United States Department of the Interior

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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 Carlsbad Project Water Operations and Water Supply Conservation, 2006-2016.

This document transmits the U.S. Fish and Wildlife Service's (Service) final biological opinion (BO) on the effects of the Bureau of Reclamation's (Reclamation) proposed Carlsbad Project Water Operations and Water Supply Conservation project, for a period of 10 years, beginning 30 days after a Record of Decision is signed, 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 Second Amended Biological Assessment (BA) on January 20, 2006. In addition, Reclamation provided supplemental information in several meetings, draft BAs, and other documents which are summarized under "Consultation History."

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.

All information required for consultation was either included with your January 20, 2006 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 but will not destroy or adversely modify 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 first initiated formal consultation with the Service in 1991 on their Pecos River operations (Reclamation 1991). On March 1, 1991, Reclamation submitted a BA which addressed impacts to the shiner, resulting from proposed Carlsbad Project operations. As part of this analysis, Reclamation included a description and analysis of the 1989 operations for filling and testing Brantley Dam and Reservoir. The 1989 operations consisted of making one large block release during the early summer months to both fill Brantley Reservoir and test it for flood control functions. After this single release, there was very little storage left in Sumner and Santa Rosa and no other water was released from Lake Sumner that calendar year, causing river intermittency. This was a one-time operation that Reclamation does not expect to repeat.

On August 5, 1991, the Service issued a BO, analyzing the effects of the proposed 1989 operations. The BO concluded that Reclamation’s 1989 Pecos River Dam operations would likely jeopardize the continued existence of the shiner and adversely modify the critical habitat of the species. The jeopardy opinion was based on the fact that the prolonged continuous release of water (47 days) transported eggs, larvae, and probably adults into Brantley Reservoir and that the subsequent river drying, because of the lack of reservoir storage, also had an adverse effect on the species. Shiner population in 1991 was considered to be low, based primarily on comparisons of shiner within the shiner guild compared to historical collections (Brooks et al. 1991). Systematic collections of shiner did not begin until 1992.

There have been several subsequent consultations on Pecos River operations which are outlined in detail in the BO that covered dam operations from March 1, 2003 through February 28, 2006 (Service 2003a). The following paragraphs outline the documents and meetings that apply directly to this consultation.

On May 11, 2005 the Service received an Administrative Draft BA for the proposed project. The Service had numerous comments and met directly with Reclamation staff on June 9 and June 13, 2005, to discuss our comments. On July 13, the Service received a revised draft BA. Outstanding issues and comments were transmitted to Reclamation at a meeting on August 8, 2005. On August 11, 2005 a final BA was delivered to the Service and on September 1, the agencies met to discuss unresolved issues and plans Reclamation had to secure supplemental water for the shiner. On September 13, 2005 the Service sent a letter to Reclamation stating that formal consultation would not be initiated until there was resolution on the outstanding issues. On October 3, November 2, and November 11, 2005, the Service met with Reclamation to discuss outstanding issues related to the shiner and tern. On November 23, 2005, the Service received a final amended BA.

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 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 obtain data on historic water levels at Brantley Reservoir during the May through August tern breeding season to help determine elevations within the storage space of Brantley Reservoir that would be suitable for habitat creation. It was decided that a site visit would occur prior to the 2006 tern breeding season to view the operating pool of the reservoir, the 2004 tern nesting area location, and locate potential areas for tern habitat enhancement.

On December 23, 2005, a memo was received from Reclamation outlining supplemental water sources for Pecos River operations.

On January 5, 2006, comments on the BA were faxed to Reclamation and NMESFO staff met with Reclamation to request additional information for the consultation. Reclamation was requested to provide the historic dates when block releases entered 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 amended BA for Pecos River Water Operations that addressed these additional requests for information on issues related to the terns at Brantley Reservoir.

On January 20, 2006. The Service received the Second Amended BA.

On April 13 and 21, 2006, Reclamation and the Service discussed details regarding supplemental water sources and scheduling for the draft BO. On April 24, 2006, the Service received a memo that outlined the details of the supplemental water.

BIOLOGICAL OPINION

I. Description of the Proposed Action

Reclamation's proposed action is comprised of diverting water to storage, releasing water from storage, and acquiring additional water for the Carlsbad Project to conserve Project water supply and to keep the river continuous. In addition, Reclamation proposes to continue monitoring the camera on the Pecos River at the lower end of the upper section of designated critical habitat, the Taiban gage, the Dunlap gage, facilitate the weekly conference calls during the irrigation season, and organize an annual Pecos River management workshop. Implementation of proposed water operations and supplemental water activities are intended to conserve Carlsbad Project water supply and to conserve the Pecos bluntnose shiner. Reclamation's proposed water management activities are expected to maintain continuous flow in the Pecos River from the Taiban Creek confluence to Brantley Reservoir. As an additional safeguard, Reclamation proposes to fund and assist in the capture and holding of shiner in refugia, if necessary.

Reclamation has been conducting an Environmental Impact Statement (EIS) process for long term water operations and will soon release the final EIS and issue a Record of Decision (ROD) for the Carlsbad Project Water Operations and Water Supply Conservation. Reclamation proposes to implement the "Taiban Constant" alternative (the preferred alternative identified in the EIS) for a period of 10 years, beginning 30 days after the ROD is issued.

This proposed alternative will operate the Carlsbad Project to: 1) divert water to storage when it is available and flows at the Pecos River Below Taiban Creek Near Fort Sumner, New Mexico (Taiban gage) are greater than 35 cubic feet per second (cfs); and 2) deliver Carlsbad Project water from storage as contracted for irrigation and consistent with applicable Federal and state laws.

The Carlsbad Project is presently permitted to store approximately 40,000 af of Carlsbad Project water in Lake Sumner for irrigation purposes, of which 500 af of Fish Conservation Pool (FCP) (an amount of water set aside for the conservation of the shiner) water can be used to maintain river flow. Under Reclamation's state water right permit, Reclamation cannot store inflow in Lake Sumner or Santa Rosa Lake that the New Mexico Office of the State Engineer (NMOSE) determines Fort Sumner Irrigation District (FSID) is entitled to receive, consistent with FSID's senior direct flow water right. Under the proposed action, Reclamation will only divert to storage inflows into Santa Rosa Lake and Lake Sumner not needed to meet FSID's water right. Reclamation will also bypass inflows when they are available to target the downstream objective of 35 cfs at the Taiban gage.

Once water is stored, it is considered Carlsbad Project water, under contract to Carlsbad Irrigation District (CID) for delivery. If an inflow is not stored, but bypassed, that flow up to 100 cfs is considered to belong to FSID. Reclamation does not own any water rights under the Fort Sumner Project and can not impede the delivery of their water. The two-week calculations during the irrigation season are used to determine the amount of inflow, up to 100 cfs, that will be passed through Sumner Dam to meet FSID's water right. Reclamation will bypass any remaining inflow available (potential Carlsbad Project Storage) that is above FSID's senior water right, to maintain the target flow of 35 cfs at Taiban gage. If there is only enough available water to maintain a 20 cfs flow at Taiban gage, Reclamation will bypass that portion. If there is enough water to maintain a 45 cfs flow at Taiban gage, Reclamation will bypass only enough water to maintain the target flow of 35 cfs and store the rest. If the calculated inflow is at or below 100 cfs, Reclamation is obligated to pass such inflows at Sumner Dam to meet FSID's diversion entitlement. FSID has the option to divert that flow or bypass that flow at the diversion dam.

Reclamation intends to secure additional water and manage supplemental water to avoid river 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 can be stored in Sumner and Santa Rosa Reservoirs during the irrigation season only if there is extra water after Reclamation bypasses FSID's two-week flow entitlement and the river flow target of 35 cfs at the Taiban Gage is being met, and

2) Water will be stored in Sumner and Santa Rosa Reservoirs during the non-irrigation season only if the target of 35 cfs at the Taiban Gage is being met, and

3) Water will not be diverted to storage in Sumner and Santa Rosa Reservoirs at any time when there is a danger of river intermittency.

B) Releasing Water from Storage

1) Release 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, if possible, to alleviate any river intermittency.

3) Restrict the duration of block releases from Sumner Reservoir to a maximum of 15 days.

4) Restrict the cumulative duration of block releases from Sumner Reservoir in a calendar year to a maximum of 65 days.

5) The number of days between block releases from Sumner Reservoir shall be no less than 14.

6) To the extent possible avoid releases during a six-week period around August 1.

C) Supplemental Water (Conservation Measures)

There are two major criteria associated with Reclamation's Pecos River operations: supplement river base flows and avoid river intermittency. These are: a) Reclamation will not store incoming 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 Reclamation has been able to schedule multiple block releases during the irrigation season. In addition, Reclamation has and is undertaking the following proactive 7(a)(1) supplemental water activities.

Forbearance program with Fort Sumner Irrigation District

Reclamation first entered into a forbearance agreement with FSID in 2000, which made available land for fallowing. The agreement provided for the return of a percentage of FSID's water diversion right directly back into the Pecos River at the Sandgate Weir above the Taiban Gage. If the diversion is 100 cfs, then the amount of water is equal to the full percent of the forbearance. For instance, the percent of forbearance in 2006 is 11 percent. If FSID is entitled to their full diversion right, 100 cfs, then the forbearance is 11 percent or 11 cfs. Smaller diversion flows would be reduced by that amount, multiplied by the percent. If flows are 85 cfs, then the forbearance at 11 percent would be 9.35 cfs.

The total percent of forbearance is based on the number of FSID participants who have declared their intent to forbear by August 1 of the year prior to the actual year of application. All FSID members who are participating in the 2006 forbearance had to enter into the agreement by August 1, 2005. This agreement is due to expire in 2007, but Reclamation expects FSID to shift their cooperation to water banking to help avoid flow intermittency.

Fish Conservation Pool

Reclamation is permanently authorized by permit from the New Mexico Office of the State Engineer to create a Fish Conservation Pool (FCP) to store 500 af of water in Sumner and/or Santa Rosa Reservoirs for the purpose of providing riverine habitat. Flow rate from the FCP may vary by need. Water from the FCP simplifies the process of getting small flows past the FSID diversion dam. The stored water can be released downstream at any time of the year to maintain instream flows and avoid river intermittency. Reclamation must replace the water released out of Sumner Reservoir with 375 af of water in Brantley Reservoir.

Water Banking

In conjunction with the Fish Conservation Pool, Reclamation is developing a water banking/exchange program which would supply additional water from Sumner or Santa Rosa Reservoirs at critical times to avoid river intermittency and protect designated shiner critical habitat. Reclamation has discussed this option with irrigation districts and State agencies.

As original mitigation for the construction of Brantley Dam, under the Fish and Wildlife Coordination Act, Reclamation committed to irrigate 640 acres of land for small grains to attract migratory birds. Reclamation has three wells and sufficient artesian water rights at Seven Rivers to accomplish the commitment, but has never been able to successfully irrigate more than 240 acres under Reclamation's present contractual arrangement with New Mexico Department of Game and Fish (NMDGF).

Reclamation proposes to reduce its mitigation commitment to only irrigate 240 acres at Seven Rivers. Reclamation would then commit 400 acres of water rights to pumping into Brantley Reservoir to create the deposit for the water bank/exchange. Details of how much water Reclamation could pump under its rights would be determined through the State Engineer's permitting process. The two wells which Reclamation would use are capable of pumping 860 acre feet (af) in 93 days.

Reclamation would make the deposits to the bank in exchange for being able to withdraw water from Santa Rosa or Sumner Reservoir to meet the needs of the shiner. It is understood that Reclamation would need to establish a maximum size for the water bank deposits to ensure that Reclamation would not adversely impact the Carlsbad Project. Initial discussions have suggested that 2,500 af might be the appropriate size. In most years Reclamation would not need that much water, but in the abnormally dry years, it is anticipated that 2,500 af from the conservation pool in combination with some of Reclamation's other efforts would keep the river from becoming intermittent.

Reclamation also proposes that FSID operate in a way which could provide additional Carlsbad Project water in Sumner Reservoir. Because FSID has senior diversion rights, they get their entitlement before the Carlsbad Project can store water. If FSID only asks for water when they need it, then Carlsbad Project is able to store any water not called for by FSID. There are times that FSID does not need its full entitlement and the river has sufficient water to meet shiner needs. For example, when rainfall meets the irrigation need or the farmers are cutting alfalfa. In exchange for FSID agreeing to manage according to need rather than right, Reclamation proposes to stop the current leasing program.

<u>Pumping to the River</u>

Reclamation has an existing five-year lease (renewed in 2005 and which they intend to maintain in the future) for 1,180 af which provides for delivery of water pumped from artesian wells directly to the Pecos River through a pipeline. These wells are located approximately 10 miles upstream of the Acme Gage. Since 2001, historic annual deliveries from these wells have ranged from 200 to 650 af (1-2 cfs delivered to river). Typically, water is pumped from the wells when Acme gage flow drops below 10 cfs. Upgrades to the pipeline, which are underway, should allow for a maximum of 3 cfs to be delivered to the river.

Reclamation also proposes to enter into a lease agreement with the New Mexico Interstate Stream Commission (ISC) for approximately 1,800 af of groundwater which will be delivered through a pipeline to the Pecos River. Based on the amount of water rights being purchased, this project will provide approximately 10 cfs of water to the river for 90 days a year. This is a cooperative effort between ISC and Reclamation. The ISC is purchasing groundwater rights from a local resident of Fort Sumner, New Mexico, under the State's Strategic Water Reserve Program. The purpose of this acquisition is to augment flows of the river for riverine habitat maintenance purposes. The ISC has hired a pipeline engineer and has developed a conceptual design for a transmission pipeline that will deliver up to 10 cfs to the Pecos River. ISC expects to have the pipeline design completed before the end of June and under construction soon thereafter if a construction contractor is available. The pipeline and full amount of 1,794 af will be available for delivery by May of 2007.

D) Other proactive measures

The proposed action described above is fully expected to prevent river intermittency. As another safeguard, Reclamation will also practice adaptive management to keep the river flowing. Reclamation has formulated an Adaptive Management Plan for the Taiban Constant alternative. Communication for the Adaptive Management Plan will be carried out primarily through conference calls among the Pecos River Stakeholder Group and preparation of an Annual Adaptive Management Report. Members of the Pecos River Stakeholder Group include the Service, Reclamation, CID, FSID, NMDGF, New Mexico Office of the State Engineer, ISC, U.S. Army Corps of Engineers (Corps), and interested environmental advocacy groups. Other stakeholders, such as the U.S. Geological Survey (USGS), will be contacted when specific information or input is needed.

As a safeguard, Reclamation is also proposing to fund and assist in the capture and holding of shiner in refugia, if necessary. Reclamation proposes to meet with the Service in the Spring of each year to discuss 1) hydrologic conditions, including snowpack levels, estimated runoff, and current and estimated reservoir storage; 2) preliminary plans for irrigation season operations; 3) current condition of the shiner; 4) and if a risk of intermittency exists. If it is determined that intermittency could possibly occur, then Reclamation will proceed to assist the Service in implementing shiner refugia for that particular year. 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 shiner 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 shiner would be collected each spring 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.

During the irrigation season, Reclamation will prepare weekly logs of the conference calls. Reclamation will implement the adaptive management plan within the context of the existing Pecos River water management working group, consisting of federal, state, and local agency managers and representatives, researchers, and water users. Reclamation's authority for participating in this group is described below. A successful adaptive management strategy will include interagency cooperation, long-term commitments, regular communications, and additional meetings as needed. Pecos River stakeholders have different interests, legal rights, and responsibilities with regard to river management. Likewise, there can be fundamental disagreement on flow and habitat needs and the effects of management actions. The adaptive management plan will provide a structure for making decisions, based on changing environmental conditions and will offer a forum to stakeholders to develop a consensus.

Reclamation will take the lead role in facilitating communication. During the irrigation season (March through October), Reclamation will coordinate weekly conference calls on flows and river operations and distribute weekly logs to the stakeholders. The conference calls will be the primary means of coordinating in response to changing conditions along the Pecos River. Key adaptive management indicators such as gage measurements, flows, projected irrigation use and demand, and other criteria will be discussed regularly. During the year, the indicators will be monitored regularly to keep the Reclamation river operations manager informed of changing conditions in the river. The Reclamation river operations manager will be informed as soon as possible (within 24 hours) whenever a key trigger (for instance, river flow reaches a certain level at a specific gage) has been activated. The response process will then be followed.

Reclamation will prepare an Annual Adaptive Management Report after the end of the calendar year. An annual meeting of the Pecos River Stakeholder Group will be held to discuss the status of the adaptive management plan. The focus of the meeting will be on the review of the Annual Adaptive Management Report. The status of the indicators will be discussed and needed changes to monitoring will be identified.

Reclamation will manage the documentation and reporting process for the adaptive management plan. Monitoring results will be incorporated into the Annual Adaptive Management Report. The report will describe the previous water year – January 1 through December 31. Monitoring results for each indicator will be incorporated into the report. In addition, the report will analyze trend data for indicators to determine if responses are needed to long-term changing conditions. The report could include recommendations for monitoring and river management for the next year. The annual report will be coordinated with the annual accounting process. When a trigger has been activated, it will be logged, and the response process will be initiated.

The adaptive management plan is designed to ensure compliance with the BO and the ROD for the Carlsbad Project Water Operations and Water Supply Conservation EIS. Actions currently available within Reclamation authority to change water flows in the Pecos River include (not listed in any priority order): (a) releasing bypass water: (b) releasing FCP water to prevent intermittency; (c) obtaining water from the Carlsbad Project Water Acquisition or Additional Water Acquisition options as described in the EIS; (d) coordinating with CID for block releases; or (e) initiating other similar actions within Reclamation's authority. Such actions will be initiated by Reclamation according to this adaptive management plan in conformance with the BO and ROD.

Interior Least Tern

As part of the proposed action, Reclamation will continue to: 1) Monitor terns to estimate the population size, nesting activity, and identify threats to the colony; 2) coordinate with the NMDGF, 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 CID to avoid flooding nests; and 5) report monitoring activities and results to the NMESFO.

II. Status of the Species/Critical Habitat

Pecos Bluntnose Shiner

A. Species/Critical Habitat Description

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 relatively small, moderately deep-bodied minnow, rarely exceeding 3.1 inches (in) (80 mm) total length (TL) (Propst 1999, Hoagstrom 2003a). 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. 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. Additional details on shiner morphology can be found in the 2003 BO (Service 2003a).

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 2003 (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. Based on current information presented by Reclamation (Reclamation 2006) and the NMFRO (Service 2003b), the current occupied range of the shiner is from the confluence of Taiban Creek with the Pecos River to Brantley Reservoir. Shiners have not been found in the reach above Taiban Creek since 1999, even though there are no apparent barriers limiting shiner access to this area (S. Davenport, Service, electronic message, 2006).

This change in boundary, eliminating approximately 5 mi (8 km) between the Old Fort Sumner State Park and Taiban Creek, reduces the occupied range to 186 mi (298 km).

For purposes of surveys and habitat considerations, the Pecos River from Sumner Dam to Brantley Reservoir was divided into three reaches (Figure 1) (Hoagstrom 2003a,b). 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 BO to describe the population status of the shiner and its habitat. The “stronghold” for the species occurs in the Rangelands reach (Hoagstrom 2003a). Habitat availability and suitability are the best within this reach of the river, all size classes of shiner are found, and population numbers are relatively stable (Hoagstrom 2003a,b).

Critical Habitat

Shiner critical habitat is divided into 2 separate reaches designated as upper and lower critical habitat (Figure 2) (Service 1987). Upper critical habitat is a 64 mi (103 km) reach 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). Upper critical habitat is encompassed within the Rangelands reach (shiner stronghold), but approximately 36 mi (58 km) are contiguous with, but downstream of, upper designated critical habitat. This area is referred to as “quality habitat,” even though it is not designated as critical habitat. Lower critical habitat is a 37 mi (60 km) reach extending 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 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, Hoagstrom 2003a). 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 (Hoagstom 2003a). The ability of lower critical habitat 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. The lower 36 mi (58 km) of the Rangelands reach (quality habitat) is located in this middle section, and the USGS Acme gage represents flows in this area. When flow is maintained in this middle section, as it was between 1991 and 2001, this area contains excellent habitat and supports large numbers of shiners (Hoagstrom 1997, 1999, 2000, 2003a). Reclamation has targeted flows of 35 cfs at the Acme gage during the winter, non-irrigation season (November through February) since the 1998 (Service 1998) to ensure maintenance of habitat through this reach of river. Additional irrigation season targets were specified for the Acme gage in the 2003 BO (Service 2003a). The quality habitat between the two areas of critical habitat is acknowledged as an important component for recovery of 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 2003b). 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, Hoagstrom et al. 1995, Hoagstrom 1997, 1999, 2000, 2001, 2003a). 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, Dudley and Platania 1999).

Kehmeier et al. (2004a) evaluated mesohabitat (discrete habitat types such as riffles, backwaters, runs) use and availability in the Rangelands reach between May 2002 and October 2003. While several of the minnow species they observed were described as habitat generalists, they determined that the shiner was a habitat specialist preferring mid-channel plunge-pool habitats. The research did not differentiate among age/size classes of shiner and it is assumed (based on the velocities and depths recorded) that these habitats were primarily adult habitat. Runs, flat-water areas, and pools with low or no velocity were avoided by the shiner. Based on volumetric calculations of the mesohabitats, the authors concluded that the availability of the preferred plunge habitats was less altered by low flows than other types of mesohabitats (Kehmeier et al. 2004a). The importance of maintaining a mosaic of habitat types for movement between the preferred habitat types was also noted (Kehmeier et al. 2004a).

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 proliferate in areas that were formerly intermittent when they remained perennially wet (e.g. the quality habitat 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 quality habitat (Hoagstrom 2000, 2001) and large individual size (see Age and Growth).

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 2003b). Adults most frequently utilized velocities between 0.7 and 0.9 feet/second (ft/s) (21 and 28 centimeters/s [cm/s]). These velocities were typically found in open-water runs, riffles, and shallow pools (Hoagstrom 2002). Large adults (2.1-2.5 in, 55-65 mm) were found in velocities that ranged from 0.15-1.5 ft/s (4.7 to 47 cm/s) with a mean of 1.0 ft/s (30.8 cm/s) (Hoagstrom 2003b). These large adults were primarily found in run habitats (Hoagstrom 2003b). Although Kehmeier et al. (2004a) did not specify the age class of shiner caught, the velocities they recorded in preferred mesohabitats ranged from about 0.6-0.7 ft/s (19-22 cm/s). Juveniles most frequently utilize velocities between 0.2 and 0.5 ft/s (7 and 17 cm/s), which are most commonly associated with shoreline areas (Hoagstrom 2003b). 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 9.0 and 10.6 in (23 and 27 cm) (Hoagstrom 2003b). Juvenile shiners utilize a variety of depths from 8.7 to 11 in (22 to 28 cm) (Hoagstrom 2003b). 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. Kehmeier et al. (2004a) recorded average depths of approximately 9.8 in (25 cm) in mesohabitats preferred by shiner, which agrees with the preferred depths recorded for adults and juveniles by Hoagstrom (2003b).

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.

Two studies that have examined shiner habitat preference and availability came to contrasting conclusions about the amount of flow that would best sustain the population. Hoagstrom (2003b) concluded from annual research conducted between 1992 and 1999 that more suitable habitat (preferred depths and velocities) was available at higher flows (particularly in the Rangelands reach) and that flows between 48 – 72 cfs provided the highest cumulative habitat suitability (Farmlands and Rangelands reaches combined) (Hoagstrom 2003b). In contrast, Kehmeier et al. (2004a) concluded that because shiner preferred mid-channel plunge pools, and these mesohabitats were as available at low flows (3-5 cfs) as they were at higher flows (up to 80 cfs), low flows were sufficient to maintain the population. Determining that the shiner was concentrated in specific mesohabitats contrasts with other reports that indicated that the species was found in variety of habitats (e.g., Hatch 1982, Hatch et al. 1985, Brooks et al. 1994, Hoagstrom 1997, 2002). It is possible that because Kehmeier et al. (2004a) conducted their research in the midst of two severe drought years (May 2002 to October 2003) they may have found shiner more aggregated than usual. In addition, Hoagstrom (2003b) delineated among size classes and their preferences, providing a more complete picture of the needs of all life stages. Age class of the fish captured by Kehmeier et al. (2004a) was not reported. Low flows down to 3-5 cfs may maintain the shiner during periods of limited water availability. However, flow variability, including large peak flow are necessary to support all aspects of the shiner’s life history.

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). Spawning is cued by substantial increases in discharge, including flash floods and block releases of water (Platania 1993, Dudley and Platania 1999).

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. Hatch et al. (1985) examined two females and found 1,049 eggs in one (57 mm standard length [SL]) and 85 eggs in the other (51 mm SL). 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 (Kehmeier et al. 2004b).

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 operations, 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 (Dudley and Platania 1999), but the eggs, larvae, and small juveniles are then displaced downstream because of the lack of low velocity habitats and the sustained high discharge. Displacement from the Rangelands to the Farmlands reach accounts for the large number of YOY and juvenile fish found in this area (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 shiner to survive and spawn below Brantley Reserevoir 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 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, shiners rely upon flow both for delivering food items and for maintaining favorable habitat.

Age and Growth

Based on seine collections, shiner population structure is bimodal (two distinct length classes) from May through August (Hoagstrom 2003a). 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 2003a). 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.

First year and second year individuals are most common 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 1.0 to 1.2 in (026 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 and Farmlands reaches. 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). In addition, 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). 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 over several years produced larger shiners (Hoagstrom 2003a). 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 (Hoagstrom 2003a). Twenty-five percent of the longest shiners caught over an 11-year period (1992 to 2002) were caught in 1999 (Hoagstrom 2003a). 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). Because flows were continuous and higher than normal from 1996-1999, higher velocity habitats that larger adults prefer may have been more available leading to better survival of adults (thus the larger sized individuals).

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 1999). This is primarily because the majority of available habitat is shallow and unsuitable for large fish. 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 1999). When captured during surveys, the majority of these predators have been small (Larson and Propst 1999, Valdez et al. 2003). Thus, low abundance and small size suggest fish predation is not a major threat to the shiner (Larson and Propst 1999). However, the impacts of predaceous fishes within intermittent pools have not been studied and it is possible that they feed on shiner (Larson and Propst 1999). With the increase in intermittent flow days in 2002-2003 (49 days in 2002, 44 days in 2003), there may have been an increase in predation on shiner trapped in pools (Larson and Propst 2003). The reduction in intermittent flow days in 2004 to eight days, and none in 2005, may have reduced the risk of predation.

Aerial and terrestrial piscivores may also threaten the shiner. 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). Larson and Propst (2004) reported that the tracks off several predators, including Great blue heron, raccoon, and coyote, were seen around isolated pools that occurred during river intermittency in 2002.

C. Population Dynamics

In 1991, Reclamation received a BO from the Service for operations on the Pecos River that included a Reasonable and Prudent Measure directing them to fund 5 years of research activities to determine the biologic and hydrologic needs of the shiner (Service 1991). To that end, in 1992, the NMFRO began a 5-year study on the shiner and its habitat. Research on the shiner population has continued, resulting in a 14-year record of population trends (1992-2005) (Fagan 2006). Population sampling has been conducted three times or more per year at 10-20 sites on the Pecos River since 1992. The timing of sampling is geared to the life history of the shiner. January-April (first trimester) is an indicator of over-winter survival. May- August (second trimester) occurs within the spawning season. Because the larval fish are too small to be caught by the seines this trimester is a reflection of the breeding population. September-December (third trimester) represents post-spawning and is when YOY are most abundant. In addition, because this time period occurs after intermittency is most likely, it is an indicator of the population’s response to this stressor.

Over the 14-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 rare in this part of the river and are infrequently collected (Hoagstrom 2003). No shiners have been caught in the Tailwaters since 1999 (S. Davenport, pers. comm., 2006). Therefore, the Tailwaters reach will not be discussed further. The remainder of this discussion will focus on the Rangelands and Farmlands reaches that remain occupied by the shiner.

From 1992-1999 shiner density within the Rangelands reach showed a gradual increase (Brooks et al. 1993, Brooks and Allan 1995, Hoagstrom et al. 1995, Hoagstrom 2003a, Fagan 2006). During these years there was a normal snow pack and spring runoff, frequent local summer 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 on block releases. Cooperation, brought about by a Memorandum of Understanding among the stakeholders on the Pecos River, enabled the experimental operations to occur and facilitated maintaining permanent flows throughout this period (Service 1991).

In 1999, New Mexico entered a period of sustained drought (Liles 2000a,b). By 2001, there was a reduction in reservoir storage to 60 percent of normal and river intermittency occurred (4 days) for the first time since 1991 (Table 1). Conditions in 2002 were even worse, with April 1 reservoir storage at 26 percent of normal. Intermittency was extensive that year with 49 days of no flow at the Acme gage and 63 days with flow less than 1 cfs (Table 1). Severe drought conditions persisted into 2003, with reservoir storage on April 1, 35 percent of normal, 44 days of 0 flow recorded at Acme gage, and 97 days of less than 1 cfs (Table 1).

From the long-term population surveys, it appears that the prolonged and extensive intermittency that occurred from 2002-2004, in combination with limited spawning opportunities had a negative impact on the shiner population (Figures 3 & 4 Tables 2,3,4) (NMFRO 2006, Fagan 2006). No other physical or biological factors have been identified that would lead to such a pronounced decline in population density. Both the relative abundance and shiner density dropped precipitously in the Rangelands reach, where the habitat is the best and where we would expect the population to be the most resilient. The years from 2001 to 2005 will be discussed in more detail in an effort to explain the patterns in population trend seen in this time frame. If not stated explicitly, all reference to flows in the following discussion are those recorded at the Acme gage (08386000) and all information is available on the USGS website (http://waterdata.usgs.gov/nm/nwis/uv/?site_no=08386000&PARAmeter_cd=00065,00060). All reference to shiner density and trend are displayed in Figures 3 and 4 and Tables 2-4 (S. Davenport, Service, pers. comm., 2006b).

In 2001, 4 days of intermittency occurred (Table 1) and the population trend continued upward (Figures 3 & 4). Most likely intermittency was not extensive enough to cause direct mortality of shiner and the population was still expanding, bolstered by the strong year classes produced in the proceeding years. In 2002, in the Rangelands reach, the first trimester (January to April) again showed an increase in density up to a high of about 47 fish/100 m^2, the highest density recorded from 1992-2005 (Table 3). However, in trimesters two and three, after intermittency occurred, density dropped down to 12 fish/100 m^2 and 10 fish/100 m^2, respectively (Table 3).

In contrast, density of shiner in the Farmlands reach the first trimester of 2002 began relatively low (10 fish/100 m^2) but then was extraordinarily high during the second trimester (74.4 fish/m^2), the highest value recorded in Farmlands between 1992-2005 (Table 4). Because there was only one block release that year (in March before spawning would occur), transport of larval fish into the Farmlands reach does not explain the increase in density. Four small flood events occurred in the 2002 spawning season (late April to September). The first (June 14), occurred after 24 consecutive days of intermittency and was of short duration (3 days). The second (June 21) was of greater magnitude (1830 cfs vs 672 on June 14), but also lasted only 3 days. The third (July 4), also lasted 3 days, with a peak of 420 cfs. The fourth flood (August 20) occurred between two periods of intermittency, with 21 days of 0 flow before the peak of 651 cfs and with intermittency occurring 12 days after the peak occurred. It is tempting to speculate that the high numbers of shiner found in the Rangelands reach in the first trimester moved to the Farmlands in the second. However, the fish caught in the Farmlands were nearly all less than 35 mm and the majority were caught at Brantley inflow (S. Davenport, Service, pers. comm., 2006c).

In 2003, in the Rangelands reach, shiner density for the first two trimesters was about 27 fish/100 m^2 (Table 3). Extensive drying (44 days of 0 flow, 97 days less than 1 cfs) occurred again throughout the summer of 2003 (Table 1), and in the third trimester the fish density was the lowest recorded since 1992 (Table 3). There was one peak flow event, a small block release from June 21- July 9, which was probably used by the shiner for spawning. Up until the block release, flows all spring had been very low with no peaks. Unfortunately, within 8 days of the block release flows were less than 1 cfs and within 15 days the river entered into a long period of intermittency (30 days). Most likely, this period of intermittency effectively eliminated all nursery habitat within the quality reach of river, and led to the death of many larval fish. There was another very small peak in flow (91 cfs) that occurred on August 30, but once again the flow at Acme was less than 1 cfs within 8 days and it stayed less than 1 cfs until September 22, when the river was again intermittent for several days. Consequently, reproductive success of the 2003 year class was most likely very poor. In the Farmlands reach, fish density increased in both the second and third trimesters, but the increase was very small compared to 2002, 13 and 28 fish/100 m^2, respectively (Table 4).

In 2004, initial density in the Rangelands reach was 2.9 fish/100 m^2, it increased slightly to 6.4 fish/100 m^2 in the second trimester, and declined in the third trimester to 1.5 fish/100 m^2, the lowest recorded in the third trimester since 1992 (Table 3). Because the drought was not as intense in 2004, intermittency was limited to 8 days. However, there was not a peak in flow until June 29 (240 cfs) which tailed off quickly and within 18 days, the river was intermittent. Two more small rain events occurred in August that may have prompted spawning but overall the monsoon season was very poor and probably contributed to another poor year class. Although two block releases occurred in 2004, both were outside the spawning season. One occurred in early March and the other in late September.

In 2005, density in the Rangelands reach for the first two trimesters was 1.1 and 1.0 fish/100 m^2 (Table 3). Although 2005 was a wet year and there was no intermittency, no days less than 1 cfs, and no days less than 5 cfs, there was not an immediate population response. However, in the third trimester, density numbers rose for the first time since 2003, to 4.5 fish/100 m^2 (Table 3).

Density was also up in the Farmlands reach in second and third trimesters to 2.8 and 4.0 fish/100 m^2, respectively (Table 4). These numbers are a positive sign that the wet hydrologic year of 2005 was beneficial to the population.

The combination of three years (2002-2004) with poor monsoonal rains and only one block release between 2002-2004 occurring in the spawning season, indicate the shiner had few opportunities to spawn during these three years. In addition, in 2002 and especially in 2003, very low flows (less than 1 cfs) and intermittency occurred almost immediately after small peak (spawning) flows. These conditions would have greatly limited or eliminated available nursery habitat and most likely led to a severe reduction in the survival and recruitment of two year classes. Because the shiner is short-lived (three years), it does not take long for environmental perturbations to drastically reduce its population numbers. It is our opinion that the combination of few spawning peaks and very limited, or no nursery habitat caused by river drying immediately after spawning from 2002-2004, severely impacted recruitment in the shiner population and led to its population decline.

Intermittency occurs primarily in the quality habitat located between upper and lower critical habitat. When intermittency occurs, typically upper critical habitat (64 mi, 103 km) and lower critical habitat (37 mi, 60 km) continue to have flowing water. The quality habitat between the two designated reaches of critical habit is approximately 36 mi (58 km). Observing such a drastic decline in shiner population, when intermittency is directly affecting a relatively short reach of river, leads us to two possible conclusions. First, although the quality habitat is relatively short, it is disproportionately important to shiner recruitment and reproductive success. It is possible that when this reach has flowing water that creates a variety of habitats, it supports a large number of shiner that contribute towards maintaining the entire population. In particular, if this area is critical nursery habitat, and the nursery habitat dries, the consequences are severe, especially when spawning opportunities are limited. When recruitment fails in the quality reach it has effects system-wide.

A second explanation why the shiner population declined so dramatically with two years of low flows and intermittency is that overall low flows system wide create low grade, continuous stress on the fish. Low flows may lead to increased competitive interactions, increased predation, lower fecundity, or increased susceptibility to disease. Although difficult to observe or detect, these factors could cumulatively lead to increased mortality or reduced reproductive success. Two very stressful years with limited flows could have a large impact on a species that only lives three years.

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 the shiner achieved its greatest relative abundance, 37.5 percent of the cyprinid guild, compared to collections made from 1950-1975, 1976-1985, and 1985-1994 (Platania 1995b). It has never reached that level subsequently (Platania 1995b, Hoagstrom 2003a). The number of shiner per sample in this time frame was 1-1,492, with a mean of 433 per sample (Platania 1995b). The mean number/sample caught in Rangelands reach in 2004 and 2005, was 7.4 and 6.3, respectively with a range of 3-12 (S. Davenport, Service, pers. comm., 2006d) Collections between 1986 and 1990 indicated 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). Based on the discussion in the population dynamics section, it is clear that the status of the shiner is currently at the lowest level seen since consistent monitoring began in 1992 (NMFRO 2006, Fagan 2006).

The Service had the population monitoring data collected through 2004 peer-reviewed by Dr. Fagan, University of Maryland. He concluded that "Regardless of the spatial or temporal scales involved, the population of the Pecos bluntnose shiner has exhibited a steep, severe decline over the period 2002-2004. Measured in terms of abundance (CPUE), the database suggests the PBS was far scarcer in 2004 than it has been over the last decade, with a population structure far more similar to that of 1992 than of any other year in recent history." He went on to say "The PBS database makes clear that the recent decline of the PBS has been system wide, affecting almost all sites, and has occurred independent of one's choice of threshold for abundance or relative abundance." (Fagan 2006)

In 1991, the Service came to the conclusion that Reclamation's 1989 Pecos River Dam operations would likely jeopardize the continued existence of the shiner and adversely modify the critical habitat of the species. That opinion was based on operations that included a block release of 47 continuous days followed by river drying. Reclamation has not had a block release of that duration since that time and block releases are currently limited to a maximum of 15 days. The long duration of the block release transported eggs, larvae, and probably adults into Brantley Reservoir. Subsequent river drying, which could not be controlled because Santa Rosa and Sumner Reservoirs were at very low levels, also had an adverse affect on the species. The shiner population in 1991 was considered to be very low, based primarily on the percent of shiner within the shiner guild compared to historical collections (Brooks et al. 1991). Systematic collections of shiner did not begin until 1992. Because we now how a long term record of population trends based on systematic sampling, we can look back and confirm that population levels at that time were very low based both on density values and percent shiner within the shiner guild. The shiner population is in a very similar situation as it was in 1992, but Reclamation's proposed action (as described in the Proposed Action section) is very different than it was in 1989.

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), and in particular over the last three years (NMFRO 2006, Fagan 2006). The decline is the result of various alterations to the Pecos River, including groundwater pumping, the diversion of water for irrigation, the storage of water in impoundments, and drought. The shiner is now restricted to about 186 mi (298 km) from Taiban Creek to Brantley Reservoir. The action area includes the total remaining population of shiner and its designated critical habitat.

Interior Least Tern

A. Species/Critical Habitat Description

Description of the Species

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). Their 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 (Service 1990). It breeds along the lower Mississippi River from approximately Cairo, Illinois, south to Vicksburg, Mississippi (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 (Service 1990). Current wintering areas of the interior least tern remain unknown (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 (Service 1990).

B. 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 1987a). 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 (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 nest 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 feet (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.

C. 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 (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 (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 were 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). During the 2005 census, water levels at Falcon Reservoir, usually an important nesting area for terns, were high, and the entire 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 year that all major reservoirs in this system were surveyed was 1989, when 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).

D. 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 (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 1993). 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 environmental baseline includes past and present impacts of all federal, state, or private actions in the action area; the anticipated impacts of all proposed federal actions in the action area that have undergone formal or early section 7 consultation; and the impact of state and private actions which are contemporaneous with the consultation process. The environmental baseline defines the current status of the species and its habitat in the action area to provide a platform to assess the effects of the action now under consultation.

<u>Pecos Bluntnose Shiner</u>

A. Status of the species within the action area

The current range of the shiner is wholly within the action area. Status of the species is discussed in section II. “Status of the Species.”

B. Factors affecting species environment within the action area

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 because historical fish collections were few and collectors sampled the river at easily accessible localities such as bridge crossings and villages (Sublette et al. 1990).

Within occupied habitat two reaches of the Pecos River are of poor quality. The Tailwaters reach from Sumner Dam to Taiban is armored with cobble and gravel because sediment-free releases from Sumner Dam have robbed this reach of its fine sediment (Kondolf 1997). In addition the reduction of peak flows is most acute in this reach because releases from Sumner Dam are typically 1,400 cfs (40 m^3/s)or less, leading to a more narrow and confined channel (discussed in greater detail below). Shiners have not been caught in this reach since 1999 (S. Davenport, Service, pers. comm., 2006b). The Farmlands reach from BLNWRMT to Brantley is also of poor quality. The channel is narrow, incised, and the bed silt-armored (Tashjian 1993). Smaller size-classes dominate and the ability of this reach to support self-sustaining populations without transport of individuals from the Rangelands reach is questionable (Hoagstrom 2003a,b). The lack of suitable habitat in these two reaches restricts potential population growth.

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).

In 1940, a survey of river pumps diverting water from the Pecos River found that there were 44 pumping plants from just above Dexter to about eight miles south of Artesia (Farmlands reach). At the time of the survey the pumping plants had a capacity of 189 cfs and irrigated about 7,800 acres (Miller 2006). River pumper diversions from 1956-1991 in this same area averaged 11,300 af/yr. In the early 1990s, ISC began purchasing river pumper rights to help meet Compact deliveries (discussed in more detail in Cumulative Effects section). Currently 10 river pumpers remain and are entitled to 4,785 af/yr. Six of the river pumper’s water rights, totaling 4,425 af/yr, are leased by Reclamation to supplement CID in payment for depletions that occur because of bypass water used to augment flows for the shiner (Reclamation 2005).

The construction of the dams has had many adverse effects on the Pecos River ecosystem over the last 100 years. 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). 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 owned and 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 (owned by Reclamation) 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 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). Sumner Dam also traps sediment that would maintain the sandy river bed that shiner prefer. The release of sediment-free water leads to channel scour below the dam, creating unsuitable habitat (Kondolf 1997).

The effect of upstream water storage and diversion on the downstream reaches of the Pecos River was to reduce the frequency and magnitude of floods (Table 5), reduce winter inflows (Table 6), and reduce summer inflows (Table 7). 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 5). 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).

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). Biological consequences of diminished peak flows 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. One of the reasons that habitat in the Rangelands reach remains suitable, is the presence of tributary streams that add sediment and monsoonal flood flows to the Pecos River. Although infrequent, peak flows as high as 45,000 cfs (1941) have been recorded at Acme (USGS peak streamflow for New Mexico website, viewed April 23, 2006). However, there has not been a peak flow over 10,000 cfs at Acme since 1963 (USGS peak streamflow for New Mexico website, viewed April 23, 2006). Floods in this reach would occur more often if Sumner Dam were not in place.

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 6). 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. Beginning 1998/1999, the winter season operation of Sumner Dam was modified to divert water to storage only when not required to meet downstream flow targets at the Acme gage. Reclamation bypassed flows in the winter to target approximately 35 cfs at the Acme gage. Typically, 5 to 10 cfs were bypassed in November to supplement natural flows in the river. By February or March up to 25 - 30 cfs was bypassed, depending on the natural flows. Flows coming into Sumner Reservoir greater than the amounts bypassed to supplement natural flows were stored (Reclamation 2002). This operation continued in the winter 2006, but will be modified under the new proposed action (i.e., target flows have been moved from Acme to the Taiban gage).

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 7). 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. From 1999 – 2006, Sumner Dam operations were modified to bypass water that was 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.

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 feeds 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.

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. 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 2006 (not including the years in which block releases were modified for hydrologic studies). The average annual number of block releases per year from 1990-2001 was 2.6 (not including the years in which block releases were modified for hydrologic studies). 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.

Block releases can provide a cue for spawning, help maintain channel morphology, and if timed correctly, can alleviate intermittency (Tetra Tech 2003, Reclamation 2006). Block releases that occur during the spawning season from May through September transport semi-buoyant shiner eggs and larvae out of the favorable habitat reach of the Rangelands, and into the less suitable Farmlands reach or 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 habitat complexity, the rate of egg and larvae development, and water velocity (Platania and Altenbach 1998, Kehmeier et al. 2004b). Swifter currents and a more uniform channel 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 between the Rangelands and Farmland reaches is not as pronounced when the total is less than 65 days per year. 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 10-15 days. 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, Kehmeier et al. 2004b).

Two studies of egg transport in the Pecos River have been conducted with contrasting results (Dudley and Platania 1999, Kehmeier et al. 2004b). Both studies concluded that egg retention was greater in the Rangelands reach where complex habitats exist at higher flows leading to greater egg retention. In the Farmlands reach egg retention is much poorer. However, the studies differ greatly in their overall estimates of egg retention with Kehmeier et al. (2004b) estimating that 92 percent of shiner eggs would be retained above Brantley Lake and Dudley and Platania (1999) estimating that 40 percent would be retained.

Because the methods of the two studies were different it is difficult to evaluate which provides the better estimate. The studies used different artificial eggs which may account for part of the difference. Although both studies used eggs of appropriate density, Dudley and Platania (1999) used cylindrical nylon beads that were 2.5 mm in diameter and did not degrade. Kehmeier et al. (2004b) used gellan beads, 3-4 mm in diameter which are more delicate (Dudley and Platania 1999, Reinert et al. 2004) and may have deteriorated under the experimental conditions of river transport (leading to higher estimates of retention). Dudley and Platania (1999) tested eight different types of artificial eggs, including gellan beads, in comparison to semibuoyant fish eggs and determined that the artificial eggs they used were the optimal mimic for use in their research.

The second major difference between the studies is when the eggs were released. Kehmeier et al. (2004b) released their eggs 24 hours after the beginning of a block release (on the ascending limb of the hydrograph), whereas Dudley and Platania (1999) released midway into a block release in some trials or on the descending limb of the hydrograph in another. Kehmeier et al. (2004b) purposefully released at the beginning of the block release because they felt this best mimicked when the shiner would be spawning and the eggs would be entrained in a pattern that reflected natural conditions (i.e., higher retention). However, because of the limited numbers of adult fish and large number of juvenile fish located in the Farmlands reach, there is no doubt that large numbers of eggs and larvae are transported to this reach from upstream.

Historically, 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 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). At the turn of the century the natural discharge of groundwater to the river was approximately 235,000 af per year (Fiedler and Nye 1933). This equals a flow of 325 cfs entering the river. 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). In 1966, a Partial Final Decree adjudicated all groundwater rights in the Roswell artesian basin in Chaves and Eddy counties, and meters were installed on wells. Metering helped regulate use but in 2002, total pumping in the Roswell artesian basin still equaled 376,885 af (Miller 2006). In 1975, water levels in the Roswell artesian basin were at their lowest recorded levels, approximately 70 ft below their original level (Balleau 1999). By 1995, the aquifer had recovered approximately 30 ft, but is still 40 ft below its original level (Balleau 1999).

Based on historical evidence and population monitoring conducted since 1992, river intermittency is considered the primary environmental factor that has led to the recent decline of the shiner (Service 1987, Hoagstrom 2003a, NMFRO 2003, 2006). Consequently, the amount of river intermittency that has occurred and some of the factors that have contributed to it in the last three years will be discussed. The Acme gage occurs below upper critical habitat and is in the quality habitat reach of river that provides excellent shiner habitat when the river is flowing. It is also in the reach of river that is susceptible to intermittency. Annual mean runoff at the Acme gage is an indicator flow through this important reach of river (Table 1). 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 (Table 1).

In the Pecos River, flows of 5 cfs or less are indicators that intermittency is imminent. Once this sand bed river reaches these low levels, especially during hot, dry, windy weather, as is common in this part of the state, intermittency can occur very quickly. Also because the channel shifts often, there is an appreciable amount of gage error. Finally, Acme is only one point in a long reach of river that is prone to intermittency. Even though a very low flow may be recorded at this site, intermittency may have already begun at another point on the river. For these reasons, it is important to look not only at the days of 0 flow but those in which less than 1 and 5 cfs were recorded. It is clear from this record that extensive intermittency occurred in 2002 and 2003 (Table 1).

Reservoir storage (the sum of Santa Rosa, Sumner, and Brantley reservoirs) is also an indicator of the amount of water that will be available for all uses for the year (Table 1). The average amount of storage is 133,500 af. Storage in 2002 and 2003 was very low and limited the options for water management. Although storage in 2004 was even worse than on the previous two years on April 1, by the end of April storage was up to 80,700 af. In contrast, at the end of April in 2003, storage was only 36,000 af. (http://www.wcc.nrcs.usda.gov/cgibin/bor2.pl?state=nm&year=2004&month=5&format=text, viewed April 26, 2006).

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 low initial reservoir storage, an early season block release, and continued 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 dewatered approximately 38 mi (61 km), including 10 to 15 mi (16 to 24 km) of upper critical habitat from near the DeBaca County line, downstream (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). Intermittency lasted from May 20 to June 13 (25 days), July 30 to August 19 (21 days), and from September 4 to September 10.

Prior to 2002, there was always a sufficient storage in Sumner Reservoir to meet FSID's calculated water allotment. From May 30 to June 1, 2002, Sumner Reservoir dried, stopping the bypass of water to FSID for 3 days. 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). Repeated releases of small blocks of water from Santa Rosa Reservoir kept Sumner Reservoir from drying again after June 1.

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 through upper critical habitat. Fort Sumner Irrigation District's pumpback operation further reduced the amount of water returning to the river and increased the amount and duration of intermittency downstream (G. Dean, Reclamation, pers. comm. 2002).

In 2003, Reclamation attempted to sustain flows in the Rangelands reach during the irrigation season, and provided 35 cfs at the Acme gage during the winter season. However, reservoir storage was low at the beginning of irrigation season and intermittency in the Rangelands reach occurred on 44 days with 97 days of flow less than one cfs (Table 1). Intermittency occurred from July 25 to August 26, 32 consecutive days, and again from September 21 to October 5.

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

In 2004, intermittency occurred 8 days, July 17 – July 24. Reclamation released water from the FCP 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 2006).

In 2005, there were no days of intermittency. During the winter season, flows at the Acme gage averaged 238 cfs, which is much higher than normal. The high average was caused by the delivery of water to the state of Texas and an early block release in February. In November 2005, the ISC purchased approximately 34,000 af of unused irrigation water from CID that was released to Texas (The Associated Press, November 23, 2005). The sale and delivery of this water to Texas will effectively limit water management options during the irrigation season in 2006, and also means farmers within CID will receive less than their full allotment of irrigation water (Carlsbad Current-Argus February 18, 2006).

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). However, reservoir storage on April 1, was 118,400 af, the highest level since 2000.

Reclamation is currently operating under an interim BO for the 2006 irrigation season; however, the 10-year BO will go into affect 30 days after the ROD is signed and may include part of the 2006 irrigation season. The proposed action for the interim BO is to maintain a continuous river during the irrigation season of 2006 (Service 2006). Because of current reservoir storage and supplemental water operations, the Service expects that the river will be continuous through the irrigation season 2006, benefiting the shiner population.

Interior Least Tern

A. Status of the Species within the Action Area

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 2006; 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).

B. Factors affecting the Species Environment within the Action Area

Historically, the Pecos River had similar characteristics all along its course, including 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 operation of dams and human activities have had many adverse effects on the Pecos River ecosystem over the past 100 years. Upstream water storage and diversions on the downstream reaches of the Pecos River greatly reduced characteristic floods and inflows. Operation of Pecos River dams has caused reductions in lateral channel migration, channel scouring and narrowing, changes in the riparian community, diminished peak flows, and a loss of connectivity between the river and flood plain. Operation of the Santa Rosa and Sumner dams trap sediment needed for tern habitat development and alter the downstream flow regime. The depletion of groundwater, diversion of river flows, capture of sediment by tributary dams, water pollution, and salt cedar colonization also contribute to large scale changes of the Pecos River hydrograph and tern habitat. 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. Downstream of Roswell, the river has become highly incised, further degrading habitat for terns. The reach from Sumner Dam to the FSID Diversion Dam has become incised and armored with gravel and cobble, and no longer provides the sand/silt habitat that terns require.

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 cocklebur (J. Montgomery, 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 has stated that they 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 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 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, 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, NMESFO, 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, NMESFO, 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.

Pecos Bluntnose Shiner

As described in the environmental baseline, the natural conditions in the Pecos River have been modified due to the ongoing water management programs by Federal and non-Federal entities. These ongoing actions are, for the most part, not going to change from their current implementation except as discussed in the Cumulative Effects section of this biological opinion. The proposed action, the Taiban Constant Alternative, as amended, modifies aspects of the current operation of the Pecos River as described in the Description of the Proposed Action and the Environmental Baseline. The current operation is the No Action Alternative from the draft EIS. The effects to the shiner and its habitat from the past implementation of Pecos River management, including discretionary and non-discretionary Federal and non-Federal actions, are documented in the Environmental Baseline.

The effects section looks at the effects of the proposed action, including both new management and continuation of existing management actions by Reclamation, using the current environmental baseline as the starting point.

Block Releases

The proposed action continues the current operational program for block releases with one exception; releases, to the extent possible, will not be scheduled within a six-week period around August 1 of each year to allow larval and YOY as much time as possible to grow before another block release occurs. The larger and stronger the fish are, the greater the likelihood they will not be carried by the strong, steady current of a block release into the Farmlands reach or Brantley Reservoir. The scheduling of releases during this time period can occur if CID determines a need or if such a release would benefit the shiner by preventing intermittency; however, Reclamation would work with CID to schedule needed releases outside of this period. Otherwise, the timing of releases, flow level and duration, and total days per year for releases remains unchanged from current operations.

Continuing Effects from Unchanged and Continuing Operations

Channel maintenance:

Historically, Pecos River channel conditions were the result of the pattern of flows that formed the natural hydrograph. These natural flow patterns shaped the channel width, bed load transport, in-channel complexity, presence of riparian vegetation, and provided connections to the wider floodplain. Changes to this natural hydrograph, as described in the Environmental

Baseline, have resulted in definable changes to the river channel. Because peak flows of 1,400 cfs from Sumner Dam (the maximum amount released during a block release) are lower than the peak flows from pre-dam periods, the current channel conditions are more a reflection of the flow level and frequency of the block releases than the historic hydrograph. The current active channel is between 25 and 50 percent of the channel width in 1900 (Tetra Tech 2000). Other management actions, such as active river channelization and bank stabilization also narrow the channel width and prevent normal functioning of a wide, sand-bed river such as the Pecos. The channel conditions, including channel width, incisement, bedload stability, and bank stabilization by non-native riparian vegetation are reasonably well-defined for the Pecos River (Tashjian 1993, 1994, 1995, 1997, Tetra-Tech 2000, Hoagstrom 2003b).

Changes to river channel conditions that result from changes in flow regimes happen over a short and a long time period. When the hydrograph changes significantly, as it has on the Pecos River, a new equilibrium between physical conditions and the flows that create them is eventually reached. However, it is difficult to know when that equilibrium has been reached, and if it has not, changes to the river channel conditions will continue to occur into the future if the same management is practiced. The status of the Pecos River in this regard is uncertain; however, it is possible to discuss what these future changes may be descriptively, if not quantitatively. Current conditions as described below are from Hoagstrom (2003b).

Current channel conditions in the Tailwaters reach are severely degraded from historic conditions. This reach is incised, armored, and restrained by salt cedar thickets along the banks. The incision and armoring may become more pronounced further downstream in the reach over the next 10 years; however, the current conditions are such that significant additional change is not likely and recovery of the area to historic conditions without artificial manipulation impossible. The reach no longer appears to support shiners due to the lack of sand/silt substrates and channel stabilization that reduces channel complexity (Hoagstrom 2003b).

The Rangelands reach provides suitable shiner habitat that includes a moderately wide river channel, unstable sand substrates, and limited incisement or salt cedar bank stabilization. This reach benefits from the significant inflows of water and sediments from the tributary streams during spring runoff and seasonal rains that provide higher flows than normal base flows and contribute to channel maintenance during the year. High flows in this reach have been affected since the 1937 construction of Sumner Dam, with the 1980 construction of the larger Santa Rosa Dam causing another change in the flow pattern due to its flood control function.

Reclamation assumes that the Rangelands reach has reached equilibrium with the existing flow regime (Reclamation 2006). If so, neither significant changes to the channel conditions or effects to the shiner would be expected. However, if the reach has not come to equilibrium with the post-dam flow regime, then over the next 10-year period we would expect to see additional channel narrowing, incisement, and stabilization occur as a result of the continuation of the restricted number and extent of high flow events, further reducing the amount of suitable habitat available to the shiner. This effect is most likely to be seen at the lower end of the Rangelands reach where conditions already show a greater degree of channel narrowing. USGS gage data from the Taiban and Acme gages indicates that during spring block releases there is less attenuation of the flows reaching the downstream end of the reach than in the summer block releases. In dry years when there is less tributary inflow to support channel maintenance, the amount of channel change may be increased. The amount of change in channel characteristics that may occur cannot be determined; however, if these do occur, there will be a net loss of suitable shiner habitat, as it exists particularly in the lower portion of the Rangelands reach, over time.

In the Farmlands reach, the channel was actively channelized and retains little of its historic condition. Even with this limitation, this reach remains valuable for the shiners because it is perennially flowing. Significant changes to conditions here are not anticipated over the 10-year period without artificial management efforts to open the channel.

Timing of Releases

Block releases can be made at any time of the year but generally occur during the irrigation season. During years when reservoir storage is low, spring releases may draw down Santa Rosa and Sumner reservoirs to the point where there is insufficient storage available later in the summer for a block release. However, in years when water is not available for a block release to prevent intermittency, it is anticipated that under the proposed action as amended, Reclamation will use supplemental water to maintain a continuous river. This is an improvement over current operations.

Spawning cues

Shiners spawn beginning on the ascending limb of a flow increase and block releases provide the same cue as natural flow increases from precipitation events in triggering spawning. In years with few natural events that provide for flow increases, the block release may be particularly important in triggering spawning events. We anticipate that this effect will not change over the period for this consultation.

Transport of eggs and larvae

Because block releases are a trigger for shiners to spawn, the number of eggs and larvae in the river that are available to be carried downstream out of the Rangelands reach to the Farmlands reach and into Brantley Reservoir increases during the release event. The number of eggs and larvae so transported will vary based on a number of factors, including:

- The number of shiners capable of spawning at the time of the release. Adults (age 2) may be capable of spawning earlier in the season (late April through September) than the age 1 adults since the ability to spawn is size-dependent. The peak spawning period (June to August) would provide the greatest numbers of eggs and larvae to be displaced downstream. Since most of the peak spawning period will remain available for block releases, this factor may not significantly change.

- The distribution of adult shiners is a factor, because eggs and larvae produced in more upstream portions of the Rangelands reach may have more opportunity to be diverted onto the floodplain areas by the high flows where velocities are lower and are not as likely to be transported as far down the river (Dudley and Platania 1999, Kehmeier et al. 2004b). Those produced further downstream where the river is channelized and the distance to Brantley Reservoir is less, are more likely to be lost. Egg and larval loss may increase if channel narrowing occurs in the downstream sections of the Rangeland reach over the next 10 years.
- Even with less than 65 days of block releases per year, there is a significant transport of shiner eggs and larvae. Since the number of block releases per year will vary, as will the timing of the releases in or out of shiner spawning season, the yearly transport will vary. Generally, this variance will not change over the next 10-year period as compared to current operations.

Effects from Changed Operations

The potential to restrict block releases in the six-week period around August 1 provides a means to reduce the number of eggs and larvae displaced during a part of the peak spawning season. The extent of this reduction is not determinable because:

- Up to three block releases could occur within the June-August peak spawning season and still avoid the six-week period. This is based on a first release on June 1 for 15 days, no releases for 14 days, with a second release on July 1, and a third release the last week of August. It is not likely that this many releases would be scheduled in this period, but it is not unreasonable to expect at least one before or after the six-week period to ensure CID supplies in Brantley Reservoir.
- Depending on the needs of CID, there can be a block release within the six-week period. The commitment of Reclamation is “to the extent possible” releases would not be scheduled, so there is no absolute protection.

Changes in Flows

The 2003 BO (Service 2003a) set the target flows for the Acme Gage and represents current operations (Table 8).

Table 8. Target Flows at Acme Gage for No Action Alternative (current operations).

Season	Dry Year	Average Year	Wet Year
Winter (Nov-Feb)	35 cfs	35 cfs	35 cfs
Irrigation (Mar-Oct)	None	20 cfs	35 cfs

The proposed action, as amended, represents a potentially significant change in management of river flows between Sumner Dam and Brantley Dam. The key change in the operations is the relocation of the target flow location from Acme Gage upstream approximately 110 miles to the Taiban Gage. Acme Gage is in the quality habitat below critical habitat. Operations from 1998-

2005, provided for flows of at least 20 to 35 cfs at Acme at all times except in the summer of drought years. The new operations target 35 cfs at Taiban Gage during all seasons and hydrologic conditions. Based on USGS daily gage data for the same period, flows at Acme Gage are generally lower than those at Taiban Gage, with the exception coming after precipitation events that increase flows below the Taiban Gage.

Reclamation's modeling for the draft EIS and in the BA provides a means to compare the various alternatives to each other using the 60-year historic flow dataset as the model input. The results of this model are not predictive of actual future conditions or actual amounts of water. They do provide a comparison between effects given the same underlying set of hydrologic conditions. The model runs provided a dry year 53 percent, an average year 31percent, and a wet year 16 percent of the simulation years. The actual effects on shiner habitat in the Pecos River from the implementation of any alternative are not known since the actual future hydrology is not known. This analysis is based on the comparison of effects of the alternatives to shiner habitat based on the modeling, and thus does not indicate what actual conditions will be.

In determining the amount of supplemental water needed to meet the requirements of the EIS alternatives, Reclamation modeled Pecos River flows to assess the amounts of water needed and the resultant flows at the various gage points on the river. These model results do not completely track the effects of the proposed action as described in this BO due to changes made to the proposed action (addition of supplemental water) during the consultation period. However, the existing modeling data remains useful to compare the differences between current operations and the proposed action in terms of comparative amounts of water provided to the river.

Current operations provide for 0, 20, and 35 cfs during the summer irrigation season at the Acme Gage, depending on hydrologic year (Table 8). We have included the Dunlap Gage as a reference point for flows in the upper critical habitat area that would also change due to the proposed action. The following information is taken from Appendix A from the draft EIS (Reclamation 2005). The numbers in parentheses in the cells for the Taiban Constant (proposed action) are the net change compared to current operations at that gage. This information reflects the average for flows over the entire year and is not separated into flows expected in the summer and winter.

Reclamation determined the amount of water that would be needed to meet the flow targets for the alternatives (Reclamation 2005). For current operations, 10,700 af of water would be needed. Of this, bypass flows from Sumner Dam would provide 7,800 af. The amount of additional water needed is 2,900 af. The proposed action would only require 2,600 af, of which bypass flows provide 1,900 af and only 720 af of additional water is needed. This results in a loss of 8,100 af of water flowing through the Rangelands reach due to the proposed action. This is a reduction of 75 percent of the water needed under current operations and likely will have significant effects to the flows present throughout the year. With the change in the proposed action to maintain continuous flow in the Pecos River (at least 5 cfs at Acme Gage), the amount of water required will be higher than shown in this model scenario.

Winter Flows

For shiner to overwinter successfully, sufficient habitat based on water depth and velocity to provide complex and heterogeneous habitats with adequate cover and resistance to anchor ice (full freezing of the water column) must be available for all sizes of shiners. Very low flows that do not provide for deep waters with sufficient velocity to resist ice formation will limit the available habitat and limit overwinter survival. Even with sufficient depth available, water temperatures may be lower due to reduced flow through the area.

Reduction in habitat area available also results in an increase in the density of fish using these habitats. Shiners are only a minor component of the total fish population of the Pecos River, and the same overwinter habitats must suffice for the total population. Crowding during the winter may not be as meaningful a stressor as it can be during the warmer seasons; however, limits on available space are likely to result in higher overall mortality of fish, including the shiner.

Effects to the shiner from the reduction in winter flow focus on the reduction in the amount of habitat area available as a result of the lower flows. The amount of suitable habitat available at different flows is difficult to determine, although both Hoagstrom (2003b) and Kehmeier et al. (2004a) have provided information relative to habitat availability and use. The two primary features are water depth and velocity, with complex habitats providing greater opportunities for the combination of suitable depths and velocities preferred by different size classes. While suitable habitat may exist in areas with low flows (Kehmeier et al. 2004a), flows below 24 cfs provide less suitable habitat than higher flows (Hoagstrom 2003b). For this analysis, we will use 24 cfs as a representative flow that would support shiner habitat in the winter.

The provision for flows of at least 35 cfs at the Acme Gage during the winter as part of current operations provides a means to maintain the winter flows above 24 cfs to provide overwintering habitat. Based on average monthly flow data, this 24 cfs threshold was met in 19 of 24 months between the winter of 1998-1999 and February 2004 (Table 9). The winter of 2000-01 accounted for three of the five occurrences when 35 cfs was not met, with the remaining two events occurring in November 2001 and 2003. With the reduction in amount of flow at Acme Gage due to the change to the Taiban Gage location, and assuming a 5 cfs loss, over the same period of record, an additional two months would not have maintained 24 cfs. Because of fluctuations within each month over the period, there were considerably more days with flows below 24 cfs and if these occurred for an extended period with in a month, even a month with an average over 24 cfs may have experienced a short-term (1-10 days) period of reduced habitat availability that could have resulted in increased stress or mortality. Data from the Dunlap Gage, located within the upper critical habitat area, also show the effects of attempting to meet a 35 cfs target at the Acme Gage

Table 9. Monthly average flow data for Taiban, Dunlap, and Acme gages. Bolded letters indicate a change in comparison to the current operations. Last column only examines times when Taiban Gage is between 35-40 cfs.

Year and Month	Taiban Gage	Dunlap Gage	Acme Gage	Acme Gage over 24 cfs	With target for Taiban = 35cfs
1998-November	61.5	79.8	147	Y	
1998-December	40.6	40.0	51.4	Y	Y
1999-January	39.5	37.8	40.9	Y	Y
1999-February	35.5	30.5	37.3	Y	Y
1999-November	45.7	53.5	43.6	Y	
1999-December	41.6	43.1	32.5	Y	
2000-January	44.6	43.4	30.2	Y	
2000-February	355	315	375	Y	
2000-November	36.2	43.3	58.4	Y	Y
2000-December	25.4	28.3	23.4	N	
2001-January	20.9	25.3	23.4	N	
2001-February	21.1	19.5	15.6	N	
2001-November	36.2	34.9	21.4	N	N
2001-December	49.5	45.8	31.2	Y	
2002-January	46.2	42.2	34.1	Y	
2002-February	43.0	40.7	32.3	Y	
2002-November	39.0	40.8	31.7	Y	Y
2002-December	42.3	39.3	38.2	Y	
2003-January	42.0	38.5	35.5	Y	
2003-February	34.1	33.8	34.3	Y	Y
2003-November	29.7	27.6	19.2	N	
2003-December	39.1	35.0	26.3	Y	**N**
2004-January	40.1	37.5	28.2	Y	**N**
2004-February	40.3	41.2	34.0	Y	Y

Table 9 also provides information on what flows at Dunlap and Acme gages could look like if Taiban Gage were maintained at 35 cfs. From the information in the last column, Taiban Gage flows of approximately 35 to 40 cfs provide for flows at Acme above 24 cfs in 7 of 10 months.

This actual flow data indicates that maintaining flows of 35 cfs at the Taiban Gage for the winter may not, based on monthly average flows during this dry and average year period, have a meaningful change to flows at Acme Gage. However, as noted previously, monthly averages do not show the range or distribution of daily flows that may impact the amount of shiner habitat on a less than monthly cycle.

Reclamation provided results of modeling for flow exceedence curves (Figure 5.3, Reclamation 2006). Because these are daily flows, this information does provide an index to the change in flows that support winter habitat under the proposed action. Figure 5.3 shows that between 0 and

25 percent of the time, winter flows at the Acme Gage would be slightly higher under the proposed action than under current conditions. At 25-30 percent of the time, the proposed action flows become slightly lower and by 50 percent of the time, these flows stabilize at 20 cfs through the remaining 50 percent. Current operations stabilize at 35 cfs to meet the target, with a drop not occurring until 98 percent. Based on this information, 50 percent of the time, flows at Acme could be 4 cfs below the 24 cfs threshold and 50 percent of the time the flows would be over the threshold with the proposed action.

While the effects of the proposed action on winter flows in the Rangeland reach do not seem to be meaningful in terms of meeting the 24 cfs threshold, there are other ramifications. At low population levels for all fish, including shiners, the habitat available at 20 cfs may be sufficient to provide enough habitats without overcrowding and resultant stressors. At higher population numbers this may not be the case and crowding could adversely affect overwinter survival. We do not have explicit information to document the effects of habitat availability on overwinter survival related to population size and monthly average flows. Using changes to shiner density between the third and first trimesters and monthly average flows for those periods from the winter of 1992-93 to the winter of 2003-04, no clear picture emerges to correlate density at the beginning of the winter with density at the end of the winter and the average flows. If there is a positive relationship, then maintaining 20 cfs during the winter may compromise increases in species density that result from lower summer mortality if the river does not become intermittent. Monitoring of shiners and comparison with winter flows will be needed to assess any connections between density and amount of habitat provided.

Summer Flows

Reductions to flows through the Rangelands reach due to the proposed action are more complex to evaluate. This is because of the variable target flows for dry, normal, and wet years that are defined for current operations. In dry years, intermittency, based on zero flows at Acme Gage, were allowed under the 2003 BO. Maintaining flows through the upper critical habitat reach was the focus (Service 2003a).

Under the proposed action, the target of 35 cfs at the Taiban Gage is anticipated to provide a range of 2 to 20 cfs at the Acme Gage. Reclamation will monitor river flows on a daily basis and will implement its 7(a)(1) activities when necessary to avoid intermittency. This new target exists at all hydrologic conditions (dry, average, and wet years) and significantly reduces the flows previously targeted for average (20 cfs) and wet (35 cfs) years at the Acme Gage. However, it is an improvement over allowing intermittency to occur.

Reclamation provides an exceedence curve for the irrigation season that compares current operations to the proposed action (Figure 5.4, Reclamation 2006). For current operations, daily flows at or above 35 cfs would occur approximately 44 percent of the time. Under the proposed action, daily flows at or above 35 cfs is also expected 44 percent of the time. The proposed action does have a lower median (50 percent) flow; 21 cfs versus 29 cfs, and is lower by 2-4 cfs through to the 88th percentile. It is higher by approximately 2 cfs over the 22-49th percentiles (the figure did not provide the 0-20th percentiles). This figure does not differentiate between the dry, average and wet hydrological seasons

Figures 5.5 through 5.7 provide the exceedence curves for the three hydrologic conditions (Reclamation 2006). The dry year (Figure 5.5) curves for the two alternatives are virtually identical. The 50 percent flow level for both is 18 cfs and both reach 5 cfs at 88 percent. With the modifications to maintain 5 cfs at Acme, this lower end of the curve would improve under the proposed action to prevent flows from dipping under 5 cfs. Under current operations, Reclamation’s commitment was to attempt to prevent intermittence within the upper critical habitat area and there was no target for Acme Gage. The provision for 35 cfs at Taiban Gage does not have any meaningful additional benefit at flows between 20 and 90 percent exceedence, since gage data indicates that flows of 35 cfs at Taiban generally result in higher flows at Acme, and the new Taiban target may be higher than what was needed to only support the upper critical habitat reach. Based on the model data and assumptions about the 5 cfs requirement at Acme, the proposed action provides protection for shiner habitats below the upper critical habitat in the event of very low flows but does not improve the conditions over current operations during the irrigation season over the range of flows projected. The model results provided for a dry scenario 32 years out of 60, so this scenario is the dominant one for the simulation. Shiner habitat would not go dry under the proposed action. However, it is unknown if the reduction in available habitat will be sufficient to provide for appreciable population growth. A possible outcome is recruitment at a level that maintains the existing population.

Figure 5.6 contains the exceedence curve for the average year (Reclamation 2006). The proposed action has higher flows (2-4 cfs) than current operations for flows above 30 cfs at the 46th percentile. Current operations have meaningfully higher flows, up to 10 cfs, associated with the 50 to 100th percentiles. Under the proposed action, the gain to the shiner only occurs at the highest flows that are seen less often than the lower flows that are more common. The reduction in available flows is most noticeable between 20 and 10 cfs, where current operations provide considerably more flows of 20 cfs than does the proposed action, which reaches 10 cfs over the same percentile range.

Recalling the 24 cfs figure that indicated a threshold for habitat, both alternatives provide this about 48 percent of the time. The significant difference is that current operations continue to provide 20 cfs to the 75th percentile, whereas the proposed action only reaches the median (50 percent) before dropping below 20 cfs. Summer periods without intermittency provide for the maintenance of the shiners. Summer periods with good flows provide the opportunity for greater recruitment to the population, in part because of additional habitat and lower mortality. The proposed action provides less of these higher flows than do current operations and has an adverse effect in that regard. Since average flows only make up 18 of the 60 years, and flows over 24 cfs are limited in at least half of those years, the ability of the shiner population to have meaningful increases and have less risk of stochastic event related extinction, is reduced over the current condition.

The wet year scenario shown in Figure 5.7 shows that flows in the proposed action are greater than those of current operations only 34 percent of the time (Reclamation 2006). The greatest differences are in the range of 10 to 40 cfs, where the proposed action shows a decrease of up to 16 cfs. The proposed action falls below 20 cfs at 58 percent, while current operations do not meet that level until 83 percent. Wet years provide the highest flows and depending on the correlation between flow and habitat, the largest amount of suitable habitat. The amount of habitat, particularly if shiner numbers have increased, provides for recruitment events that can increase the population size and provide enough habitat to support the expanded population. The proposed action decreases the amount of flow available for the shiner in wet years over current operations. Wet years occur in only 10 of the 60-year simulation; however, those wet years may be important in allowing the population to expand. Population expansion may be limited under the proposed action.

Summary

The block release portion of the proposed action has a limited beneficial effect for the shiner in that a portion of the peak spawning season would not generally be subject to block releases. This prohibition is not absolute, and, may under dry year scenarios, be violated to ensure that intermittency does not occur by scheduling a block release to raise flows that have reached a dangerously low level.

Reclamation has committed to maintaining continuous flow through the Pecos River as part of the proposed action. This commitment avoids the risk of intermittency that is viewed as the greatest threat to the shiner and its habitat. However, the change in targeted flow location to the Taiban Gage from the Acme Gage is generally adverse to the shiner in terms of a reduction in both summer and winter habitat availability. This loss is split between the two seasons, and serves to reduce the amount of habitat for all life stages in years where available water to support higher flows is no longer available. In dry years, low flows during the summer spawning season are not meaningfully different. While this may only lead to maintenance of population levels in dry years, avoiding intermittency is expected to prevent any further declines, an improvement over current operations.

The present status of the shiner is precarious after significant declines in population resulting from intermittency prior to 2005. Restoration of population metrics to levels seen in 2000-2002 would provide a reduced level of risk from random environmental events such as a disease outbreak or a water contamination event. The model simulations are of little use to predict the hydrologic conditions for the next 10 years. A series of dry years may further stress the population and increase risks. The benefits of increased flows in average and wet years afforded by current operations to allow for additional habitat and enhanced recruitment are less available under the proposed action, and given the current status of the species, this reduction may be meaningful in terms of population conservation.

Effects of Flow-Related Changes to Habitat on Shiners

The previous discussion addressed the changes to the amount of habitat that could be available under the current operation versus that available under the proposed action. The issue was stated in terms of habitat availability; however, the actual effect to the shiner relates to other factors in the habitat that are also related in part to the amount of habitat.

Stressors

Stressors are those conditions that affect the ability of an organism to thrive in its environment. For fish, these include water quality, habitat availability, competition with other species, predation by other species, food resources, and the presence of parasites and diseases.

For the shiner, intermittency is a significant cause for the increase in stressors, particularly water quality, competition, predation, food resources, and parasites and diseases. The biochemical effects of stressors on individuals can be insidious and lead beyond debilitation to mortality. Appendix A describes the action of stressors on parasites and disease in shiners.

Reduction in habitat availability is a consequence of the proposed action. While the stressors in winter and summer are not identical (for example, anchor ice is a winter concern, while water quality degradation due to evaporation and nutrient loading is a summer concern), the categories for the stressors remains largely the same. The literature on the interactions of various fish species and these stress categories is extensive; however, the effect analysis in this BO does not provide the degree of detail on the changes to habitat that would enable a comprehensive review of the literature to assess the significance of the effects to the shiner. Instead, the types of stressors are categorized below.

Habitat conditions include both the amount available and its quality as determined by the presence of the structure and other physical attributes identified as preferred or suitable for the species (Hoagstrom 2003b, Kehmeier et al. 2004a). For the shiner, these include factors identified by Hoagstrom (2003b) and in other papers cited previously in the Environmental Baseline, particularly defined by the complex interaction of water depth and velocity to create areas suitable for all life stages. Changes in the amount of flow will alter the depth-velocity interaction and thus the availability of a range of conditions that constitute suitable habitat. Because habitat suitability is not absolute, that is, there is not one condition that meets the needs of the shiner, the effect of overall reductions in flow may be the creation of one type of suitable habitat to the exclusion or reduction of other suitable types. The created habitat may not meet the needs of all life stages at a level needed to support the population structure. It is beneficial therefore to maintain flows that provide a variety of depth-velocity conditions that meet the needs of all life stages. The habitat needed by different life stages for the shiner is discussed in the status of the species and Environmental Baseline of this BO, and there are significant differences and needs between life stages that must be met by the flows provided under the proposed action.

Related to the amount of habitat is the effect of crowding. This is both an intra- and inter-specific issue. During times when habitat is limited, either in terms of gross area or in the structural components, the number of individuals of all species that must share the habitat becomes an issue. Crowding may be less of an issue in the winter when fish are less active and more individuals may be able to exist in the same area. Summer conditions, particularly as they affect water quality and available food resources, may be more critical and promote greater stress on individuals. Competition and predation are likely to increase in crowded conditions, as does transferal of disease and parasites (Appendix A).

Food availability may become a concern. The shiner relies largely on invertebrates produced outside of the aquatic habitat and are entrained into the river. The proximity of the river to sources of these invertebrates, and the size of the river, are both factors in how much forage will be available for the shiner. Smaller flows are likely to have less entrainment potential based solely on surface area. Such smaller wetted areas may also be farther from the riparian and upland areas that produce the invertebrate forage base. In crowded situations in small habitats, depletion of available forage by the shiners present would affect the individuals. Other food resources not normally preferred would also be limited by other species present in the habitat. The point at which food becomes limiting due to the size of the habitat is not known and likely exhibits considerable variation.

Water quality, particularly temperature, oxygen, and nutrient loading are also likely to increase in concern during times of lower flows because there is both less room and less water to refresh the system. The source of the water during the summer is also a concern for nutrient loading and increases in salinity. Drain return flows from agricultural areas or wastewater treatment have higher nutrient loads and agricultural returns are more saline. If most of the available flow is from these sources and not from clean inflows, evaporation will concentrate these chemicals and degrade water quality as the flow continues downstream. While evaporation occurs at all flow levels, lower flows have more available surface area (particularly in shallow sand-bed rivers like the Pecos River), have higher temperatures, and experience more evaporation. The effects of evaporation will be seen more downstream in the system than upstream as flows decrease.

Interior Least Tern

Operation of Pecos River dams has caused reductions in lateral channel migration, channel scouring and narrowing, changes in the riparian community, diminished peak flows, and reduction in connectivity between the river and flood plain. Operation of the Santa Rosa and Sumner dams trap sediment needed for tern habitat development and alter the downstream flow regime. The depletion of groundwater, diversion of river flows, capture of sediment by tributary dams, water pollution, and salt cedar colonization also contribute to large scale changes in the Pecos River hydrograph and tern habitat. 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. Downstream of Roswell, the river has become highly incised, further degrading habitat for terns. The reach from Sumner Dam to the FSID Diversion Dam has become incised and armored with gravel and cobble, and no longer provides the sand/silt habitat that terns require.

The tern is generally restricted to river segments that have not been heavily altered from historical conditions (Service 1990). Prior to the operation of Sumner and Santa Rosa dams, maximum peak flows in the Pecos River reached 26,200 cfs. Operation of the dams reduced maximum peak flow by 92.5 percent to 1,980 cfs. Sandbar geomorphology 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 habitats 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.

The indirect effects of human disturbance on tern habitats at Brantley Reservoir are an important factor impacting the presence of terns and their reproductive success. The use of all-terrain and four-wheel drive vehicles and watercraft has allowed recreational users to explore areas at the reservoir previously inaccessible other than by foot. Users occasionally violate restricted Wildlife Management areas. Even brief human activity may be enough to directly or indirectly affect the breeding or nesting behavior of terns. Since tern nests consist of shallow or low depressions in the sand and their eggs are virtually indistinguishable from the substrate, nest contents can accidentally be crushed under foot or wheel without being noticed. Displaced adults may be forced to leave their nests, resulting in mortality to eggs or young. Human use of reservoirs can also result in increased predation on terns by introducing additional predators, including dogs, cats, and wild predators that increase around campsites, such as coyotes and rats.

Reclamation is authorized to store a maximum of 40,000 af of water in Brantley Reservoir for the Carlsbad Project (Reclamation 2006). 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 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 has 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.

Reclamation moves water downstream for Project demands and may fill any or all storage space up to the top of Brantley Reservoir's conservation storage; however, this is rarely done. Since storage space is limited in Brantley Reservoir by the State of New Mexico, and any water exceeding the top of conservation storage is remitted, or spilled, to the State, water levels are kept several hundreds of af below the storage limit in case of unexpected flood inflows. However, when water is needed in Brantley Reservoir, for either irrigation or State-line delivery, a large volume is moved to increase the efficiency of Brantley Reservoir storage. This space may be available habitat for terns, and is subject to inundation by flood inflows or upstream releases.

If terns arrive at Brantley Reservoir in spring and cannot find suitable habitat, they could lose an entire season of reproduction and recruitment, as occurred in 2005. 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 within the conservation space, then it is more likely that nests could be inundated by a block release. Adult terns would be able to easily escape this inundation, although the terns would potentially lose some reproduction and recruitment depending upon the timing. Juvenile birds could 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.

There is also risk of inundation of tern nests by flood inflows from upstream weather events. Spring runoff may also occur upstream of Santa Rosa Dam in early spring. The Corps and/or Reclamation may initiate emergency flood operations depending on the fullness of upstream reservoirs, such as Santa Rosa and Sumner, or to prevent exceeding channel capacity. Such balancing of reservoir storage does not occur under normal operating conditions. Emergency bypasses of high spring flows may be necessary to pass water down to lower reservoirs. However, these events would be expected to occur early in spring, prior to tern nesting, and could inundate tern habitat, but not cause mortality to terns.

Effects to Critical Habitat

<u>Pecos bluntnose shiner</u>

Because continuous river flow will be maintained, 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. There is the possibility that the channel is still very slowly changing (narrowing) in response to the much lower than historical flows. It is believed that block releases are maintaining the current channel width and morphology and it is unlikely within the timeframe of this BO (10 years), an appreciable change in morphology will be detected.

<u>Interior least tern</u>

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.

<u>Pecos Bluntnose Shiner</u>

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 above the Taiban gage. 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 have occurred since 2002 and 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 return 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, particularly in times of very low flow.

- 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.

- On March 25, 2003, the State of New Mexico, the United States, CID, and the Pecos Valley Artesian Conservancy District reached a Settlement Agreement to settle the surface water claims of CID and the United States. Among other items, the Settlement Agreement calls for the ISC to purchase up to 6,000 water right acres in CID (2,350 acres have already been bought), up to 11,000 water right acres in the Roswell basin (2,476 acres have already been bought) and up to 1,000 acres from FSID. The water rights acquired will be transferred to augmentation wells developed and operated by the ISC. The well field will be operated to deliver water to the Pecos River to enhance the water supply of CID and to comply with the Pecos River Compact (delivery of water to Texas) (Miller 2006). Addition of water to the Pecos River from these well fields will primarily occur in the Farmlands reach or near Brantley Reservoir. In the Roswell artesian basin 6,000 af/yr and 20,000 af/yr are to be retired from the shallow and deep aquifers, respectively (McCord et al. 2005). One of the goals of the Settlement Agreement is to bring the aquifers in the basin back into hydrologic balance (McCord 2005). Although groundwater levels in the Roswell artesian basin are expected to rise through retirement of lands within Pecos Valley Artesian Conservancy District that are not part of the Settlement Agreement, the Settlement Agreement is anticipated to provide approximately 7,500 af/yr of additional baseflow to the Pecos River in the Farmlands reach by the end of 30 years (Carron 2003).

  Through the Strategic Water Reserve (State bill passed in 2005), ISC can manage water and water rights for benefit of threatened and endangered species. To that end, 1,800 af of water rights that have been retired from property in the FSID area (through the Settlement Agreement) will be used when needed for the shiner (part of the proposed action). Water from this source will be delivered to the Pecos River in the Tailwaters reach via a pipeline (most likely with a 10 cfs capacity).

- On June 9, 1949 the Pecos River Compact was approved by Congress and was signed into law. One of the major purposes of the Compact was to limit New Mexico’s depletions of stream flow at the New Mexico-Texas state line. Depletions were to be limited to those occurring under conditions found in 1947. In 1974, the State of Texas filed a complaint against New Mexico alleging violations of the Compact. In 1988, the Supreme Court determined that New Mexico had under-delivered water to Texas on average, 10,000 af/year from 1950-1983. New Mexico cleared its debt with a payment of $14 million to Texas. However, the court mandated that New Mexico deliver its future water obligations to Texas on an annual basis without ever incurring a cumulative shortfall. Delivery credits are permitted to accumulate with no limits imposed. The court-appointed river master determines New Mexico's compliance with delivery obligations to Texas on the Pecos River each year. The ISC ensures that the state complies with the requirements of the Compact. Consequently, ISC monitors the flow of water in the Pecos River very closely. The New Mexico Legislature, in response to the U.S. Supreme Court order, directed the ISC to purchase and retire adequate water rights on the Pecos River to meet compact obligations. Approximately $33.8 million has been spent on the Pecos River water rights acquisition program and water leases between 1991 and 2004. The ISC estimates that the purchase and retirement of water rights has increased state-line flows by about 8,600 af/yr (NM ISC 2004).

To help meet Compact deliveries, at the beginning of each irrigation season ISC and CID sign a Miscellaneous Purposes contract which allows a certain amount of CID irrigation water (varies by year) to be used for other purposes. The CID Board of Directors decides at the beginning of each irrigation season if there is enough water in storage to provide for all the irrigation needs of their farmers, with enough left over (typically 10,000 af or more) to enter into an agreement. If there is sufficient water, they enter into a forbearance contract with ISC to deliver water to the stateline at the end of the irrigation season. In addition, if at the end of the irrigation season, CID has not used all of their allotted water, they may enter into an agreement with ISC at that time. For instance, in 2005, 34,000 af of water was purchased by ISC from CID in November and transferred to the state line. New Mexico can build a water credit and would like to do so to protect themselves against the possibility of not being able to deliver if a series of very dry years were to occur. Currently, the credit is about 30,000 af but ISC would like over the long-term, to build that credit to 115,000 af.

There are three primary consequences of ISC's requirement to deliver Pecos River water to Texas. 1) ISC competes with agencies such as Reclamation to find available water rights to lease within the basin. This makes it more difficult for Reclamation to secure sources of supplemental water. 2) Water that could be stored for future use is sent to Texas. If CID had not sold water to ISC in 2005, there would have been 34,000 af in storage that could have been used in the 2006 irrigation season and which could potentially have been used to maintain higher flows in the Pecos River for the benefit of the shiner (through block releases). 3) The transfer of water typically occurs in November and December when water transfer is most efficient. However, the amount of water released (1,000 -1,500 cfs) is much greater than the amount of water typically in the channel at that time (50-100 cfs).

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 NMDGF 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-wheel 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 brief human activity can 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 CID will continue to call for block releases that cause the water elevation in Brantley Reservoir to rise, possibly inundating tern nests and habitat.

- Increased agricultural and urban use of Pecos River water, including municipal and private uses, will further reduce optimal river flow and decrease available habitat for terns.

- Capture of sediment by flood-control dams on tributary streams to the Pecos River will continue to decrease the input of fine sediments into the Pecos River. Terns require sand substrate for nesting. Reduction of fine sediment materials can alter substrate composition over time.

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, and the cumulative effects, it is the Service's biological opinion that the proposed Carlsbad Project Water Operations and Water Supply Conservation project, 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.

The Service reached this conclusion because:

1) After a wet year (2005) in which the river was continuous (more than 5 cfs), there was an improvement in shiner density in both Rangeland and Farmland reaches. Evidence to

date suggests that when river flow is continuous, it has a beneficial effect on the shiner. The shiner recovered from very low densities which occurred in 1992, and we anticipate that under the appropriate conditions, it will be able to do so again.

2) 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.
3) The proposed action will provide less overall water to the shiner compared to current operations. Consequently, less habitat will be available for all life stages and there is the possibility that lower flows will increase stressors to the shiner, particularly in the summer. However, we have insufficient information to predict whether habitat availability for any life stage limits population growth and the degree to which this may impact the population.
4) Block releases are in part beneficial (cues for spawning, can alleviate intermittency, help maintain channel morphology) and will be managed in such a way as to minimize their impact on the shiner (15 day maximum length, 14 day minimum between releases, avoiding a 6-week period in August).
5) We do not anticipate that the proposed action will adversely affect the primary constituent elements of critical habitat; clean permanent water, a main channel with sandy substrate, and low water velocity, or alter the function of critical habitat.

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 the action area on the Pecos River represents a relatively small portion of their entire range in the interior United States. 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 of endangered and threatened species, respectively, without a special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. 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 an incidental take statement. Our incidental take statement is specific to juveniles and adults which will serve as a surrogate measure of the eggs and larvae lost to Brantley Reservoir.

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 applicants 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)]

Pecos Bluntnose Shiner

Amount or Extent of Take

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 final BO, take of shiner will occur in the form of harm, harassment, and kill.

It is unknown whether environmental stressors resulting from lower flows in both summer and winter will cause harm, harassment, or death of adult shiners. As a result, this biological opinion assumes, in the absence of meaningful data or research, no incidental take of adult shiners will occur as a result of lower overall flows occurring under the proposed action.

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 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 because when they are transported into the Farmlands reach there is little suitable low velocity nursery habitat available to them. Lack of suitable nursery habitat leads to poorer growth and most likely limits reproductive success of these individuals. 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.

Two studies of egg transport in the Pecos River have been conducted with contrasting results (Dudley and Platania 1999, Kehmeier et al. 2004b). Both studies concluded that egg retention was greater in the Rangelands reach where complex habitats exist at higher flows leading to greater egg retention. In the Farmlands reach egg retention is much poorer. However, the studies differ greatly in their overall estimates of egg retention with Kehmeier et al. (2004b) estimating that 92 percent of shiner eggs would be retained above Brantley Lake and Dudley and Platania (1999) estimating that 40 percent would be retained. Because the methods of the two studies were different it is difficult to evaluate which provides the better estimate and so for the purposes of this incidental take statement, we will use an average of the two studies and assume 34 percent of eggs and larvae would be lost in Brantley Lake.

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, the small size of the species' eggs and larvae, and the wide area over which take is anticipated.

Population density is used as a surrogate measure of incidental take of larvae and eggs by the impact of loss of those larvae and eggs to recruitment of adults into the population the following year. It is also useful for this purpose because there is good baseline data on that measure and it is related to the overall population size. The shiner density has been calculated by year since 1992 (S. Davenport, Service, pers.comm. 2006b). One fish/100 m^2 remains the lowest shiner population density value ever recorded. This value was recorded in the first and second trimesters in 2005 (Table 4) (S. Davenport, Service, pers.comm. 2006b).

Incidental take will be exceeded if:

1) The 2-year running average population density of shiner is less than 2.5 fish/100 m^2 between the time this biological opinion goes into effect and the first trimester of 2008 or is less than 4 fish/100 m^2 by the third trimester in 2008.

2) The 2-year running average population density of shiner is less than 3.5 fish/100 m^2 in the first trimester in 2009 or less than 5 fish/100 m^2 by the third trimester in 2009.

3) The two-year running average population density of shiner falls below 3.5 fish/100 m^2 for the first trimester or 8.0 fish/100 m^2 in the third trimester in any year beginning in 2010.

Table 10. Take schedule for shiner. All values are the two-year running average of density of shiner per 100 m^2. Take will be exceeded if density falls below the value listed. NA = not applicable.

Year	Trimester 1	Trimester 3	Any trimester
2006	NA	2.5	2.5
2007	2.5	2.5	2.5
2008	2.5	4	2.5
2009	3.5	5	NA
2010	3.5	8	NA
2011	3.5	8	NA
2012	3.5	8	NA
2013	3.5	8	NA
2014	3.5	8	NA
2015	3.5	8	NA
2016	3.5	8	NA

Effect of the Take

In the accompanying biological opinion, the Service determined that the level of anticipated take is not likely to result in jeopardy to the shiner or destruction or adverse modification of critical habitat.

<u>Interior Least Tern</u>

Amount or Extent of Take

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 inundation, 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, 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 (Reclamation 2006; J. Montgomery, Service permittee, electronic mail message, August 23, 2004). We therefore estimate that the following numbers of adults and young may be incidentally taken during each of 10 years 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 and/or human recreation, and by harm and/or harassment caused by predation. The eggs and very young, immobile chicks aged 6 days or less may be incidentally taken in the form of harm caused by water levels rising as a result of block releases, human recreation and/or predation. The number of chicks taken per year 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. In each of 10 years, 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, human recreation and/or predation. Some of this age cohort could die as a result of displacement by high water levels or human recreation 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

<u>Pecos Bluntnose Shiner</u>

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

1) Reclamation will partner with Federal, state, and private entities to participate and assist in the completion of ongoing habitat improvement projects on the Pecos River and to restore 1-1.5 miles of quality habitat within the Farmlands reach by 2009 and another 1-1.5 miles by 2014. Activities that restore and optimize the interaction of river channel and floodplain habitats with available flows will be most successful in mitigating the observed displacement of shiner eggs in severely degraded river systems (Medley et al. 2005). The reach that would provide the most benefit for the shiner is from the BLNWRMT south to Hagerman where flows are perennial due to inflow for the Roswell Basin and habitat is degraded (Tashjian, 2006).

2) In coordination with the NMESFO, Reclamation will initiate intensive monitoring whenever flows at Acme Gage drop below 10 cfs.

3) Continue to monitor the status of the shiner population using methods consistent to those used over the last 3 years (Service 2003) to ensure that incidental take of eggs and larvae is not limiting recruitment of adult shiners to an extent that will not sustain the population.

Terms and Conditions

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:

1.1) Reclamation will attend meetings and work with Federal, state, and private entities as a cooperating agency to support and enhance shiner habitat restoration at the Bitter Lake National Wildlife Refuge.

1.2) Reclamation will attend meetings and work with Federal, state, and private entities as a cooperating agency to support and enhance related hydrogeomorphic processes improvements to the reach of the Pecos River north of Dexter Bridge and adjacent to the Bureau of Land Management waterfowl area.

1.3) Reclamation will partner with Federal, state, and private entities to complete habitat improvement projects totaling two meander sequences 0.5-1 mile in length between Dexter and Hagerman.

1.4) Reclamation will partner with federal, state, and private entities to monitor the success of habitat restoration projects in terms of winter and summer habitat conditions through the use of color infra-red videography, at least 4 cross sections within the site, and fish population and habitat use data. Videography should be used to map riparian habitat within each restoration site including in-channel and riparian habitats.

Considerable information is available for these projects including; 1) A restoration design for the Pecos River at BLNWR based on topographic surveys, hydraulic modeling and sediment data (FLO Engineering 1999), and 2) a restoration and flood conveyance improvement design prepared for Chavez County based on topographic data, hydraulic modeling, and sediment modeling (Corps 1999).

The following implements reasonable and prudent measure 2:

2.1) Reclamation's proposed action for the Carlsbad Project Water Operations and Water Supply Conservation EIS includes a supplemental water program with the goal of utilizing water management flexibility and water acquisition options needed to keep the Pecos River continuously flowing.

Because of gage error, fluctuations in river flow, and accessibility to the river, the Service recognizes the difficulties in determining when intermittency in flow occurs on the Pecos River. Because of these difficulties, Reclamation will continuously monitor flows at numerous locations when the Taiban Gage approaches 40 cfs, and/or Acme Gage approaches 10 cfs, and/or there are other non-operational factors which cause concern over river flows. Reclamation, in coordination with the Service, shall intensively monitor the river by the best methods available at the time, including website gage readings, field site verification and surveys, flights to monitor river connectivity, monitoring the video camera, or other technology as it becomes available. Reclamation will verify as soon as sudden changes in flows in the range of the above levels occur and/or when flows approach the levels described.

The following implements reasonable and prudent measure 3:

3.1) In cooperation with the Service and NMDGF, continue population monitoring of the shiner using methods and sites that are consistent with the surveys that have been conducted over the last 3 years.

> 3.1a) Monthly monitoring will be required until the third trimester of 2010.
>
> 3.1b) Monitoring frequency will be reassessed after 2010, but will be conducted at a minimum of 6 times per year.

New sample protocols may be implemented; however, sampling consistent with methods used over the last 3 years must continue concurrently with the new method for at least 5 years so comparisons of the data sets can be made.

<u>Interior Least Tern</u>

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

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

2) Reclamation shall survey and monitor terns throughout the action area of the proposed action and consult with NMESFO if terns are detected at new sites.

Terms and Conditions

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:

1.1) Reclamation shall enhance and/or maintain habitat for terns each year at least three times the size of the 28-ac 2004 tern colony at Brantley Reservoir, equaling 84 or more acres of nesting and brood-rearing habitat by 2007. This habitat shall include the 56 acres cleared in 2006. Tern habitat enhancement sites shall be based on: (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 requires 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 interface with the lakeshore, where possible; 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.

Brood Rearing Habitat:

- 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 where feasible, and 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.

Foraging Habitat:

- 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 physical condition requirements listed in 1.1, Reclamation shall enhance 21 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 and maintained in at least the following three areas: 1) Directly above and behind the 2004 colony site, 2) across the Seven Rivers inlet north of the 2004 colony site, and 3) on a suitable portion of the reservoir where human access is restricted and where predation is minimized. 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) Reclamation shall continue its normal operations and maintenance activities along the Brantley shoreline annually and remove vegetation and stubble to reduce nutrient loading and algae production in the reservoir and achieve the physical conditions described in 1.1.

1.4) In accordance with the physical conditions described in 1.1, Reclamation shall incorporate tern habitat enhancements, such as creation of sandbars and removal of vegetation from nesting and brooding habitat, into the habitat improvement projects for the shiner, in consultation with NMESFO.

1.5) Because terns are sensitive to human disturbance and predation, Reclamation shall work with other willing land managers on a buffer zone of at least 1/4 mile to be maintained around areas where terns are exhibiting breeding behavior and around active colonies to protect them from potentially detrimental actions.

1.6) Reclamation shall coordinate with and update NMESFO on the implementation of these terms and conditions biweekly during April and May of each year. Reclamation shall again meet with NMESFO if terns establish nests that could be subject to take. If terns do not successfully nest in habitat enhancements areas, Reclamation, in consultation with NMESFO, shall use adaptive management methodology to annually modify habitat enhancement locations and/or techniques until a stable colony of terns is established.

The following implements reasonable and prudent measure 2:

2.1) Reclamation shall survey and monitor terns throughout the action area, and consult with NMESFO if terns are detected at new sites. Reclamation shall submit interim update reports to NMESFO at biweekly intervals from June through August. A final report shall be submitted to NMESFO by December 15 of each year.

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. Determine the effective population size of shiners.

2. Determine the extent of shiner movement between reaches.

3. Reclamation should monitor fish health to ensure proposed flow regime is not having adverse physiological consequences for the shiner.

4. 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 reach below BLNWR.

5. The New Mexico Department of Agriculture (NMDA) is currently administering the New Mexico Saltcedar 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.

6. Reclamation should continue to pursue opportunities for leasing water to provide supplemental water to the shiner consistent with state and federal law.

7. Determine water quality impacts on the shiner.

8. 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.

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

10. Conduct a watershed analysis of check dams. Prioritize for removal those structures that have the greatest potential for providing additional sediment into the Pecos River.

11. Color infra-red videography, cross sectional information, and fish monitoring should be used to assess habitat suitability during winter and summer base flow conditions for occupied shiner habitat.

12. In coordination with the Service, Reclamation will pursue Section 10 coverage for FSID.

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.

Interior Least Tern

13. 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.

14. 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.

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

16. 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.

17. 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 terns, the Service requests notification of the implementation of any conservation recommendations by notifying the lead biologist for the tern at the NMESFO.

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 January 20, 2006, request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where 42 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; or (4) a new species is listed or critical habitat designated that may be affected by the action. This consultation is only valid for a period of 10 years beginning 30 days after the Record of Decision is issued for the Carlsbad Project Water Operations and Water Supply Conservation Environmental Impact Statement 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.

Updates of any environmental commitments may require reinitiation of 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 Lyle Lewis (505) 761-4714, Marilyn Myers (505) 761-4754, or Patricia Zenone (505) 761-4718.

Brian Hanson

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

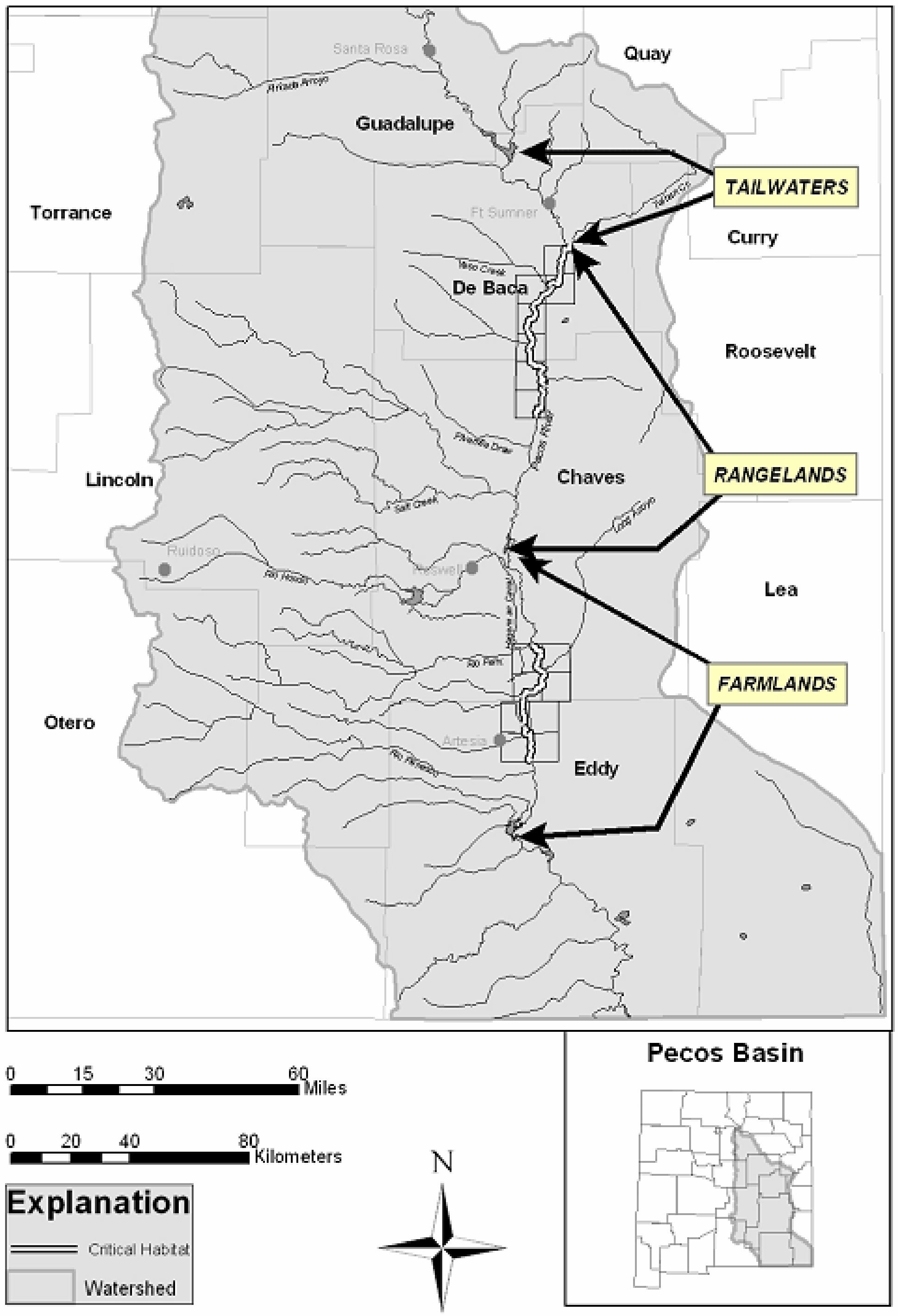


Figure 1. River reaches of similar character designated for Pecos bluntnose shiner research.

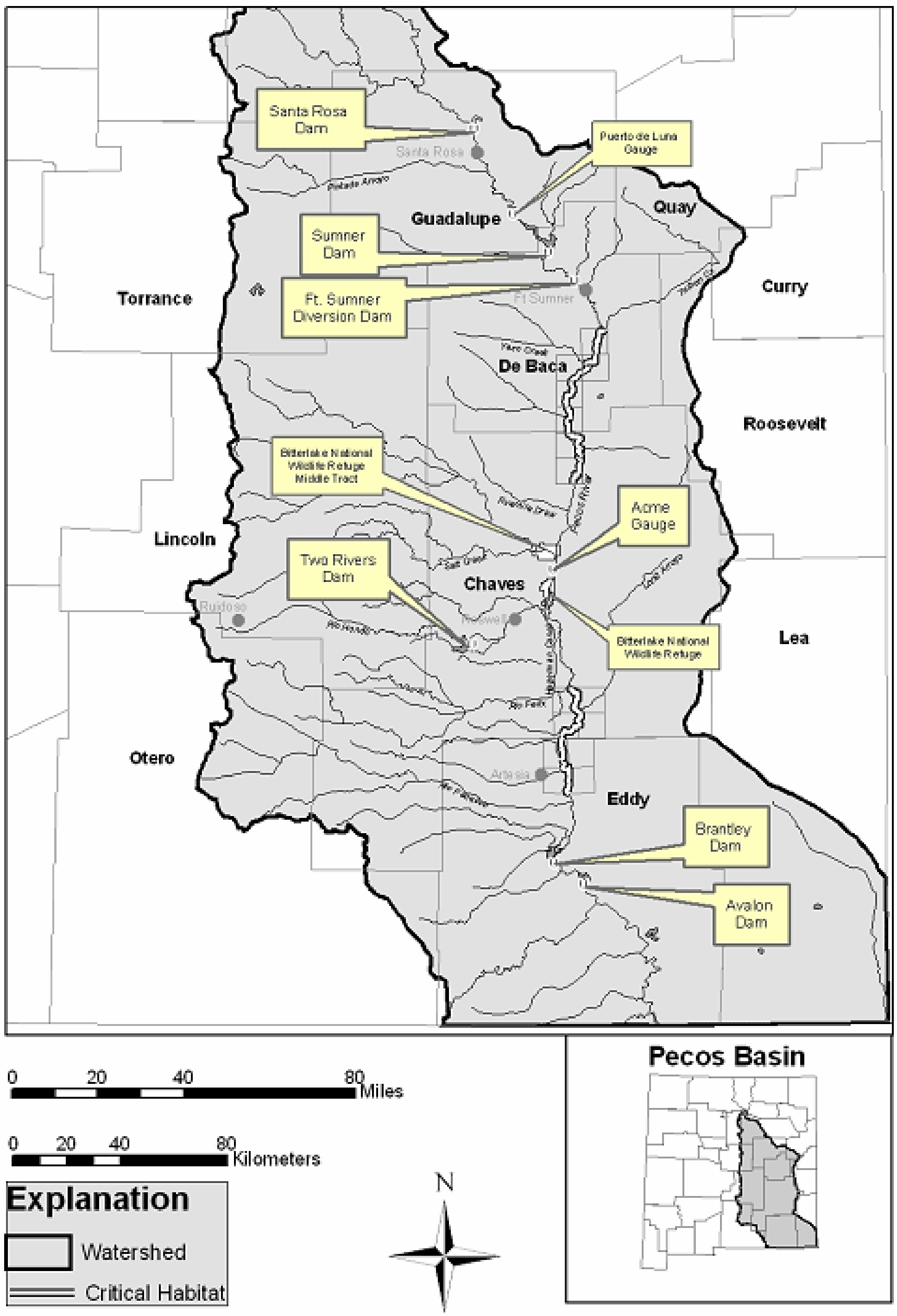
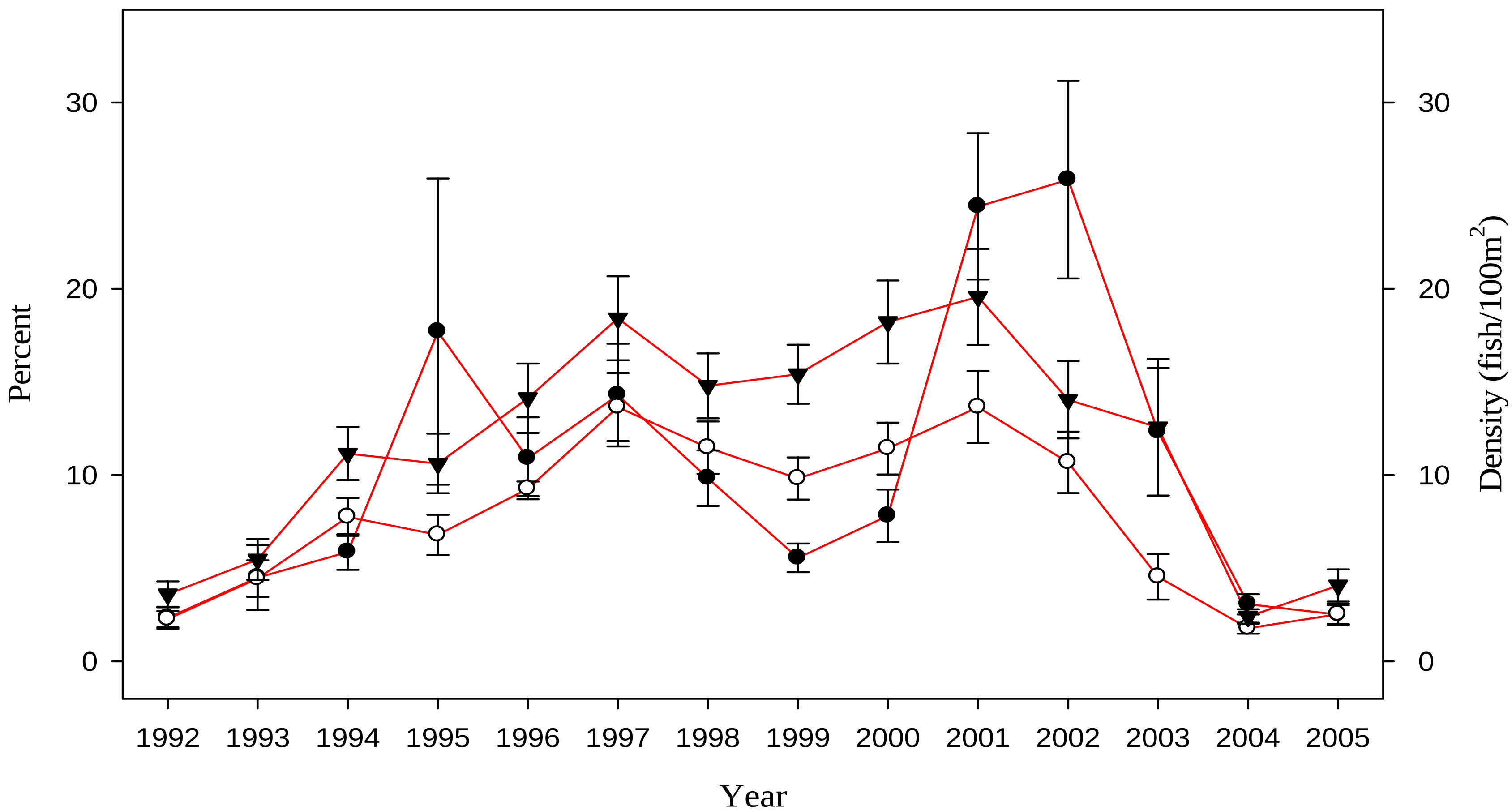


Figure 2. Pecos bluntnose shiner critical habitat, dams and two gauging stations on the Pecos River, New Mexico.

Figure 3. All abundance metrics used to track status and trends of Pecos bluntnose shiner including: density, percent of total fish community, and percent of shiner guild for the years 1992 through 2005. All river sections and trimesters are combined and data is presented with $\pm$ one standard error. Filled in circles = density (fish/100m2), open circles = percent shiner within the total fish community, filled in triangles = percent shiner within the shiner guild. Source: New Mexico Fishery Resources Office 2006.

Figure 4. All abundance metrics used to track status and trends of Pecos bluntnose shiner including: density, percent of total fish community, and percent of shiner guild for the years 1992 through 2005. All river sections and trimesters are combined and data is presented with $\pm$ one standard error, and data is log transformed. Filled in circles = density (fish/100m2), open circles = percent shiner within the total fish community, filled in triangles = percent shiner within the shiner guild. Source: New Mexico Fishery Resources Office 2006.

Figure 3



30
20
10
0
Percent
Density (fish/100m²)
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year

Figure 4

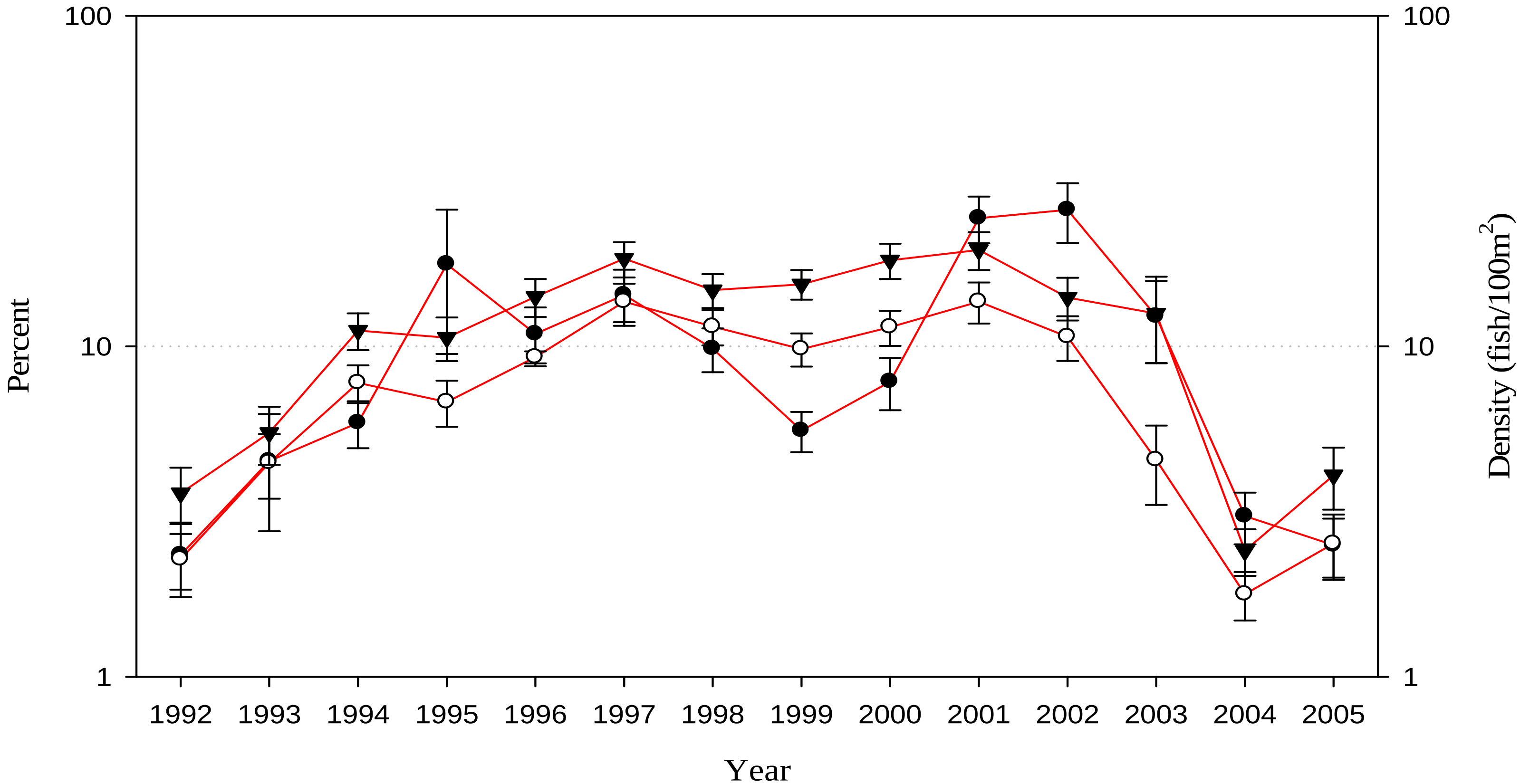

100
10
1
Percent
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
Year
100
10
1
Density (fish/100m2)

Table 1. Annual mean flow (calendar year), days of intermittency (0 flow), days less than one cfs, and days less than 5 cfs as recorded at the Acme gage, New Mexico and total reservoir storage as of April 1 of each year (summarized from U.S. Geological Survey records and Natural Resources Conservation Services, State Basin Outlook Reports).

	2000	2001	2002	2003	2004	2005
Annual mean flow	173	92	72	51	141*	146*
Days of intermittency	0	4	49	44	8	0
Days less than one cfs	0	13	63	97	15	0
Days less than 5 cfs	14	21	75	110	26	0
April 1 reservoir storage	136,600	79,500	35,200	47,100	29,200	115,000

* Provisional

Table 2. Total abundance of Pecos bluntnose shiner (n), seining effort (effort), and mean Pecos bluntnose shiner density (mean density = mean number of Pecos bluntnose shiner divided by area seined x 100). Data presented by four month trimester; Tri 1 = Jan-Apr, Tri 2 = May-Aug, Tri 3 = Sep-Dec for 1992 through 2005. **All three river sections (Tail-water, Rangeland and Farmland) are combined.**

	n				effort				mean density							
	Tri 1	Tri 2	Tri 3	**Total**	Tri 1	Tri 2	Tri 3	**Total**	Tri 1	se	Tri 2	se	Tri 3	se	**Total**	**se**
1992	32	83	218	**333**	3,156	6,828	6,123	**16,107**	1.26	0.9	1.3	0.4	3.6	1.2	**2.3**	**0.6**
1993	103	149	384	**636**	4,712	8,530	3,128	**16,370**	1.75	1.0	1.9	0.5	14.6	7.8	**4.5**	**1.7**
1994	105	238	473	**816**	5,543	5,772	6,314	**17,629**	2.54	0.8	5.3	1.4	8.8	2.0	**5.8**	**0.9**
1995	96	1,534	657	**2,287**	4,361	9,103	6,128	**19,592**	2.37	1.3	28.7	18.9	14.1	3.8	**17.7**	**8.2**
1996	338	384	1,110	**1,832**	5,034	7,040	6,905	**18,979**	9.45	4.9	5.7	1.6	16.4	4.2	**10.9**	**2.2**
1997	381	346	1,224	**1,951**	2,307	3,875	8,034	**14,216**	19.1	9.8	9.1	1.7	15.6	3.4	**14.3**	**2.7**
1998	302	613	866	**1,781**	3,201	6,732	9,558	**19,491**	9.5	2.9	11.1	3.0	8.9	2.0	**9.8**	**1.5**
1999	411	471	999	**1,881**	11,730	9,684	11,082	**32,496**	3.2	0.8	5.2	1.3	8.9	1.7	**5.5**	**0.7**
2000	445	415	1,527	**2,387**	9,417	11,340	11,163	**31,920**	4.7	1.5	3.5	0.7	14.5	3.3	**7.8**	**1.4**
2001	931	1,102	1,241	**3,274**	9,379	2,868	3,390	**15,637**	12.5	4.6	38.7	7.2	35.9	8.7	**25.9**	**4.1**
2002	1,843	504	585	**2,932**	8,056	1,960	3,780	**13,796**	27.4	7.2	31.7	15.6	17.6	5.3	**25.8**	**5.3**
2003	379	286	151	**828**	1,947	1,798	1,708	**5,453**	19.7	7.7	19.5	7.0	12.5	9.9	**17.4**	**4.6**
2004	114	248	118	**480**	4,718	5,709	6,011	**16,438**	2.4	0.8	4.8	1.1	2.3	0.9	**3.2**	**0.6**
2005	90	117	174	**381**	7,648	8,059	4,388	**20,095**	1.2	0.4	1.7	0.6	4.2	1.0	**2.3**	**0.4**
Total	**5,570**	**6,490**	**9,899**	**21,935**	**81,209**	**89,338**	**87,712**	**258,219**	**8.36**	**2.2**	**12.01**	**3.3**	**12.8**	**2.2**	**10.8**	**2.2**

Table 3. Total abundance of Pecos bluntnose shiner (n), seining effort (effort), and mean Pecos bluntnose shiner density (mean density = mean number of Pecos bluntnose shiner divided by area seined x 100). Data presented by four month trimester; Tri 1 = Jan-Apr, Tri 2 = May-Aug, Tri 3 = Sep-Dec for 1992 through 2005. **Rangeland River Section only**.

	n				effort				mean density							
	Tri 1	Tri 2	Tri 3	**Total**	Tri 1	Tri 2	Tri 3	**Total**	Tri 1	se	Tri 2	se	Tri 3	se	**Total**	**se**
1992	12	54	64	**130**	1,391	2,616	2,823	**6,830**	0.7	0.7	2.0	0.4	2.3	5.8	**1.9**	**0.3**
1993	21	65	76	**162**	1,932	2,623	583	**5,138**	1.1	0.5	2.6	0.6	13.0	0.8	**3.4**	**0.9**
1994	60	116	85	**261**	2,109	1,602	2,117	**5,828**	3.2	1.0	7.5	1.3	4.8	1.9	**5.1**	**0.9**
1995	62	148	56	**266**	1,484	3,162	1,635	**6,281**	5.1	4.1	4.7	0.8	4.0	0.9	**4.6**	**1.1**
1996	117	161	364	**642**	1,546	2,223	2,382	**6,151**	10.1	3.3	7.9	3.2	15.7	5.2	**11.8**	**2.6**
1997	110	272	850	**1,232**	1,002	1,862	3,795	**6,659**	15.4	5.4	14.3	2.3	23.6	5.8	**18.6**	**2.1**
1998	237	392	574	**1,203**	1,692	3,444	6,012	**11,148**	14.3	3.5	15.6	5.1	10.2	2.2	**12.8**	**1.6**
1999	385	246	505	**1,136**	8,346	4,689	6,066	**19,101**	4.3	1.1	5.6	1.4	8.5	2.0	**5.8**	**0.9**
2000	232	279	585	**1,096**	5,061	5,565	5,985	**16,611**	4.8	1.7	5.0	1.0	10.9	2.4	**7.1**	**1.1**
2001	560	456	413	**1,429**	4,083	1,561	1,389	**7,033**	18.0	8.2	30.4	7.5	30.8	8.3	**24.8**	**4.8**
2002	1,541	127	219	**1,887**	3,405	1,116	2,319	**6,840**	46.6	11.2	11.8	3.4	9.6	1.9	**28.0**	**6.4**
2003	352	206	22	**580**	1,245	896	912	**3,053**	29.1	10.1	25.7	10.4	2.4	0.6	**20.2**	**5.8**
2004	79	190	57	**326**	2,936	3,306	3,855	**10,097**	2.9	1.1	6.4	1.3	1.5	0.3	**3.6**	**0.6**
2005	65	48	121	**234**	4,809	5,115	2,960	**12,884**	1.1	0.5	1.0	0.2	4.5	2.4	**2.2**	**0.6**
Total	**3,833**	**2,760**	**3,991**	**10,584**	**41,041**	**39,780**	**41,398**	**123,654**	**11.2**	**3.5**	**10.0**	**2.4**	**10.3**	**2.4**	**10.7**	**2.3**

Table 4. Total abundance of Pecos bluntnose shiner (n), seining effort (effort), and mean Pecos bluntnose shiner density (mean density = mean number of Pecos bluntnose shiner divided by area seined x 100). Data presented by four month trimester; Tri 1 = Jan-Apr, Tri 2 = May-Aug, Tri 3 = Sep-Dec for 1992 through 2005. **Farmland River Section only**.

	n				effort				mean density							
	Tri 1	Tri 2	Tri 3	**Total**	Tri 1	Tri 2	Tri 3	**Total**	Tri 1	se	Tri 2	se	Tri 3	se	**Total**	**se**
1992	20	27	154	**201**	971	2,853	2,344	**6,168**	2.7	2.6	1.3	0.8	6.5	2.8	**4.0**	**1.5**
1993	82	70	308	**460**	2,422	4,518	1,619	**8,559**	2.5	1.9	1.8	0.8	20.7	13.5	**6.1**	**3.1**
1994	45	112	388	**545**	2,342	3,262	3,081	**8,684**	2.8	1.5	5.1	2.2	13.6	3.0	**7.8**	**1.6**
1995	34	1385	601	**2,020**	2,184	4,077	3,401	**9,663**	1.5	0.7	54.7	37.4	21.5	5.7	**29.9**	**14.7**
1996	221	223	746	**1,190**	2,358	3,209	3,496	**9,063**	13.0	9.2	7.1	2.5	22.0	7.2	**14.5**	**3.8**
1997	271	74	374	**719**	1,074	1,713	3,423	**6,210**	28.0	22.8	4.4	2.1	11.2	4.3	**13.2**	**5.8**
1998	65	221	292	**578**	1,254	2,796	2,817	**6,867**	5.5	5.5	7.7	3.1	9.6	4.8	**7.9**	**2.4**
1999	26	225	492	**743**	2,697	3,954	4,083	**10,734**	1.1	0.6	6.2	2.5	11.9	3.5	**6.7**	**1.7**
2000	213	136	942	**1,291**	3,990	4,734	4,182	**12,906**	5.1	2.8	2.7	1.0	22.7	7.0	**10.3**	**3.0**
2001	371	646	828	**1,845**	4,558	1,084	1,860	**7,503**	9.1	5.5	58.1	9.5	45.3	15.2	**31.7**	**7.2**
2002	302	377	366	**1,045**	4,030	541	1,461	**6,033**	9.3	6.3	74.4	41.5	27.0	10.4	**26.8**	**9.8**
2003	27	80	129	**236**	701	671	570	**1,944**	4.0	3.4	13.4	10.2	28.4	24.5	**16.0**	**8.9**
2004	35	58	61	**154**	1,233	1,829	1,773	**4,835**	2.4	1.4	3.5	2.2	4.1	2.4	**3.4**	**1.2**
2005	25	69	53	**147**	2,554	2,700	1,287	**6,541**	1.5	0.9	2.8	1.3	4.0	2.2	**2.7**	**0.7**
Total	**1,737**	**3,703**	**5,896**	**11,351**	32,368	37,940	35,398	105,710	**6.3**	**1.9**	**17.3**	**6.6**	**17.7**	**3.0**	**12.9**	**2.6**

Table 5. 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

Table 6. 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 same records were used in this Table as described in Table 5.

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

Table 7. Summary of flows at the Pecos River Below Sumner Dam Gage during the FSID irrigation season (March through October). The same records were used in this Table as described in Table 5.

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

LITERATURE CITED

Adolf, S.L. 1998. Distribution, productivity, and habitat use by interior least terns and piping plovers on the Niobrara River in northern Nebraska, 1996-1997. M.S. Thesis, South Dakota State University, Brookings.

Akin, P.D., C.R. Murray, and C.V. Thesis. 1946. Five groundwater investigations for U.S. Army airfield near Fort Sumner, New Mexico. Pages 293-322 *in* Sixteenth and Seventeenth Biennial Reports of the State Engineer of New Mexico, Santa Fe.

Allen, G.T. and S.H. Blackford. 1997. Arsenic, mercury, selenium and organochlorine compounds in interior least tern eggs in the Northern Plains States, 1992-1994. Contaminant Report R6/515M/97. U.S. Fish and Wildlife Service, Manhattan, Kansas. 48 pp.

American Ornithologists' Union. 1957. Checklist of North American birds. Fifth edition. Baltimore, American Ornithologists' Union. 691 pp.

American Ornithologists' Union. 1983. Checklist of North American birds. Sixth edition. American Ornithologists Union, Lawrence, Kansas. 877 pp.

Anderson, D.P. 1990. Immunological indicators: effects of environmental stress on immune protection and disease outbreaks. Pages 38-50 *in* S. M. Adams (editor) Biological Indicators of Stress in Fish. American Fisheries Symposium 8. Bethesda, Maryland.

Anderson, E.A. 1983. Nesting productivity of the interior least tern in Illinois. Unpublished report, Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, Illinois. 19 pp.

Anderson, R. 1971. Nesting least terns. Audubon Bulletin 160:1718.

Anonymous. 1987. Endangered, threatened, and watch lists of vertebrates of Texas. Texas Organization for Endangered Species. Publication 4.

Armbruster, M.J. 1986. A review of habitat criteria for least terns and piping plovers using the Platte River. Unpublished report. National Ecology Research Center, U.S. Fish and Wildlife Service, Fort Collins, Colorado.

Ashworth, J.B. 1990. Evaluation of ground-water resources in parts of Loving, Pecos, Reeves, Ward, and Winkler Counties, Texas. Texas Water Development Board, Report 317. 50 pp.

Bacon, L.M. 1996. Nesting ecology of the interior least tern on the Yellowstone River, Montana. M.S. Thesis, Montana State University, Bozeman.

Balleau, W.P., Wolford, R.A., Romero, D.M., and S.E. Silver. 1999. Source-Water Protection Zones for Bitter Lake National Wildlife Refuge. U.S. Fish and Wildlife Service, Branch of Water Resources, Albuquerque, New Mexico.

Bent, A. C. 1921. Life histories of North American gulls and terns. U.S. National Museum Bulletin 113:270-279.

Bestgen, K.R., S.P. Platania, J.E. Brooks, and D.L. Propst. 1989. Dispersal and life history traits of *Notropis girardi* (Cypriniformes: Cyprinidae), introduced into the Pecos River, New Mexico. American Midland Naturalist 122:228-235.

Bestgen, K.R. and S.P. Platania. 1990. Extirpation of *Notropis simus simus* (Cope) and *Notropis orca* Woolman (Pisces: Cyprinidae) from the Rio Grande in New Mexico, with notes on their life history. Occasional Papers of the Museum of Southwestern Biology 6:1-8.

Bottrell, C.E., R.H. Ingersol, and R.W. Jones. 1964. Notes on the embryology, early development, and behavior of *Hybopsis aestivalis tetranemus* (Gilbert). Transactions of the American Microscopical Society 83: 391-399.

Boyd, R.L. 1987. Habitat management and population ecology studies of the least tern in Kansas. Kansas Fish and Game Commission. Unpublished report.

Brooks, J.E., S.P. Platania, and D.L. Propst. 1991. Effects of Pecos River reservoir operation on the distribution and status of Pecos bluntnose shiner (*Notropis simus pecosensis*): preliminary findings. Report to U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation, Albuquerque, New Mexico. 14 pp.

Brooks, J.E., M.R. Brown, and N.L. Allan. 1994. Pecos River fishery investigations: fish community structure, habitat use and water quality as a response to reservoir operations. 1992 Annual Report. Submitted to the U.S. Bureau of Reclamation, Albuquerque Projects Office. 60 pp.

Brooks, J.E. and N.L. Allan. 1995. Pecos River fishery investigations: fish community structure and habitat use and availability as a response to reservoir operations. 1993 Annual Report. Submitted to the U.S. Bureau of Reclamation, Albuquerque Projects Office. 31 pp.

Burger, J. 1981. Effects of human disturbance on colonial species, particularly gulls. Colonial Waterbirds 4:28-36.

Burger, J. 1984. Colony stability in least terns. Condor 86:61-67.

Burroughs, R.D., ed. 1961. The natural history of the Lewis and Clark expedition. Michigan State University Press. 340 pp.

Campbell, L.S. 1958. Basic survey and inventory of species present in the Pecos River of Texas. Fisheries Investigations and Surveys of the Waters of Region 3-B, Dingell-Johnson Project F-5-R-5, job B-13. 31 pp.

Chapman, D.W. and T.C. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding. Pages 153-176 *in* T.G. Northcote (ed.). Symposium on salmon and trout in streams. Institute of Fisheries, University of British Columbia, Vancouver.

Carron, J. 2003. Pecos River adjudication settlement negotiations: model evaluation of proposed settlement terms. Final Report. Prepared for the New Mexico Interstate Stream Commission. 21p.

Chase, C. and C. Loeffler. 1978. Arkansas valley shorebird inventory. Colorado Division of Wildlife.

Chernoff, B., R.R. Miller, and C.R. Gilbert. 1982. *Notropis orca* and *Notropis simus*, cyprinid fishes from the American Southwest, with description of a new subspecies. Occ. Papers Mus. Zool., Univ. Michigan No. 698. 49 pp.

Collier, M., R.H. Webb, and J.C. Schmidt. 1996. Dams and rivers, a primer on the downstream effects of dams. U.S. Geological Survey, Circular 1126:94 pp.

Cope, E.D. and H.C. Yarrow. 1875. Report upon the collections of fishes made in portions of Nevada, Utah, California, Colorado, New Mexico, and Arizona during the years 1871, 1872, 1873, and 1874. Chapter 6, pages 635-703 *in* United States Army Engineers Department Report, in charge of George M. Wheeler. Geography and Geology of the Explorations and Surveys west of the 100th meridian, 5, 1-1021.

Coues, E. 1874. Birds of the northwest: a handbook of the ornithology of the region drained by the Missouri River and its tributaries. U. S. Geological Survey of the Territories, Miscellaneous publication number 3. 791 pp.

Cross, F.B. 1967. Handbook of fishes of Kansas. Museum of Natural History, University of Kansas, Lawrence. 355 pp.

Cross, F.B., R.E. Moss, and J.T. Collins. 1985. Assessment of dewatering impacts on stream fisheries in the Arkansas and Cimarron Rivers.

Currier, P.J., G.R. Lingle, and J.G. VanDerwalker. 1985. Migratory bird habitat on the Platte and North Platte Rivers in Nebraska. Platte River Whooping Crane Critical Habitat Maintenance Trust, Grand Island, Nebraska.

Davenport, S. 2006. February 6, 2006, electronic message receive at 3:40 pm.

Davenport, S. 2006b. May 4, 2006, electronic message receive at 11:19 am.

Davenport, S. 2006c. April 27, 2006, electronic message receive at 4:58 pm.

Davenport, S. 2006d. April 27, 2006, electronic message receive at 1:46 pm.

Deacon, J.E., G. Kobetich, J.D. Williams, and S. Contreras. 1979. Fishes of North America endangered, threatened, or of special concern: 1979. Fisheries 4:30-44.

Dearen, P. 1996. Crossing Rio Pecos. Texas Christian University Press, Fort Worth. 196 pp.

Department of the Interior. 1989. Review of water quality, sediment, and biota associated with the Fort Sumner and Carlsbad Irrigation Projects, Middle Pecos River area, New Mexico. A Department of Interior intensive desk evaluation of irrigation drainage. 34 pp.

Dinsmore, J.J. and S.J. Dinsmore. 1988. Piping plover and least tern population and habitat in western Iowa. Unpublished report. 17 pp.

Dirks, B.J. 1990. Distribution and productivity of least terns and piping plovers along the Missouri and Cheyenne Rivers in South Dakota. M.S. Thesis, South Dakota State University, Brookings. 64 pp.

Dirks, B. and K.F. Higgins. 1988. Interior least tern and piping plover surveys, Missouri River, South Dakota. U.S. Fish and Wildlife Service report to the U.S. Army Corps of Engineers, Omaha, Nebraska.

Dryer, M.P., and P. J. Dryer. 1985. Investigations into the population, breeding sites, habitat characteristics, threats, and productivity of the least tern in North Dakota. U. S. Fish and Wildlife Service. Resource information paper number 1. Bismarck, North Dakota. 17 pp.

Ducey, J.E. 1981. Interior least tern (Sterna antillarum athalassos). U.S. Fish and Wildlife Service, Pierre, South Dakota. Unpublished report. 56 pp.

Ducey, J.E. 1988. Nest scrape characteristics of piping plover and least tern in Nebraska. Nebraska Bird Review 56:42-44.

Dudley, R.K. and S.P. Platania. 1999. Downstream transport rates of drifting semibuoyant cyprinid eggs and larvae in the Pecos River, NM. DRAFT Reports to U.S. Bureau of Reclamation, Albuquerque. 53 pp.

Dugger, K.M. 1997. Foraging ecology and reproductive success of least terns nesting on the lower Mississippi River. Ph.D. Dissertation, University of Missouri-Columbia. 137 pp.

Erwin, R.M. 1983. Interior least tern (*Sterna antillarum athalassos*). Pages 212-226 *in* J. Armbruster, editor. Impacts of coal surface mining on 25 migratory bird species of high Federal interest. U.S. Fish and Wildlife Service, FWS/OBS-83/35. Washington, D.C. 384pp.

Eschner, T., R. Hadley, and K. Crowley. 1981. Hydrologic and morphologic changes in the Platte River Basin in Colorado, Wyoming, and Nebraska: a historical perspective. U.S. Geological Survey Open File Report 81-1125. U.S. Geological Survey, Denver, Colorado.

Etnier, D.A. and W.C. Starnes. 1993. The fishes of Tennessee. University of Tennessee Press, Knoxville. 681 pp.

Evermann, B.W. and W.C. Kendall. 1894. The fishes of Texas and the Rio Grande Basin, considered chiefly with reference to their geographic distribution. U.S. Fish Commission, Bulletin, 12:57-126, with plates.

Faanes, C. 1983. Aspects of the nesting ecology of least terns and piping plovers in central Nebraska. Prairie Naturalist 15(4):145-154.

Fagan, W.F. 2006. Peer review of Pecos bluntnose shiner database and sampling protocol. Final Report to the U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Fausch, K.D. 1984. Profitable stream positions for salmonids: relating specific growth rate to net energy gain. Canadian Journal of Zoology 62:441-451.

Fausch, K.D. and R.J. White. 1981. Competition between brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) for positions in a Michigan Stream. Canadian Journal of Fisheries and Aquatic Science 38:1220-1227.

Fiedler, A.G. and S.S. Nye. 1933. Geology and ground-water resources of the Roswell Artesian Basin New Mexico. U.S. Geological Survey, Water-Supply Paper 639. 372 pp. with attachments.

Fisher, C.A. 1906. Geology and underground waters of the Roswell Artesian area New Mexico. U.S. Geological Survey Water-Supply Paper 158. 29 pp.

Fishery Resource Office, U.S. Fish and Wildlife Service. 2006. Electronic message received from the Albuquerque Fishery Resources Office on 2005 Pecos bluntnose shiner data. Received February 28, 2006.

Freeman, W.B. and J.G. Mathers. 1911. Surface water Supply of the United States; 1910; Part VIII. western Gulf of Mexico. U.S. Geological Survey Water-Supply Paper 288.

Friedman, J.M., W.R. Osterkamp, M.L. Scott, and G.T. Auble. 1998. Downstream effects of dams on channel geometry and bottom land vegetation: regional patterns in the Great Plains. Wetlands. 18:619-633.

Funk, J.L. and J.W. Robinson. 1974. Changes in the channel of the lower Missouri River and effects on fish and wildlife. Missouri Department of Conservation, Aquatic Series 11, Jefferson City. 52 pp.

Goodrich, L.J. 1982. The effects of disturbance on the reproductive success of the least tern. M.S. Thesis, Rutgers State University, New Brunswick, New Jersey. 100 pp.

Griffith, J.S., Jr. 1974. Utilization of invertebrate drift by brook trout (*Salvelinus fontinalis*) and cutthroat trout (*Salmo clarki*) in small streams in Idaho. Transactions of the American Fisheries Society 103:440-447.

Grover, N.C. 1922. Surface water supply of the United States; 1918; Part VIII. Western Gulf of Mexico basins. U.S. Geological Survey Water-Supply Paper 478. 106 pp.

Grozier, R.U., H.W. Albert, J.F. Blakey, and C.H. Hembree. 1966. Water-delivery and low-flow studies, Pecos River, Texas; quantity and quality, 1964 to 1965. Texas Water Development Board, Austin, TX. 21 pp.

Hallberg, G.R., J.M. Harbaugh, and P.M. Witinok. 1979. Changes in the channel area of the Missouri River in Iowa, 1879-1976. Iowa Geologic Survey Special Report Series 1. 32 pp.

Hardy, J.W. 1957. The least tern in the Mississippi River. Publication of the Museum, Michigan State University, Biological Series 1:1-60.

Harvey, B.C. 1987. Susceptibility of young-of-the-year fishes to downstream displacement by flooding. Transactions of the American Fisheries Society 116:851-855.

Hatch, M.D. 1982. The status of *Notropis simus pecosensis* in the Pecos River of New Mexico, with notes on life history and ecology. New Mexico Department of Game and Fish, Santa Fe, New Mexico.

Hatch, M.D., W.H. Baltosser, and C.G. Schmitt. 1985. Life history and ecology of the bluntnose shiner (*Notropis simus pecosensis*) in the Pecos River of New Mexico. The Southwestern Naturalist 30(4):555-562.

Hoagstrom, C.W., N. L. Allan, and J. E. Brooks. 1995. Pecos River fishery investigations: fish community structure and habitat use and availability as a response to reservoir operations. 1994 Annual Report to 1995 Annual Report to U. S. Bureau of Reclamation, Albuquerque, New Mexico. 41 pp.

Hoagstrom, C.W. 1997. Pecos River fishery investigations: fish habitat availability and use; fish community structure in relation to reservoir operation. 1995 Annual Report to U. S. Bureau of Reclamation, Albuquerque, New Mexico. 35 pp.

Hoagstrom, C.W. 1999. Status of Pecos River, New Mexico fFish and habitat with emphasis on Sumner Dam operation and Federal and State threatened Pecos bluntnose shiner (*Notropis simus pecosensis*). Pecos River fishery investigation draft final research report. U.S. Fish and Wildlife Service, Fishery Resources Office, Albuquerque, NM. 357 pp.

Hoagstrom, C.W. 2000. Status of Pecos River fishes between Sumner Dam and Brantley Reservoir, New Mexico with emphasis on Sumner Dam operation, discharge-flow regime relations, and Federal and State threatened Pecos bluntnose shiner. Draft Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 643 pp.

Hoagstrom, C.W. 2001. Summary of Pecos bluntnose shiner (*Notropis simus pecosensis* Gilbert and Chernoff) population status 1992 to 2001. Draft Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 37 pp.

Hoagstrom, C.W. 2002. Pecos bluntnose shiner depth and velocity preference, Pecos River, New Mexico, 1992 to 1999. Draft Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 86 pp.

Hoagstrom, C.W. 2003a. Pecos bluntnose shiner population dynamics and seasonal flow regime, Pecos River, New Mexico. Final report submitted to Bureau of Reclamation 25 August, 2003. 148 pp.

Hoagstrom, C.W. 2003b. Pecos bluntnose shiner habitat suitability, Pecos River, New Mexico, 1992-1999. Revised final report submitted to Bureau of Reclamation 19 April, 2003. 167 pp.

Hubbs, C.L. and G.P. Cooper. 1936. Minnows of Michigan. Cranbrook Institute of Science, Bulletin No. 8. 84pp.

Hubbs, C., R.J. Edwards, and G.P. Garrett. 1991. An annotated checklist of the freshwater fishes of Texas, with keys to identification of species. Texas Journal of Science, 43 (supplement). 56 pp.

Hufstetler, M. and L. Johnson. 1993. Watering the land: the turbulent history of the Carlsbad Irrigation district. National Perk Service, Rocky Mountain Region, Division of National Preservation Programs, Denver. 180 pp.

Huser, G. 1996. Breeding success of least terns and piping plovers in 1995 at the mid-American generating facility near Sioux City. Iowa Bird Life 66: 73-75.

Jenks-Jay, N. 1982. Chick shelters decrease avian predation in least terns on the Mississippi Gulf Coast. Mississippi Kite 6(2):25-35.

Johnson, R. 1987. Least tern survey of the Wabash River, 1987, and evaluation of available habitat. Endangered species progress report E- 1-1. Indiana Department of Natural Resources.

Johnson, N.K., J.V. Remsen Jr., and C. Cicero. 1998. Refined colorimetry validates endangered subspecies of the Least Tern. Condor 100:18-26.

Kasner, A.C., T.C. Maxwell, and R.D. Slack. 2005. Breeding distributions of selected Charadriiforms (Charadriiformes: Charadriidae, Scolopacidae, Laridae) in Interior Texas. Texas Journal of Science 57:1-16.

Kehmeier, J.W., C.N. Medley, R.A. Valdez, and O.B. Meyers. 2004a. Relationships between river discharge, mesohabitat availability, and cyprinid habitat selection in the Pecos River, New Mexico. Prepared for New Mexico Interstate Stream Commission, Santa Fe, New Mexico. September 13, 2004. 65 pp.

Kehmeier, J.W., C.N. Medley, and O.B. Meyers. 2004b. Assessment of Pecos bluntnose shiner egg and larval drift potential in the Pecos River, New Mexico. Prepared for the NMISC. 39 p.

Kirsch, E.M. 1987. Annual Report 1987: Least tern and piping plover on the lower Platte River in Nebraska. Nebraska Game and Parks Commission. Unpublished report.

Kirsch, E.M. 1988. Annual Report 1988: Least tern and piping plover on the lower Platte River in Nebraska. Nebraska Game and Parks Commission. Unpublished report.

Kirsch, E.M. 1989. Annual Report 1989: Least tern and piping plover on the lower Platte River in Nebraska. Nebraska Game and Parks Commission. Unpublished report.

Kirsch, E.M. 1990. Final Report 1990: Least tern and piping plover on the lower Platte River in Nebraska. Nebraska Game and Fish Commission. Unpublished report.

Kirsch, E.M. and J.G. Sidle. 1999. Status of the interior population of least tern. Journal of Wildlife Management 63(2):470-483.

Klimkiewicz, K.M. and A.G. Futcher. 1989. Longevity records of North American birds, Supplement 1. Journal of Field Ornithology 60: 469-494.

Kondolf, G.M. 1997. Hungry water: effects of dams and gravel mining on river channels. Environmental Management 21:533-551.

Koster, W.J. 1957. Guide to the fishes of New Mexico. University of New Mexico Press, Albuquerque, New Mexico, U.S.A. 116 pp.

Lagasse, P.F. 1980. Variable response of the Rio Grande to dam construction. Pages 395-420 *in* The Variability of Large Alluvial Rivers. ASCE Press, New York, New York.

Lane, E.W. 1934. Retrogression of levels in riverbeds below dams. Engineering News-Record, 112: June 28, pp. 836-840.

Larimore, R.W., W.F. Childers, and C. Heckrotte. 1959. Destruction and re-establishment of stream fish and invertebrates affected by drought. Transactions American Fisheries Society 88:261-285.

Larson, R.D., and D.L. Propst. 1999. Distribution, abundance, and food habits of piscivorous fishes inhabiting the Pecos River between Sumner Dam and Brantley Reservoir, New Mexico. New Mexico Department of Game and Fish. Santa Fe, New Mexico.

Larson, R.D., and D.L. Propst. 2003. An investigation on the effects of low flow to the fish community of the middle Pecos River, New Mexico during 2001. Report submitted to the U.S, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, NM. 21p.

Larson, R.D., and D.L. Propst. 2004. An investigation on the effects of flow intermittency to the fish community of the middle Pecos River, New Mexico during 2002. Report submitted to the U.S, Bureau of Reclamation, Albuquerque Area Office, Albuquerque, NM. 28p.

Lawson, L.M. 1925. Effect of Rio Grande storage on river erosion and deposition. Engineering News-Record 95:372-376.

Liles, Charlie A. 2000a. Pacific Decadal Oscillation and New Mexico precipitation. National Weather Service, Albuquerque, New Mexico. Http://www.srh.noaa.gov/ABQ/feature/PDO_NM.htm (Viewed 10 January 2003)

Liles, Charlie A. 2000b. Relationships between the Pacific Decadal Oscillation and New Mexico annual and seasonal precipitation. National Weather Service, Albuquerque, New Mexico. Http://www.srh.weatger.gov/ABQ/feature/pdo5stdy_new_version_short.pdf (Viewed 6 February 2003).

Lingle, R.T. and D. Linford. 1961. The Pecos River Commission of New Mexico and Texas. A report of a decade of progress: 1950-1960. The Rydal Press, Santa Fe, New Mexico. 284 pp.

Lott, C.A. 2006. Distribution and abundance of the interior population of the Least Tern (*Sterna antillarum*), 2005: A review of the first complete range-wide survey in the context of historic and ongoing monitoring efforts. Dredging Operations and Environmental Research Program Technical Notes Collection, U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Lyons, J. and T. Randle. 1988. Platte River channel characteristics in the Big Bend Reach. U.S. Bureau of Reclamation, Denver, Colorado.

Marshall, N. 1947. Studies on the life history and ecology of *Notropis chalybaeus* (Cope). Journal of the Florida Academy of Sciences 9:163-188.

Massey, B.W. 1972. The breeding biology of the California least tern. M.S. Thesis. California State University, Long Beach. 101pp.

Massey, B.W. 1974. Breeding biology of California least tern. Proceedings of the Linnaean Society, New York 72:124.

Massey, B.W. and J.A. Atwood. 1979. Application of ecological information to habitat management for the California least tern. Progress Report 1, U.S. Fish and Wildlife Service, Laguna Niguel, California.

Mayer, P.M., and M.P. Dryer. 1988. Population biology of piping plovers and least terns on the Missouri River in North Dakota and Montana: 1988 field season report. U. S. Fish and Wildlife Service, Bismarck, North Dakota. Unpublished report.

Mayer, P.M. and M.P. Dryer. 1990. Population biology of piping plovers and least terns on the Missouri River in North Dakota and Montana: 1989 field season report. Unpublished report. U.S. Fish and Wildlife Service, Bismarck, North Dakota.

McCord, J.T., Clark, A.A., and Smith, J.L. 2005. Review of groundwater hydrology associated with spring flows at Bitter Lake National Wildlife Refuge, New Mexico. Prepared for the New Mexico Interstate Stream Commission. 26p.

Medley, C.N., J.W. Kehmeier, O.B. Myers, and R.A. Valdez. 2005. Influence of habitat-flow interactions on cyprinid egg retention in a regulated river. Unpublished manuscript.

Mendelson, J. 1975. Feeding relationships among species of *Notropis* (Pisces: Cyprinidae) in a Wisconsin stream. Ecological Monographs 45:199-230.

Miller, R.R., J.D. Williams, and J.E. Williams. 1989. Extinctions of North American fishes during the past century. Fisheries 14:22-38.

Miller, W.J. 2006. Bottomless Lakes State Park aquatic habitat restoration feasibility study. Report on water use and water rights. Prepared for Blue Earth Mussetter LLC. 15 p.

Minckley, W.L. 1963. The ecology of a spring stream, Doe Run, Meade County, Kentucky. Wildlife Monographs. No. 11, 124 pp.

Moore, G.A. 1944. Notes on the early life history of *Notropis girardi*. Copeia 1944:209-210.

Moseley, L.J. 1976. Behavior and communication in the least tern (*Sterna albifrons*). Ph.D. dissertation, University of North Carolina, Chapel Hill. 164 pp.

Moser, R. 1940. The piping plover and least tern in Omaha. Nebraska Bird Review 8:92-94.

Mundie, J.H. 1969. Ecological implications of the diet of juvenile coho in streams. Pages 135-152 *in* T.G. Northcote (ed.). Symposium on salmon and trout in streams. Institute of Fisheries, University of British Columbia, Vancouver.

National Weather Service. 2003. Hydrologic outlook - January 24, 2003. Http://www.srh.noaa.gov/data/ABQ/ESF/ABQESFABQ.1.TXT (Viewed 6 February 2003).

Natural Resources Conservation Service. 2006. New Mexico water supply outlook - January 1, 2003. Ftp://ftp.wcc.nrcs.usda.gov/support/water/basin_outlook/new_mexico/wy2003/bornm1.txt (Viewed 12 April 2006).

Neck, R.W. and D. H. Riskind. 1981. Direct and indirect human impact on least tern nesting success at Falcon Reservoir, Zapata County, Texas. Bulletin of the Texas Ornithological Society 14:27-29.

Newell, F.H. 1891. Hydrography of the arid regions. Pages 213-336 *in* Twelfth Annual Report of the United States Geological Survey to the Secretary of the Interior, 1890-'91; Part II-Irrigation.

New Mexico Fishery Resources Office. 2003. Memo received on January 12, 2003, reporting on the current status of the Pecos bluntnose shiner.

New Mexico Fishery Resources Office. 2006. Memo received on February 28, 2006, reporting on the current status of the Pecos bluntnose shiner.

New Mexico Interstate Stream Commission. 2004. New Mexico Office of the State Engineer, Interstate Stream Commission. 2003-2004 Annual Report. 59p.

O'Brien, J.S. and P.J. Currier. 1987. Channel morphology, channel maintenance, and riparian vegetation changes in the Big Bend reach of the Platte River in Nebraska. Unpublished report. 49pp.

Platania, S.P. 1993. Pecos bluntnose shiner (*Notropis simus pecosensis*) research; 1992 Annual Progress Report. University of New Mexico *in* Pecos River Investigations Annual Research Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 27 pp.

Platania, S.P. 1995a. Pecos bluntnose shiner (*Notropis simus pecosensis*) research: larval fish drift studies. 1993 Annual Progress Report. Submitted to the U.S. Bureau of Reclamation, Albuquerque, New Mexico. 12 pp.

Platania, S. P. 1995b. Distribution, relative abundance, and conservation status of Pecos bluntnose shiner, *Notropis simus pecosensis*. Report to New Mexico Department of Game and Fish, Santa Fe, New Mexico. 32 pp.

Platania, S. and C. Altenbach. 1998. Reproductive strategies and egg types of seven Rio Grande basin cyprinids. Copeia 1998(3): 559-569.

Polzin, M.L. and Rood, S.B. 2000. Effects of damming and flow stabilization on riparian processes and black cottonwoods along the Kootenay River. Rivers 7:221-232.

Pope, J. 1854. Report of exploration of a route for the Pacific Railroad, near the thirty-second parallel of north latitude, from the Red River to the Rio Grande. Explorations and Surveys for a Railroad from the Mississippi River to the Pacific Ocean. War Department. Washington. 50 pp. plus appendices.

Power, M.E., W.E. Dietrich, and J.C. Finlay. 1996. Dams and downstream aquatic biodiversity: Potential food web consequences of hydrologic and geomorphic change. Environmental Management 20:887-895.

President's Water Resources Policy Commission. 1950. Ten rivers in America's future, No. 4. The Rio Grande. Volume 2, The Report of the President's Water Resources Policy Commission, U.S. Government Printing Office, Washington. 67 pp.

Propst, D.L. 1999. Threatened and Endangered Fishes of New Mexico. Technical Report No. 1. New Mexico Department of Game and Fish, Santa Fe, New Mexico. 84 pp.

Prindiville, E.M. 1986. Habitat selection and productivity of piping plovers in central North Dakota. M.S. Thesis, University of Missouri, Columbia.

Reinert, T.R., T.A. Will, C.A. Jennings, and W.T. Davin. 2004. Use of egg surrogates to estimate sampling efficiency of striped bass eggs in the Savannah River. North American Journal of Fisheries Management. 24:704-710.

Ruelle, R. 1993. Contaminant evaluation of interior least tern and piping plover eggs from the Missouri River in South Dakota. Pages 159-171 *in* K.F. Higgins and M.R.. Brashier, editors. Proceedings, The Missouri River and its tributaries: Piping plover and least tern symposium. South Dakota State University, Brookings.

Rumancik, J.P., Jr. 1985. Survey of the interior least tern on the Mississippi River from Cape Girardeau, Missouri, to Greenville, Mississippi, 1985. U.S. Army Corps of Engineers, Memphis District, Memphis, Tennessee. Unpublished report.

Rumancik, Jr., J. P. 1987. Population survey of the interior least tern on the Mississippi River from Cape Girardeau, Missouri to Greenville, Mississippi, 1987. U. S. Army Corps of Engineers, Memphis District, Memphis, Tennessee. Unpublished report. 22 pp.

Rumancik. Jr. J. P. 1988. Population survey of the interior least tern on the Mississippi River from Cape Girardeau, Missouri to Greenville, Mississippi, 1988. U.S. Army Corps of Engineers, Memphis District, Memphis, Tennessee. Unpublished report. 25 pp. and appendices.

Sandheinrich, M.B. and G.J. Atchison. 1986. Environmental effects of dikes and revetments on large riverine systems. Technical Report E86-5. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

Schiemer, F. 1995. Restoration of floodplains – possibilities and constraints. Archiv für Hydrobiologie 101:383-398.

Schwalbach, M., C. Vandel, and K. Higgins. 1986. Status, distribution, and production of the interior least tern and piping plover along the mainstem Missouri River in South Dakota, 1986. Report number 86-10 to the U.S. Army Corps of Engineers, Missouri River Division, Omaha, Nebraska.

Schwalbach, M., G. Vandel, and K. Higgins. 1988. Status, distribution, and production of the interior least tern and piping plover along the mainstem Missouri River in South Dakota, 1986-1987. Completion report to the U.S. Army Corps of Engineers, Missouri River Division, Omaha, Nebraska.

Schweitzer, S.H. and D.M. Leslie, Jr. 1996. Foraging patterns of the least tern (*Sterna antillarum*) in North-central Oklahoma. Southwestern Naturalist 41:307-314.

Shafroth, P. 1999. Downstream effects of dams on riparian vegetation: Bill Williams River, Arizona. Ph.D. Dissertation, Arizona State University.

Sherrard, J.J. and W.D. Erskine. 1991. Complex response of a sand-bed stream to upstream impoundment. Regulated Rivers: Research and Management 6:53-70.

Shields, F.D. Jr., A. Simon, and L.J. Steffen. 2000. Reservoir effects on downstream river channel migration. Environmental Conservation 27:54-66.

Shomaker, J.W. 1971. Gains and losses in Pecos River between Alamogordo Dam and Acme, New Mexico. U.S. Geological Survey open-file report, 36 pp.

Shomo, L. 1988. Observations on the interior least tern near Roswell, New Mexico, May-August 1987. New Mexico Department of Game and Fish. Contract number 519-76-01. 22 pp.

Sidle, J.G. and E.M. Kirsch. 1993. Least tern and piping plover nesting and sand pits in Nebraska. Colonial Waterbirds 16:139-148.

Sidle, J.G., E.D. Miller, and P.J. Currier. 1989. Changing habitats in the Platte River valley of Nebraska. Prairie Naturalist 21:91-104.

Simons, D.B. and E.V. Richardson. 1962. The effect of bed roughness on depth-discharge relations in alluvial channels. U.S. Geological Survey Water-Supply Paper 1498-E. 26 pp.

Sliger, W.A. 1967. The embryology, egg structure, micropyle and egg membranes of the plains minnow, *Hybognathus placitus* (Girard). M.S. Thesis, Oklahoma State University.

Smith, J.W. 1985. Improving the status of endangered species in Missouri (interior least tern habitat and nest survey). Missouri Dept. of Conservation endangered species project number SE-01-12. 142 pp.

Smith, J.W., and N.P. Stucky. 1988. Habitat management for interior least terns: Problems and opportunities in inland waterways. Pages 134-149 *in* M. C. Landin, Ed. Inland Waterways: Proceedings national workshop on the beneficial uses of dredged material. TRD-88-8. U. S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Smith, J.W., and R.B. Renken. 1990. Improving the status of endangered species in Missouri: least tern investigations. Final report, Jobs 1 and 2, Missouri Department of Conservation endangered species project SE-Ol-19.

Smith, J.W. and R.B. Renken. 1991. Least tern nesting in the Mississippi River Valley adjacent to Missouri. Journal of Field Ornithology 62(4):497-504.

Smith, K.L. and W.M. Shepherd. 1985. A survey of the interior least tern on the Arkansas and White Rivers in Arkansas. Arkansas Natural Heritage Commission. Unpublished. report. 5 pp.

Starrett, W.C. 1950. Food relationships of the minnows of the Des Moines River Iowa. Ecology 31:216-233.

Stiles, B. 1939. The least tern in Iowa. Iowa Bird Life14:18-21.

Stinnett, D.P., R.W. Smith, and S.W. Conrady. 1987. Riparian areas of western Oklahoma: A special study of their status, trends, and values. U.S. Fish and Wildlife Service, Tulsa, Oklahoma. Unpublished report. 80 pp.

Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. Univ. New Mexico Press, Albuquerque, New Mexico. 393 pp.

Summerfelt, R.C. and C.O. Minckley. 1969. Aspects of the life history of the sand shiner, *Notropis stramineus* (Cope), in the Smoky Hill River, Kansas. Transactions of the American Fisheries Society 98:444-453.

Sweet, M.J. 1985. Least tern population survey, 1984. Illinois Dept. of Conservation. Unpublished report.

Tashjian, P.J. 1993. Channel morphology, reservoir operations, and bluntnose shiner habitat, Pecos River, New Mexico; 1992 Annual Report *in* Pecos River Investigations Annual Report, Bureau of Reclamation, 1993, Albuquerque, New Mexico. 27 pp.

Tashjian, P.J. 1994. Channel response to flow regimes and habitat diversity under differing flow conditions: Middle Pecos River, New Mexico. 1993 Annual Report. 26 pp.

Tashjian, P.J. 1995. Channel response to flow regimes and habitat diversity under differing flow conditions: Middle Pecos River, New Mexico *in* Pecos River Investigations Annual Report, Bureau of Reclamation, 1994, Albuquerque, New Mexico. 27 pp.

Tashjian, P.J. 1997. Channel morphology and bluntnose shiner habitat, Pecos River, New Mexico, 1995 *in* Pecos River Investigations Annual Report, Bureau of Reclamation, Albuquerque, New Mexico. 17 pp.

Task Force on Bed Forms in Alluvial Channels. 1966. Nomenclature for bed forms in alluvial channels. Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers. 92:51-64.

Tetra Tech Inc. 2000. Pecos River Hydrology Report. Draft report submitted to U.S. Bureau of Reclamation. 49 pp.

Tetra Tech Inc. 2003. Pecos River sediment transport/channel geometry study. Draft report submitted to U.S. Bureau of Reclamation. 17 pp.

Thomas, H.E. 1959. Causes of depletion of the Pecos River in New Mexico. Contributions to the Hydrology of the United States, Geological Survey Water Supply Paper 619-G. U.S. Government Printing Office, Washington D.C., 14 pp.

Tomkins, I.R. 1959. Life history notes on the least tern. Wilson Bulletin 71:313-322.

U.S. Army Corps of Engineers. 1999. Pecos River, Chaves County, New Mexico: Channel capacity and riparian habitat planning study. Report to Chaves County Flood Control Authority, Roswell, New Mexico, U.S.A. 62 pp. plus appendices.

U.S. Bureau of Reclamation. 1991. Santa Rosa Lake, Lake Sumner, and Brantley Reservoir water operations, Pecos River, New Mexico. Final Biological Assessment. 58 pp.

U.S. Bureau of Reclamation. 2002. Biological assessment of proposed Pecos River Dam operations March 1, 2003 through February 28, 2006. 52 pp.

U.S. Bureau of Reclamation. 2005. Carlsbad Project Water Operations and Water Supply Conservation Draft EIS Appendices, September 2005.

U.S. Bureau of Reclamation. 2006. Second Amended biological assessment of the proposed Carlsbad Project water operations and water supply conservation environmental impact statement. Albuquerque Area Office, Albuquerque, New Mexico. January 2006. 86 pp.

U.S. Fish and Wildlife Service. 1983. Northern states bald eagle recovery plan. U.S. Fish and Wildlife Service, Denver, Colorado. 76 pp.

U.S. Fish and Wildlife Service. 1985. Interior population of the least tern determined to be endangered. Federal Register 50:21784-21792.

U.S. Fish and Wildlife Service. 1987. Endangered and threatened wildlife and plants; determination of threatened status for the Pecos bluntnose shiner and designation of its critical habitat. Federal Register 52:5295-5303.

U.S. Fish and Wildlife Service. 1987a. Least tern in: Endangered species information system (computer data base). U. S. Department of the Interior, Fish and Wildlife Service, Division of Endangered Species and Habitat Conservation, Washington, D.C.

U.S. Fish and Wildlife Service. 1990. Recovery plan for the interior population of the least tern (*Sterna antillarum*). U. S. Fish and Wildlife Service, Twin Cities, Minnesota. 90 pp.

U.S. Fish and Wildlife Service. 1991. Biological opinion for Pecos River water operations, New Mexico. Submitted to the Regional Director, U.S. Bureau of Reclamation, Upper Colorado Regional Office, Salt Lake City, Utah, U.S.A. 16 pp.

U.S. Fish and Wildlife Service. 1992. Pecos bluntnose shiner recovery plan. U.S. Fish and Wildlife Service, Region 2, Albuquerque, New Mexico. 57 pp.

U.S. Fish and Wildlife Service 1998. Biological opinion on proposed winter operations on Pecos River, 1998-1999. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 2000. Biological opinion on the operation of the Missouri River mainstem reservoir system, the operation and maintenance of the Missouri River bank stabilization and navigation project, and the operation of the Kansas River Reservoir System. U.S. Fish and Wildlife Service, Denver, Colorado.

U.S. Fish and Wildlife Service 2003a. Biological opinion for the Bureau of Reclamation's proposed Pecos River Dam operations, March 1, 2003, through February 28, 2006 (June 18, 2003). U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service 2003b. Pecos bluntnose shiner status report for 2003. USFWS, NM Fishery Resources Office, Albuquerque. 14 pp.

U.S. Fish and Wildlife Service 2006. Biological opinion for the Bureau of Reclamation's proposed Pecos River Dam operations through summer 2006 (July 31, 2006) or until Peclamation implements an new operation defined in a ROD, whichever comes first. U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

U.S. Geological Survey. 2001. Water resources data, New Mexico, Water Year 2000.

U.S. Geological Survey. 2002. Water resources data, New Mexico, Water Year 2001.

U.S. National Resources Planning Board. 1942. The Pecos River joint investigation-reports of participating agencies. U.S. Government Printing Office, Washington. 407 pp.

Valdez, R.A., J. Kehmeier, S.W. Carothers, and C. Berkhouse. 2003. Relationships between stream flow and habitat of Pecos bluntnose shiner and response of the fish community to intermittent summer flows in the Pecos River, New Mexico. Draft Report. SWCA Environmental Consultants, Albuquerque, New Mexico.

Ward, J.V. and J.A. Stanford. 1995. Ecological connectivity in alluvial river ecosystems and its its disruption by flow regulation. Pages 105-119 *in* Selected papers from the international conference, sustaining the ecological integrity of large floodplain rivers, K. Lubinski, J. Wiener, and N. Bhowmik (editors). Regulated Rivers: Research and Management 11:105-119.

Whitaker, J.O., Jr. 1977. Seasonal changes in food habits of some cyprinid fishes from the White River at Petersburg, Indiana. American Midland Naturalist 97:411-418.

Wilbur, S.R. 1974. The literature of the California least tern. U.S. Department of the Interior, Bureau of Fish and Wildlife, Washington, D.C., Species Science Report 175. 18pp.

Williams, J.D., D.B. Bowman, J.E. Brooks, A.A. Echelle, R.J. Edwards, D.A. Hendrickson, and J.J. Landye. 1985. Endangered aquatic ecosystems in North American deserts with a list of vanishing fishes of the region. Journal of the Arizona - Nevada Academy of Science 20(1):1-62.

Williams, J.E., J.E. Johnson, D.A. Hendrickson, S. Contreras-Balderas, J.D. Williams, M. Navarro-Mendoza, D.E. McAllister, and J.E. Deacon. 1989. Fishes of North America endangered, threatened, or of special concern: 1989. Fisheries 14:2-20.

Williams, G.P. and M.G. Wolman. 1984. Downstream effects of dams on alluvial rivers. Professional Paper 1286. Washington DC: U.S. Geological Survey.

Wilson, B.L. 1984. 1984 search for piping plover and least tern in Iowa. Unpublished report. 10 pp.

Wilson, E.C., W.A. Hubert, and S.H. Anderson. 1993. Nesting and foraging of least terns on sand pits in central Nebraska. Southwestern Naturalist 38:9-14.

Wolk, R.G. 1974. Reproductive behavior of the least tern. Proceedings of the Linnaean Society, New York 72:44-62.

Woodson, R.C. and J.T. Martin. 1965. The Rio Grande comprehensive plan in New Mexico and its effects on the river regime through the middle valley. Proceedings of the Federal Inter-Agency Sedimentation Conference, 1963. Misc. pub. 970, USDA.

Wycoff, R. 1960. The least tern. Nebraska Bird Review 28:39-42.

Youngworth, W. 1930. Breeding of the least tern in Iowa. Wilson Bulletin 42:102-103.

Youngworth, W. 1931. The American egret and least tern in South Dakota. Wilson Bulletin 43:309-310.

Ziewitz, J.W., J.G. Sidle, and J.J. Dinan. 1992. Habitat conservation for nesting least terns and piping plovers on the Platte River, Nebraska. Prairie Naturalist 24:1-20.

APPENDIX A

April 25, 2006

Memorandum

To: Lead Pecos Bluntnose Shiner Biologist, New Mexico Ecological Services Field Office, Albuquerque, New Mexico

From: Senior Environmental Contaminants Specialist, New Mexico Ecological Services Field Office, Albuquerque, New Mexico

Subject: Potential Health Effects to the Bluntnose Shiner from Environmental Stressors

Confining riverine fish to pools or to intermittent conditions during low flow has been identified as an environmental stressor of concern to the health of fish in the Rio Grande Basin (U.S. Fish and Wildlife Service [USFWS] 1994, Caldwell 2005). In 2005, river intermittency isolated Rio Grande silvery minnow in large pools throughout several miles of the Middle Rio Grande Valley (Caldwell 2005). During this time, Rio Grande silvery minnow were rescued from these pools by the USFWS and placed in bags for transport. Subsamples of the rescued fish were sent to the USFWS Fish Health Center for diagnostic examination. Of the fish examined, gill tissue was found to be infested with flagellated protozoan parasites and kidney tissue was infected with many species of bacteria (P. Hines, USFWS, written comm. October 13, 2005). Hines (USFWS, written comm. October 13, 2005) reported that the Rio Grande silvery minnow collected from these intermittent pools were in poor health and any additional stressors could lead to high rates of mortality or these fish could experience delayed mortality up to a week or more after fish were relocated. Low flow conditions could be expected to similarly stress Pecos bluntnose shiner.

Changes in environmental conditions of a fishes habitat (i.e., reduced water flow resulting in elevated water temperature, low dissolved oxygen concentrations, and degraded water quality) can contribute to excess parasitism and pathogen burdens in fish. Long term environmental stressors will ultimately reduce a fish’s immunity and the survival of local fish populations, including the bluntnose shiner. Physiological responses to stress include measurable changes in blood cortisol levels that can lead to changes in metabolism, hydromineral balance, cardiovascular, respiratory and immune functions, behavior, food intake, feed efficiency, growth and even survivorship (Anderson 1990). Elevated blood cortisol levels may compromise an immune response in fish by inhibiting inflammatory reactions and phagocytosis (i.e., reduced lymphocytes and macrophages) and retarding healing processes (Pickering 1987; Ellasaesser and Clem 1986). Malnutrition, metabolic disorders, and environmental stressors such as rapid changes in water quality will result in decreased food intake, decreased feed efficiency, growth retardation, or adversely affect the immune response (Anderson 1990). The final result will be increased susceptibility to disease (MacArthur et al. 1984; Woo et al. 1987).

However, disease in fish is not the result of a single event, but the result of multiple interactions between the fish, the pathogen and the aquatic environment. Most often, stress-mediated diseases are those associated with pathogens and parasites that are widespread, continuously present in the environment and opportunistic (i.e., these diseases are not manifested unless stress results in increased susceptibility) (Wedemeyer and Wood 1974). The presence of most pathogens do not result in disease unless unfavorable conditions compromise the fish's defense system. Different fish species display a wide variation in their physiological responses to stress, with elevated circulating cortisol after an acute disturbance. Species differences and genetic history will account for much of this variation. An appreciation of the factors that affect the magnitude, duration and recovery of cortisol and other physiological changes caused by stress in the bluntnose shiner would be important for proper interpretation of effective biological monitoring programs. Monitoring the longterm health of the bluntnose shiner population over time would be one means to obtain biologically-relevant information about the potential effects of changes the environment will have on the bluntnose shiner.

If a fish is healthy, both the fish and its protozoan parasites can exist in a symbiotic relationship. However, this relationship changes quickly to pathogenic if the fish host becomes stressed. The reproductive potential of the protozoans and bacteria increases exponentially if there is also a change in the environmental conditions that favor these pathogens (e.g., increased temperature, nutrients) or conditions that stress the fish or compromise its immune system (e.g., low dissolved oxygen, crowding, elevated blood cortisol, elevated ammonia, poor nutritional status, genetic fitness), which can favor the rapid reproduction of these pathogens or increase the susceptibility of the fish to disease (Caldwell 2005 citing Post 1983) and result in fish mortalities. Fish in all environments sometimes die because of stressful conditions (Anderson 1990). Although fish may appear healthy before, during and immediately after a period of stress, a disease outbreak can occur afterwards. Chronic mortality in those populations has been tied to a specific pathogen (Anderson 1990). In many cases, pathogens are already present in the environment or carried by the fish and a compromised immune system will make the fish more susceptible to these agents. Therefore, impairment of immune mechanisms in fish may lead to reduced resistance against opportunistic pathogens in the wild.

Anderson, D. 1990. Immunological indicators: effects of environmental stress on immune protection and disease outbreaks. American Fisheries Society Symposium 8:38-50.

Caldwell C. December 5, 2005. Diagnostics and blood chemistry of Rio Grande Silvery Minnow Collected During Rescue Operations. Memorandum from Acting Leader, New Mexico Cooperative Fish and Wildlife Research Unit, New Mexico State University to Field Supervisor, UFWS, Ecological Services Field Office, Albuquerque, NM.

Ellsaesser, C.F. and L.W. Clem. 1986. Haematological and immunological changes in channel catfish stressed by handling and transport. Journal of Fish Biology 28:511-521.

MacArthur, J.I., T.C. Fletcher, B.J.S. Pirie, R.J.L. Davidson, and A.W. Thomson. 1984. Peritoneal inflammatory cells in plaice, *Pleuronectes platessa* L.: effects of stress and endotoxin. Journal of Fish Biology 25:69-81.

Pickering, A.D. 1987. Stress responses and disease resistance in farmed fish. In: Aqua Nor 87, Conference 3: Fish diseases- a threat to the international fish farming industry. Trondheim, Norway.

USFWS. 1994. Endangered and Threatened Wildlife and Plants; Final Rule to list the Rio Grande Silvery Minnow as an Endangered Species. Federal Register 59:36988–37001.

Wedemeyer, G.A. and J.W. Wood. 1974. Stress as a predisposing factor in fish diseases. Fish Disease Leaflet 38. U.S. Fish and Wildlife Service.

Woo, P.T.K., J.F. Leatherland, and M.S. Lee. 1987. *Cryptobia salmositica*: cortisol increases the susceptibility of *Salmo gairdneri* Richardson to experimental crypotobiosis. Journal of Fish Diseases 10:75-83.