because the peak of a flood hydrograph lasts for a very short time (several hours). In contrast, the peak flow in a block release is maintained for several days (10 to15). The narrow channel and lack of slack and backwater habitat in the lower reach of critical habitat results in fewer eggs and larvae being retained in that reach, poor survival and growth of the juveniles, and greater transport of eggs and larvae into the reservoir (Hoagstrom 1997, 1999, 2000, Dudley and Platania 1999). Block releases do help maintain channel morphology (Tetra Tech 2003).

From monitoring conducted on one day of a block release in August 1997, it was estimated that approximately 22 million eggs would be transported into Brantley Reservoir (Reclamation 2002). That equals approximately 1.2 million eggs per day of a block release (Reclamation 2002). Clearly the number of eggs and larvae transported to Brantley will be highly variable depending upon the number of females producing eggs, the number of eggs produced per female, the magnitude of the discharge, and the timing within the spawning season. Eggs and larvae would enter Brantley Reservoir by natural flood flows without block releases, but the number would be much smaller (Dudley and Platania 1999). There is little retention of eggs and larvae downstream of Roswell due to unsuitable habitat (relatively narrow and deep channel).

Groundwater pumping has reduced Pecos River base-flow. Local pumping reduced seepage inflows from Truchas Creek, near Fort Sumner (Akin et al. 1946) and along the Pecos River between Fivemile Draw and the U.S. Geological Survey surface water gaging station near Acme (Shomaker 1971). Inflows from the Roswell Artesian Basin (from the Pecos River near Acme to McMillan Dam) were severely reduced during the 1920s to 1950s (Fiedler and Nye 1933, Thomas 1959). Groundwater development of the Roswell basin aquifers reduced the amount of natural discharge into the Pecos River by 80 to 90 percent (Reynolds 1989 as cited in Reclamation 2002). The State of New Mexico has retired many of these water rights, and the result has been an increase in the water level in the Roswell artesian aquifer (Garn 1988, Balleau et al. 1999). Increases in groundwater pumping that could affect flows in the Rangelands reach could be adverse to the shiner, particularly during dry years where summer intermittency is an issue.

In 2000, Reclamation leased 3,492 af of water rights from river pumpers. Additionally, as a result of mediation in Federal District Court, Reclamation entered into an emergency forbearance program with FSID paying for crops foregone as a result of reduced water use by participating FSID members. The Service provided additional funding ($100,000) in October 2000 to increase the number of irrigators participating in the forbearance program. In 2002, Reclamation leased approximately 4,500 af of water from a variety of land owners to make up for water bypassed for the shiner.

In 2002, Reclamation bypassed approximately 5,500 af from Sumner Dam with only 228 af bypassed in the irrigation season. Reclamation leased approximately 4,300 af of water from a variety of land owners to make up for water bypassed for the shiner.

In March 2002, CID moved 27,000 af of irrigation water from Santa Rosa and Sumner Reservoirs, drawing Sumner down to its minimum pool of 2,500 af and leaving only 1,000 af in Santa Rosa. The combination of the early season block release and the drought conditions led to extensive river drying throughout the summer of 2002. With no storage left in the reservoirs, alternative water operation actions to limit intermittency were precluded. The subsequent river drying killed shiners and dewatered approximately 38 mi (61 km), including 10 to 15 mi (16 to 24 km) of upper critical habitat (D. Propst, NMDGF, pers. comm. 2002, C. Hoagstrom, Service, pers. comm. 2002, USGS 2002 stream flow records as reported at: http://waterdata.usgs.gov/nm/nwis/rt). Sumner Reservoir was drained May 30 to June 1, 2002. As the reservoir was drained, silty, muddy water was released downstream affecting water quality in the Pecos River below the dam (G. Dean, Reclamation, pers. comm. 2003).

Prior to 2002, there was always a sufficient amount of water in Sumner Reservoir to bypass to meet FSID's calculated water right for water. From May 30 to June 1, 2002, Sumner Reservoir dried, stopping the bypass of water to FSID for 3 days. When there is no release from Sumner Reservoir for approximately 8 days, the probability of drying in the reach from Sumner Dam to the Taiban Creek confluence becomes very high (G. Dean, Reclamation, pers. comm. 2002). Repeated releases of small blocks of water from Santa Rosa Reservoir kept Sumner Reservoir from drying again after June 1.

In 2002, intermittency occurred in the Pecos River from near 6-mile Draw to Bitter Lake National Wildlife Refuge (38 mi [61 km]) and led to the death of shiners (D. Propst, NMDGF, pers. comm. 2002). The lower end of the upper critical habitat designated for the shiner became intermittent from near the DeBaca County line, downstream. The 30 mi (48 km) reach of the Pecos River from Taiban Creek to Dunlap normally remains perennial even in extremely low flow conditions. During low flows, the source of water for this reach is primarily from groundwater seepage, return flows from the FSID diversion canal, and Taiban Creek. A second, 2 mi (3 km) reach of river is kept wet because of the pumping of water from the Lynch Ranch Well. When the flow at the Acme gage falls to 10 cfs (0.28 m^3/s) pumping from the Lynch Ranch Well begins (G. Dean, Reclamation, pers. comm. 2002). After intermittency, it is believed that shiners from these two refugia repopulate the river downstream.

From May through August 2002, FSID diverted virtually the entire flow of the Pecos River (http://waterdata.usgs.gov/nm/nwis/rt viewed February 26, 2003). This caused river drying from the FSID Diversion Dam to the Taiban Creek confluence (10 mi [16 km]) and increased the probability of intermittency downstream of the Taiban Creek confluence. Fort Sumner Irrigation District's pumpback operation further reduces the amount of water returning to the river and increases the amount and duration of intermittency downstream (G. Dean, Reclamation, pers. comm. 2002).

The combined effects of Sumner Dam block releases of water for CID, and water diversion and pumpback operations by FSID, have reduced the amount of water in the channel, increased the likelihood of the river drying, reduced the amount and suitability of habitat for the shiner, and decreased the survival of shiner eggs, larvae, and adults. Drought conditions in 2002 increased the difficulties of maintaining water in the river for the shiner. Diversions by FSID contributed significantly to river drying in 2002 and the early season block release by CID may have significantly reduced the opportunity to alleviate later season drying.

In 2003, Reclamation bypassed approximately 5,700 af from Sumner Dam; approximately 350 af were bypassed during the irrigation season. In addition Reclamation signed an agreement with FSID to return approximately 18 percent of their diversion right to the Pecos River. Reclamation leased approximately 3,200 af of water from a variety of land owners to make up for water bypassed for the shiner.

On August 1, 2003, Reclamation and CID received emergency authorization from the New Mexico State Engineer to create a Fish Conservation Pool to store water in Sumner or Santa Rosa Reservoir for the purpose of providing riverine habitat. The Fish Conservation Pool contained 500 af in 2003. The Fish Conservation Pool does not affect the storage entitlement in Sumner Reservoir. Water from the Fish Conservation Pool was released from August 2, 2003 to September 7, 2003. The flow rate varied from 5 to 10 cfs. The water from the Fish Conservation Pool was diverted into the FSID's main canal and returned to the river at the nearest wasteway (Sandgates). This operation simplifies the process of getting the small flows past the diversion dam. A final permit for the Fish Conservation Pool in Sumner Reservoir and Santa Rosa Reservoir was received in March 2004. The permit authorizes Reclamation to store and release 500 af from Sumner Reservoir to maintain riverine habitat in the upper critical habitat of the Pecos River. Reclamation must replace the water released out of Sumner Reservoir with 375 af of water in Brantley Reservoir.

Winter season bypasses were initiated on November 6, 2002, and discontinued on February 16, 2003. Irrigation season bypasses occurred once, from June 4 through June 15 (10 to 20 cfs). The only CID block release of the 2003 irrigation season was initiated on June 18 and terminated on June 30, a total of 21,898 af were released from Sumner Dam (Figure 4). There were 8 days at peak discharge of 1,400 cfs.

In 2004, Reclamation bypassed approximately 5,400 af during the non-irrigation season from November 1, 2003, through February 28, 2004. A total of approximately 200 af was bypassed during the 2004 irrigation season.

In 2004 the retired acreage ranged from 1,164 to 716 ac (changes on August 15), a total of 6,800 af was bypassed by the FSID into the Pecos River under this lease agreement.

Two Carlsbad Project block releases occurred during the 2004 irrigation season. The first block release was initiated on March 3 and terminated on March 10, a total of 18,345 af were released from Sumner Dam. The second block release was initiated on September 17 and terminated on September 30, a total of 33,472 af were released from Sumner Dam. Sumner Reservoir reached a maximum total storage of 23,573 af on December 31, 2004. Sumner Reservoir's lowest total storage was on July 22, at 2,050 af. Sumner Reservoir end-of-year total storage was 23,573 af.

There were three Carlsbad Project block releases in 2005. In addition, the New Mexico Interstate Stream Commission (ISC) purchased approximately 34,000 af of unused irrigation water from CID which was released to Texas (The Associated Press, November 23, 2005). Despite continuous flows in 2005, preliminary data from the first and second trimester indicate that shiner abundance did not increase and may have decreased. This may be due to higher flows in spring and not during the monsoon when shiner spawning is triggered and because of low shiner abundance.

An early Carlsbad Project block release occurred from February 20 to March 1, 2006, releasing a total of approximately 16,455 af. Santa Rosa and Sumner Reservoir's total storage as of April 10, 2006, was 84,042 af.

Status of the Species within the Action Area

Interior Least Tern

The breeding population of terns in New Mexico declined from about 60 birds in the early 1960s to 3 poorly producing nesting pairs annually from 1987 to 1990. In New Mexico, terns were first recorded as nesting at Bitter Lake National Wildlife Refuge in 1949, and terns have continuously nested on or adjacent to refuge lands annually since then. Population counts over the period have been variable, ranging as high as 60 birds in 1961, but typically 20 to 30 individuals during a breeding season. For several years during the 1980s, the breeding colony was on a vegetation-free area of the Roswell Test Facility adjacent to the refuge. The colony then shifted back to barren alkali "flats" on the refuge following the growth of vegetation at the off-refuge site. A 1997 survey of potential nesting habitat on Bureau of Land Management lands by the New Mexico Natural Heritage Program located two nests at the Grace Well flats just north of the refuge.

The following list summarizes the breeding activity of the tern colony at Bitter Lake National Wildlife Refuge from 1996 through 2005 (J. Montgomery, Fish and Wildlife Service permittee, annual survey report, December 30, 2005):

	Number of pairs	Number of chicks observed	Number of chicks fledged	Number fledged per pair
1996	7	4	5	0.71
1997	7	11	3	0.43
1998	7	10	9	1.29
1999	7	1	1	0.14
2000	10	19	15	1.50
2001	11	14	9	0.82
2002	11	18	17	1.89
2003	12	15	13	1.08
2004	11	13	7	0.64
2005	14	24	23	1.64

On June 9, 2004, 5 pairs of interior least terns were first observed in a backwater area of Brantley Reservoir on the Pecos River in Eddy County. The nearest documented nesting elsewhere in

New Mexico was at Bitter Lake National Wildlife Refuge, 60 mi north of Brantley Reservoir. It is unknown whether interior least terns had used areas around Brantley Reservoir for nesting in previous years. In 2004, a total of at least 14 adults were observed, with an estimated 7 nests on the lakeshore. Six juvenile terns were observed near the nesting area in late August (Bureau of Reclamation 2005; J. Montgomery, Fish and Wildlife Service permittee, electronic mail message, August 23, 2004). The nesting area used by terns in 2004 spanned approximately 28 ac.

In 2005, terns did not nest at Brantley Reservoir due to the 2004 nesting areas being inundated, vegetated, or impacted by human disturbance (J. Montgomery, Fish and Wildlife Service permittee, annual survey report, December 30, 2005). Approximately six to eight adults and up to five immature (one-year-old) terns occupied Brantley Reservoir until August. The 2005 nesting season was the most successful year at Bitter Lake National Wildlife Refuge since the mid-1980s, when observers began monitoring nesting on a regular basis, and probably back to 1937, when the refuge was established. Fourteen pairs fledged 23 juveniles (J. Montgomery, Fish and Wildlife Service permittee, electronic mail message, September 7, 2005).

Factors affecting the Species Environment within the Action Area

Interior Least Tern

Brantley Reservoir is the southern-most, large water storage facility on the Pecos River, located in Eddy County in the southeastern portion of New Mexico. The Reservoir encompasses approximately 44,000 ac of land. The area around Brantley Reservoir is surrounded by Bureau of Land Management, State of New Mexico, and privately-owned lands. The New Mexico State Parks and Recreation Division has managed human-use of selected lands around Brantley Reservoir since 1977. Since 1994, the New Mexico Department of Game and Fish has had a 25-year lease agreement to authorize and enforce State fishing and hunting regulations at Brantley Reservoir.

In 2004, the top of conservation storage space for the Carlsbad Project in Brantley Reservoir was 3,256.05 ft for a total of 42,308 af. Tern nests were observed at elevation 3,245.71 ft in June 2004. At that time, the water was approximately one vertical foot below the tern nests at elevation 3,244.76 ft. No Reclamation block releases were expected at that time, but flood inflows due to weather-related causes were possible. No adults or chicks were affected by reservoir operations during the 2004 season while nests were occupied. Nests were located at varying distances from the water's edge and approximately 1 to 3 ft above the water surface elevation.

Terns were again present at Brantley Reservoir in May 2005 in the Champion Cove area. This area of the Brantley Reservoir shoreline is on the south side of the North Seven Rivers inlet. At this time, the reservoir level was at an elevation of 3,248 ft, which is above the level of the 2004 breeding site at elevation 3,245.71 ft in June 2004. In response to a block release in May 2005, the reservoir's surface level rose above 3,253 ft in elevation, inundating most of the previously-exposed potential nesting substrate on the reservoir's shoreline. Water in Brantley Reservoir was near the top of conservation storage, which in 2005 was elevation 3,256.13 ft for a total conservation storage of 42,556 af. By June 9, 2005, a large increase in water level had submerged all potential nesting habitat for the terns, with one small exception that measured approximately 100 by 75 meters to the west of the 2004 colony area, and it was becoming overgrown with sprouting kochia and cockleburr (J. Montgomery, Fish and Wildlife Service permittee, annual survey report, December 30, 2005). Regular monitoring found no evidence of tern nesting during the summer months. Because block releases depend on an assortment of variables which include, but are not limited to, the annual snowpack in the upper Pecos Basin, the current volume of water stored at each of the Pecos River reservoirs, the demand by downstream irrigators, and the amount of local rainfall, Reclamation can not predict the frequency and timing of block releases that may affect terns at Brantley Reservoir within a given year.

Terns roosting at Brantley Reservoir in 2005 were subject to disturbance, displacement, and inundation of their nesting habitat. Irrigation block releases from Sumner Dam, flood inflows from natural events, predation, and human disturbance adversely affect terns. If terns nest at elevations near or above the top of conservation storage, then the highest risk of inundation of tern nests has been from unpredictable flood inflows from upstream weather events, depending on nest locations to the existing water's edge. Such weather events may include local and regional storms that occur below Sumner Dam, causing imminent and immediate flooding or stalled weather patterns that provide large inflows of water over extended periods of time. Even if Carlsbad Irrigation District demand does not immediately require a release from Sumner, natural inflows could also inundate nests established at low elevation.

Another type of flood inflow, spring runoff, occurs upstream of Santa Rosa Dam in early spring. The Corps of Engineers may initiate emergency flood operations depending on the fullness of upstream reservoirs, such as Santa Rosa and Sumner. Emergency bypasses of high spring flows may be necessary to pass water down to lower reservoirs. This event occurred in 1999 and 2005. These events have the potential to inundate tern nesting areas, but it is unlikely that nests would be active during these events in early spring.

Human recreational disturbance at this location was a likely contributing factor to the lack of tern breeding activity in 2005. In late June, a campsite was erected adjacent to the site where terns were roosting and exhibiting courtship behavior. This site is located within Seven Rivers Waterfowl Area, a designated Wildlife Management Area, where overnight camping is not permitted. Vehicle tracks were also observed in this area at different times in July.

During the winter of 2003 to 2004, Reclamation, through its Operations and Maintenance (O&M) contract with CID, supported the removal of large expanses of salt cedar trees from the shoreline of Brantley Reservoir in the vicinity of the 2004 tern nesting location (L. Robertson, Reclamation, pers. comm., February 13, 2006). The salt cedar removal beneficially contributed to the creation of suitable unvegetated habitat for the tern colony in 2004. Unfortunately, clearing also resulted in the area producing dense, tall kochia and cockleburr in 2005 that caused the previously used area to become unsuitable for tern nesting and brooding (J. Montgomery, Fish and Wildlife Service permittee, annual survey report, December 30, 2005).

Episodic golden algae blooms that have killed fish have been reported at Brantley Reservoir since at least 2002 (J. Lusk, New Mexico Ecological Services Field Office, electronic mail message, April 11, 2006). However, it is currently unknown if these fish kills are adversely affecting terns foraging at the reservoir. It has also been reported that DDT (dichloro-diphenyl-trichloroethane) levels are elevated at Brantley Reservoir when compared to other lakes across the U.S. (J. Lusk, New Mexico Ecological Services Field Office, electronic mail message, April 11, 2006), but it is currently unknown whether these DDT residues are adversely affecting terns feeding at Brantley Reservoir.

IV. Effects of the Action

The Service must consider the direct and indirect effects, as well as the effects of interdependent and interrelated actions to the shiner and the tern. Indirect effects are those that are caused by, or result from, the proposed action, and are later in time, but are reasonably certain to occur.

Direct Effects

Pecos Bluntnose Shiner

This year, Reclamation and the Service will continue to work together with river users to monitor the water supply and work to devise management options to meet the needs of both the shiner and the river users. We anticipate this coordination will be especially important to ensure that river management provides continuous flows. A negative effect of the proposed action is the loss of semi-buoyant eggs and larvae into the Farmlands reach and Brantley Reservoir during block releases. While some loss of eggs and larvae can occur during block releases in May and June, July would be the primary month when significant loss of these life stages would occur because shiners normally spawn during elevated flows associated with monsoonal storm events. The eggs require water velocity to remain suspended in the water column. In the reservoir, the eggs sink to the bottom and will likely perish when they are covered with sediments and suffocate or are eaten by predators. Larval fish will likely be eaten by predatory fish. Eggs and larvae can drift downstream for a total of 3 to 5 days; the distance they travel depends on the rate of egg and larvae development and water velocity (Platania and Altenbach 1998). Assuming a drift rate of 1.8 mi/h (3 km/h), the eggs and larvae could be transported 176 to 220 mi (284 to 354 km) in 4 to 5 days. Swifter currents and a more uniform channel would carry the eggs and larvae a greater distance. Block releases exceeding 65 days per year have a cumulative negative effect on shiner size class distribution because many age-0 shiners are transported into the Farmlands reach (Hoagstrom 2002). The effect is not as pronounced when the total is less than 65 days per year; we do not anticipate block releases exceeding 65 days (Hoagstrom 2002).

There are numerous benefits to the shiner that will result from Reclamation's proposed action to keep the river whole. Because shiners normally spawn during monsoonal storm events in July and August, their ability to maintain or improve their condition during the pre-spawn period of March through June will increase their spawning success. Even when fish survive intermittent conditions, they are less likely to spawn successfully because of the increased energetic expenditure associated with survival. Poor water quality, predators, and competitors all become problematic when flows are not continuous. We expect shiner abundance to stabilize and/or improve slightly with continuous flows.

Reclamation is proposing to assist the Service in the capture and holding of shiner in refugia. The refugia would provide a secondary shiner population should any unforeseen circumstances (e.g., disease, parasites) impact the wild population. Because only a small fraction of the river will be sampled, there are few anticipated impacts to the shiner population from c apture and movement of individuals to a refugia.

Indirect Effects

We anticipate there will be no indirect, interdependent or interrelated effects to the shiner that are reasonably certain to occur.

Direct Effects

<u>Interior Least Tern</u>

The tern is generally restricted to river segments that have not been heavily altered from historic conditions (U.S. Fish and Wildlife Service 1990). Prior to the construction of Sumner and Santa Rosa Dams, maximum peak flows in the Pecos River reached 26,200 cfs. Post-dam, maximum peak flow was 1,980 cfs, a 92.5 percent reduction. Sandbar geophysiology and associated hydrology are integral components of suitable tern habitat. Those natural components necessary for successful tern nesting on the Pecos River were and likely will be eliminated by water operations that restrict maximum flows. The effect of these water operations has been the utilization of human-created ecosystems like Brantley Reservoir and Bitter Lakes National Wildlife Refuge that the terns have found as surrogates for the river sandbars that are no longer present.

Reclamation is authorized to store a maximum of 40,000 af of water in Brantley Reservoir for the Carlsbad Project (Reclamation 2005). Conservation storage space is comprised of this water and some sediment. Each year, the quantity of sediment increases. In 2005, the total conservation storage space was 42,556 af at an elevation of 3,256.13 ft. Reclamation makes block irrigation releases from Sumner Dam to deliver water to Brantley Reservoir to meet the irrigation requirements of the Carlsbad Irrigation District. Reclamation is authorized to fill all storage space up to the top of conservation storage. Usually, water levels are kept several hundred af below the storage limit in case of unexpected-flood inflows. Any water exceeding the top of conservation storage is remitted, or spilled, to the State of New Mexico and is foregone to the Carlsbad Project. Because block releases depend on an assortment of variables which include, but are not limited to, the annual snowpack in the upper Pecos Basin, the current volume of water stored at each of the Pecos River reservoirs, the demand by downstream irrigators, and the amount of local rainfall, Reclamation stated that they can not predict, and have limited discretion over, the frequency and timing of block releases that may affect terns at Brantley Reservoir within a given year.

If terns arrive at Brantley Reservoir in late April and May 2006 with their previous colony site and they find their nesting area unuseable and they cannot find any other suitable habitat nearby, they may lose an entire season of reproduction and recruitment, as occurred in 2005. On the other hand, if terns can locate suitable habitat at Brantley and nest at elevations near or above the top of conservation storage, then Reclamation's block releases would pose little risk to the terns. However, if they nest at elevations quite low within the conservation space, then it is more likely that the nests could be inundated by a block release. Adult terns would be able to easily escape this inundation, although the terns would potentially lose reproduction and recruitment depending upon the timing. Juvenile birds would likely be harassed and possibly harmed by inundation of the active colony if it interfered with their dependency on parent terns and finding adequate shelter. Any eggs and very young chicks that could not move out of the way of the rising water would be killed by inundation of their nests.

Effects to Critical Habitat

Pecos bluntnose shiner

The critical habitat constituent element for the shiner likely to be affected is the maintenance of a wide channel with sandy substrate. Reduced peak flows cause channel narrowing (Friedman et al. 1998) and allow non-native vegetation to encroach on the channel (Shafroth 1999, Polzin and Rood 2000, Shields et al. 2000). Once non-native vegetation is established, it maintains a narrower channel leading to increased water velocities and the loss of fine sediments such as sand. Peak flows also maintain high levels of habitat diversity through channel migration (Ward and Stanford 1995). A reduction in peak flows reduces channel migration and channel complexity (Shields et al. 2000). The result is less available habitat to the shiner. Although block releases help maintain the existing channel width, the magnitude of the block release is limited by Sumner Dam and is much less than historical peak flows leading to a reduction in shiner habitat. Given the duration of this BO, there are no anticipated impacts to channel width.

Interior least tern

There is no designated critical habitat for the tern in the action area.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this BO. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. Although many adverse effects have occurred to the shiner, it appears that river intermittency is the primary threat to the continued existence of the shiner.

Pecos Bluntnose Shiner

Cumulative effects include:

- Increased urban use of water, including municipal and private uses. Further use of surface water from the Pecos River will reduce optimal river flow and decrease available habitat for the shiner.

- The diversion of up to 100 cfs (2.8 m^3/s) from March 1 through October 31, by FSID and the pumpback operation that sends return flows back to agricultural fields. The FSID diverts 100 percent of the river onto agricultural fields when their calculated allotment is 100 cfs or less. In dry years, seldom does the calculated allotment reach 100 cfs (2.8 m^3/s). Consequently, FSID is able to divert the entire natural flow. This reduction in flow played a large role in the drying of the river in 2002 (Reclamation 2002). It is expected that the diversion will continue to have a significant impact on the amount of water available to the river in the future. Without a pumpback system as much as half the diverted water returns to the river. With the pumpback operation, less than 20 cfs (0.6 m^3/s) returned to the river in 2002 and it is expected that similar low returns will occur in the future. The FSID diversion reduces river flow, reduces shiner habitat, and increases the probability of river drying and subsequent mortality of shiners.

- Capture of sediment by dams on streams tributary to the Pecos River. There are many flood control dams built to protect municipalities that effectively stop the input of fine sediments into the Pecos River. The shiner prefers a silt/sand substrate. Reduction of these fine materials can alter the substrate composition over time.

- The water quality of irrigation return flows to the Pecos River is unknown. However, irrigated agriculture amounts to 84 percent of total water use in De Baca, Chaves, and Eddy counties (Department of Interior 1989). Typically, irrigation return flows are higher in salts than freshwater and may also contain pesticides, herbicides, and elevated amounts of nutrients (nitrogen and potassium) from fertilizers used on crops (http://www.fao.org/docrep/W2598E/w2598e04.htm). When irrigation return flows are diluted by natural flows water quality is not usually a problem. However, in situations where return flows provide a large portion of the total water available to the shiner (i.e., below the FSID diversion canal) and the pesticides, herbicides, and nutrients from fertilizers become further concentrated as the water evaporates, it is possible that water quality could negatively affect the shiners.

- Oil and gas development. There is extensive development of oil and gas wells between Artesia and Carlsbad with associated roads and pipelines. Most of the pipelines are laid on top of the ground. Many pipelines cross ravines and some cross the Pecos River. Leaks and breaks in the lines have been documented (Steve Belinda, Bureau of Land Management, pers. comm. 2002). Delivery of petroleum products to the Pecos River either directly or by storm runoff, could have a negative impact on the shiner.

In summary, human activities have had many adverse effects on the Pecos River ecosystem in the last 100 years. Although many adverse effects have occurred, it appears that lack of permanent flow and an altered hydrograph (diminished peak flows and sustained block flows) are the primary threats to the continued existence of the shiner.

Interior Least Tern

The New Mexico State Parks and Recreation Division will continue to manage human use of selected lands around Brantley Reservoir. The New Mexico Department of Game and Fish will continue their lease agreement to authorize and enforce State fishing and hunting regulations at Brantley Reservoir. State Park recreational use and other forms of human disturbance are expected to continue and can adversely affect tern breeding success. The use of all-terrain and four-wheeled drive vehicles and watercraft may allow recreational users to explore areas previously inaccessible other than by foot. Occasionally, users may violate restricted Wildlife Management Areas. Even momentary presence of human activity may be enough to directly or indirectly affect the breeding or nesting behavior of terns. Displaced adults may be forced to leave their nests open, resulting in direct disturbance. Nest contents can be accidentally crushed under foot or wheel without being noticed.

The Carlsbad Irrigation District will continue to call for block releases that cause the water elevation in Brantley Reservoir to rise, possibly inundating tern nests and habitat.

V. Conclusion

Pecos Bluntnose Shiner

After reviewing the current status of the shiner, the environmental baseline for the action area, the effects of the proposed water operations, the short duration of time covered by this BO, and the cumulative effects, it is the Service's biological opinion that the proposed Pecos River water operations as proposed, is not likely to jeopardize the continued existence of the shiner, and is not likely to destroy or adversely modify designated critical habitat. We found that the proposed action is not likely to have adverse effects to designated critical habitat or alter the function and intended conservation role of shiner critical habitat.

Despite the extremely low runoff forecast for the Pecos River Basin this year, the Service reached these conclusions because Reclamation has the reservoir storage to meet their commitment of maintaining a continuous river. The relatively high storage in the upstream reservoirs this year provides Reclamation with more flexibility to manage block releases and avoid intermittency for shiners. Because intermittency is associated with declines in the shiner population, continuous flow is essential to maintain minimum population levels. Reclamation is also pursuing additional water acquisitions (i.e., lease agreements with FSID, Pecos River water users, groundwater pumping) that, if successful, would provide even more flexibility with their future water operations and contribute to ensuring that the flow of water in the Pecos River will not become intermittent. Therefore, we did not analyze the effects of river intermittency in the BO.

Reclamation's proposed operations, including the proposed supplemental water activities, will augment base flows for the shiner and avoid river intermittency. We anticipate the river will remain whole through the use of existing reservoir storage, bypass flows, the fish conservation pool, and managing block releases in cooperation with CID. Additionally, Reclamation has verbally committed to coordinating block releases with CID such that river intermittency will be avoided.

Interior Least Tern

After reviewing the current status of the tern, the environmental baseline for the action area, the effects of actions associated with this amendment of the biological assessment of Reclamation's proposed Pecos River dam operations, and cumulative effects, it is the Service's biological opinion that this action, as proposed, is not likely to jeopardize the continued existence of the tern because Brantley Reservoir represents a very small portion of their range. To date, no critical habitat has been designated for the tern; therefore, none will be affected.

VI. Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of endangered and threatened species, respectively, without special exemption. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary, and must be undertaken by Reclamation so that they become binding conditions of any grant or permit issued to any applicants, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(i)(3)]

Amount or Extent of Take

Pecos Bluntnose Shiner

Based on the best available information concerning the habitat needs of this species, the project description, and information furnished by Reclamation, from the date of this biological opinion, through October 31, 2006, take of the shiner will occur. Take will occur in the form of harm, harassment, and kill.

Adult shiner populations generally increased until the summer of 2002 (Hoagstrom 2003), indicating that block releases of less than 15 days did not significantly affect adult shiner population numbers upstream. Therefore, we do not anticipate that block releases will result in take of adult shiners.

The Service anticipates that shiner eggs and larvae will be taken as a result of this proposed action. This incidental take is expected to be in the form of harm, harass, and kill as the result of block releases during the spawning season. These block releases are anticipated to transport the eggs and larvae downstream into Brantley Reservoir. This will harm many eggs and larvae by modifying their habitat and subjecting them to abnormally large and lengthy discharges that will transport them into Brantley Reservoir where death will occur, or where they will be unable to successfully develop and breed and thereby contribute offspring to the next generation. It will also harass larvae through the disruption of the normal behavior pattern of seeking sheltered mesohabitats as they would under more natural, lower discharges. It is anticipated that killing of larvae and eggs will occur when they reach Brantley Lake through consumption by predatory fish, by exposure to higher salinity, or by other unsuitable habitat conditions in the reservoir. Reclamation's BA estimates that approximately 1.2 million eggs could be transported into Brantley Lake per day of block release (Reclamation 2005b). Because the survival of shiner from egg to adult is probably 1 percent or less (Reclamation 2005b), in this particular case, approximately 12,000 adults are potentially lost to the population. However, because these numbers were derived from a study conducted in 1997, when shiner abundance was much higher (approximately 6 times higher based on density), it is appropriate to decrease this number to match the current situation. Consequently, take for the loss of eggs and larvae into Brantley is reduced to 2,000 adults. Loss of these individuals has an adverse effect on the population. The precise level of incidental take is difficult to identify and quantify because shiner eggs and larvae are similar in size and color to four other fish species in the Pecos River.

As part of their proposed action, Reclamation is proposing to assist the Service in the capture and holding of shiner in refugia. The refugia would provide a secondary shiner population should any unforeseen circumstances (e.g., disease, parasites) impact the wild population. The NMFRO would coordinate with the NMESFO the collection and transfer of fish to the Dexter National Fish Hatchery and the NMFRO. Using experienced crews supervised by the NMFRO, shiners would be collected in spring 2006 and transferred to the Dexter facility and the NMFRO. Dexter and NMFRO would provide care and handling to maximize the survival of the translocated fish. Although the Service anticipates that take would occur with handling and translocating shiners into refugia (less than 20 percent), take is expected to be less than natural mortality (J. Brooks, pers. comm. 2006). With only 500 shiners expected to be collected for the refugia, take is anticipated to be less than 100 individuals.

Effect of the Take

In the accompanying biological opinion, the Service determined that the level of anticipated take is not likely to jeopardize the continued existence of the shiner.

Amount or Extent of Take

Interior Least Tern

Incidental take in the form of harm and harassment will result in actual death or injury in the form of loss of reproduction and recruitment caused by habitat loss and alteration from continued operation and maintenance of Reclamation's proposed Pecos River dam operations. This take will be difficult to detect because terns are wide-ranging and may change nesting colonies from year to year. Therefore, reduced reproductive success may be masked by annual variability in localized population numbers. However, take of terns can be anticipated by continued river operations that fail to provide habitat conditions that support self-sustaining populations of terns in the action area. The level of take is based on periodic nest innundation, erosion and/or degradation of suitable nesting and foraging habitat, and continued human-disturbance and predation of terns at Brantley Reservoir, resulting in actual death and injury to terns. The following types of losses are possible:

1. Taking of eggs and chicks by flooding or erosion;

2. Precluding nesting and renesting of terns by inundation or wetting of shoreline nesting habitat;

3. Increasing predation on nests and chicks as a result of reduced nesting habitat or changes in predatory/prey relationships;

4. Increasing susceptibility of eggs and young to disturbance and/or destruction by human activities as a result of reduced nesting habitat;

5. Continued loss of habitat due to degradation and vegetation encroachment, resulting in actual death and injury as described above.

Terns were present at Brantley Reservoir in May 2005 in the cove where terns nested in 2004. In response to a block release in May 2005, the reservoir's surface level rose above 3,253 ft in elevation, inundating most of the previously-exposed potential nesting substrate on the reservoir's shoreline. By June 9, 2005, a large increase in water level had submerged all potential nesting habitat for the terns, except for one small area that was unsuitable because it had become overgrown with sprouting kochia and cockleburr (J. Montgomery, Fish and Wildlife Service permittee, annual survey report, December 30, 2005). Human recreational disturbance at this location in late June and July was a likely contributing factor to the lack of tern breeding activity later in the breeding season. Regular monitoring found no evidence of tern nesting during the summer months even though approximately six to eight adults occupied Brantley Reservoir until August. Continued lack of recruitment in future breeding seasons could lead to complete loss of the colony at Brantley Reservoir. For these reasons, ensuring availability of suitable habitat when terns are expected to arrive in 2006 is an important measure to minimize incidental take.

In 2004, a total of at least 14 adult terns nested at Brantley Reservoir, with an estimated 7 nests on the lakeshore. Six juvenile terns were observed near the nesting area in late August (Bureau of Reclamation 2005b; J. Montgomery, Fish and Wildlife Service permittee, electronic mail message, August 23, 2004). We therefore estimate that the following numbers of adults and young may be incidentally taken by implementing this proposed action: Up to 14 adult terns are authorized to be taken in the form of harassment caused by high water levels resulting from block releases. The eggs and very young, immobile chicks of these pairs may be incidentally taken in the form of harm caused by water levels rising as a result of block releases. The number of chicks taken may be up to 3 per pair, or a total of up to 21 eggs or immobile chicks in any combination for first nests, and the same number for renesting terns, for a combined total of 42 eggs or immobile chicks. Up to 42 older, mobile young may be taken in the form of harm or harassment caused by high water levels resulting from block releases. Some of this age cohort could die as a result of displacement by high water levels and others may survive displacement.

Effect of the Take

In the accompanying biological opinion, the Service determined that these levels of anticipated take are not likely to result in jeopardy to the tern.

VII. Reasonable and Prudent Measures

Pecos Bluntnose Shiner

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the shiner.

1. Monitor the shiner population and river conditions.

2. Coordinate between all parties in the Pecos River to meet both the needs of the shiner and the water users.

Terms and Conditions

Pecos Bluntnose Shiner

In order to be exempt from prohibitions of section 9 of the Act, Reclamation must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The following implements reasonable and prudent measure 1:

a. Continue population monitoring of the shiner using methods and sites that are consistent with the surveys that have been conducted. A minimum of 4 surveys will be made during the year, with at least 2 months separating each collection. Surveys should not be made when discharge is greater than 250 cfs. Twelve to fifteen sites will be sampled between Sumner and Brantley Reservoirs. Ten to twenty seine hauls should be made at each site, depending on habitat complexity, discharge, and fish abundance (i.e., if habitat heterogeneity is high or fish abundance is low, more samples would be taken). Results from each seine haul should be recorded individually (i.e., do not lump all seine hauls from one site together). All mesohabitats at a site should be sampled at least once. Seine hauls should be taken roughly in proportion to the area of the mesohabitat types present (i.e., if 80 percent of the area is a run then the majority of seine hauls should occur in runs). The length, area, and mesohabitat type of each seine haul should be recorded. Sample design should be evaluated and coordinated yearly with NMDGF and NMFRO.

b. Monitor the video camera at the lower end of the upper critical habitat to assist in ensuring flows are sufficient to maintain a continuous river.

c. Monitor river gages with emphasis on the Acme gage to assist in ensuring flows are sufficient to maintain a continuous river.

d. Monitor the river between Bitter Lakes National Wildlife Refuge and the Taiban Creek confluence through weekly flights to ensure the river remains continuous.

e. During the peak irrigation season, coordinate water operations with Pecos water managers and stakeholders on a weekly basis.

The Service believes that incidental take will not limit the ability of the shiner population to sustain itself. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action.

Interior Least Tern

The Service believes the following reasonable and prudent measure is also necessary and appropriate to minimize or avoid impacts of incidental take to the tern:

1) In cooperation with other willing land managers at Brantley Reservoir, Reclamation shall fund, implement and/or assist with enhancement of tern nesting and brood-rearing habitat at Brantley Reservoir prior to the arrival of terns in May 2006, in consultation with NMESFO. This measure will ensure that suitable habitat is available when terns arrive this spring.

<u>Terms and Conditions</u>

Interior Least Tern

1.1 Reclamation shall enhance habitat for terns at least twice the size of the 28-ac 2004 tern colony at Brantley Reservoir, equaling 56 or more acres of nesting and brood-rearing habitat. Tern habitat enhancement sites shall be based upon: (1) The following NMESFO recommendations where they are applicable, (2) site analyses by NMDGF and other tern experts, (3) new or existing scientific, peer-reviewed research at this or similar sites, and (4) in consultation with NMESFO. Potential site enhancements shall incorporate important characteristics of the occupied habitat at Brantley Reservoir, as well as new or existing research on tern breeding habitat preferences, movements and establishment of territories at Brantley Reservoir and similar habitats throughout the subspecies' range.

The NMESFO recommends the following physical conditions for tern nesting, brood-rearing, and foraging habitats (U.S. Fish and Wildlife Service 2000):

<u>Nesting Habitat</u>:

- Substrate – Nesting substrates consist of well-draining particles ranging in size from fine sand to stones < 1 in (2.5 cm) in diameter.
- Size/Shape – Nesting areas should be a minimum of 1 ac (.4 ha), preferably 10 acres (4 ha); circular to oblong in shape, maximizing surface area; recommended slopes of 1:25 with maximum slopes not exceeding 1:10; surface height above water to exceed 18 inches (45.7 cm) at nest initiation.
- Visibility – Smooth topography with < 10 percent early successional vegetation.

<u>Brood Rearing Habitat</u>:

- Substrate – Same as nesting substrate but may contain fine silts, organic detritus, and other unconsolidated fine particulate matter.
- Size/Shape – Brood-rearing areas should be 3 to 5 times larger than the nesting area; very irregular in shape, maximizing shoreline to water interface; recommended slopes of 1:25 with maximum slopes not exceeding 1:10.
- Visibility – Vegetation can increase up to 25 percent ground coverage but should occur in a patchy pattern.
- Connectivity – Brood rearing areas must occur connected to nesting areas or immediately adjacent and separated only by shallow channels (< 1 in [2.5 cm] deep) or mud flats.

<u>Foraging Habitat</u>:

- Substrate –Terns require shallow, slow velocity water that provides habitat for schooling baitfish that are 0.5 to 3.0 in (1.3-7.6 cm) in length. Substrates range from large grained sand to heavy silts.

- Connectivity – Tern foraging areas should not be greater than 438 yards (400 m) from the brood-rearing areas.

Suggested management techniques for habitat creation include: (1) Replenishment or nourishment of river sandbars and islands; (2) creation of suitable nesting habitat in reservoir depositional zones; (3) creation or enhancement of shallow and backwater areas, off-channel chutes, and flats as foraging habitat; (4) removal of early successional vegetation from nesting areas; (5) peninsular cutoffs or island creations in reservoir side bays; and (6) dike construction to dewater reservoir side bays for nesting and foraging habitat.

1.2 In accordance with the recommendations listed in 1.1, Reclamation shall enhance 14 or more acres as tern nesting habitat and approximately 3 or more times this amount as brood-rearing habitat, using elevated areas around Brantley Reservoir as close to the full conservation pool level and the 2004 colony site as feasible. Tern nesting and brood-rearing habitats shall be created in at least two new areas: 1) Directly above and behind the 2004 colony site, and 2) across the Seven Rivers inlet north of the 2004 colony site. In areas designated for enhancement or clearing where migratory birds may be concurrently nesting, Reclamation shall survey for active nests and ensure that neither migratory bird eggs nor young will be killed while enhancing habitat for terns.

1.3 Because terns are sensitive to human disturbance, Reclamation shall work with other willing land managers to ensure that a buffer zone of at least 1/4 mile is maintained around areas where terns are exhibiting breeding behavior and around active colonies to protect them from potentially disturbing activities.

1.4 Reclamation shall coordinate with and update NMESFO on the details and implementation of these terms and conditions weekly during April and May 2006. Reclamation shall again meet with NMESFO if terns establish nests that could be subject to take.

1.5 Reclamation shall monitor the implementation and success of these habitat enhancements and survey and monitor terns throughout the breeding season, and submit interim update reports to NMESFO at biweekly intervals from June through August. A final report shall be submitted to NMESFO by December 15, 2006.

VIII. Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

Pecos Bluntnose Shiner

1. The Service and Reclamation should encourage CID and FSID to develop a Habitat Conservation Plan for the shiner or be part of the long-term water operations BO. This would provide CID and FSID with incidental take permits for their water operations.

2. Reclamation should cooperate with the Corps, CID and FSID in developing river restoration projects to benefit the shiner. These could include the removal of salt cedar, destabilizing the banks and widening of the channel, especially in the reaches below BLNWR.

3. The New Mexico Department of Agriculture (NMDA) is currently administering the New Mexico Salt Cedar Control Project through local soil and water conservation districts along the Pecos River. To improve habitat for shiner, Reclamation should collaborate with NMDA to investigate the possibility of removing stands of dead salt cedar and destabilizing the river banks so that the river can become reconnected with the flood plain.

4. Reclamation should continue to pursue opportunities for leasing water to provide supplemental water to the shiner, to create a water bank, and to secure a long-term supply of water that may be used to meet species needs, consistent with state and federal law.

5. Determine water quality impacts on the shiner.

6. Work with the shiner recovery team to investigate the competitive interactions between the species and any other factors that may affect the shiner if/when the minnow is stocked in the Pecos River.

7. Examine competitive interactions among the Pecos River fishes to determine the extent that non-native fish or the red shiner may affect the shiner population.

8. Investigate the possibility of modifying outlet structures at Sumner Dam so that releases greater than 1,400 cfs could be made.

Interior Least Tern

9. Reclamation should work with the State, CID, FSID, and the Service to investigate ways to manage water levels in Brantley Reservoir to benefit terns without impacting the shiner or water deliveries.

10. Reclamation should continue to work with CID and others to clear areas of salt cedar and early successional vegetation from areas around and in proximity to Brantley Reservoir that will create additional nesting and brood-rearing habitat for terns.

11. Reclamation should investigate ways to enhance foraging habitat for terns, using the habitat recommendations listed in Term and Condition 1.1.

12. Reclamation should investigate management opportunities, including protection of peninsular habitat, overburden removal, island construction, and water-control structures to provide long-term habitat to support terns on Pecos River reservoirs.

13. Determine whether water quality is directly or indirectly affecting the tern through effects to prey base quality, abundance, and/or availability, and if so, determine available remedies.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations. These accomplishments may be reported in the weekly conference calls and notes.

Reporting Requirements

The nearest Service Law Enforcement Office must be notified within 24 hours in writing should any listed species be found dead, injured, or sick. Notification must include the date, time, and location of the carcass, cause of injury or death (if known), and any pertinent information. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. If necessary, the Service will provide a protocol for the handling of dead or injured listed animals. In the event Reclamation suspects that a species has been taken in violation of Federal, State, or local law, all relevant information should be reported in writing within 24 hours to the Service's New Mexico Law Enforcement Office (505/883-7814) or the New Mexico Ecological Services Field Office (505/346-2525).

IX. Reinitiation Notice

This concludes formal consultation on the action(s) outlined in the December 19, 2005, request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this BO; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this BO; (4) a new species is listed or critical habitat designated that may be affected by the action, or (5) any river intermittency (i.e., 0 to 5 cfs) occurs. This consultation is only valid through October 31, 2006 (or until completion of the long-term BO for water operations, whichever occurs first) and therefore consultation must be reinitiated prior to the expiration of this BO to ensure continued compliance with section 7 and 9 of the Act. Consultation must be reinitiated should intermittency occur at the Acme gauge, elsewhere in designated critical habitat, or in any other known reaches occupied by shiners. Updates of any environmental commitments may also require reinitiating consultation. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. Any questions regarding this BO should be directed to me at (505) 761-4781 or Brian Hanson at (505) 761-4708.

Russ Holder

cc:
Assistant Regional Director, U.S. Fish and Wildlife Service, Region 2 (ES), Albuquerque, New Mexico
Regional Section 7 Coordinator, U.S. Fish and Wildlife Service, Region 2 (ES), Albuquerque, New Mexico

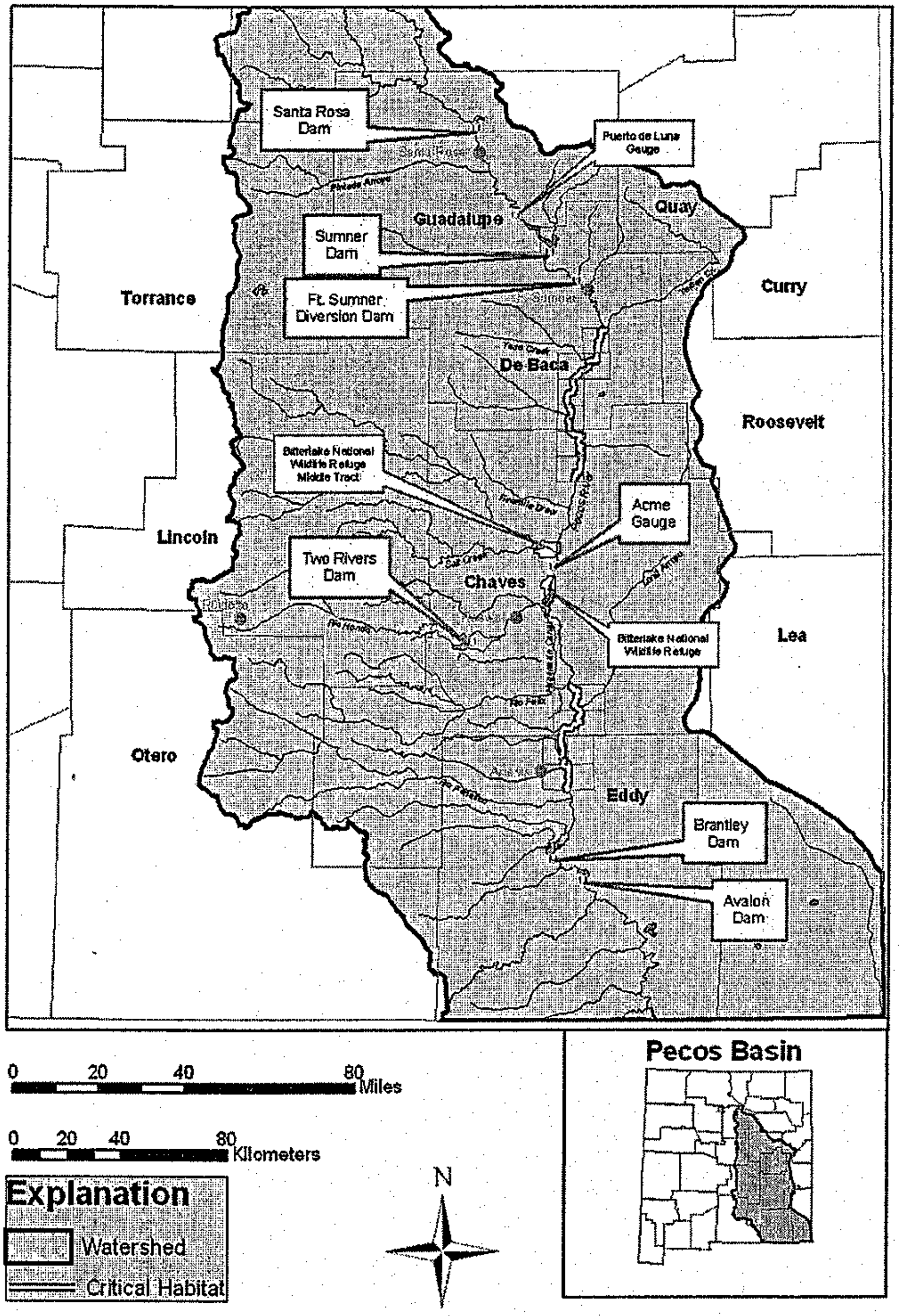


Figure 1. Pecos bluntnose shiner critical habitat, dams and two gauging stations on the Pecos River, New Mexico.

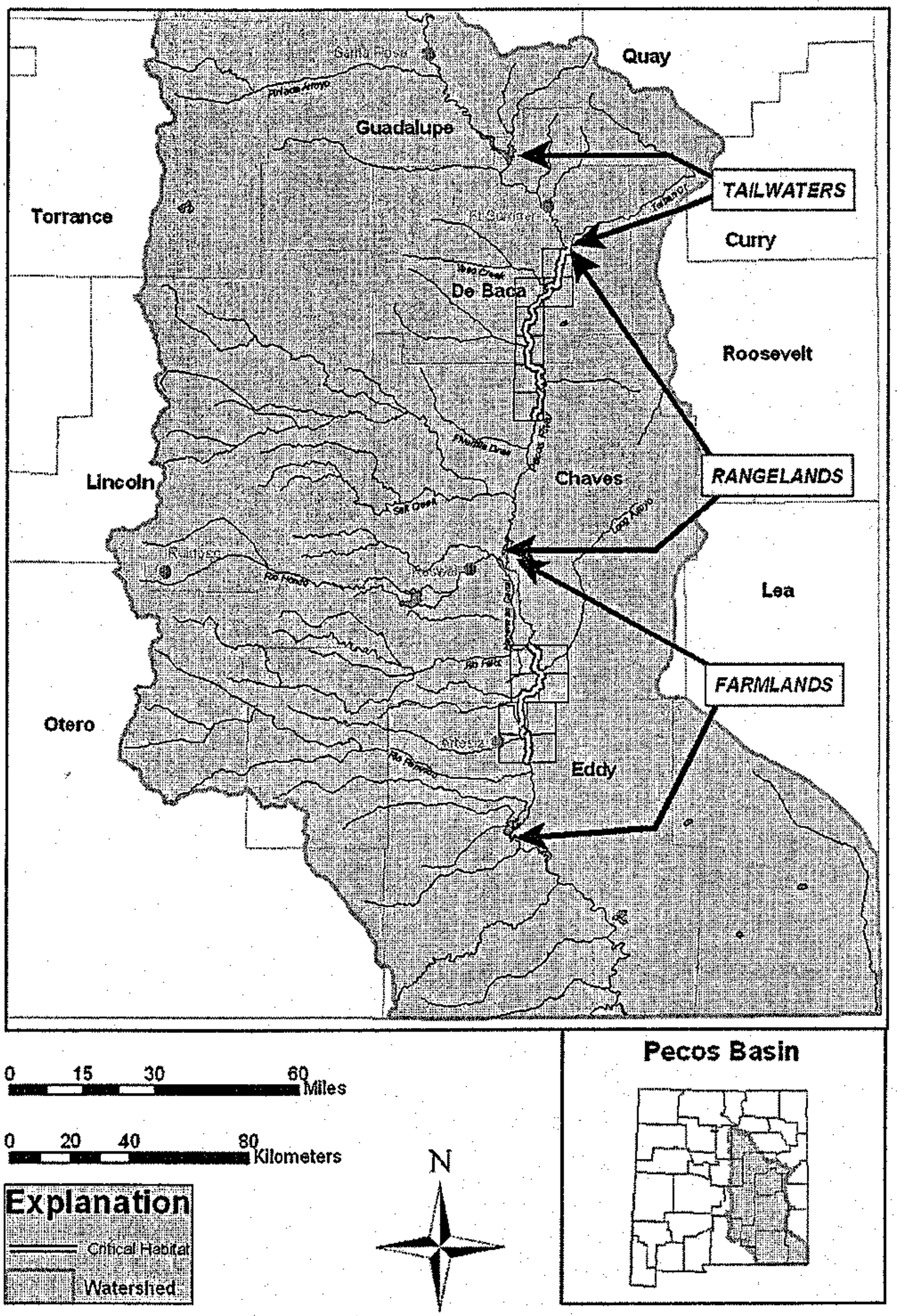


Figure 2. River reaches of similar character designated for Pecos bluntnose shiner research.

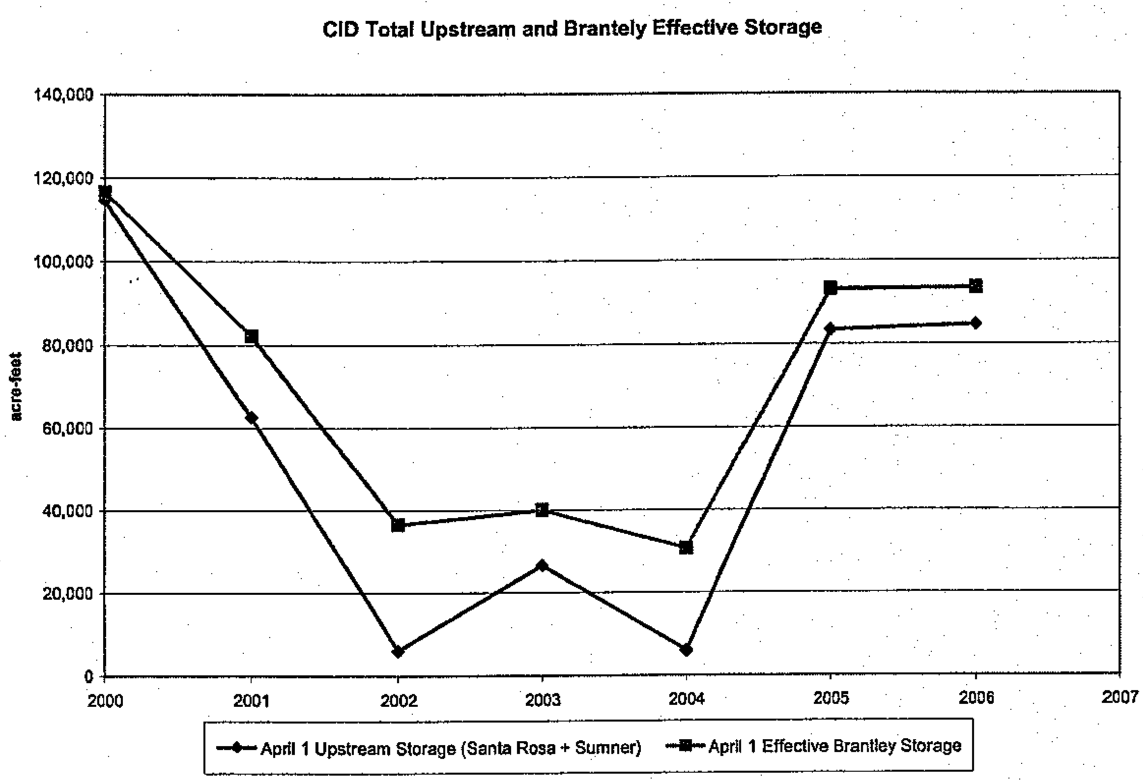
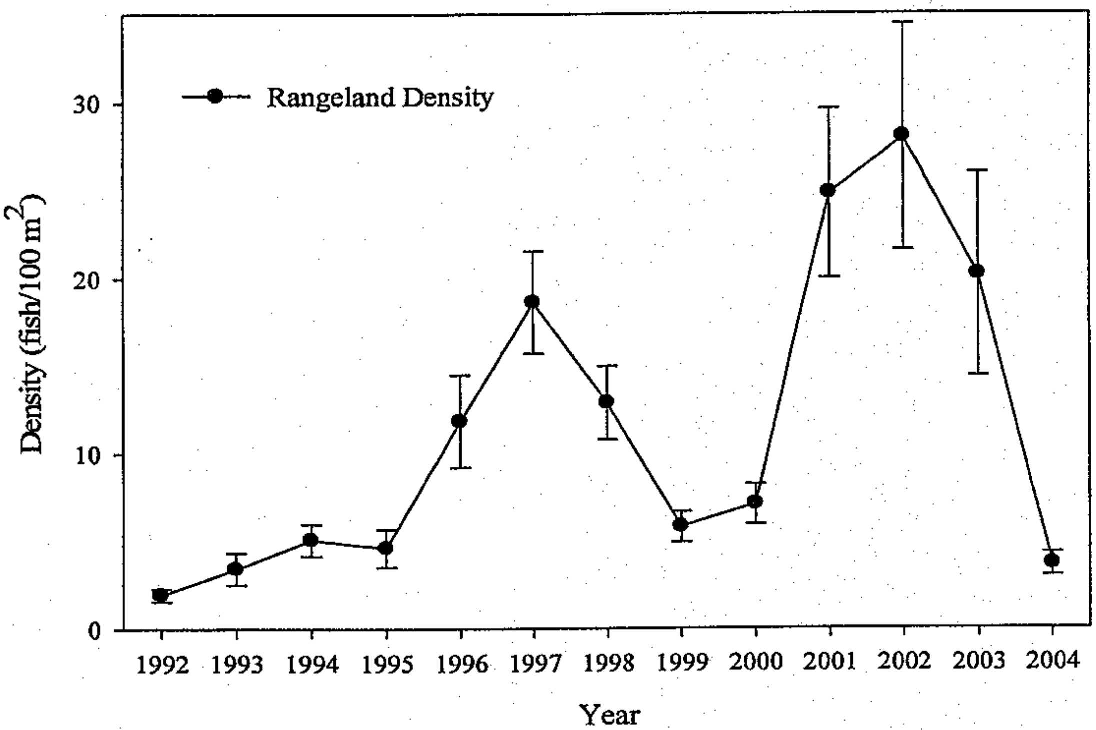


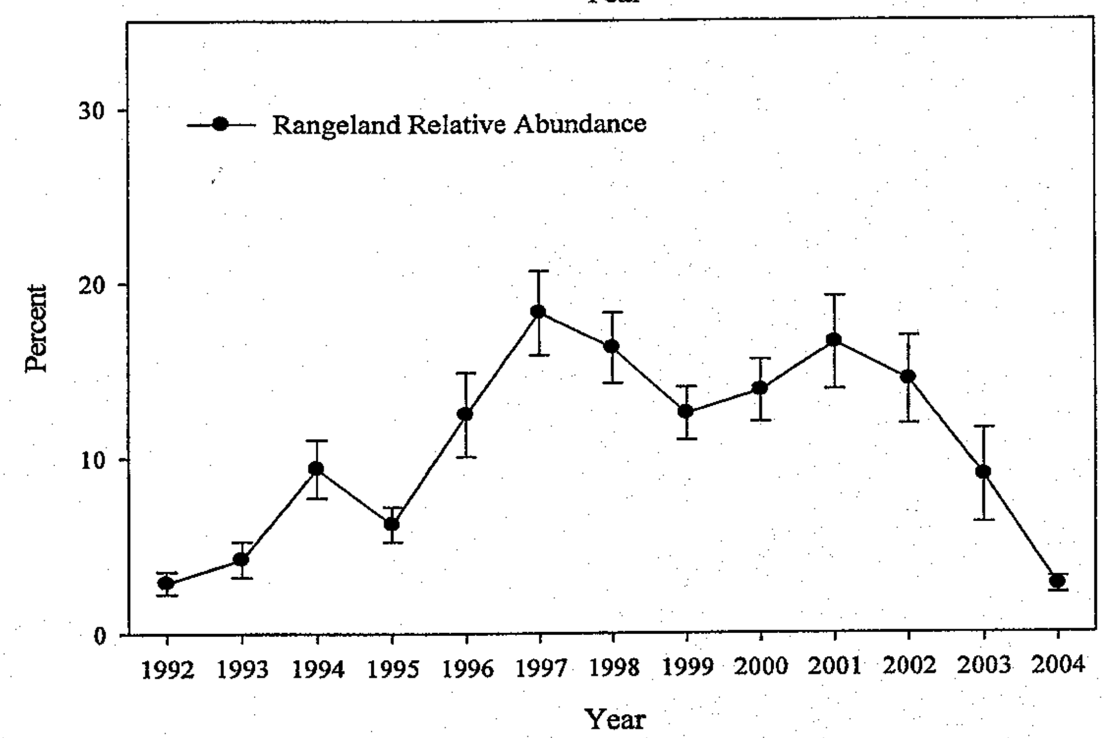
Figure 3. Total upstream reservoir storage in Santa Rosa and Sumner Reservoirs (bottom line) and effective Brantley storage (top line). The number of days of intermittency by year are 2001 (4 days), 2002 (49 days), 2003 (44 days), and 2004 (8 days). There were no days of intermittency in 2000 and 2005. In addition, the 4 days of intermittency that occurred in 2001 could have been avoided if the Fish Conservation Pool were available in 2001 (Reclamation facsimile message, April 7, 2006).

Figure 4. Density of Pecos bluntnose shiner in the Rangelands from 1992 to 2004. See Figure 2 for location of the Rangelands. Source: New Mexico Fishery Resources Office.

Figure 5. Relative abundance Pecos bluntnose shiner (number of Pecos bluntnose shiner caught divided by total number of fish caught) in the Rangelands from 1992 to 2004. Source: New Mexico Fishery Resources Office.



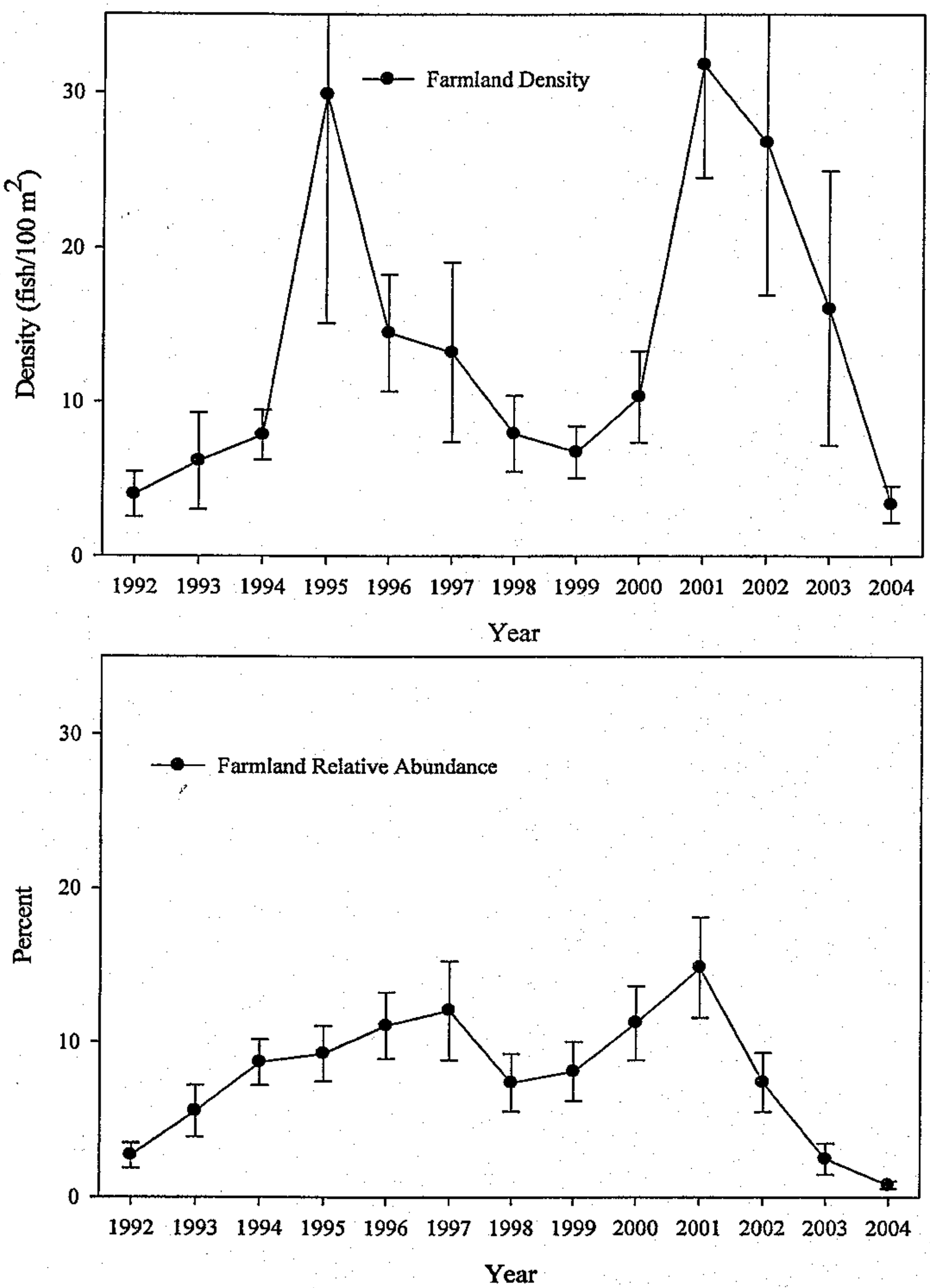
Rangeland Density
Density (fish/100 m^2)
0
10
20
30
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year



Rangeland Relative Abundance
Percent
0
10
20
30
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year

Figure 6. Density of Pecos bluntnose shiner in the Farmlands from 1992 to 2004. See Figure 2 for location of Farmlands. Source: New Mexico Fishery Resources Office.

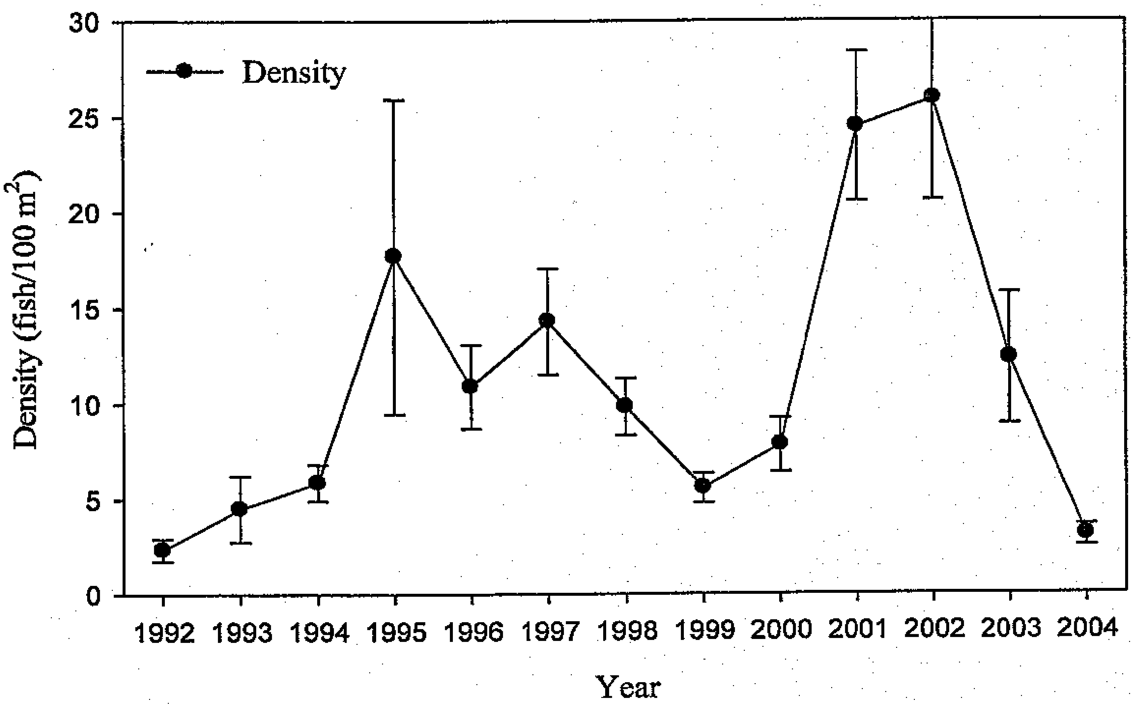
Figure 7. Relative abundance Pecos bluntnose shiner (number of Pecos bluntnose shiner caught divided by total number of fish caught) in the Farmlands from 1992 to 2004. Source: New Mexico Fishery Resources Office.

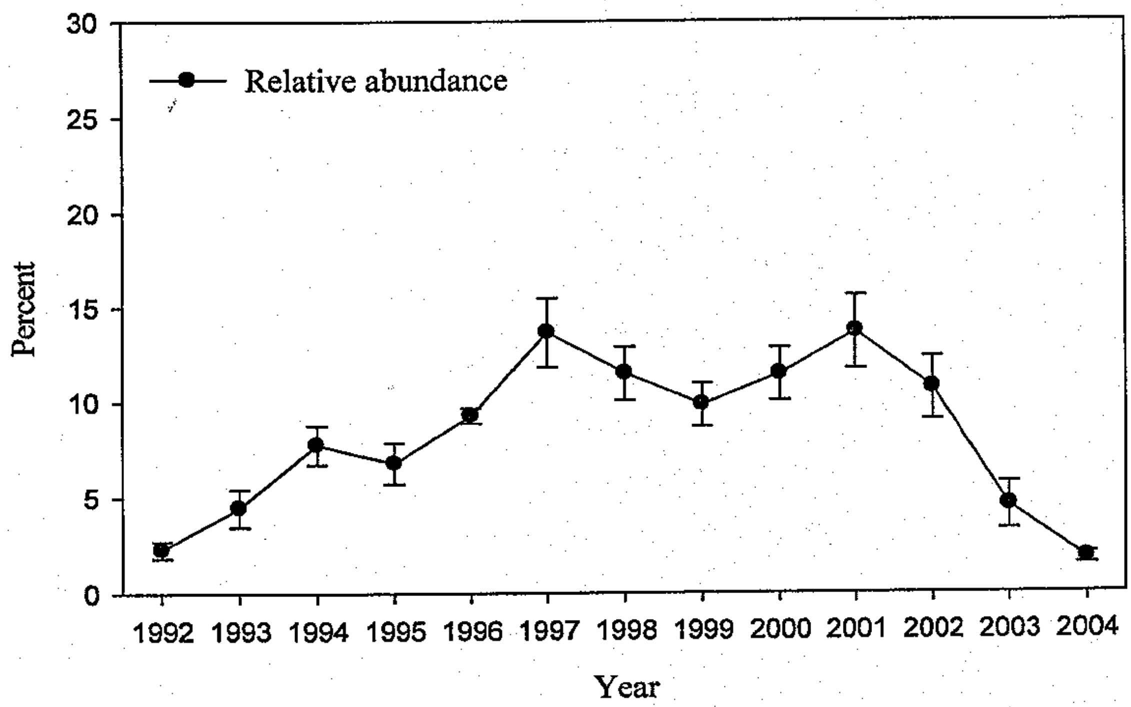


Farmland Density
Density (fish/100 m2)
30
20
10
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
Farmland Relative Abundance
Percent
30
20
10
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year

Figure 8. Annual density estimates (number of fish/ 100 m^2), $\pm$ one standard error of Pecos bluntnose shiner between 1992 and 2004. Data from all trimesters and river sections are combined. Source: New Mexico Fishery Resources Office.

Figure 9. Annual relative abundance estimates (number of Pecos bluntnose shiner divided by all fish collected), $\pm$ one standard error of Pecos bluntnose shiner between 1992 and 2004. Data from all trimesters and river sections are combined. Source: New Mexico Fishery Resources Office.


Density
Density (fish/100 m²)
0
5
10
15
20
25
30
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
Year


Relative abundance
Percent
0
5
10
15
20
25
30
1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
Year

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