Pecos Bluntnose Shiner
(*Notropis simus pecosensis*)

5-Year Review:
Summary and Evaluation

Photo: Stephanie Carman

U.S. Fish and Wildlife Service
New Mexico Ecological Services Field Office
Albuquerque, New Mexico

5-YEAR REVIEW

Pecos bluntnose shiner (*Notropis simus pecosensis*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Southwest Regional Office, Region 2
Susan Jacobsen, Chief, Threatened and Endangered Species
505-248-6641
Wendy Brown, Recovery Coordinator, 505-248-6664
Julie McIntyre, Recovery Biologist, 505-248-6657

Lead Field Office: New Mexico Ecological Services Field Office
Susan Oetker, Fish and Wildlife Biologist, 505-761-4761

Cooperating Office: New Mexico Fish and Wildlife Conservation Office, Albuquerque, New Mexico
Stephen Davenport, Fisheries Biologist, 505-342-9900

1.2 Methodology used to complete the review

This review was conducted through public review notification and a comprehensive review of all documents regarding Pecos bluntnose shiner that were available to the U.S. Fish and Wildlife Service's (Service) New Mexico Ecological Services Field Office (NMESFO). The Federal Register notice (71 FR 20714) announcing this review was published on April 21, 2006. The notice solicited new information about species biology, habitat conditions, conservation measures implemented, threats, and trends, from other agencies, both Federal and State, nongovernmental organizations, academia, and the general public. Information compiled for a 2006 formal biological opinion, unpublished reports on the Pecos bluntnose shiner, monitoring data collected by the Service since 1992, and peer-reviewed literature provided the basis for the review. This review was drafted by Marilyn Myers, lead biologist for the Pecos bluntnose shiner. Technical information was reviewed by Stephen Davenport of the New Mexico Fish and Wildlife Conservation Office, Dr. Christopher Hoagstrom, Weber State University, Dr. Robert Dudley, American Southwest Ichthyological Researchers, and Dr. Megan Osborne, University of New Mexico.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review: 71 FR 20714; April 21, 2006.

1.3.2 Listing history:

Original Listing:

FR notice: 52 FR 5295
Date listed: February 20, 1987
Entity listed: subspecies, *Notropis simus pecosensis*
Classification: Threatened

1.3.3 Associated rulemakings: A special 4(d) rule was part of the initial listing package that gave New Mexico Department of Game and Fish permitting authority (52 FR 5302).

1.3.4 Review History: This is the first formal 5-year review for this species since the species was listed in 1987. However, three significant biological opinions (BOs) have been written for this species in the intervening years and each resulted in a comprehensive assessment of the species' status.

1.3.5 Species Recovery Priority Number at start of review: 3. This priority number indicates a subspecies with high degree of threat and high potential for recovery.

1.3.6 Recovery Plan or Outline
Name of plan: Pecos Bluntnose Shiner Recovery Plan
Date issued: September 30, 1992
Dates of previous revisions: The recovery plan has not been revised.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) Policy

2.1.1 Is the species under review a vertebrate? Yes

2.1.2 Is the species under review listed as a DPS? No

2.1.3 Is there relevant new information for this species regarding the application of the DPS policy? No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan? Yes. Although there is a final recovery plan, it does not reflect the most up-to-date information on the species' biology, nor does it address all of the five listing factors that are relevant to the species.

2.2.1.1 Does the recovery plan contain objective, measurable criteria? No. Objective, measurable criteria are not given for delisting or uplisting. When the recovery plan was written, population "stabilization" was the primary objective. The plan stated that if stabilization was achieved, delisting objectives would be determined in 2002.

2.3 Updated Information and Current Species Status

At the time of listing, there was a limited amount of information available on the life history and habitat requirements of the Pecos bluntnose shiner. The recovery plan identified specific information needs and consequently, since 1992, results of many studies have added greatly to our understanding of this species. We review and summarize the new information that has been obtained in the sections below.

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

The Pecos bluntnose shiner is a relatively small, moderately deep-bodied minnow, rarely exceeding 3.1 inches (in) (80 millimeters (mm)) total length (TL) (Propst 1999, Hoagstrom et al. 2007, Hoagstrom et al. 2008). It has a fusiform silvery body and a fairly large, terminal and slightly oblique mouth that is overhung by a bluntly rounded snout. The fish is pallid gray to greenish brown dorsally and whitish ventrally. Adult Pecos bluntnose 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.

For purposes of surveys and habitat considerations, occupied habitat in the Pecos River from the Fort Sumner Irrigation District (FSID) Diversion Dam to Brantley Reservoir was divided into three reaches (Hoagstrom 2003a, b). The uppermost is the Tailwater reach, which extends from FSID Diversion 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); and the third is the Farmlands reach which extends from the BLNWRMT to Brantley Reservoir. These reach names (Tailwater, Rangelands, and Farmlands) will be used throughout this document.

Food Habits
A short intestine, large terminal mouth, silvery peritoneum, and pointed, hooked pharyngeal teeth indicate that the Pecos bluntnose shiner is carnivorous (Hubbs and Cooper 1936, Bestgen and Platania 1990). Although Platania (1993) found both animal and vegetable matter within Pecos bluntnose 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 Pecos bluntnose shiners likely consume zooplankton primarily, while Pecos bluntnose shiners of increasing size rely upon terrestrial and aquatic insects (Platania 1993, Propst 1999). In a cursory analysis of 655 Pecos bluntnose 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 Pecos bluntnose 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 Pecos bluntnose shiner's 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 also of low enough speed to form refugia where the fish can rest within striking distance of target items (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 Pecos bluntnose shiner feeding. Alluvial bed forms may be the most abundant form of habitat structure in sand-bed rivers and these bed forms require a certain velocity for formation and maintenance (Simons and Richardson 1962, Task Force on Bed Forms in Alluvial Channels 1966). Thus, Pecos bluntnose shiners rely upon flow both for delivering food items and for maintaining favorable habitat.

Reproduction (Spawning)

The Pecos bluntnose 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 that float in the water column (Platania and Altenbach 1998). Because these minnows 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). 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 spawned multiple times during the spawning season. Spreading the reproductive effort over a prolonged period (late April to September) is most likely a bet-hedging strategy to counter frequent fluctuations in environmental conditions (Durham and Wilde 2006). Hatch et al. (1985) examined two females and found 1,049 eggs in one (2.2 in standard length (SL) (57 mm)) and 85 eggs in the other (2.0 in SL (51 mm)). 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 two to four days. During this time, blood circulation begins, the yolk sac is absorbed, and the swim bladder, mouth, and fins develop (Moore 1944, Bottrell et al. 1964, Sliger 1967, Platania 1993). As the larvae drift, they "swim up", a behavior in which they repeat a cycle of swimming toward the surface perpendicular to the current, sinking to the bottom, and upon touching substrate, propelling 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 Pecos bluntnose shiner recruitment (Medley et al. 2007, Dudley and Platania 2007).

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, Medley et al. 2007). In contrast, transport of water in block releases, which 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 Pecos bluntnose 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 young-of-the-year (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 Pecos bluntnose shiner eggs or larvae may be able to pass through Brantley Dam, as indicated by the detection of a few young Pecos bluntnose shiner below the dam in 2003 and 2008 (Service 2003b, Davenport 2008b).

2.3.1.2 Abundance, population trends (e.g., increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.) or demographic trends:

Population trends

Sampling of fishes in the Pecos River was limited and sporadic prior to 1950 (Platania 1995b), hindering our ability to accurately track population trends over time. Platania (1995b) reported on the status of Pecos bluntnose shiner by analyzing museum records and concluded there had been a decline in the range and abundance of the species. In currently occupied habitat, it appears that Pecos bluntnose shiner abundance began to decline in the 1940s (Hatch et al. 1985, Brooks et al. 1991, Platania 1995b, Propst 1999). The Pecos bluntnose shiner achieved its greatest relative abundance in pre-1950 collections, forming 37.5 percent of the cyprinid guild, compared to collections made from 1950-1975, 1976-1985, and 1985-1994 (Platania 1995b). The number of Pecos bluntnose shiner per sample in this time frame was 1-1,492, with a mean of 433 per sample (Platania 1995b). Relative abundances and mean number per sample have never reached that level subsequently (Platania 1995b, Hoagstrom 2003a). Koster (1957) collected 818 Pecos bluntnose 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, New Mexico Fish and Wildlife Conservation Office collected a total of 815 Pecos bluntnose shiners in 39 trips (Hoagstrom 2000).

From 1992-2002, the density of Pecos bluntnose shiner within the Rangelands reach showed a gradual increase (Brooks and Allan 1995, Hoagstrom et al. 1995, Hoagstrom 2003a, Fagan 2006, Hoagstrom et al. 2008) (Figure 1). During these years there was 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 among stakeholders on the Pecos River, brought about by a Memorandum of Understanding, 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 Santa Rosa, Fort Sumner, and Brantley 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 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 gauge (gauge is located in quality habitat reach) and 63 days with flow less than 1 cubic foot per second (cfs) (0.03 cubic meters per second (m^3/s)) (Table 1). Severe drought conditions persisted into 2003, with reservoir storage on April 1 at 35 percent of normal, 44 days of 0 flow recorded at Acme gage, and 97 days of less than 1 cfs (0.03 m^3/s) (Table 1). River intermittency was initially reflected in a dramatic increase in mean annual density in the Rangelands (from 7 to 25 fish/100 square meters (m^2)) which persisted through 2003 (Hoagstrom et al. 2008). Most likely this increase was due to enhanced sampling efficiency caused by the crowding of fish into isolated, suitable habitats. Subsequently, mean annual density declined from greater than 19 fish/100 m^2 in 2003 to less than 3 fish/100 m^2 in 2005, the lowest level recorded since 1992 (Hoagstrom et al. 2008).

From 2002-2004 monsoonal rainstorms were infrequent and only one block release occurred in these years during the spawning season, providing the Pecos bluntnose shiner few opportunities to spawn during these three years. In addition, in 2002 and especially in 2003, very low flows (less than 1 cfs (0.03 m^3/s)) and intermittency occurred almost immediately after small peak (spawning) flows (Service 2006). 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. The same environmental conditions also occurred in the Canadian and Brazos Rivers in Texas and led to the lack of reproduction in two other *Notropis* species with the same reproductive strategy as Pecos bluntnose shiner (Durham and Wilde 2006, 2009).

Table 1. Days of intermittency (no flow), days less than one cfs (0.03 m^3/s) as recorded at the Acme gauge, New Mexico, and total reservoir storage (acre feet) for Santa Rosa, Sumner, and Brantley Reservoirs 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
Days of intermittency	0	4	49	44	8	0
Days less than one cfs	0	13	63	97	15	0
April 1 reservoir storage	136,600	79,500	35,200	47,100	29,200	115,000

Because the Pecos bluntnose shiner is short-lived (approximately three years), it does not take long for environmental perturbations to drastically reduce its population numbers (Durham and Wilde 2009). It is likely 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 Pecos bluntnose shiner population and contributed to its population decline. Direct loss of adults either through deterioration of water quality in isolated pools (Ostrand and Wilde 2004) or predation by terrestrial or aquatic predators may have also contributed to the population decline, but these sources of mortality were not documented. The Service had the population monitoring data collected through 2004 peer reviewed by Dr. Fagan from the University of Maryland. He concluded that there had been severe, system-wide decline in the population from 2002 to 2004 (Fagan 2006).

Annual catch rate in the years following surface flow intermittence (2005-2008) has increased gradually (Figure 1). Recovery of Pecos bluntnose shiner following disturbances such as surface flow intermittence is slow, and multiple years are required for stable catch rates to persist (Davenport 2008a).

Demographics

Based on seine collections, Pecos bluntnose shiner population structure is bimodal (two distinct length classes) from May through August (Hoagstrom 2003a, Hoagstrom et al. 2008). 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, Hoagstrom et al. 2008). Large juveniles and adults dominate the population at this time. Young-of-the-year present in May and June are not collected with a seine because they are small enough to pass through the mesh.

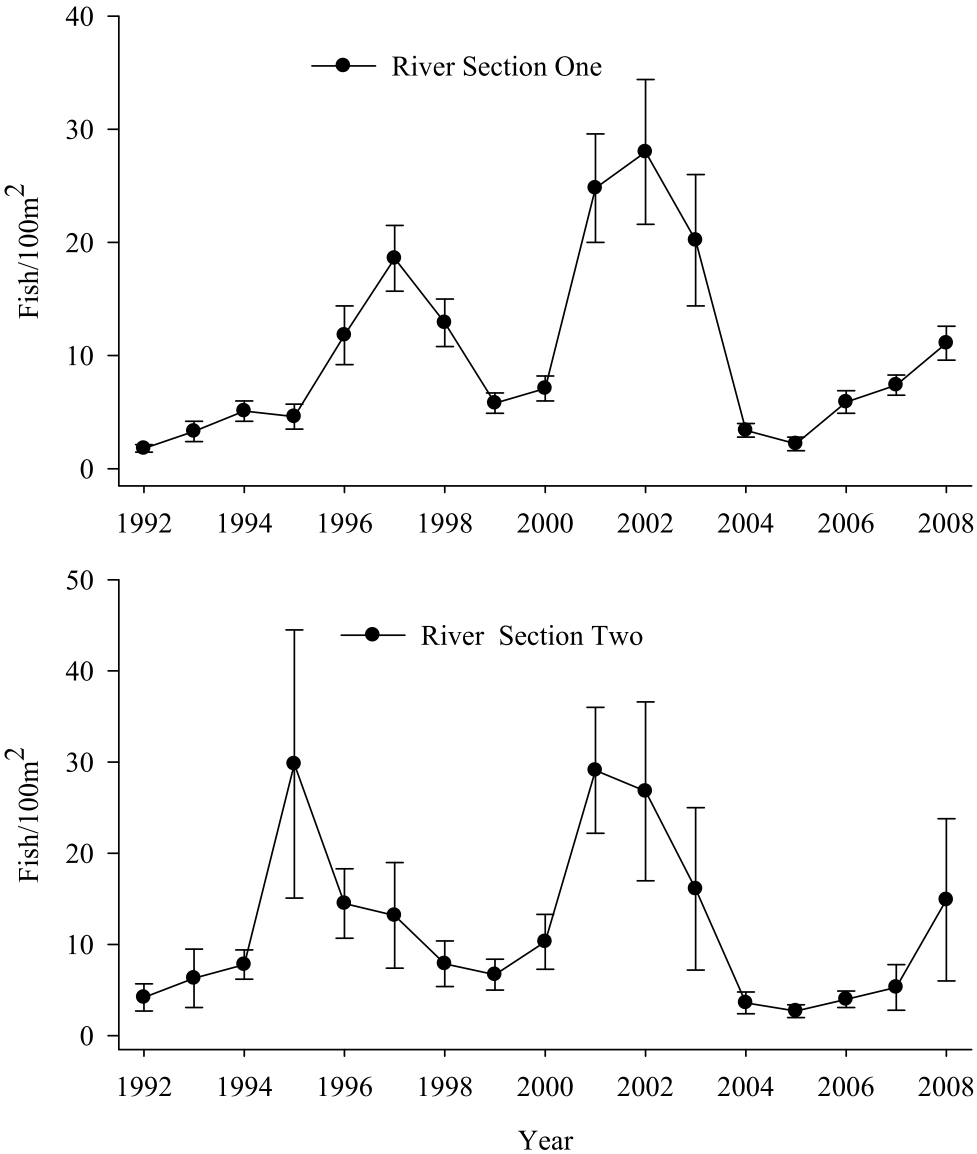

Figure 1. Annual Pecos bluntnose shiner catch-rate (fish/100m^2), ± one standard error, in the Rangelands (River Section 1) and Farmlands (River Section 2) reaches, 1992-2008 (Davenport 2008b).

First- and second-year individuals are most common in the Pecos bluntnose shiner population, comprising 97 percent of captures. Third year individuals are much less prevalent (Hatch et al. 1985). First-year individuals grow rapidly, reaching 1.0-1.2 in (26-30 mm) SL within 60 days. Hatch et al. (1985) reported that age-0 (first-year) Pecos bluntnose shiner ranged from 0.75-1.3 in (19.0-32.5 mm) SL, age-1 (second-year) individuals ranged from 1.28-1.77 in (32.6-45.0 mm) SL, and that age-2 (third-year) individuals ranged from 1.77- 2.22 in (45.1-56.5 mm) SL. Age-2 fish (greater than 40 mm) may not be present in all years and appear to die in spring or early summer after spawning (Hoagstrom et al. 2008). Burckhardt et al. (2009) determined that SL age-1 plus fish were 1.4 in (36 mm) or greater. Pecos bluntnose shiners begin spawning as one-year-olds, once they reach 1.6 in (41 mm) in SL (Hatch 1982).

Data from 1992-1999 (years of high precipitation and experimental base-flow supplementation) suggest that favorable flow conditions over several years produced larger Pecos bluntnose shiner (Hoagstrom et al. 2008). Numerous individuals captured during that period were larger than previously recorded. Abundance of record-length Pecos bluntnose shiner peaked between April and July 1999 when the 16 largest Pecos bluntnose shiners, ranging in size from 2.58-3.01 in (65.5-76.4 mm) SL were captured (Hoagstrom et al. 2008). Twenty-five percent of the longest Pecos bluntnose shiners caught over an 11-year period (1992-2002) 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 Pecos bluntnose 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).

Mean length of the Pecos bluntnose shiner is significantly different between the Rangeland and Farmlands reaches (Hoagstrom 2003a). In the Rangelands reach the mean length of Pecos bluntnose shiner was 1.3 in (34.2 mm), with a standard deviation (SD) of 0.36 in (9.3 mm) (N=7,477). Downstream, in the Farmlands reach, the mean length was 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, 2003a). 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 Pecos bluntnose shiner) and the influx of small Pecos bluntnose shiners into this lower reach during high flows.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Between 2002 and 2009, 1,361 Pecos bluntnose shiners were collected to obtain genetic data (Osborne and Turner 2006, 2009). This was the first such effort to look at both the population genetics and the effective population size of the species. Usually the effective population size is smaller than the actual population size because the effective population size is based on the number of reproductive individuals and assumes reproducing individuals will contribute genes equally to the next generation (i.e. equal ratio of breeding females to males, random mating, and constant immigration and emigration). The study compared estimates of contemporary effective population size with estimates of historical effective size, determined baseline measures of genetic diversity, and examined the spatial distribution of genetic diversity. Osborne and Turner (2006, 2009) found that: 1) contemporary effective population size is a fraction of the historical estimates of effective size; 2) both mitochondrial and microsatellite DNA showed moderate to high levels of allelic diversity; and 3) the population is panmictic (not divided or segregated) throughout its current range. There was a surprisingly large number of rare mitochondrial haplotypes. Analysis suggests that population expansion following a population bottleneck is the most likely explanation (Osborne and Turner 2009). However, hybridization with other pelagic spawning species (e.g., Plains minnow, Arkansas River shiner) is also a possible source of the genetic diversity. Additional research is needed to determine if hybridization with other pelagic spawning minnows is occurring.

Estimates of contemporary effective population size ranged from 75-569 Pecos bluntnose shiner individuals based on microsatellite DNA. There was considerably more variability around the mitochondrial DNA estimates that ranged from 197 to 49,663 individuals (Osborne and Turner 2009). For several reasons outlined in Osborne and Turner (2006), the mitochondrial DNA estimates are most likely overestimates of effective population size and those based on the microsatellite data are most likely more accurate. Historic effective population ranged from about 2.7 to 12 million (Osborne and Turner 2006). It has been suggested that net effective population size should exceed 500 to preserve genetic variation at neutral loci and should exceed 5,000 to maintain sufficient variation for quantitative traits such as fecundity, time of spawning, and body size (Lande 1995, Lynch & Lande 1998). The genetic effective size for Pecos bluntnose shiner has fallen below 100 in the recent past but has since rebounded. Assuming that the microsatellite DNA data are more accurate, the net effective population size for Pecos bluntnose shiner is currently within a safe range, however, further or prolonged reductions would be cause for concern.

For management purposes, these results indicate that any bottlenecks the population has experienced have not reduced genetic diversity to levels that appear to be harmful. There are no barriers which are isolating subpopulations or preventing dispersal throughout currently occupied habitat. Although the effective population size is a fraction of historic, that result is not surprising considering that the population occupies a fraction of its historic habitat, it must share the habitat with invasive species, and its population size is likely much reduced compared to historic conditions.

2.3.1.4 Taxonomic classification or changes in nomenclature:

There is no new information.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species within its historic range, etc.):

The historic range of the Pecos bluntnose shiner in the Pecos River was 392 river miles (mi) (631 kilometers (km)) from Santa Rosa, New Mexico, to the New Mexico-Texas border (Delaware River confluence). At the time of listing in 1987, the Pecos bluntnose 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 Pecos bluntnose shiner was described as extending from Old Fort Sumner State Park to Brantley Reservoir (194 mi, 318 km), comprising about 23 percent of the historical range of the species. The current occupied range of the Pecos bluntnose shiner is from the confluence of Taiban Creek with the Pecos River to Brantley Reservoir. Pecos bluntnose shiner has not been found in the reach above Taiban Creek since 1999, even though there are no apparent barriers limiting Pecos bluntnose shiner access to this area (Service 2003a, Davenport 2008b). This change in distribution, 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). 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 and all size classes of are present (Hoagstrom 2003a, b).

Critical habitat

Pecos bluntnose shiner critical habitat is divided into two separate reaches designated as upper and lower critical habitat (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 downstream to the Crockett Draw confluence. Upper critical habitat is encompassed within the Rangelands reach (Pecos bluntnose shiner stronghold). Approximately 36 mi (58 km) of the Rangelands reach is suitable habitat contiguous with, but downstream from, the upper designated critical habitat. This area is referred to as "quality habitat," because of its habitat suitability and large Pecos bluntnose shiner population, but 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 they had permanent flow and populations of Pecos bluntnose shiner. However, these two areas vary greatly in their habitat characteristics. Upper critical habitat has a wide sandy river channel with moderately incised banks, and provides habitat suitable for all age classes (Hoagstrom et al. 2007). 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 Pecos bluntnose shiner and only smaller size classes are common in this reach (Hatch et al. 1985, Brooks et al. 1991, Hoagstrom 2003a). The predominance of YOY Pecos bluntnose shiner in this reach is explained by periodic downstream displacement of eggs, larvae, and small juveniles during block releases or flood events (Brooks and Allan 1995, Hoagstrom et al. 1995, Hoagstrom 1997, 1999, 2000; Platania and Altenbach 1998, Dudley and Platania 1999, Dudley and Platania 2007). The ability of this area to support self-sustaining populations of the Pecos bluntnose shiner over the long-term is uncertain.

Given that sporadic water flow in the Pecos River was identified as the greatest threat to the shiner and its habitat at the time of critical habitat designation, the intervening reach between upper and lower critical habitat was not included because it was subject to frequent drying (Hatch et al. 1985). Water within this 114 mi-long (184 km) middle reachhad been reduced due to water diversions, ground and river water pumping, and water storage, which had altered the hydrograph with which the shiner evolved. The lower 36 mi (58 km) of the Rangelands reach (quality habitat) is located in this middle section, and the U.S. Geological Survey (USGS) Acme gauge measures 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 Pecos bluntnose shiner (Hoagstrom 1997, 1999, 2000, 2003a; Hoagstrom et al. 2008). With constant flow in this stretch of the Pecos River, the primary constituent elements of critical habitat for the Pecos bluntnose shiner as they were determined at the time of critical habitat designation are provided, consisting of clean, permanent water; a main river channel with sandy substrate; and low water velocity (Service 1987). The quality habitat between the two sections of critical habitat is acknowledged as an important component of recovery for the Pecos bluntnose shiner.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Typical of other members of the subgenus *Alburnops* (Etnier and Starnes 1993), the Pecos bluntnose 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). The Pecos bluntnose shiner is found in wide river channels with perennial flow that have 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, Musetter Engineering 2004, Roberts et al. 2006).

Flood inflows from numerous uncontrolled tributaries contribute to favorable river channel conditions in the Rangelands reach of the Pecos River. In the remainder of the historic bluntnose shiner range, closely spaced impoundments that control floods (favoring salt cedar encroachment) and block sediment transport have virtually eliminated these features (Lagasse 1980, Hufstetler and Johnson 1993, Collier et al. 1996).

In a six month survey of the Pecos River from Santa Rosa to Carlsbad, Hatch et al. (1985) found Pecos bluntnose shiner below FSID Diversion Dam and collected them from every major habitat except stagnant pools. However, they found that Pecos bluntnose shiners were most often in main channel habitats with low velocity laminar flows and depths from 17-41 centimeters (cm). Age-2 fish were found only in main channel habitats (Hatch et al. 1985).

Hoagstrom et al. (2007) studied Pecos bluntnose shiner populations from 1992 to 1996 in flows that ranged from 7 cfs (0.21 m^3/s) to 858 cfs (24.3 m^3/s). They found no clear relationship between water depth and age class with all ages using depths from approximately 4 to 50 cm. However, there was a distinct trend in velocity with age-0 fish found primarily in velocities less than 20 cm per second and age 1 and 2 fish found primarily in velocities greater than 22 cm per second. They concluded that depths and velocities most often occupied by Pecos bluntnose shiner were most abundant at intermediate discharges of 17.6 to 140 cfs (0.5 to 4 m^3/s). Favorable flow conditions between 1992 and 2001 corresponded with increased Pecos bluntnose shiner density in the quality habitat (Hoagstrom et al. 2008).

Suitable depths and velocities were least abundant in the Farmlands reach (Hoagstrom 2002). The uniformity of the channel created by channelization, channel narrowing (from salt cedar-lined banks), and uniform, armored substrate (silt) 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 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.

Kehmeier et al. (2007) evaluated mesohabitat (discrete, identifiable habitat types such as pools, riffles, backwaters, and runs) use and availability in the Rangelands reach between May 2002 and October 2003 in flows ranging from 1.8 cfs (0.05 m^3/s) to 81 cfs (2.29 m^3/s). They concluded that although several of the minnow species they observed were habitat generalists, the Pecos bluntnose shiner was a habitat specialist preferring mid-channel plunge-pool habitats. Plunge pools are small, deep pools, usually carved into bedrock and cooler than surrounding water, formed at the base of currently or previously flowing waterfalls. Eighty percent of Pecos bluntnose shiners were caught in perpendicular plunge pools, parallel plunge pools, or pools which represented only five percent of the total volume of mesohabitat available (Kehmeier et al. 2007). The research did not differentiate among age/size classes of Pecos bluntnose shiner and it is assumed (based on the results of other Pecos bluntnose shiner studies) that these habitats were primarily occupied by adults. They determined that runs, flat-water areas, and pools with low or no velocity were avoided by the Pecos bluntnose shiner (Kehmeier et al. 2007). 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 and suggested that plunge-pool habitats were important for feeding, escaping, resting, or spawning (Kehmeier et al. 2007). The importance of maintaining a mosaic of habitat types for movement between the preferred habitat types was also noted (Kehmeier et al. 2007).

The two studies that have examined Pecos bluntnose shiner habitat use and availability came to contrasting conclusions about the amount of flow that would best sustain the population (Kehmeier et al. 2007, Hoagstrom et al. 2007). Kehmeier et al. (2007) concluded that because Pecos bluntnose shiner preferred mid-channel plunge pools and these mesohabitats were as available at low flows (3 to 5 cfs (0.08 to 0.1 m^3/s)) as they were at higher flows up to 80 cfs (2.3 m^3/s), low flows were sufficient to maintain the population. Determining that the Pecos bluntnose 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, Hoagstrom et al. 2008). It is likely that because Kehmeier et al. (2007) conducted their research in the midst of two severe drought years (May 2002 to October 2003) they found Pecos bluntnose 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. (2007) was not reported. Therefore, while low flows down to 3 to 5 cfs (0.08 to 0.1 m^3/s) may maintain adults at least for the short term, we cannot rule out the possibility that higher flows would benefit all age classes (through maintenance of appropriate habitat) and are necessary for the species to complete all phases of its life history (i.e., spawning).

Studies have shown that Pecos bluntnose shiner avoid (or perish within) areas subjected to frequent surface flow intermittence (Hatch et al. 1985, Brooks et al. 1991, Hoagstrom et al. 2007, Davenport 2008a, Hoagstrom et al. 2008). Pecos bluntnose shiner proliferate in formerly intermittent areas when these areas remain perennially wet (e.g. the quality habitat of between the two critical habitat segments) (Hoagstrom et al. 2008). Two other species of *Notropis* (*N. oxyrhynchus* and *N. buccula*) which have the same reproductive strategy as Pecos bluntnose shiner, did not successfully produce YOY during periods of intermittency, even though there was evidence that eggs were released in isolated pools (Durham and Wilde 2009). The authors concluded that reproductive success of these species depends on the persistence of discharge in the river throughout the reproductive season (May through September) (Durham and Wilde 2006). Based on the population monitoring done before, during, and after intermittency in the Pecos River, it appears the same is true for Pecos bluntnose shiner (Fagan 2006, Davenport 2008a).

2.3.1.7 Other: Improved analytic methods resulted in new information.

Beginning in 1992, systematic sampling of the Pecos bluntnose shiner was initiated using a single pass through distinct mesohabitats at multiple sites from Sumner Dam to Brantley Reservoir. Improvements to sampling design since 2003 include the establishment of 12-14 permanent sites and the increase in sampling visits per year (sampling occurs in every month except January). The

Service continues to track catch per unit effort and relative abundance of the Pecos bluntnose shiner with methods consistent with those used since 1992.

The New Mexico Interstate Stream Commission contracted SWCA Environmental Services (referred to hereafter as SWCA) to evaluate depletion methods for estimating populations of Pecos River fishes (Kehmeier and Widmar 2006, Burckhardt et al. 2009). A pilot study was conducted in 2005 (Kehmeier and Widmar 2006) and additional collections were made in 2007 (Burckhardt et al. 2009). The 2007 survey results estimated that the core population of age-0 Pecos bluntnose shiners was 18,790 ±5,011, and the age-1+ population was 46,815 ±11,862. This is the first population estimate that has been made. Across all subreaches, Pecos bluntnose shiners composed 2.4 percent of the total fish abundance (Burckhardt et al. 2009). SWCA compared one pass sampling of specific mesohabitats with their depletion sampling methods. They found that the correlation between the number of age-0 Pecos bluntnose shiners caught during the first pass and the total population estimate was highest for all strata combined ($r = 0.962$, $n = 10$) and relatively consistent among all strata sampled. The correlation between the first pass catch and population estimate was more variable for age-1+ Pecos bluntnose shiner, ranging from $r = 0.592$ to $r = 0.994$ depending on where in the river the samples were taken (Burckhardt et al. 2009).

SWCA also conducted a power analysis to determine the detectability of a 20 or 30 percent increase or decrease in Pecos bluntnose shiners over a 5-year period with $\alpha = 0.10$ or $\alpha = 0.05$ (Burckhardt et al. 2009). Generally, a power of 0.8 or higher is desirable (Brown and Guy 2007). SWCA found that that neither depletion sampling nor a single pass catch per unit effort method is adequate (with current sample sizes) to confidently detect a 20 or 30 percent change in the population in five years (Burckhardt et al. 2009).

The use of depletion sampling is labor intensive and its use in sand bed streams is still being evaluated. When population numbers are low, using depletion sampling becomes problematic because the method depends on decreasing numbers of a species being caught with each subsequent sampling pass. When fish numbers are low, a species may only be caught in the first pass, or none may be caught in the first pass but then the species is caught in subsequent passes (Kehmeier and Widmar 2006). The analysis for depletion sampling is based on the assumption that the most fish are caught on the first pass and fewer fish are caught on subsequent passes. Consequently, the method may have limited value for population estimates if population numbers again become as low as they were in 2005.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification, or curtailment of its habitat or range

Reduced flow and associated altered riparian habitats and hydrographs remain the primary threats to the Pecos bluntnose shiner. The construction of dams has had many adverse effects on the Pecos River ecosystem (Dudley and Platania 2007, Hoagstrom et al. 2007). Dams have many downstream effects on the physical and biological components of a stream ecosystem including habitat fragmentation, 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 (Williams and Wolman 1984, Sherrard and Erskine 1991, Collier et al. 1996, Power et al. 1996, Kondolf 1997, Friedman et al. 1998, Polzin and Rood 2000, Shields et al. 2000, Dudley and Platania 2007, Hoagstrom et al. 2007). In the case of a pelagic spawner (fertilized eggs float in the water column) such as the Pecos bluntnose shiner, reproductive products (eggs and larvae) may also be lost in the unsuitable habitat of a downstream reservoir (Dudley and Platania 2007). Six dams control the flow of the Pecos River in New Mexico. Operations of four of these (Santa Rosa, Sumner, Fort Sumner Irrigation Diversion Dam, Brantley) affect the Pecos bluntnose shiner.

After Sumner Dam was completed in 1937, it prevented all movement between the Pecos bluntnose shiner populations above and below the dam. Pecos bluntnose shiner was last collected upstream from Sumner Dam in 1963 (Platania and Altenbach 1998). Sumner Dam also traps sediment that would maintain the sandy river bed that Pecos bluntnose shiner prefers. The release of sediment-free water leads to channel scour below the dam, creating unsuitable habitat in the Tailwaters Reach where the species has not been collected since 1999 (Kondolf 1997, Service 2003a, Davenport 2008b).

Maintaining a natural flow regime in managed rivers is considered important to conserving the native fauna of the aquatic ecosystem (Poff et al. 1997, Bunn and Arthington 2002, Richter et al. 2003). The flow regime of the Pecos River is highly modified and does not mimic natural conditions. Operation of Sumner Dam significantly alters flow regimes in the reach of river occupied by the Pecos bluntnose shiner (Service 1992, Tetra Tech 2000, Mussetter Engineering 2004). The effect of upstream water storage and diversion on the downstream reaches of the Pecos River is to reduce the frequency and magnitude of floods and reduce winter and summer flows (Service 2006). The construction of Sumner Dam reduced the 100-year peak flow below Sumner Dam from 43,100 cfs (1,220 m^3/s) to 22,800 cfs (645 m^3/s). The construction of Santa Rosa Dam caused an additional reduction peak flows to the current 100-year peak of 1,620 cfs (46 m^3/s) (Mussetter Engineering 2004). Similar decreases are seen for all other return intervals of peak flows and at all of the downstream gauges (Mussetter

Engineering 2004). Reduced peak discharge has caused the channel to become narrower and 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 (Schiemer 1995, Ward and Stanford 1995, Power 1996, Shafroth 1999). One of the reasons that habitat in the Rangelands reach remains suitable for Pecos bluntnose shiner, is the presence of tributary streams that add sediment and monsoonal flood flows to the Pecos River below Sumner Dam.

In addition to a reduction in the magnitude of flood flows, the flow regime of the Pecos River is also modified by "block releases." The U. S. Bureau of Reclamation (Reclamation) diverts water to storage at Sumner Reservoir for the Carlsbad Project and then releases the stored water for the Carlsbad Irrigation District in "blocks" in which large amounts of water (usually a minimum of 1,000 cfs [28 m^3/s]) are released, typically for a period of two weeks. Blocks of water are used to reduce conveyance depletions. 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 first block release of the season typically occurs in March, before Pecos bluntnose shiners are ready to spawn. Timing of the subsequent block releases is highly variable and may or may not coincide with spring runoff. Under the current biological opinion, block releases may not last more than 15 days and the number of days between block releases will be no less than 14 (Service 2006).

Block releases provide a cue for spawning, help maintain channel morphology, and if timed correctly, can alleviate intermittency (Reclamation 2005). Block releases that occur during the spawning season from May through September transport semi-buoyant Pecos bluntnose 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. Also, larval fish are likely eaten by predatory fish.

Two studies of egg transport in the Pecos River have been conducted with contrasting results (Dudley and Platania 1999, Dudley and Platania 2007, Medley et al. 2007). 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 Medley et al. (2007) estimating that 92 percent of Pecos bluntnose shiner eggs would be retained above Brantley Lake, even during a sustained block release, and Dudley and Platania (1999) estimating that 40 percent would be retained. Dudley and Platania (2007) also concluded that mean transport distance of eggs was much reduced during rapid drops in flows (e.g. natural runoff events) compared to block releases. Because the methods of the two studies were different it is difficult to evaluate which provides the better estimate of the loss of propagules into Brantley Reservoir. The studies used different artificial eggs which may account for part of the discrepancy in the results. Although both studies used eggs of appropriate density, Dudley and Platania (1999) used nylon beads that were 2.5 mm (0.1 in) in diameter and did not degrade. Medley et al. (2007) used gellan beads, 3-4 mm (0.1-0.2 in) in diameter which are more delicate (Dudley and Platania 1999, Reinert et al. 2004) and may deteriorate under the experimental conditions of river transport (leading to higher estimates of retention). In addition, the studies used different formulas to analyze retention. Because of the large number of juvenile fish located in the Farmlands reach and the lack of adults, there is no doubt that eggs and larvae are transported to this reach and that some proportion of reproductive effort is lost to Brantley Reservoir.

Up to 100 cfs (2.8 m^3/s) is diverted from the Pecos River by FSID 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, this diversion is typically 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 pre-date Sumner Dam construction. The water entitlement is based on a calculation made by the Office of the State Engineer 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. Here the water is diverted into a main canal that is 15 mi (24 km) long and feeds smaller lateral canals. A drain canal collects seepage and runoff from the fields and carries these return flows back to the Pecos River between Old Fort Sumner Sate Park and the confluence of Taiban Creek. The return flows to the Pecos River may be up to half of the amount diverted.

Before November 1998, all water available above FSID's 100 cfs (2.8 m^3/s) requirement was stored in Sumner Lake. Since 1999, 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 critical habitat (1999-2005) or to keep the river whole (2006 to present). However, once spring runoff ceases or in times of drought, no bypass water is available. During drought (i.e., 2002-2004), there is insufficient water available to provide FSID with their 100 cfs and they are entitled to divert the entire flow of the river. During these periods it is much more likely that the river will become intermittent because agricultural return flows are insufficient to keep the river whole.

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 such as Pecos bluntnose shiner (Summerfelt and Minckley 1969, Cross et al. 1985). Ostrand and Wilde (2004) found that although cyprinids (including two species of shiner, *N. buccula* and *N. oxyrhynchus*) were the most abundant species when isolated pools first formed in the Brazos River, Texas, there was a significant decline in the abundance of sharpnose shiner and an absence of plains minnow, smalleye shiner, and red shiner from collections after six days of confinement in pools. They determined that intolerance to increases in salinity was the reason for the decline in the cyprinids. In addition, without flows to deliver food items, species dependent upon drift, such as the Pecos bluntnose shiner, are at a disadvantage (Mundie 1969).

Introduced 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 of pelagic spawners to which the Pecos bluntnose shiner belongs (Platania 1995a). As a result of these introductions, interspecific competition may be a factor in the reduction in Pecos bluntnose shiner abundance and distribution. Young fishes of these species also use low velocity backwater areas and may compete directly with young Pecos bluntnose shiners for space and food (if food is limited); however, competitive interactions among Pecos River fishes have not been studied.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes.

Overutilization for any purpose is not considered a threat at this time.

2.3.2.3 Disease or predation

Large-bodied piscivorous fishes in the Pecos River are uncommon in currently occupied Pecos bluntnose shiner habitat between the Taiban Creek confluence and Brantley Reservoir (Hoagstrom 2000, Larson and Propst 2000). This is primarily because the majority of available habitat is shallow and unsuitable for large fish. High turbidity likely inhibits sight-oriented predators such as the sunfishes (Centrarchidae). Predators that occupy the most suitable Pecos bluntnose shiner habitat include the native longnose gar (*Lepisosteus osseus*), flathead catfish (*Pylodictis olivaris*), and green sunfish (*Lepomis cyanellus*), and the non-native channel catfish (*Ictalurus punctatus*), white bass (*Morone chrysops*), and spotted bass (*Micropterus punctulatus*) (Larson and Propst 2000). When captured during surveys, the majority of these predators has been small (less than 100 mm (3.9 in)) (Larson and Propst 2000, Valdez et al. 2003). Thus, low abundance and small size suggest fish predation is not a major threat to the

Pecos bluntnose shiner (Larson and Propst 2000). However, the impacts of predaceous fishes within intermittent pools have not been studied and it is possible that they feed on Pecos bluntnose shiner (Larson and Propst 2000). The increase in intermittent flow days in 2002-2003 may have increased the risk of predation on Pecos bluntnose shiner caught in pools. The reduction in intermittent flow days in 2004 to eight days, and none in 2005, reduced that risk of predation. By maintaining continuous flows, the degree of risk from predation should be reduced.

Aerial and terrestrial piscivores may also threaten the Pecos bluntnose 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. raccoons, skunks, coyotes) on the Pecos bluntnose 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 of several predators, including Great blue heron, raccoon, and coyote, were seen around isolated pools that occurred during river intermittency

Golden Algae

Fish kills caused by golden algae (*Prymnesium parvum*) have been documented in the Texas portion of the Pecos River since 1985 (James and de la Cruz 1989). From 1985-1989 it was estimated that more than two million fish had died in the Pecos River because of golden algae (James and de la Cruz 1989). Fish kills attributed to golden algae in the New Mexico portion of the Pecos River have been documented since 2002 (NMDGF 2007). These kills have occurred from Brantley Reservoir downstream. The activity of the toxin produced by the algae is inversely proportional to salt concentrations in the water with concentrations of 3-50 parts per thousand (ppt) being optimal for toxin production (Watson 2001). It is likely that increased salinization in the lower Pecos (Hoagstrom 2009) has contributed to the number of fish kills. Kehmeier et al. (2004) did not record any salinity values over 2.4 ppt in habitat occupied by Pecos bluntnose shiner in 2002 and 2003, and no fish kills have been recorded in the Pecos River upstream of Brantley Reservoir. However, the spread of the algae upstream over time, the increased potential for drought, salinization, and nutrient concentrations over time (discussed under climate change below) are reasons for concern.

2.3.2.4 Inadequacy of existing regulatory mechanisms

Pecos bluntnose shiner is federally listed as threatened (52 FR 5295) and state listed in New Mexico as endangered (NMDGF 2006). Take of Pecos bluntnose shiner from river operations is monitored through systematic sampling and annual reporting. All projects on the Pecos River that may affect the species receive section 7 consultation through the New Mexico Ecological Services Field Office. All research activities are regulated by permits issued by the NMDGF.

Reclamation owns three facilities on the Pecos River: Sumner Dam, the FSID Diversion Dam, and Brantley Dam. The Carlsbad Project is a Reclamation project located in southeastern New Mexico near the city of Carlsbad. The Carlsbad Project irrigates 25,055 acres (10,139 hectares) of the Carlsbad Irrigation District from just below Avalon Dam to the Black River area. Project water is also stored in Santa Rosa Lake, a U.S. Army Corps of Engineers facility. Reclamation manages the delivery of water to the irrigation districts during the summer irrigation season (March through October). In 2005, Reclamation submitted a biological assessment to the Service because they proposed changing their water operations on the Pecos River.

The proposed changes in the water operations are designed to conserve the Pecos bluntnose shiner and prevent destruction or adverse modification of critical habitat, while conserving the Carlsbad Project water supply. The proposed action for river operations included maintaining 35 cfs (0.99 m^3/s) at the Taiban gauge and maintaining a continuous flow between Sumner Dam and Brantley Reservoir using supplemental water (Service 2006). However, their options to deliver supplemental water to the river are limited. Reclamation has four primary sources of supplemental water: a well field which can deliver approximately 12 cfs (0.34 m^3/s) via the Vaughan pipeline to the river above the Taiban River confluence; a 1,000 acre foot fish conservation pool; bypass water; and the Lynch wells which provide approximately 1-2 cfs (0.03- 0.06 m^3/s) in the quality habitat reach. Although these sources of water have been adequate to maintain a flowing river since 2005, these were also years of average snowpack and runoff. Under more severe drought conditions, it is unlikely these sources of water would be adequate to maintain flow in the Pecos River.

When critical habitat was proposed, two perennially wet sections were designated creating a 114 mi (184 km) gap between upper and lower critical habitat. It has since been determined that the habitat between the two designated reaches is of high quality when wet, and is important to the long term persistence of the species. Since 2005, Reclamation has been maintaining constant flow in both critical habitat reaches and within the intervening reach of the Pecos River as part of Reclamation's proposed action described above. Continuous flow in these areas has prevented the destruction or adverse modification of critical habitat and has enhanced the status of the fish, as indicated by a steady rise in the annual catch rate of Pecos bluntnose shiner each year since 2005 (Figure 1). The positive response of the fish to continuous flow within the entire stretch, from the confluence of Taiban Creek to Brantley Reservoir, highlights the essential role of the intervening river section located between the two critical habitat reaches in the recovery of the Pecos bluntnose shiner.

2.3.2.5 Other natural or manmade factors affecting its continued existence.

Climate change

According to the Intergovernmental Panel on Climate Change (IPCC 2007) "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1,300 years (IPCC 2007). It is very likely that over the past 50 years cold days, cold nights, and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). Data suggest that heat waves are occurring more often over most land areas, and the frequency of heavy precipitation events has increased over most areas (IPCC 2007).

The IPCC (2007) predicts that changes in the global climate system during the 21st century will very likely be larger than those observed during the 20th century. For the next two decades a warming of about 0.2°C (0.4°F) per decade is projected (IPCC 2007). Afterwards, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 1.1°F-7.2°F (0.6°C-4.0°C) with the greatest warming expected over land (IPCC 2007).

Localized projections suggest the southwest region of the U.S. may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007), with warming in southwestern states greatest in the summer (Christensen et al. 2007). The IPCC also predicts hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007). There is also high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to climate change (IPCC 2007), as a result of less annual mean precipitation and reduced length of snow season and snow depth (Christensen et al. 2007). Milly et al. (2005) projected a 10-30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models.

In consultation with leading scientists from the southwestern U.S., the New Mexico Office of the State Engineer (2006) prepared a report for the Governor which made the following observations about the impact of climate change in New Mexico:

(1) Warming trends in the American southwest exceed global averages by about 50 percent;

(2) Models suggest that even moderate increases in precipitation would not offset the negative impacts to the water supply caused by increased temperature;

(3) Temperature increases in the southwest are predicted to continue to be greater than the global average;
(4) There will be a delay in the arrival of snow and acceleration of spring snow melt, leading to a rapid and earlier seasonal runoff ; and
(5) The intensity, frequency, and duration of drought may increase.

Consistent with the outlook presented for New Mexico, Hoerling (2007) stated that, relative to 1990-2005, simulations indicate that a 25 percent decline in stream flow will occur from 2006-2030 and a 45 percent decline will occur from 2035-2060 in the southwestern U.S. Seager et al. (2007) showed that there is a broad consensus among climate models that the southwestern U.S. will get drier in the 21st century and that the transition to a more arid climate is already under way. Only 1 of 19 models has a trend toward a wetter climate in the southwest (Seager et al. 2007). Stewart et al. (2004) showed that timing of spring streamflow in the western U.S. during the last five decades has shifted so that the major peak now arrives one to four weeks earlier, resulting in less flow in the spring and summer. An earlier onset to spring runoff has already been documented in the Pecos River (Hall et al. 2006).

Similar to many rivers in the western U.S., the Pecos River has experienced a considerable reduction in stream flow due to increased irrigation demands, groundwater pumping, and water impoundments since the late 1930s (Thomas 1963, Yuan et al. 2007). Because of groundwater inflow, the Pecos River naturally had a substantial dry-weather flow (Thomas 1963). Prior to the closure of Sumner Dam, flows were never less than 1 cfs (0.03 m^3/s) at the Sumner Dam gauge. After closure of the dam, flows less than 1 cfs (0.03 m^3/s) occurred an average of 55 days per year (Service 2006). Fort Sumner Irrigation District is entitled to 100 cfs (2.8 m^3/s), which during drought years of 2002-2003 was more flow than the river had. Irrigation return flows may be up to half the amount diverted, but in 2002 they were less than 20 cfs (0.6 m^3/s), which is insufficient to keep the river flowing downstream. At the turn of the 19th century the natural discharge of groundwater to the Pecos River was 235,000 acre feet per year which equals a flow of 325 cfs (9.2 m^3/s) (Fiedler and Nye 1933). Groundwater development of the Roswell basin reduced the amount of discharge into the Pecos River by 80 to 90 percent (Reynolds as cited in Reclamation 2002). These changes in the Pecos River basin predispose the river to drying.

Although the Pecos River basin experienced drought historically, the impacts of habitat fragmentation and alteration increase the cumulative effect of river drying on the species. The combination of drought and reduced flows led to many days of river intermittency in 2002 and 2003 and a subsequent decline in the Pecos bluntnose shiner population. Historically, springs (e.g. Major Johnson Spring, North Spring) and groundwater inflow, abundant backwaters, and large oxbows absent of nonnative species could have provided refuge during times of drought. No barriers would have existed between perennial and intermittent reaches to prevent recolonization of impacted reaches and the number of fish available to recolonize rewetted habitat would have been much greater. Consequently, the impact of occasional river intermittency would have been much less compared to today.

Intermittency occurs primarily in the quality habitat located between upper and lower critical habitat. When intermittency occurs, typically upper critical habitat and lower critical habitat continue to have flowing water. Observing the river-wide decline in the Pecos bluntnose shiner population when intermittency directly affected a relatively short reach of river, we come to two possible conclusions. First, although the quality habitat is relatively short, it is disproportionately important to Pecos bluntnose shiner recruitment and reproductive success. When this reach has flowing water it supports a large number of Pecos bluntnose shiners that contribute toward maintaining the entire population (Hoagstrom et al. 2008). 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 may have effects system-wide.

A second explanation why the Pecos bluntnose shiner population declined so dramatically with two years of low flows and intermittency is that low flows system-wide may 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.

Currently, there are few options available to ensure continuous flow in the Pecos River, and those options are sufficient to accommodate minor deficits, not major deficits in flow. In addition, during periods of low flow, agricultural return flows can represent a substantial portion of the water in the river. A combination of an extended period of low flow or intermittency with much of the flow coming from agricultural fields could lead to increased salinization and nutrient loading, creating a greater threat from golden algae than exists today. Solutions that can provide water for the Pecos bluntnose shiner in light of decreasing water availability and increasing human demand need to be sought and implemented to address the threat of climate change on the Pecos bluntnose shiner.

If climate change leads to intense, widespread or long-lasting drought, it is anticipated that conflict over the limited water available in the Pecos River will increase as agricultural and municipal demands increase. There are no regulatory mechanisms that address climate change.

Conservation measures

Reclamation has secured and continues to develop supplemental sources of water to provide water directly to the Pecos River or to augment the Fish Conservation Pool. Increasing the size of the Fish Conservation Pool so that more water will be available during drought situations remains an important goal. These sources of water enabled Reclamation to maintain a continuous flowing river from 2005 through 2009. Reclamation is also developing a water banking and exchange program to supply water from Sumner or Santa Rosa Reservoirs when needed to protect designated Pecos bluntnose shiner critical habitat.

Currently, under the conditions of the Biological Opinion from the section 7 consultation by the Service extending from 2006 to 2016, Reclamation has agreed to operate 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) (Service 2006). Reclamation's water management activities are expected to maintain continuous flow in the Pecos River from the Taiban Creek confluence to Brantley Reservoir at least through 2016. At that time, consultation under section 7 of the ESA will have to be reinitiated to continue to provide bluntnose shiner habitat by avoiding river water intermittancy. During the 10 years covered by the Biological Opinion, Reclamation will implement adaptive management based on changing environmental and hydrological conditions along the Pecos River to keep the river flowing (Service 2006). As an additional safeguard should drought conditions lead to an inadequate water supply in a particular year, Reclamation has proposed to fund and assist in the capture and holding of shiner in refugia with the assistance of the New Mexico Fisheries Resource Office and Dexter National Fish Hatchery and Technology Center (Service 2006).

In 2009, Reclamation completed a habitat restoration project on the Pecos River at Bitter Lake National Wildlife Refuge to increase the amount of suitable habitat for Pecos bluntnose shiner. An oxbow that had been channelized in the 1940s, reducing the amount of suitable habitat, was reconnected to the river, creating over a mile of suitable habitat. An additional project at Bitter Lake National Wildlife Refuge was funded by the State of New Mexico to remove salt cedar and reconnect the river to the floodplain to improve Pecos bluntnose shiner habitat. In accordance with the current biological opinion, Reclamation will complete habitat restoration projects that will improve an additional 0.5-1 mi (0.8-1.6 km) of habitat.

2.4 Synthesis

Dams have fragmented Pecos bluntnose shiner habitat and altered the natural river hydrograph, limiting occupied habitat to a 298 km (186 mi) reach of the Pecos River from the confluence of Taiban Creek to Brantley Reservoir. Sumner Dam in particular, blocks the transport of sediment into occupied habitat and has created unsuitable habitat from the dam down to the confluence with Taiban Creek. The flow regime in the Pecos River is highly modified and is dictated by water irrigation needs. No attempt has been made to mimic the natural hydrograph. Spring runoff from headwater streams is captured in Santa Rosa Reservoir and is released in "blocks" to maximize transport efficiency. Although the block releases in some aspects mimic a natural flood (rapid increase in discharge), the high discharge lasts much longer (7 to 14 days compared to 1 to 2 days), and is of much less magnitude than pre-dam flood events. Although the Pecos bluntnose shiner uses block releases for spawning, because of the extended time of high flow and the loss of riparian habitat complexity leading to diminished egg retention, a portion of their eggs and larvae (estimates range from 8 to 60 percent) is flushed downstream during extended high flow releases and lost in Brantley Lake. Because the block releases are always of the same magnitude (1,400 cfs or 42 m^3/s), the channel has adjusted to this "flood" magnitude, causing the channel to become narrower, less braided, and to have less diverse fish habitat. In upper critical habitat, undammed tributaries occasionally create floods greater than the block releases and add sediment to the river. For these reasons upper critical habitat maintains more of a natural character and suitable habitat for all life stages of the Pecos bluntnose shiner. Lower critical habitat consistently has water but the habitat quality is poor. Because of the poor habitat quality and its proximity to Brantley Reservoir, it is questionable whether lower critical habitat could maintain a population without input of individuals from the upper reach.

The biggest threat to Pecos bluntnose shiner is river intermittency. The negative effect of intermittency on the population has been documented. Although Reclamation is committed to keeping the river whole between Sumner Dam and Brantley Reservoir, their options for maintaining flow are currently limited. If climate change leads to drier and/or hotter conditions, it is unlikely that intermittency could be prevented with the water currently available for Pecos bluntnose shiner conservation. Although golden algae is not currently a threat to Pecos bluntnose shiner, with climate change (decreases in flow, greater proportion of flow coming from agricultural return, leading to increased nutrient and salt concentrations) golden algae could become an issue in portions of the river, depending on how the river is managed.

Because of unsuitable habitat below Brantley Reservoir and repeated fish kills from golden algae, expansion of its range downstream is not feasible. Loss of Pecos bluntnose shiner, as well as three of four of the other native pelagic spawners, between Santa Rosa and Sumner Dams, indicates that either the habitat is unsuitable or the reach of river is not long enough to sustain this pelagic spawning fish (i.e., loss of reproductive effort to Sumner Reservoir exceeds that needed to sustain a population). Dudley and Platania (2007) note that pelagic spawning fish have been extirpated from nearly all short (less than 62 mi (100 km)) river reaches in the Rio Grande basin. The reach between Santa Rosa Dam and Sumner Reservoir is approximately 62 mi (100 km), but only about 25 mi (40 km) is potentially suitable habitat. Thus, successful expansion of the population above Sumner Dam is unlikely.

The reach of the Pecos River between designated critical habitat zones is of high quality when it remains wetted and the Pecos bluntnose shiner can attain high densities in this area. Based on population monitoring before, during, and after river intermittency, we conclude that maintaining water in this reach is important for sustaining the population as a whole and is an important element for the Pecos bluntnose shiner's recovery.

It is anticipated that climate change will add to the difficulty in maintaining flow throughout occupied habitat. An extended or intense drought will exceed the ability of managers to keep the river whole, given current operations and the amount of water available for Pecos bluntnose shiner conservation. During periods of drought, as was seen in 2002 and 2003, FSID's water right exceeds the amount of water in the river. The Pecos bluntnose shiner population is slowly recovering from a population low in 2005, caused by extensive river intermittency and the very low flows in 2002 and 2003. The challenge of the coming decades will be finding sufficient water to maintain the species and satisfy agricultural demand.

No change in classification is warranted. The Pecos bluntnose shiner population is currently stable and, with the continuous river flows since 2005, is increasing. Under the current biological opinion, there is more protection in place for the species than there was previously. Additional secure sources of supplemental water still need to found, funded, and authorized to ensure that flowing water can be maintained from the Taiban Creek confluence to Brantley Reservoir. If climate change leads to consistently less snow pack in the headwaters, or widespread, long-lasting drought, maintaining a continuous river will become very challenging under current river operations. River intermittency could cause the Pecos bluntnose shiner to become an endangered species.

3.0 RESULTS

3.1 Recommended Classification: No change is needed.

3.2 New Recovery Priority Number: No change; remain at 3.

3.3 Listing and Reclassification Priority Number: Not applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- The highest priority to facilitate recovery for the Pecos bluntnose shiner is maintaining a continuous river flow from the confluence of Taiban Creek to Brantley Reservoir.
- Revise the recovery plan so that threat assessments incorporate new information along with clearly defined recovery actions and measurable, threats-based criteria. During the recovery plan update process, evaluate the efficacy of including the entire reach of the Pecos River, from the confluence of Taiban Creek to Brantley Reservoir, as critical habitat.
- Continue habitat restoration projects that create favorable habitat for Pecos bluntnose shiner.
- Investigate whether hybridization between Pecos bluntnose shiner and other pelagic spawning fish is occurring.
- Determine the fate of the Pecos bluntnose shiner in the Farmlands reach. Do shiners perish or do they disperse upstream?
- Continue population monitoring.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW
Pecos bluntnose shiner (*Notropis simus pecosensis*)

Current Classification: Threatened.

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: N/A.

Review Conducted By: Marilyn Myers, Fish and Wildlife Biologist, New Mexico Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve ______ Acting Field Supervisor Date 2/25/2010

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service

Approve ______ Date 5/19/2010