United States Department of the Interior

FISH AND WILDLIFE SERVICE

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AUG 29 2005

Cons. # 2-22-05-F-0350

Daniel Malunchuk, Chief
Regulatory Branch
U.S. Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109-3435

Re: U.S. Fish and Wildlife Service's biological opinion on the Effects of the Rio Grande Island Removal Project at the Pueblo of Isleta.

Dear Mr. Malunchuk:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion on the effects of the action described in the Biological Assessment for the Rio Grande Island Removal Project on Pueblo of Isleta lands in Valencia County, New Mexico. The duration of this action is from the issuance of this biological opinion through August 2015. This biological opinion concerns the effects of the action on the endangered Rio Grande silvery minnow (*Hybognathus amarus)* (silvery minnow), the endangered southwestern willow flycatcher (*Empidonax trailli extiums)* (flycatcher), and the threatened bald eagle (*Hailiaeetus leucocephalus)* (eagle*)*. Your request for formal consultation, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 531 *et seq.*), was received on April 14, 2005. The Albuquerque District, Corp of Engineers (Corps) is the lead Federal agency in this consultation. The Pueblo of Isleta (POI) is the applicant.

This biological opinion is based on information submitted in the biological assessment dated April 13, 2005; meetings between the Corps, and the POI, and other sources of information available to the Service. A complete administrative record of this consultation is on file at the Service's New Mexico Ecological Services Field Office (NMESFO).

You have determined that the proposed island removal project may affect, is not likely to adversely affect, the eagle and the flycatcher. We concur with these determinations for the following reasons:

Eagle
Conditions of the Corps' 404 Clean Water Act permit require that the construction area be surveyed daily prior to activity. If, as a result of those surveys, an eagle is observed within 0.25 mi upstream or downstream of the active project site in the morning before project activity starts, or following breaks in project activity, the contractor will suspend all activity until the bird leaves of its own volition, or a POI biologist, in consultation with the Service, determines that the potential for harassment is minimal. If an eagle arrives during construction activities or is beyond that distance, construction need not be interrupted. If eagles are found consistently in the immediate project area during the construction period, the Corps and/or applicant will contact the Service to determine whether formal consultation is necessary. It is highly likely that implementation of these actions will reduce effects to the eagle to an insignificant level.

Flycatcher
Vegetation removal work may occur in the action area. To reduce effects to occupied habitat, protocol surveys for the flycatcher will be conducted every year prior to each work period in May, June, and July. If flycatchers are present, then the Corps will contact the Service for further consultation. If no flycatchers are present, then the work can proceed. Surveys conducted in the summer of 2005 indicated that flycatchers are not currently nesting in the action area. Vegetation removal work will occur outside the flycatcher nesting season and would not involve the use of heavy equipment.

The remainder of this biological opinion will deal with the effects of implementation of the proposed action on the silvery minnow.

Consultation History
The consultation history of the project includes an informal consultation (Cons. #: 02-22-04-I-646) on the removal of one in-channel island. In September of 2004, the POI, in cooperation with the Bureau of Reclamation (BOR) and the Service conducted a pilot project to test passive techniques for removing sediment islands downstream of the Isleta Diversion Dam. Vegetation and soils on the island closest to the dam were destabilized using rakes and root plows. Subsequently, in cooperation with the Middle Rio Grande Conservancy District (MRGCD), flows were directed at the island to mobilize the sediment. All of the work occurred outside of the wet channel, no flycatcher habitat was removed, and eagle activity was monitored resulting in informal consultation. The pilot project was not successful; thus, the current action has been proposed.

This consultation began with an application by POI to the Corps for a 404 permit under the Clean Water Act. On November 16, 2004, representatives from the Service, POI and the Corps met to discuss the project in detail and review conditions of the 404 permit. Subsequent meetings were held on January 7, 2005, and February 3, 2005 to discuss the project further and review the consultation process. A draft Biological Assessment was prepared by the Corps and given to the Service to review on March 15, 2005. A final Biological Assessment was received on April 14, 2005.

BIOLOGICAL OPINION

I. Description of the Proposed Action

The Proposed Action involves the removal of islands below the Isleta Diversion Dam. All work will be conducted when the flow through the Isleta Diversion Dam is less than 100 cubic feet per second (cfs) or the riverbed is dry. The staging area for equipment working on the project is located on the left/east bank adjacent to the Isleta Diversion Dam and the riverbank. This area currently contains little or no vegetation.

A pilot channel will be constructed with a bulldozer along the west bank of the channel to divert flows away from the work areas at the beginning of construction (if flows are present). Approximately 14,000 cubic yards (cys) of accumulated sediment will be moved during this process. The excavated material will be pushed onto the adjacent islands parallel to the west bank and removed with scrapers.

A dike, approximately 100-feet long by 10-feet wide by 8-feet high, will then be constructed with a bulldozer to divert flows into the pilot channel. At the end of the first season's excavation work, the dike will be removed by scrapers. The dike material will be placed into an existing disposal area, as described below. Once the pilot channel has been created, construction of a diversion dike is not expected to be necessary during future work periods. However, the 404 permit allows it to be reconstructed prior to, and removed following each work period, if necessary.

Two ramps will be constructed (using a bulldozer, loader, or excavator) along the east bank of the Rio Grande to provide access for equipment. The first ramp will be constructed downstream of the Peralta (irrigation) Heading and the second ramp will be constructed approximately 3/4 mile downstream. The ramps will be approximately 30-feet wide by 15-feet long and will be from 6-foot to 8-foot high (from the river's surface to the top of the bank). Approximately 100 cys of bank material will be pushed into the dry channel for each of the ramps. This material will be removed and the bank contoured to the original bank profile upon completion of each year's construction period.

Once the ramps are in place, bulldozers with rake and root plow attachments will remove the vegetation from the selected islands. The vegetation will be pushed into piles and loaded into articulating trucks for removal from the islands. The island soils will then be raked and ripped to destabilize the soils. Scrapers will remove the de-stabilized soils from the islands and will deposit this material within an existing 70-acre disposal site located on the east side of the Rio Grande approximately 1/3 mile south of the irrigation head works. The POI Hydrology Department will direct the scraper operators to remove material until groundwater is encountered. The islands to be removed range from 0.8 acres to 3.0 acres in area (total island area is 11.4 acres) and from 2 to 5 feet in height (see Figure 1).

The total quantity of fills to be placed or moved below the ordinary high water mark of the Rio Grande over the life of the project is estimated to be approximately 144,500 cys. This estimate includes the material to be used for dike and ramp construction, the material moved for the pilot channel, and the material stockpiled and moved during the island removal work. The island removal work will occur between permit issuance and August 2015. River conditions will be monitored during this time. The POI, Corps, and Service will coordinate annually to monitor and modify techniques for island removal and for minimizing effects to listed species, as appropriate.

Action Area

The action area is defined as the area from the Isleta Diversion Dam to the San Acacia Diversion Dam and the entire width of the 100 year floodplain within that reach. Adult and young-of-year (YOY) silvery minnow that are present during island excavation, will be directly affected as water is diverted into an alternative channel. Adult fish as far south as the San Acacia Diversion Dam may be indirectly affected as habitat behind and among the islands is modified.

II. Status of the Species

Species Description

The silvery minnow was federally listed as endangered under the ESA on July 20, 1994 (Service 1994). The species is listed by the State of New Mexico as an endangered species. Primary reasons for listing the silvery minnow involved a number of factors, described in the Status and Distribution section (below).

The silvery minnow is a stout minnow, with moderately small eyes, a small, sub-terminal mouth, and a pointed snout that projects beyond the upper lip (Sublette *et al.* 1990). The back and upper sides of the silvery minnow are silvery to olive, the broad mid-dorsal stripe is greenish, and the lower sides and abdomen are silver. Maximum length attained is about 3.5 inches (90 millimeters) (mm). The only readily apparent sexual dimorphism is the expanded body cavity of ripe females during spawning (Bestgen and Propst 1994).

The silvery minnow has had an unstable taxonomic history, and in the past was included with other species of the genus *Hybognathus* due to morphological similarities. Phenetic and phylogenetic analyses corroborate the hypothesis that it is a valid taxon, distinctive from other species of *Hybognathus* (Cook *et. al.* 1992, Bestgen and Propst 1994). It is now recognized as one of seven species in the genus *Hybognathus* in the United States and was formerly one of the most widespread and abundant minnow species in the Rio Grande basin of New Mexico, Texas, and Mexico (Pflieger 1980, Bestgen and Platania 1991). Currently, *Hybognathus amarus* is the only remaining endemic pelagic spawning minnow in the Middle Rio Grande. The speckled chub (*Extrarius aestivalus*), Rio Grande shiner (*Notropis jemezanus*), phantom shiner (*Notropis orca*), and bluntnose shiner (*Notropis simus simus*) are either extinct or have been extirpated from the Middle Rio Grande (New Mexico Department of Game and Fish 1998b, Bestgen and Platania 1991).

Critical Habitat

Critical habitat was proposed for the silvery minnow on June 6, 2002 (67 FR 39205) and was finalized on February 19, 2003 (68 FR 8088). The critical habitat designation extends from Cochiti Dam, Sandoval County, New Mexico downstream to the utility line crossing the Rio Grande, a permanent identified landmark in Socorro County, New Mexico, a total of approximately 157 mi (252 km). The Pueblo lands of Santo Domingo, Santa Ana, Sandia, and Isleta within this area are not included in the critical habitat designation. Except for these Pueblo lands, the remaining portion of the silvery minnow's occupied range in the Middle Rio Grande in New Mexico is designated as critical habitat (68 FR 8088).

Life History

The silvery minnow travels in schools and tolerates a wide range of habitats (Sublette *et al.* 1990), but generally prefers low velocity (< 0.33 feet per second, 10 centimeters/second [cm/sec]) areas over silt or sand substrate that are associated with shallow (< 15.8 inches [40 cm]) braided runs, backwaters or pools (Dudley and Platania 1997). Adults are most commonly found in backwaters, pools, and habitats associated with debris piles; whereas, YOY occupy shallow, low velocity backwaters with silt substrates (Dudley and Platania 1997). A study conducted between 1994 and 1996 characterized habitat availability and use at two sites in the Middle Rio Grande at Rio Rancho and Socorro (Dudley and Platania 1997). Dudley and Platania (1997) reported that this fish species was most commonly found in habitats with depths less than 19.7 inches (50 cm). Over 85 percent were collected from low velocity habitats (< 0.33 feet/sec [10 cm/sec]) (Dudley and Platania 1997, Watts *et al.* 2002). Habitat for the silvery minnow includes stream margins, side channels, and off-channel pools where water velocities are low or reduced from main-channel velocities. Stream reaches dominated by straight, narrow, incised channels with rapid flows are not typically occupied by the silvery minnow (Sublette *et. al.* 1990, Bestgen and Platania 1991).

The species is a pelagic spawner that produces 3,000 to 6,000 semi-buoyant, non-adhesive eggs during a spawning event (Platania 1995, Platania and Altenbach 1996). Adults spawn in about a one-month period in late spring to early summer (May to June) in association with spring runoff. Platania and Dudley (2000, 2001) found that the highest collections of silvery minnow eggs occurred in mid- to late May. In 1997, Smith (1999) collected the highest number of eggs in mid-May, with lower frequency of eggs being collected in late May and June. These data suggest multiple silvery minnow spawning events during the spring and summer, perhaps concurrent with flow spikes. It is unknown if individual silvery minnows spawn more than once a year or if some spawn earlier and some later in the year.

An artificial flow spike of 1,800 cfs (51 cubic meters/second) for 24 hours was released from Cochiti Dam on May 19, 1996. This flow spike apparently stimulated a spawning event and resulted in the collection of 49 silvery minnow eggs by researchers at Albuquerque on May 22, the day after the spike passed (Platania and Hoagstrom 1996). A late spawn was documented in the Isleta and San Acacia Reaches in July 2002, following a high flow event produced by a thunderstorm. This spawn was smaller than the typical spawning event in May, but a significant number of eggs were collected (N = 496) in two hours of effort (J. Smith, Service, *pers. comm.* 2002). In 2002, small spawning events of a few eggs have been documented in all reaches except the Cochiti Reach as late as August 7 (J. Smith, Service, *pers. comm.* 2002).

Platania (2000) found that development and hatching of eggs are correlated with water temperature. Eggs of the silvery minnow raised in 30° C water hatched in about 24 hours while eggs reared in 20 – 24° C water hatched within 50 hours. Eggs were 0.06 inches (1.6 millimeters [mm]) in size upon fertilization, but quickly swelled to 0.12 inches (3 mm). Recently hatched larval fish are about 0.15 inches (3.7 mm) in standard length and grow about 0.005 inches (0.15 mm) in size per day during the larval stages. Eggs and larvae have been estimated to remain in the drift for 3 – 5 days, and could be transported from 134 to 223 miles (216 to 359 km) downstream depending on river flows. About three days after hatching the larvae move to low velocity habitats where food (mainly phytoplankton and zooplankton) is abundant and predators are scarce. Young-of-year attain lengths of 1.5 to 1.6 inches (39 to 41 mm) by late autumn (Service 1999). Age 1 fish are 1.8 to 1.9 inches (45 to 49 mm) by the start of the spawning season. Most growth occurs between June (post spawning) and October, but there is some growth in the winter months. In the wild, maximum longevity is about 25 months, but very few survive more than 13 months (Service 1999). Captive fish have lived up to four years (C. Altenbach, City, *pers. comm.* 2003).

Platania (1995) suggested that historically the downstream transport of eggs and larvae of the silvery minnow over long distances was likely beneficial to the survival of their populations. This behavior may have promoted recolonization of reaches impacted during periods of natural drought (Platania 1995). The spawning strategy of releasing floating eggs allows the silvery minnow to replenish populations downstream, but the current presence of diversion dams (Angostura, Isleta, and San Acacia Diversion Dams) prevents recolonization of upstream habitats (Platania 1995). As populations are depleted upstream, and diversion structures prevent upstream movements, isolated extirpations of the species through fragmentation may occur (Service 1999). Adults, eggs and larvae are also transported downstream to Elephant Butte Reservoir. It is believed that none of these fish survive because of poor habitat and predation from reservoir fishes (Service 1999).

The silvery minnow is herbivorous (feeding primarily on algae); this is indicated indirectly by the elongated and coiled gastrointestinal tract (Sublette *et al.* 1990). Additionally, detritus, including sand and silt, is filtered from the bottom (Sublette *et al.* 1990, Service 1999).

Population Dynamics

The majority of spawning silvery minnows are one year old. Two year old fish comprise less than 10 percent of the spawning population. High silvery minnow mortality occurs during or subsequent to spawning, consequently very few adults are found in late summer. By December, the majority (> 98 percent) of individuals are YOY (Age 0). This population ratio does not change appreciably between January and June, as Age 1 fish usually constitute over 95 percent of the population just prior to spawning. Generally, the population consists of only two age classes (Service 1999).

Platania (1995) found that a single female in captivity could broadcast 3,000 eggs in eight hours. Females produce 3 to 18 clutches of eggs in a 12-hour period. The mean number of eggs in a clutch is approximately 270 (Platania and Altenbach 1996). In captivity, silvery minnows have been induced to spawn as many as four times in a year (C. Altenbach, City, *pers. comm.* 2000). It is not known if they spawn multiple times in the wild. The high reproductive potential of this fish appears to be one of the primary reasons that it has not been extirpated from the Middle Rio Grande. However, the short life span of the silvery minnow increases the population instability. When two below-average flow years occur consecutively, a short-lived species such as the silvery minnow can be impacted, if not completely eliminated from the dry reaches of the river (Service 1999).

Status and Distribution

Historically, the silvery minnow occurred in 2,465 mi (3,967 km) of rivers in New Mexico and Texas. They were known to have occurred from Española upstream from Cochiti Lake; in the downstream portions of the Chama and Jemez Rivers; throughout the Middle and Lower Rio Grande to the Gulf of Mexico; and in the Pecos River from Sumner Reservoir downstream to the confluence with the Rio Grande (Sublette *et al.* 1990, Bestgen and Platania 1991).

The construction of mainstem dams, such as Cochiti Dam and irrigation diversion dams have contributed to the decline of the silvery minnow. The construction of Cochiti Dam in particular has affected the silvery minnow by reducing the magnitude and frequency of flooding events that help to create and maintain habitat for the species. In addition, the construction of Cochiti Dam has resulted in degradation of silvery minnow habitat within the Cochiti Reach. Flow in the river at Cochiti Dam is now generally clear, cool, and free of sediment. There is relatively little channel braiding, and areas with reduced velocity and sand or silt substrates are uncommon. Substrate immediately downstream of the dam is often armored cobble (rounded rock fragments generally 8 to 30 cm (3 to 12 inches) in diameter). Further downstream the riverbed is gravel with some sand material. Ephemeral tributaries including Galisteo Creek and Tonque Arroyo introduce sediment to the lower sections of this reach, and some of this is transported downstream with higher flows (Service 2001b; 1999). The Rio Grande gains sediment below Angostura Dam and becomes a predominately sand bed river with low, sandy banks in the downstream portion of the reach. The construction of Cochiti Dam also created a barrier between silvery minnow populations. As recently as 1978, the silvery minnow was collected upstream of Cochiti Lake; however surveys since 1983 suggest that the fish is now extirpated from this area (Service 1999).

Silvery minnow catch rates have declined two to three orders of magnitude between 1993 and 2004. Additionally, relative abundance of silvery minnows declined from approximately 50 percent of the total ichthyofaunal community in 1995 to about 5 percent in 2004. However, the October density of silvery minnows was significantly higher ($p<0.05$) in 2004 than in 2003 and autumnal catch rates increased by over an order of magnitude between those years. Silvery minnow catch rates in 2004 were comparable to those in 2001. Despite seasonal fluctuations in the abundance of this species, recent samples indicate an increase over the last two years with gains occurring in all three reaches. Although population levels in 2004 only approached the lows observed following extensive river drying in 1996, it is noteworthy that the percent increase between 2003 and 2004 was the single largest (i.e., over an order of magnitude) observed since the onset of systematic sampling (1993). Similar trends were also evident from a comparison of annual catch rates (Platania and Dudley 2005).

Increased discharge in the Rio Grande during 2004 contrasted with the extended low-flow conditions observed throughout the Middle Rio Grande during 2003 and 2002. The timing of the 2004 flow spike was typical of a flow increase that would normally occur at the onset of the spring runoff period. Elevated and extended flows during 2004 likely resulted in more favorable conditions for the growth and survivorship of newly hatched silvery minnow larvae. It is possible that even low numbers of eggs and larvae could have resulted in greatly increased recruitment success because of the inundation of shoreline habitats, abandoned side channels, and backwaters. Low velocity and shallow areas provide the warm and productive habitats required by larval fishes to successfully complete their early life history.

Spring runoff in 2005 was also above average, leading to a peak of over 6,000 cfs at Albuquerque and sustained high flows (> 3,000 cfs) for more than two months. These flows likely resulted in improved conditions for spawning and recruitment. Monitoring reports for 2005 show increased numbers over 2004 (Dudley and Platania, *pers. comm.* 2005)

Middle Rio Grande Distribution

Generally, the density of silvery minnows increases from upstream (Angostura Reach) to downstream (San Acacia Reach). During surveys in 1999, over 98 percent of the silvery minnows captured were downstream of San Acacia Diversion Dam (Dudley and Platania 2002). This distributional pattern has been observed since 1994 (Dudley and Platania 2002) and is attributed to downstream drift of eggs and larvae and the inability of adults to repopulate upstream reaches because of diversion dams.

In 2004, Dudley et al. (2005) found that catch rates were generally highest in the Angostura Reach and approximately equal in the Isleta and San Acacia reaches. The Angostura Reach yielded the most silvery minnow (n=2,226) in 2004, followed by the Isleta Reach (n=442), and San Acacia Reach (n=371). This pattern is explained by the addition of hatchery and salvaged fish to the Angostura Reach as well as perennial flow in Angostura. By contrast, the Rio Grande south of San Acacia Diversion Dam has been routinely dewatered. Fish in the San Acacia Reach are generally trapped in drying pools, and unless rescued and returned to flowing water, die.

Reasons for Listing

The silvery minnow was federally listed as endangered for the following reasons:

1. Regulation of stream waters, which has led to severe flow reductions, often to the point of dewatering extended lengths of stream channel;

2. Alteration of the natural hydrograph, which impacts the species by disrupting the environmental cues the fish receives for a variety of life functions, including spawning;

3. Both the stream flow reductions and other alterations of the natural hydrograph throughout the year can severely impact habitat availability and quality, including the temporal availability of habitats;

4. Actions such as channelization, bank stabilization, levee construction, and dredging result in both direct and indirect impacts to the silvery minnow and its habitat by severely disrupting natural fluvial processes throughout the floodplain;

5. Construction of diversion dams fragment the habitat and prevent upstream migration;

6. Introduction of nonnative fishes that directly compete with, and can totally replace the silvery minnow, as was the case in the Pecos River, where the species was totally replaced in a time frame of 10 years by its congener the plains minnow (*Hybognathus placitus*); and

7. Discharge of contaminants into the stream system from industrial, municipal, and agricultural sources also impact the species (Service 1993b, 1994).

These reasons for listing continue to threaten the species throughout its currently occupied range in the Middle Rio Grande. The final recovery plan for the silvery minnow was released in July 1999 (Service 1999c) and is currently undergoing revision. The primary objectives for recovery are to increase numbers of the silvery minnow, enhance its habitat in the Middle Rio Grande valley, and to reestablish the species in at least three other areas in its historic range.

III. Environmental Baseline

Drought, as an overriding condition of the last decade in the southwest, is an important factor in the environmental baseline. The Rio Grande basin has received below normal precipitation, only adding to the long-term moisture deficits. The wet fall and early winter of 2002 provided some drought relief; however, long term moisture deficits averaging 9 inches over the past three years and deficits as high as 15 inches over the past 5 years contribute to current drought conditions in northern New Mexico, an area that supplies water to the Rio Grande basin (National Weather Service 2003a).

The United States Geological Survey (USGS) in Albuquerque, New Mexico reports that stream flow conditions for April 2005 were well above average to significantly above average statewide. The 2005 water year to date percent of average stream flow volumes range from average to significantly above average. Stream flow for April 2005 improved significantly compared to the April 2004 (National Weather Service 2005a). Nevertheless, while the runoff forecasts are good, reservoir levels continue to be below average across the state. It would take a least another year or two of well above average precipitation to reach pre-drought reservoir conditions.

Status of the Species within the Action Area

Past actions have eliminated and severely altered habitat conditions for the silvery minnow. These actions can be broadly categorized as changes to the natural hydrology of the Rio Grande and changes to the morphology of the channel and floodplain. Other factors that influence the environmental baseline are water quality, the release of captively propagated of silvery minnows, on-going research efforts, and past projects in the Middle Rio Grande. Also of importance is the current drought, the expected weather pattern for the near future, and how it may affect flow in the Rio Grande. Each of these topics is discussed below.

Changes in Hydrology

There have been two primary changes in hydrology as a result of the construction of dams on the Rio Chama and Rio Grande that affect the silvery minnow: Loss of water and changes to the magnitude and duration of peak flows.

Prior to measurable human influence on the system, up to the fourteenth century, the Rio Grande was a perennially flowing, aggrading river with a shifting sand substrate (Biella and Chapman 1977). There is now strong evidence that the Middle Rio Grande first began drying up periodically after the development of Colorado's San Luis Valley in the mid to late 1800s (Scurlock 1998). After humans began exerting more influence on the river, there are two documented occasions when the river became intermittent; during prolonged, severe droughts in 1752 and 1861 (Scurlock 1998). The silvery minnow historically survived low-flow periods because such events were infrequent and of lesser magnitude than they are today. There were also no diversion dams to block repopulation of upstream areas, the fish had a much greater geographical distribution, and there were oxbow lakes, cienegas, and sloughs that supported fish until the river became connected again.

Lack of water is the single most important limiting factor for the survival of the species. Water management and use has resulted in a large reduction of suitable habitat for the silvery minnow. Agriculture accounts for 90 percent of surface water consumption in the Middle Rio Grande (Bullard and Wells 1992). The average annual diversion of water in the Middle Rio Grande by the MRGCD was 535,280 af (65,839 hectare-meters) for the period from 1975 to 1989 (Reclamation 1993). In 1990, total water withdrawal (groundwater and surface water) from the Rio Grande Basin in New Mexico was 1,830,628 af, significantly exceeding a sustainable rate (Schmandt 1993). Water withdrawals have not only reduced overall flow quantities, but also caused the river to become locally intermittent and/or dry for extended reaches. Irrigation diversions and drains significantly reduce water volumes in the river. However, the total water use (surface and groundwater) in the Middle Rio Grande by the MRGCD may range from 28 – 37 percent (S.S. Papadopulos & Associates, Inc. 2000; USGS 2002c). In addition, a portion of the water diverted by the MRGCD returns to the river and may be re-diverted (in some cases more than once) (Bullard and Wells 1992; MRGCD, *in litt.* 2003).

River reaches particularly susceptible to drying are immediately downstream of the Isleta Diversion Dam (river mile 169), a 5-mile (8-km) reach near Tome (river miles 150 – 155), a 5-mile (8-km) reach near the U.S. Highway 60 Bridge (river miles 127 – 132), and an extended 36-mile (58-km) reach from near Brown's Arroyo (downstream of Socorro) to Elephant Butte Reservoir. Extensive fish kills, including tens of thousands of silvery minnows, have occurred in these lower reaches when the river has dried (C. Shroeder, Service, *pers. comm.* 2002). Since 1996, an average of 32 miles of the Rio Grande has dried, most in the San Acacia Reach. The most extensive drying has occurred in the last two years when 70 and 68 miles, respectively, were dewatered. Most documented drying events lasted an average of two weeks, before flows returned.

Predatory birds have been seen hunting and consuming fish from isolated pools during river intermittence (J. Smith, NMESFO, *pers. comm.* 2003). Though the number of fish present in any pool is unknown, it must be assumed that many of the fish preyed upon in these pools are silvery minnows. Thus, while some dead silvery minnows were collected during the shorter drying events, it is assumed that many more mortalities occurred than were documented.

Population monitoring efforts of the fish community in the Middle Rio Grande show that silvery minnow catch rates declined about two orders of magnitude from 1993 to 2004. Analysis of silvery minnow catch rates in 2004 revealed significant differences ($p<0.05$) in mean catch rates between population monitoring localities. The Angostura Reach yielded the most silvery minnows in 2004, followed by the Isleta Reach, and the San Acacia Reach. Additionally, relative abundance of Rio Grande silvery minnow has declined since 1995. However, the October density of silvery minnows was significantly higher ($p<0.05$) in 2004 than in 2003 and autumnal catch rates had increased by an order of magnitude between those years. This is attributed to increases in flow rates in the fall and winter of 2004.

During recent years, the City of Albuquerque and other San Juan-Chama (SJC) project contractors allowed the use of their SJC water for the purpose of providing flows in the river that were crucial for the silvery minnow population in the San Acacia Reach. Albuquerque is currently in the process of building a water diversion facility to fully utilize its SJC water for municipal uses; this water is not expected to be available for silvery minnow conservation.

Water in the active river channel has been reduced with the construction of drains along both banks of the Rio Grande. The majority of the Middle Rio Grande valley has drains paralleling the river. The west side of the Rio Grande has 160 miles (258 km) of drains, including the Low Flow Conveyance Channel (LFCC), in a 180-mile (290 km) stretch between Cochiti Dam and the Narrows at Elephant Butte Reservoir. This represents 89 percent of the total length between Cochiti Dam and Elephant Butte Reservoir. The east-side drains also parallel the river to San Acacia Diversion Dam for a distance of 100.5 miles (162 km).

The LFCC that parallels the river for 75 miles (121 km) was designed to expedite delivery of compact water to Elephant Butte Reservoir during low flow conditions. Water was diverted to the LFCC from the Rio Grande from 1959 to 1985. The LFCC has a capacity of approximately 2,000 cfs. Because the LFCC is at a lower elevation than the river bed, there is seepage from the river to the LFCC. This causes a significant loss of surface flows in the river channel. If the flow in the Rio Grande is 2,000 cfs or less, diverting water into the LFCC can dewater the river from the San Acacia Diversion Dam south to Elephant Butte Reservoir. The LFCC has not been fully operational since 1985, because of outfall problems at Elephant Butte Reservoir. In 1997, 1998, and 2001, experimental operations occurred in the upper 10 miles of the LFCC for sedimentation studies; however, the diverted flows were returned to the Rio Grande through a temporary outfall near Escondida. It is estimated that 67 percent of the flow in the Rio Grande is lost to seepage in the project area, with much of this water seeping into the LFCC (Jim Wilber, Reclamation, *pers. comm.* 1999).

Water management has also resulted in a loss of peak flows that historically initiated spawning. The reproductive cycle of the silvery minnow is tied to the natural river hydrograph. A reduction in peak flows and/or improper timing of flows may inhibit reproduction. Since completion of Elephant Butte Dam in 1916, four additional dams have been constructed on the middle Rio Grande, and two have been constructed on one of its major tributaries, the Rio Chama (Shupe and Williams 1988). Construction and operation of these dams – which are either irrigation diversion dams (Angostura, Isleta, San Acacia), or flood control and water storage dams (Elephant Butte, Cochiti, Abiquiu, El Vado) – have modified the natural flow of the river. Mainstem dams store spring runoff and summer inflow, which would normally cause flooding, and release this water back into the river channel over a prolonged period of time. These releases are often made during the winter months, when low flows would normally occur. The releases depart significantly from natural conditions, and can substantially alter the natural habitat. At other times, artificially low flows may limited the amount of habitat available to the species and may also limit dispersal of the species (Service 1999).

Mainstem dams and the altered flows they create can affect habitat by preventing overbank flooding, trapping nutrients, altering sediment transport regimes, prolonging summer base flows, and creating reservoirs that favor non-native fish species. These changes may affect the Rio Grande silvery minnow by reducing its food supply, altering its preferred habitat, preventing dispersal, and providing a continual supply of non-native fish that may compete with or prey upon the species. Altered flow regimes may also result in improved conditions for other native fish species that occupy the same habitat, causing those populations to expand at the expense of the Rio Grande silvery minnow (Service 1999).

In addition to providing a cue for spawning, flood flows also maintain a channel morphology to which the silvery minnow is adapted. The changes in channel morphology that have occurred from the loss of flood flows is discussed below.

Changes in Channel Morphology

Historically, the Rio Grande was sinuous, braided, and freely migrated across the floodplain. Changes in natural flow regimes, narrowing and deepening of the channel, and restraints to channel migration (i.e., jetty jacks) adversely affect the silvery minnow. These effects result directly from constraints placed on channel capacity by structures built in the floodplain.

These environmental changes have and continue to degrade and eliminate spawning, nursery, feeding, resting, and refugia areas required for species survival and recovery (Service 1993a).

The active river channel through the reaches where the silvery minnow persists in the Angostura and San Acacia Reaches is being narrowed by the encroachment of vegetation, resulting from continued low flows and the lack of overbank flooding. The lack of flood flows has allowed non-native riparian vegetation such as saltcedar and Russian olive to encroach on the river channel (Reclamation 2001). These non-native plants are very resistant to erosion, resulting in narrowing of the channel. When water is confined to a narrower cross-section, its velocity increases, which gives it more power. Fine sediments such as silt and sand are carried away leaving coarser bed materials such as gravel and cobble. Habitat studies during the winter of 1995 and 1996 (Dudley and Platania 1996), demonstrated that a wide, braided river channel with low velocities resulted in higher catch rates of silvery minnows, and narrower channels resulted in fewer fish captured. The availability of wide, shallow habitats that are important to the silvery minnow are decreasing. Narrow channels have few backwater habitats with low velocities that are important for silvery minnow fry and juveniles.

Within the current range of the silvery minnow, human development and use of the floodplain have greatly restricted the width available to the active river channel. A comparison of river area between 1935 and 1989 shows a 52-percent reduction, from 26,598 acres (10,764 ha) to 13,901 acres (5,626 ha) (Crawford *et al.* 1993). These data refer to the Rio Grande from Cochiti Dam downstream to the "Narrows" in Elephant Butte Reservoir. Within the same stretch, 234.6 miles (378 km) of levees occur, including levees on both sides of the river. Analysis of aerial photography taken by Reclamation in February 1992, for the same river reach, shows that of the 180 miles (290 km) of river, only 1 mile (1.6 km), or 0.6 percent of the flood plain has remained undeveloped.

Development in the flood plain, makes it difficult, if not impossible, to send large quantities of water downstream that would create low velocity side channels that the silvery minnow prefers. For example, the channel capacity under the railroad bridge at San Marcial has prevented higher releases from Cochiti Dam during spring runoff to avoid damage to the bridge. The presence of houses in the flood plain on the east side of the river at Socorro also require reductions in peak flows to prevent damage to the homes. These reduced releases decrease the available habitat for the silvery minnow and make encroachment into the floodplain by non-native species possible.

Water Quality

Both point (pollution discharges from a pipe) and non-point (diffuse sources of pollution) sources affect the Middle Rio Grande. Major point sources are waste water treatment plants (WWTPs) and feedlots. Major non-point sources include agricultural activities (e.g., fertilizer and pesticide application, livestock grazing), storm water run off, and mining activities.

Effluents from WWTPs contain contaminants that may affect the water quality of the river. It is anticipated that WWTP effluent may be the primary source of perennial flow in the lower portion of the Angostura Reach during extended periods of intermittency. For that reason the water quality of the effluent is extremely important. In the project area, the largest WWTP discharges are from Albuquerque, followed by Rio Rancho, Los Lunas, and Bernalillo, (mean annual discharge flows are 80.4, 2.5, 0.9, and 0.7 cfs, respectively; (Bartolino and Cole 2002). Since 1998, total residual chlorine (chlorine) and ammonia, as nitrogen (ammonia), have been discharged unintentionally at concentrations that exceed protective levels for the silvery minnow.

In addition to chlorine and ammonia, WWTP effluents may also include cyanide, chloroform, organophosphate pesticides, semi-volatile compounds, volatile compounds, heavy metals, and pharmaceuticals and their derivatives, which can pose a health risk to silvery minnows when discharged in concentrations that exceed the protective water quality criteria (J. Lusk, Service, *in litt.* 2003). Even if the concentration of a single element or compound is not harmful by itself, chemical mixtures may be more than additive in their toxicity to silvery minnows (Buhl 2002). The long-term effects and overall impacts of chemicals on the silvery minnow are not known.

Large precipitation events wash sediments and pollutants into the river from surrounding lands through storm drains and intermittent tributaries. Contaminants of concern to the silvery minnow that are frequently found in storm water include the metals aluminum, cadmium, lead, mercury, and zinc, organics such as oils, the industrial solvents trichloroethene and tetracholoroethene (TCE), and the gasoline additive methyl tert-butyl ether (USGS 2001).

Harwood (1995) studied the North Floodway Channel (Floodway) of Albuquerque, which drains an urban area of about 90 square miles and crosses Pueblo of Sandia lands. He found that storm water contributions of dissolved lead, zinc, and aluminum were significant and posed a threat to the water quality of the Rio Grande. Because the Floodway crosses lands of the Pueblo of Sandia and enters their portion of the Rio Grande, the Pueblo requested that the Environmental Protection Agency conduct toxicity tests on water in the Rio Grande collected below the Floodway. Aquatic crustaceans exposed to this water were found to have significant reproductive impairment and mortality when compared with controls. Additionally, larval fish also experienced significant mortality and/or narcosis when exposed to water and bed sediment collected from this same area on April 22, 2002 (http://oaspub.epa.gov/enviro/pcs det_reports.detail_report?npdesid=NM0022250). This study indicates that storm water runoff can impact the water quality of the Rio Grande and the aquatic organisms that live in the river.

Sediment is the sand, silt, organic matter, and clay portion of the river bed, or the same material suspended in the water column. Ong *et al.* (1991) recorded the concentrations of trace elements and organochlorine pesticides in suspended sediment and bed sediment samples collected from the Middle Rio Grande between 1978 and 1988. These data were compared to numerical sediment quality criteria (Probable Effects Criteria [PEC]) proposed by MacDonald *et al.* (2000). According to MacDonald *et al.* (2000) most of the PECs provide an accurate basis for predicting sediment toxicity to aquatic life and a reliable basis for assessing sediment quality in freshwater ecosystems. Although PECs were developed to assess bed (bottom) sediments, they also provide some indication of the potential adverse effects to organisms consuming these same sediments when suspended in the water column. Some concentrations of trace elements and organochlorine pesticides in suspended sediment collected from the Rio Grande floodway at San Acacia and San Marcial exceeded the PECs for copper, chromium, and zinc. The concentrations of trace elements and organochlorine pesticides in bed sediments were much lower than the PECs, suggesting a differential adherence pattern to suspended sediments and bed sediments and dilution by clean sediments. Additional trace elements were elevated in suspended sediments collected from the Rio Grande at San Felipe. The concentrations of contaminants adhered to suspended sediments may pose a health risk to silvery minnows depending on ingestion rates, bioavailability, and the relative sensitivity of this species (Rand and Petrocelli 1985, pp.496-502).

Volatile organic compounds that have been detectable in the Middle Rio Grande at Isleta include chlorpyrifos, and trichlorofluoromethane (Ellis *et al.* 1993). Important sources of recharge that affect shallow ground-water quality in the Albuquerque area include infiltration of surface water, which is used in agricultural land-use areas to irrigate crops, and infiltration of septic-system effluent in residential areas (Anderholm *et al.* 1995). The presence of synthetic organic compounds (volatile organic compounds and pesticides) in shallow ground water in the study area indicated that human activities have affected shallow ground-water quality. Past spills of TCE and other toxic substances have polluted some of the groundwater in the Albuquerque area. The connection of the surface water quality to the shallow ground water and the exchange of volatile organic compounds is currently being investigated by USGS.

Levings *et al.* (1998) show one or more PAH compounds at 14 sites along the Rio Grande with the highest concentrations found below the Cities of Albuquerque and Santa Fe. Polycyclic aromatic hydrocarbons and other semi-volatile compounds affect the sediment quality of the Rio Grande and may affect silvery minnow behavior, habitat, feeding, and health.

Pesticide contamination occurs from agricultural activities, as well as from the cumulative impact of residential and commercial landscaping activities. The presence of pesticides in surface water depends on the amount applied, timing, location, and method of application. Water quality standards have not been set for many pesticides, and existing standards do not consider cumulative effects of several pesticides in the water at the same time. Roy *et al.* (1992) reported that DDE, a degradation product of DDT, was detected most frequently in whole body fish collected throughout the Rio Grande. He suggested that fish in the lower Rio Grande may be accumulating DDE in concentrations that may be harmful to fish and their predators. In a study at the Refuge, Ong *et al.* (1991) found detectable levels of DDE in American coot (*Fulica americana*) and carp (*Cyprinius carpio*). Carter (1997) reported that sediment collected and analyzed in the Rio Grande had detectable concentrations of DDE, but that no other organochlorine insecticides or polychlorinated biphenyls were detected. Whole-body fish samples were also collected at the site of sediment collection and analyzed for organic compounds. Organic compounds were reported more frequently in samples of fish, and more types of organic compounds were found in whole-body fish samples than in bed-sediment samples. Concentrations of DDE, polychlorinated biphenyls, cis-chlordane, trans-chlordane, trans-nonachlor, and hexachlorobenzene were also detected in whole-body samples of fish. The presence of DDT and its metabolites, DDD and DDE, in bed sediment and whole-body fish confirms the persistence of this pesticide in the Rio Grande. Although DDT applications have stopped and concentrations in fish tissue have declined dramatically, DDT compounds may still pose adverse health risks to fish species when bioaccumulated from contaminated environments (Rand and Petrocelli 1985).

In addition to the compounds discussed above, several other constituents are present and affect the water quality of the Rio Grande. These include nutrients such as nitrates and phosphorus, total dissolved solids (salinity), and radionuclides. Each of these also has the potential to affect the aquatic ecosystem and health of the silvery minnow. As the river dries, pollutants will be concentrated in the isolated pools. Even though these pollutants do not cause the immediate death of silvery minnows, the evidence suggests that the amount and variety of pollutants present in the Rio Grande, could compromise their health and fitness (Rand and Petrocelli 1985).

Silvery Minnow Propagation and Augmentation

In 2000, the Service identified captive propagation as an appropriate strategy to assist in the recovery of the silvery minnow. Consistent with Service policy (65 FR 183), captive propagation is conducted in a manner that will, to the maximum extent possible, preserve the genetic and ecological distinctiveness of the silvery minnow and minimize risks to existing wild populations.

Silvery minnows are currently housed at five facilities in New Mexico. The New Mexico facilities are: the Dexter Fish Hatchery; New Mexico State University Coop Unit (Las Cruces); Rock Lake State Fish Hatchery; the Service's New Mexico Fishery Resources Office (NMFRO), and the City of Albuquerque's propagation facilities. These facilities are actively propagating and rearing silvery minnows. In 2000, the total combined capacity of these facilities was approximately 175,000 silvery minnow juveniles and adults (J. Brooks and J. Landye, Service, *in litt.* 2000). Silvery minnows are also held in South Dakota at the U.S. Geological Survey, Biological Resources Division (USGS-BRD) Lab, but there is no active spawning program at this facility.

Since 2000 over 600,000 silvery minnows have been propagated and released into the wild. At the onset of the project, adult wild silvery minnows from the San Acacia Reach and eggs from San Marcial reach were collected for a pilot propagation and augmentation program. Wild gravid adults were successfully spawned in captivity at the City of Albuquerque's propagation facilities. Approximately 500 silvery minnows were induced to spawn producing approximately 203,600 eggs (Platania and Dudley 2001b). These eggs were raised for 2 to 3 days and released as larval fish at Bernalillo (91,600) and Los Lunas (112,000) (Platania and Dudley 2001b).

Over 300,000 marked fish have been released by the NMFRO since 2002 under a formal augmentation effort funded by the Collaborative Program. Currently, wild eggs are collected after peak flows, hatched at the facilities listed above and released into the wild as larval fish to augment spawning the following year. Silvery minnows are released into the Angostura reach of the river near Alameda Bridge to ensure downstream repopulation. Eggs left in the wild have a very low survivorship and this ensures that an adequate number of spawning adults are present to repopulate the river each year. While hatcheries continue to successfully spawn silvery minnows, wild eggs are collected and adults spawned in captivity to ensure genetic diversity within the remaining population.

Ongoing Research

There is on-going research by the NMFRO and University of New Mexico (UNM) to examine the movement of silvery minnows. The fish are marked with a visible fluorescent elastomer tag and released in large numbers in a few locations. Crews sample upstream and downstream from the release site in an attempt to capture the marked fish. In January 2002, approximately 13,000 silvery minnows were released by UNM into the San Acacia Reach. In June 2002, 2,082 silvery minnows were released by NMFRO 1,640 ft (500 m) above the Alameda Bridge in Albuquerque; in December 2002, 41,500 silvery minnows were released in Rio Rancho; and in January 2003, approximately 61,000 silvery minnows were released in Bernalillo. The last three releases were made by NMFRO. In addition to providing information on movement, these releases have augmented the wild population.

Preliminary results indicate that the majority of silvery minnows dispersed. However, one individual was captured 15.7 miles (25.3 km) upstream from its release site (S. Platania, UNM, *pers. comm.* 2003). Monitoring within 48 hours after the release of the 41,500 silvery minnows resulted in the capture of 937 fish. Of these, 928 were marked and 927 were collected downstream of the release point. However, the results of this study are too preliminary to draw any solid conclusions at this time.

In 2002, a hybridization study involving the plains minnow and silvery minnow was conducted to determine the genetic viability of hybrids. The results are preliminary because the number of trials was low and because there is some question about the fitness of the females used in the experiments. The plains minnow and silvery minnow did spawn with each other and the hybrid eggs hatched. However, none of the larvae lived longer than 96 hours. The control larvae (non-hybrids) for both the plains minnow and silvery minnow lived until the end of the study (24 days) (Caldwell 2002). It is important to know if hybridization (or competition) with the plains minnow occurs.

Due to the increased efforts in captive propagation, recent studies by UNM have focused on the genetic composition of the silvery minnow. This research indicates that the net effective population size (Ne) (the number of individuals that contribute to maintaining the genetic variation of a population) of the silvery minnow in the wild is between 60-250 fish (T. Turner, UNM, *pers. comm.* 2003). It has been suggested that a Ne of 500 fish is needed to retain the long-term adaptive potential of a population (Franklin 1980). No significant genetic differences have been found in populations isolated in the different reaches of the Rio Grande (D. Alo UNM, *pers. comm.* 2002). Because the number of wild fish in the river appears to be low, the addition of thousands of silvery minnows raised in captivity could impact the genetic structure of the population. The propagation effort should be sufficient to maintain 100,000 to 1,000,000 fish in the wild (T. Turner, UNM, *pers. comm.* 2003). For instance if it were determined that 50,000 silvery minnow were in the wild, a minimum of 50,000 adult fish should be in propagation facilities. We do not know how many fish are in the wild so it is difficult at this time to determine the exact number needed in propagation facilities. However, to insure against a catastrophic event where most wild fish are lost, it is suggested that 100,000 to 1,000,000 silvery minnow should be kept in propagation facilities to maintain a sufficient amount of genetic variability for propagation efforts (T. Turner, UNM, *pers. comm.* 2003). Approximately 300,000 silvery minnows are currently being maintained in captivity (M. Ulibarri, USFWS *pers. comm.* 2005).

Permitted and/or Authorized Take
Take is authorized by section 10 and incidental take permitted under section 7. These permits and/or authorizations are issued by the Service. Applicants for section 10 permits must also acquire a permit from the State to "take" or collect silvery minnows. Many of the permits issued under section 10 allow take for the purpose of collection and salvage of silvery minnows and eggs for captive propagation. Eggs, larvae, and adults are also collected for scientific studies to further our knowledge about the species and how best to conserve the silvery minnow. Since 2000, the Service has reduced the amount of take permitted for voucher specimens as a result of the increasingly precarious status of the species in the wild. Incidental take is authorized through section 7 consultation for silvery minnows associated with the March 2003, programmatic biological opinion on water operations and maintenance in the Middle Rio Grande and the City of Albuquerque Drinking Water project (October 9, 2003).

Factors Affecting Species Environment within the Action Area
Nine islands have formed as a result of sediment build up down stream of the Isleta Diversion Dam. This has occurred mainly due to low water levels in the river over the last several years. The presence of these islands has created a braided river system, with narrow and relatively deep channels between islands. The varied morphology of the river in this area is currently beneficial to all life stages of the silvery minnow. Islands slow down the flow of water and provide areas where eggs can get lodged in vegetation and move into slower moving water, which is ideal for silvery minnow eggs and larva. Deep channels formed between islands provide areas where silvery minnows can hide from predators and find warmer water during the winter.

Other Projects
On the Middle Rio Grande, the following past and present Federal, State, private, and other human activities, in addition to those discussed above, have affected the silvery minnow and its critical habitat:

1. <u>Release of Carryover Storage from Abiquiu Reservoir to Elephant Butte Reservoir</u>: The Corps consulted with the Service on the release of water during the winter of 1995. Ninety-eight thousand af (12,054 hectare-meters) of water was released from November 1, 1995, to March 31, 1996, at a rate of 325 cfs (9.8 cm). This discharge is above the historic winter flow rate. Substantial changes in the flow regime that do not mimic the historic hydrograph can be detrimental to the silvery minnow. For example, during the winter release habitat study, Dudley and Platania (1996) observed an

apparent increase in flow between two winter sampling trips, January 19 – 26, 1996, and February 3 – 5, 1996, resulting in a decrease in low-velocity and side-channel habitats favored by silvery minnows.

2. Corrales, Albuquerque, and Belen Levees: These levees contribute to floodplain constriction and habitat degradation for the silvery minnow. Levees at these sites result in a reduction in the amount and quality of suitable habitat for the silvery minnow.

3. Santa Ana River Restoration Project: In August 1999, Reclamation submitted a biological assessment to the Service to proceed with a restoration project located on Santa Ana Pueblo in an area where the river channel was incising and eroding into the levee system. This project is included a Gradient Restoration Facility (GRF), channel re-alignment, bioengineering, riverside terrace lowering, and erodible bank lines. The primary component of the Santa Ana Restoration Project is the GRF which should control river hydraulics upstream of its location and also river bed control. The GRF was designed to: (1) Store more sand sediments at a stable slope for the current sediment supply; (2) decrease the velocities and depths and increase the width in the river channel upstream; (3) be hydraulically submerged at higher flows while simultaneously increasing the frequency and duration of overbank flows upstream; (4) provide velocities and depths suitable for passage of the silvery minnow through the structure; and (5) halt or limit further channel degradation upstream of its location. The channel re-alignment involved moving the river away from the levee system and over the grade control structure, and involves excavation of a new river channel and floodplain. Another significant component of the Santa Ana Restoration project is riverside terrace lowering for the creation of a wider floodplain. The bioengineering and deformable bank lines are also involved to assist in establishing the new channel bank and regenerating native species vegetation in the floodplain.

4. Creation of a Conservation Pool for Storage of Native Water in Abiquiu and Jemez Canyon Reservoirs and Release of a Spike Flow: The City created space (100,000 af) in Abiquiu Reservoir and the Corps created space in Jemez Canyon Reservoir to store Rio Grande Compact credit water for use in 2001, 2002, and 2003 for the benefit of listed species. The conservation pool was created with the understanding that the management of this water would be decided in later settlement meetings or during water operations conference calls. In addition, a supplemental release (spike) occurred in May 2001 to accommodate movement of sediment as a part of habitat restoration and construction on the Rio Grande and Jemez River on the Santa Ana Pueblo.

5. Programmatic Biological Opinion on the Effects of Actions Associated with the U. S. Bureau of Reclamation's, U.S. Army Corps of Engineers', and non-Federal Entities' Discretionary Actions Related to Water Management on the Middle Rio Grande: The Service completed this biological opinion on March 2003, determining the effects of water management by the applicants on the silvery minnow and flycatcher. This biological opinion had one RPA with several elements. These elements set forth a flow

regime in the Middle Rio Grande and described habitat improvements necessary to alleviate jeopardy to both the silvery minnow and flycatcher.

6. Los Lunas Habitat Restoration Project: On February 6, 2002, the Service completed this consultation, which tiered from the programmatic biological opinion on water management on the Middle Rio Grande issued June 29, 2001. This project is intended to partially fill element J of the Reasonable and Prudent Alternative from the programmatic biological opinion to conduct habitat/ecosystem restoration projects in the Middle Rio Grande to benefit the silvery minnow and flycatcher. Approximately 37 acres of native riparian and 40 acres of aquatic habitat have been created by this project. This project includes side-channels resulting in increased inundation frequency and will result in inundation of the area at flows greater than or equal to 2,500 cfs. A variety of substrate elevations will also allow inundation of some areas when flows are less than 2,500 cfs.

7. Albuquerque Drinking Water Project: The Drinking Water Project (October 9, 2003), involves the construction and operation of: (1) A new surface diversion dam north of Paseo del Norte Bridge, (2), conveyance of raw water from the point of diversion to the new water treatment plant, (3) a new water treatment plant on Chappell Road NE, (4) transmission of treated (potable) water to residential and commercial customers throughout the Albuquerque metropolitan area, and (5) aquifer storage and recovery. During typical operations, the project will divert a total of 94,000 acre-feet per year (AFY) of raw water from the Rio Grande (47,000 AFY of City San Juan-Chama water and 47,000 AFY of Rio Grande native water) at a near constant rate of about 130 cubic-feet per second (cfs) (3.68 cubic-meters per second [cms]). Peak diversion operations will consist of up to 103,000 AFY being diverted at a rate of up to 142 cfs (4.02 cms). A new water treatment plant with a normal operating rate of 84 million gallons per day (mgd) (381.9 million liters per day [mld]) and a peak capacity of about 92 mgd (418.2 mld) or 142 cfs (4.02 cms) will be constructed as part of the proposed action.

Summary

The remaining population of the silvery minnow is restricted to about 5 percent of its historic range. Every year since 1996, there has been at least one drying event in the river that has further reduced the silvery minnow population. During 2004, approximately 68 miles within the approximately 200 miles of silvery minnow occupied range was dry for several days. Dead silvery minnows have been documented during channel drying events from 1999 to 2005 (Platania and Dudley 1999; J. Smith, NMESFO, *pers. comm.* 2002; Service 2002b; M. Hatch, *pers. comm.* 2005; Service 2005). However, the October density of silvery minnows was significantly higher ($p<0.05$) in 2004 than in 2003 and autumnal catch rates had increased by an order of magnitude between those years. This is attributed to a number of factors including augmentation and increases in flow rates in the fall and winter of 2004.

Spring runoff in 2005 was also above average, leading to a peak of over 6,000 cfs and sustained high flows (> 3,000 cfs) for more than two months. These flows likely resulted in improved conditions for spawning and recruitment. Spring monitoring reports for 2005 show increased numbers over 2004 (J. Brooks, NMFRO, *pers. comm.* 2005)

The population is unable to expand its distribution, because three diversion dams currently block upstream movement and Elephant Butte Reservoir blocks downstream movement (Service 1999). Augmentation of silvery minnows with captive-reared fish will continue, however continued monitoring and evaluation of these fish is necessary to obtain information regarding the survival and movement of individuals.

Water withdrawals from the river and water releases from dams severely limit the survival of silvery minnows. The consumption of shallow groundwater and surface water for municipal, industrial, and irrigation uses continues to reduce the amount of flow in the Rio Grande and eliminate habitat for the silvery minnow (Reclamation 2002b). However, under state law, the municipal and industrial users are required to offset the effects of groundwater pumping on the surface water system. The City, for example, has been offsetting their surface water depletions with 60,000 af per year (Reclamation 2002b). The combined effect of water withdrawals and the drought mean that discharge from WWTPs and irrigation return flows will have greater importance to the silvery minnow and a greater impact on water quality. Lethal levels of chlorine and ammonia have been released from the WWTPs in the last several years. In addition, a variety of organic chemicals, heavy metals, nutrients, and pesticides have been documented in storm water channels feeding into the river and the river itself and contribute to the overall degradation of water quality.

IV. Effects of the Action

Effects of the action refer to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated and interdependent with that action, which will be added to the environmental baseline. Indirect effects are those that are caused by the proposed action and are later in time, but are still reasonably certain to occur. The primary effects of the proposed action on the silvery minnow result from the need to dewater the river during construction and excavation and the loss of habitat associated with the loss of the islands.

Direct Effects

The primary effects of the action will occur when flows move away from the main channel (either by diversion or gravity) to the pilot channel. Fish in the main channel may become stranded in isolated pools and will likely die as water quantity and quality decreases. The use of salvage operations to rescue fish from these pools will ameliorate these effects, but not eliminate them.

Other direct effects are possible if heavy equipment used to create the pilot channel operates in flowing water where fish are present. Silvery minnows could be crushed or removed from the water as excavators move soil from the river bed. Silvery minnows may also be crushed or excavated during the building of the dike, should soil be placed in water occupied by fish.

Efforts by POI to work in a dry river when possible will minimize these effects but not eliminated them. In some years, work in flowing water may occur.

Indirect Effects

Indirect effects of the action will include the loss of habitat associated with the islands. Pools that form behind islands can provide wintering habitat for silvery minnows. These same islands and island vegetation, when inundated, can provide nursery habitat for eggs and larvae. Finally, the islands, in this reach tend to concentrate lower flows into a single channel during the summer which results in continuous flow through the project area. Without the islands, flows may disperse across the channel leaving the river more susceptible to drying. However, if the project succeeds in returning the riverbed elevation to that of the groundwater, the reach below the project area may become a gaining reach. This would result in continuous flow in the river to the Alejandro drain return (5 miles downstream) even when there are no flows passing the dam. In this case, long term maintenance of the project area (by removing accumulated sediment) may result in beneficial effects to silvery minnows.

Habitat in the project area may be replaced by other suitable silvery minnow habitat in the medium and long term, particularly if groundwater is accessed as a result of island removal. Silvery minnows utilize shallow, low velocity habitats that may be created in areas where islands and point bars are removed.

Summary

The river morphology in this reach is diverse and contains each of the habitat types needed for all life stages of the silvery minnow. In the short term, the proposed action will eliminate nursery and wintering habitat for the silvery minnow in this reach. This habitat is expected to be replaced by other suitable silvery minnow habitat. Silvery minnows will be directly affected during channel diversion as the river is dewatered.

V. 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 biological opinion. 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 ESA. Cumulative effects include:

- Increased urban use of water, including municipal and private uses. Further use of surface water from the Rio Grande will reduce river flow and decrease available habitat for the silvery minnow.

- Contamination of the water (i.e., sewage treatment plants, runoff from small feed lots and dairies, and residential, industrial, and commercial development). A decrease in water quality and gradual changes in floodplain vegetation from native riparian species to non-native species (i.e., saltcedar) could adversely affect the silvery minnow and its habitat. Silvery minnow larvae require shallow, low velocity habitats for development.

Therefore, encroachment of non-native species results in less habitat available for the silvery minnow.

- Human activities that may adversely impact the silvery minnow by decreasing the amount and suitability of habitat include dewatering the river for irrigation; increased water pollution from non-point sources; habitat disturbance from recreational use, suburban development, and removal of large woody debris.

The Service anticipates that these types of activities will continue to threaten the survival and recovery of the silvery minnow by reducing the quantity and quality of habitat through continuation and expansion of habitat degrading and destroying actions.

VI. Conclusion

After reviewing the current status of the silvery minnow, the environmental baseline for the action area, the effects of the proposed actions, and cumulative effects, it is the Service's biological opinion that the proposed Isleta Island Removal Project, as proposed in the April 15, 2005, biological assessment, is not likely to jeopardize the continued existence of the silvery minnow. Critical habitat for the silvery minnow is not currently designated in the action area, so none will be affected.

Incidental Take Statement
Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without 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, 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 ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

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

Amount or Extent of Take Anticipated

The Service has developed the following incidental take statement based on the premise that the Isleta Island Removal Project will be implemented. Silvery minnows are a short-lived species who apparently respond quickly to changes in flow and habitat conditions. The Service recognizes that the status of the species may change significantly over the 10 year period of this biological opinion, in which case, this take statement may be revised in coordination with the Corps and applicant. The 2004 population year will be used as a benchmark. Significant deviations from this value may result in recalculation of take.

Take of silvery minnows is expected: 1) during island removal activities (as flows are diverted away from occupied areas), and 2) as a result of island removal (loss of habitat).

1) The Service anticipates that up to 150 silvery minnows greater than 30 mm (1.2 in) standard length (SL) per year may be taken during island removal actions described and analyzed in this biological opinion. Take will occur as flows are diverted away from the project area and silvery minnows become trapped in isolated pools. Previous observations of river drying in the action area indicate that these pools may contain as many as 10,000 silvery minnows. Up to 10 pools are expected to be isolated during island removal activities. No more than 0.15 percent of the silvery minnows present in these pools are expected to die as a result of drying or low water quality. Therefore, if more than 150 silvery minnows greater than 30 mm (1.2 in) are found dead, the level of anticipated take will have been exceeded. This take will be in the form of kill and harm.

The Service notes that this number is only a best estimate of the amount of take that is likely under the proposed action. Thus, estimated incidental take may be modified from the above should other silvery minnow monitoring information, data from silvery minnow rescue operations, or other research indicate substantial deviations from estimated values. In this case, further consultation, may be necessary.

Rescued silvery minnows will count toward the Service's Regional Director's 10(a) (1) (A) permit.

2) Under the effects of the action, the Service estimates a loss of 11.4 acres of habitat. Habitat loss includes both nursery and larval habitat that is available during high flows, channel areas between the islands that exist during low flows, and winter habitat behind and adjacent to the islands. The total estimated loss equals that of the island removal area. Actual loss may be lower if other beneficial habitat is created. The Pueblo of Isleta anticipates removing islands to ground water levels. In the event that this action supports continuous flows, habitat loss may be minimized.

Estimating take due to loss of island habitat is difficult, both because surveys for silvery minnows in the action area have not occurred in the past and because the effects of island removal on silvery minnows has not been studied. Young of year will lose nursery habitat and adult fish will lose wintering habitat in this reach. Quantifying take of young of year minnows is complicated, because these fish are not usually found dead. Young of year tend to disintegrate quickly after death, and often are too small to be identified. Additionally, only a small percentage of eggs and larval fish reach maturity in the wild. Therefore the number of eggs and larvae taken as a result of this action cannot be quantified. The number of silvery minnows larger than 35 mm that may be taken as a result of island removal is also not known. Take of silvery minnow will occur in the form of harm.

Effect of the Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the silvery minnow when the Isleta Island Removal project is implemented.

Reasonable and Prudent Measures

The Service believes the following RPMs are necessary and appropriate to minimize impacts of incidental take of the silvery minnow due to island removal activities.

1) The Corps and the applicant shall minimize the take of silvery minnows due to island removal actions.

2) The Corps and the applicant shall minimize the take of silvery minnows from loss of habitat due to the proposed action.

3) The Corps and the applicant shall minimize the take of silvery minnows within the Action Area.

Terms and Conditions

Compliance with the following terms and conditions must be achieved in order to be exempt from the prohibitions of section 9 of the ESA. These terms and conditions implement the Isleta Island Removal Project described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

To implement RPM 1, the Corps and the applicant shall:

1.1) Excavate the pilot channel starting in the middle of the dry section, working downstream then upstream leaving the upstream channel unexcavated approximately 5 meters short of flowing water to minimize the degree of contact between equipment and wetted area. Avoid excavation at the interface between flowing water and the channel by leaving a low berm at the upstream end. Lower this berm gradually by pulling sediment to the side or into the channel until flows breach the berm.

1.2) When flows are diverted, coordinate with the Service to seine isolated pools. The sampling protocol developed by NMESFO will be used. At least two week's notice must be provided to allow coordination of salvage efforts. This will minimize take by rescuing silvery minnows to the maximum extent practicable.

To implement RPM 2, action the Corps and the applicant shall:

2.1) Use adaptive management to modify island removal activities as appropriate. Monitor habitat use by silvery minnows within the Action Area and effects of island removal. Coordinate with the Service at least annually to determine whether methods to remove islands may be modified to meet the intent of the project, but minimize effects of habitat loss.

To implement RPM 3, the Corps in coordination with the applicant shall:

3.1) In cooperation with the Service, restore bosque habitat near the Alejandro Drain area to improve floodplain connectivity and provide nursery habitat.

3.2) In cooperation with the Service, investigate and implement opportunities to improve in channel habitat near drain outfalls within the Action Area following recommendations of the Collaborative Program's workgroup studying the "in-channel wetted refugia" concept.

3.3) In cooperation with the Service, construct an off-channel silvery minnow grow-out facility.

Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA 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. The POI is integral to these efforts. Implementation of any conservation recommendations that involve access to or use of Indian Pueblo or Tribal lands requires the consent of the affected Indian Pueblo or Tribe. If the Federal agencies plan or implement conservation recommendations that may affect Indian Pueblo or Tribal trust resources, then government-to-government consultation is required.

1) Monitor silvery minnow populations within the Action Area.

2) Continue to work collaboratively to assist in salvage and recovery of the silvery minnow.

3) Monitor fluctuations of groundwater in the shallow and deep aquifers to better understand the groundwater/surface water relationship.

4) Encourage adaptive management of flows and conservation of water to benefit listed species.

Re-initiation Notice

This concludes formal consultation on the action(s) described in the April 14, 2005, biological assessment. This consultation is valid until August 5, 2015. As provided in 50 CFR § 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) The amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this biological opinion; (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 biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. Consultation must be reinitiated prior to the expiration of this biological opinion to ensure continued compliance with sections 7 and 9 of the ESA. In instances where the amount or extent of incidental take is exceeded, any Federal operations causing such take must cease pending re-initiation.

In future correspondence on this project, please refer to consultation number 2-22-05-F-0350. If you have any questions or would like to discuss any part of this biological opinion, please contact Jennifer Parody of my staff at (505) 761-4710.

Sincerely,

Susan MacMullin

Susan MacMullin
Field Supervisor

cc: Cody Walker, Hydrology Department, Pueblo of Isleta
Assistant Regional Director, Region 2 (ES)
Regional Section 7 Coordinator, Region 2 (ES)

LITERATURE CITED

Bartolino, J.R. and J.C. Cole, 2002. Ground-Water Resources of the Middle Rio Grande Basin, New Mexico. U.S. Geological Survey Circular 1222. 132 pp.

Bestgen, K. and S.P. Platania. 1991. Status and Conservation of the Rio Grande Silvery Minnow, *Hybognathus amarus*. Southwestern Naturalist 26(2):225–232.

Bestgen, K. and D.R. Propst. 1994. Redescription, Geographic Variation, and Taxonomic Status of the Rio Grande Silvery Minnow, *Hybognathus amarus* (Girard, 1856). Contribution 69. Larval Fish Laboratory, Colorado State University.

Biella, J., and R. Chapman (eds.). 1977. Archeological Investigations in Cochiti Reservoir, New Mexico. Vol. 1: A Survey of Regional Variability. Report submitted to the National Park Service, Santa Fe, for the U.S. Army Corps of Engineers, Albuquerque, New Mexico.

Buhl, K. J. 2002. The Relative Toxicity of Waterborne Inorganic Contaminants to the Rio Grande Silvery Minnow (*Hybognathus amarus*) and Fathead Minnow (*Pimephales promelas*) in a Water Quality Simulating that in the Rio Range, New Mexico. Final Report to the U.S. Fish and Wildlife Service, Study No. 2F33 9620003. U.S. Geological Survey, Columbia Environmental Research Center, Yankton Field Research Station, Yankton SD.

Bullard, T.F., and S.G. Wells . 1992. Hydrology of the Middle Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. U.S. Department of the Interior, U.S. Fish and Wildlife Service Research Publication 179.

Caldwell, C. 2002. Hybridization Potential and Spawning Behavior of Rio Grande silvery Minnow (*Hybognathus amarus*) and Plains Minnow (*Hybognathus palcitus*). Interim report submitted to U.S. Fish and Wildlife Service Ecological Services Field Office, September 2002. 18 pp.

Carter, L.F. 1997. Water-quality Assessment of the Rio Grande Valley, Colorado, New Mexico, and Texas: Organic Compounds and Trace Elements in Bed Sediment and Fish Tissue, 1992-93. U.S. Geological Survey Water-Resources Investigations Report 97-4002. 23 pp.

Cook, J.A., K.R. Bestgen, D.L. Propst, and T.L. Yates. 1992. Allozymic Divergence and Systematics of the Rio Grande Silvery Minnow, *Hybognathus amarus* (Teleostei: Cyprinidae). Copeia 1992(1): 36–44.

Crawford, C., A. Cully, R. Leutheuser, M. Sifuentes, L. White, and J. Wilber. 1993. Middle Rio Grande Ecosystem; Bosque Biological Management Plan. Middle Rio Grande

Dudley, R.K., and S.P. Platania. 1996. Rio Grande Silvery Minnow Winter Population Habitat Use Monitoring Project, April 1996. Summary of four trips (December 1995–March 1996). Report to the U.S. Army Corps of Engineers, Albuquerque. 12 pp.

Dudley, R.K., and S.P. Platania. 1997. Habitat Use of the Rio Grande Silvery Minnow Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 88 pp.

Dudley, R.K., and S.P. Platania. 1999. Draft Summary of Aquatic Conditions in the Middle Rio Grande between San Acacia Diversion Dam and San Marcial Railroad Bridge Crossing for the period 14 through 26 April 1999. Report to U.S. Bureau of Reclamation, Albuquerque, New Mexico. 15 pp.

Dudley, R.K., and S.P. Platania. 2002. Summary of Population Monitoring of Rio Grande Silvery Minnow (1994–2002). Report to New Mexico Ecological Services Field Office, September 10, 2002, Albuquerque, New Mexico. 14pp.

Edwards, G.B., and J.G. Nickum. 1993. Use of Propagated Fishes in Fish and Wildlife Service

Ellis, S.R., G.W. Levings, L.F. Carter, S.F. Richey, and M.J. Radell. 1993. Rio Grande Valley, Colorado, New Mexico, and Texas. *In* Leahy, P.P., B.J. Ryan, and A.I. Johnson, eds. American Water Resources Association Monograph Series no. 19. pp. 617-646.

Franklin, I. R. 1980. Evolutionary Change in Small Populations. Pages 135 – 148 in M. E. Soulé and B. A. Wilcox (editors) Conservation Biology: an evolutionary-ecological perspective. Sinauer Associates, Inc. Sunderland, Massachusetts.

Harwood, A.K. 1995. The Urban Stormwater Contribution of Dissolved Trace Metal from the North Floodway Channel, Albuquerque, NM, to the Rio Grande. University of New Mexico, Water Resources Program, Professional Project Report.

Hoagstrom, C., and J. Brooks. 2000. Memorandum to Joy Nicholopoulos, Supervisor, New Mexico Ecological Services Field Office from New Mexico Fishery Resources Office, entitled *Rio Grande silvery minnow recovery priorities*. August 14, 2000. 10 pp.

Levings, G.W., D.F. Healy, S.F. Richey, and L.F. Carter. 1998. Water Quality in the Rio Grande Valley, Colorado, New Mexico, and Texas, 1992-95. U.S. Geological Survey Circular 1162. Http://water.usgs.gov/pubs/circ1162 (viewed on May 18, 1998) .

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems. Archives of Environmental Toxicology and Chemistry 39:20–31.

National Weather Service. 2002. West Gulf River Forecast Center, 2002 water supply forecast. Issued as of April1, 2002. Http://www.srh.noaa.gov/wgrfc/watersupply/wgrfc_APR_espfwr_2002.txt (viewed on April 9, 2002).

National Weather Service and Natural Resources Conservation Service. 2003. Water supply forecast, March 2003. Http://www.nm.nrcs.usda.gov/snow/forecast/wy03/mar/nr0303.htm (Viewed 10 March 2003).

Natural Resources Conservation Service. 2003b. Rio Grande Basin as of January 1, 2003. Http://www.nm.nrcs.usda.gov/snow/forecast/wy03/jan/nm1s22.htm (Viewed 10 January 2003).

Natural Resources Conservation Service. 2003c. New Mexico Water Supply Outlook as of March 1, 2003.Http://www.wcc.nrcs.usda.gov/water/snow/bor2.pl? (10 March 2003).

New Mexico Department of Game and Fish. 1998b. Rio Grande Silvery Minnow Monitoring in 1997. Santa Fe, New Mexico.

New Mexico Interstate Stream Commission and New Mexico Drought Monitoring Workgroup. Potential Stream Flows, Reservoir Elevations, and Drought Impacts through Summer 2003.

Ong, K., T.F. O'Brien, and M.D. Rucker. 1991. Reconnaissance Investigation of Water Quality, Bottom Sediment, and Biota Associated with Irrigation Drainage in the Middle Rio Grande and Bosque del Apache National Wildlife Refuge in New Mexico 1988–89: U.S. Geological Survey Water-Resources Investigations Report 91-4036, Albuquerque, New Mexico.

Pflieger, W. 1980. *Hybognathus nuchalis* Agassiz. *In* D. lee, C. Gilbert, C. Hucutt, R. Jenkins, McCallister, and J. Stauffer, eds., Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History, Raleigh, North Carolina. 177 pp.

Platania, S. 1991. Fishes of the Rio Chama and the Upper Rio Grande, New Mexico with Preliminary Comments on their Longitudinal Distribution. Southwestern Naturalist 36(2):186–193.

Platania, S. 1993. The Fishes of the Rio Grande between Velarde and Elephant Butte Reservoir and Their Habitat Associations. U.S. Bureau of Reclamation, Albuquerque, New Mexico. 188 pp.

Platania, S.P. 1995. Reproductive Biology and Early Life-history of Rio Grande Silvery Minnow, *Hybognathus amarus*. U.S. Army Corps of Engineers, Albuquerque, New Mexico. 23 pp.

Platania, S. P. 2000. Effects of Four Water Temperatures Treatments On Survival, Growth, and Developmental Rates of Rio Grande Silvery Minnows, *Hybognathus amarus*, Eggs and Larvae. Report to U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Platania, S.P., and C. Altenbach. 1998. Reproductive Strategies and Egg Types of Seven Rio Grande Basin Cyprinids. Copeia 1998(3): 559–569.

Platania, S.P., and R. Dudley. 1997. Monitoring the Status, Habitat Association, and Seasonal Occurrence of Rio Grande Silvery Minnow in the Vicinity of the Montaño Bridge. American Southwest Ichthyological Consulting, Albuquerque, New Mexico.

Platania, S.P., and R. Dudley. 1999. Draft Summary of Aquatic Conditions in the Middle Rio Grande between San Acacia Diversion Dam and San Marcial Railroad Bridge Crossing for the period 14 through 26 April 1999. Prepared for the Bureau of Reclamation and New Mexico Ecological Services Field Office.

Platania, S.P., and R. Dudley. 2000. Spatial Spawning Periodicity of Rio Grande Silvery Minnow during 1999, http://www.uc.usbr.gov/progact/rg/rgsm2002/egg_salvage/ wrg/aop/rgo/progact/rg/rgsm2002/progact/rg/rgsm2002/index.html.

Platania, S.P., and R. Dudley. 2001. Summary of Population Monitoring of Rio Grande Silvery Minnow (21–27 February 2001). Report to the Bureau of Reclamation and Corps of Engineers. Albuquerque. 7pp.

Platania, S.P., and R. Dudley. 2002. Spawning Periodicity of Rio Grande Silvery Minnow during 2001. Http://www.uc.usbr.gov/progact/rg/rgsm2002/egg_salvage/ wrg/aop/rgo/progact/rg/rgsm2002/progact/rg/rgsm2002/index.html.

Platania, S.P., and R. Dudley. 2003. Spawning Periodicity of Rio Grande Silvery Minnow, *Hybognathus amarus*, during 2002. Draft final report submitted to the U. S. Bureau of Reclamation, January 22, 2003. 49 pp.

Platania, S.P., and R. Dudley. 2005. 2004 Summary of Population Monitoring of Rio Grande Silvery Minnow. Report to the Bureau of Reclamation and Corps of Engineers. Albuquerque. 193pp.

Platania, S.P., and C.W. Hoagstrom. 1996. Response of Rio Grande Fish Community to and Artificial Flow Spike: Monitoring Report Rio Grande Silvery Minnow Spawning Peak Flow. New Mexico Ecological Services State Office, Albuquerque, New Mexico.

Rand, G.M., and Petrocelli, S.R. 1985. Fundamentals of Aquatic Toxicology – Methods and Applications. Hemisphere Publishing Corporation, New York. 666 pp.

Rand, G.M., and Petrocelli, S.R. 1985. Fundamentals of Aquatic Toxicology B Methods and Applications. Hemisphere Publishing Corporation, New York. 666 pp.

Roy, Richard, T.F. O'Brien, and M. Rusk-Maghini. 1992. Organochlorine and Trace Element Contaminant Investigation of the Rio Grande, New Mexico. U.S. Fish and Wildlife Service, New Mexico Ecological Services Office, Albuquerque, NM. 39 pp.

S.S. Papadopulos & Associates, Inc. 2000. Middle Rio Grande Water Supply Study. Boulder, CO: August 4, 2000.

Schmandt, J. 1993. Water and Development in the Rio Grande/Río Bravo Basin. University of Texas Press, Austin, Texas.

Scurlock, D. 1998. From the Rio to the Serria: An Environmental History of the Middle Rio Grande Basin. USDA Rocky Mountain Research Station, Fort Collins, Colorado, 80526.

Smith, J.R. 1999a. Summary of Rio Grande Investigations for FY1997. Draft. U.S. Fish and Wildlife Service Report Submitted to the U.S. Bureau of Reclamation, Albuquerque, New Mexico.

Smith, J.R. 1999b. Summary of Easy Egg Catching in the LFCC in the 9 Mile Study Reach during Spring 1998 Operation. U.S. Fish and Wildlife Service Report Submitted to the U.S. Bureau of Reclamation, Albuquerque, New Mexico on April 28, 1999.

Smith, A.B., C.E. Paradzick, A.A. Woodward, P.E.T. Dockens, and T.D. McCarthey. 2002. Southwestern Willow Flycatcher 2001 Survey and Nest Monitoring Report. Nongame and Endangered Wildlife Program Technical Report #191. Arizona Game and Fish Department, Phoenix, Arizona.

Smith, J.R., and C.W. Hoagstrom. 1997. Fishery Investigations on the Low Flow Conveyance Channel Temporary Outfall Project and on Intermittency in the Rio Grande. Progress Report, 1996 to Bureau of Reclamation, Albuquerque, New Mexico.

Smith, J.R., and J.A. Jackson. 2000. Draft memorandum from the New Mexico Fishery Resources Office to the New Mexico Ecological Services Field Office, U.S. Bureau of Reclamation and U.S. Army Corps of Engineers. Preliminary 1999 Rio Grande Collections of Rio Grande Silvery Minnow Only. January 5, 2000.

Smith, J.R., and A. Muñoz. 2002. Rio Grande Silvery Minnow Rescue and Salvage Fiscal Year 2003 Project Proposal. Submitted to the Bureau of Reclamation, Albuquerque, New Mexico on October 25, 2002.

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

U.S. Bureau of Reclamation. 1993. Final Supplement to the Final Environmental Impact Statement-River Maintenance program for the Rio Grande-Velarde to Caballo Dam-Rio Grande and Middle Rio Grande projects, New Mexico. 140 pp.

U.S. Bureau of Reclamation. 2001. U.S. Bureau of Reclamation's Discretionary Actions Related to Water Management, U.S. Army Corps of Engineers Water Operations Rules, and Non-Federal Actions Related to Ordinary Operations on the Middle Rio Grande, New Mexico: June 30, 2001, through December 31, 2003. June 8, 2001.

U.S. Bureau of Reclamation. 2002a. Supplement to the Biological Opinion for the Proposed Rio Grande and Low Flow Conveyance Channel Modification, San Marcial to Elephant Butte Reservoir.

U.S. Bureau of Reclamation. 2002b. Draft Environmental Impact Statement for the City of Albuquerque Drinking Water Project.

U.S. Bureau of Reclamation. 2003. Biological Assessment of Bureau of Reclamation's Water and River Maintenance Operations, Army Corps of Engineers' Flood Control Operation, and Related Non-Federal Actions on the Middle Rio Grande, New Mexico, March 1, 2003 February 28, 2013. February 19, 2003.

U.S. Fish and Wildlife Service. 1993a. Proposal Rule to List the Rio Grande Silvery Minnow as Endangered, with Critical Habitat. 58 Federal Register 11821-11828.

U.S. Fish and Wildlife Service. 1993b. Notice of 12-month Petition Finding/Proposal to List *Empidonax traillii extimus* as an Endangered Species, and to Designate Critical Habitat. Federal Register 58:39495–39522..

U.S. Fish and Wildlife Service. 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.

U.S. Fish and Wildlife Service. 1996. Biological Opinion for Modification of Roosevelt Dam, Arizona Ecological Services Office, Region 2, Phoenix, AZ.

U.S. Fish and Wildlife Service. 1999. Rio Grande Silvery Minnow (Hybognathus amarus) Recovery Plan. Region 2, U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 138 pp.

U.S. Fish and Wildlife Service. 2001b. Programmatic Biological Opinion on the Effects of Actions Associated with the U.S. Bureau of Reclamation's, U.S. Army Corps of Engineers', and non-Federal Entities' Discretionary Actions Related to Water Management on the Middle Rio Grande, New Mexico, June 29, 2001.

U.S. Fish and Wildlife Service. 2002b. Report to the Rio Grande Compact Commission, U.S. Fish and Wildlife Service Activities in the Rio Grande Basin Calendar Year 2001. Prepared for the Rio Grande Compact Commission by the New Mexico Ecological Services Field Office, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 2002c. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Rio Grande Silvery Minnow; Proposed Rule. Federal Register 67:39205 – 39235.

U.S. Fish and Wildlife Service. 2003. Endangered and Threatened Wildlife and Plants; Final rule for the Designation of Critical Habitat for the Rio Grande Silvery Minnow. Federal Register 68:8088–8135.

U.S. Fish and Wildlife Service. 2005. Rio Grande Silvery Minnow Rescue and Salvage Fiscal Year 2004. New Mexico Ecological Services Field Office, April 11, 2005.

U.S. Geologic Survey. 2002a. Water Resources Data, New Mexico, Water Year 2001. Water-Data Report NM-2001-1.

U.S. Geologic Survey real-time data. 2002b. USGS 08358300 Rio Grande Conveyance Channel at San Marcial, NM, http://www.spa.usace.army.mil/wc/adbb/riogrt.htm.

U.S. Geologic Survey. 2002c. Ground-water resources of the Middle Rio Grande basin, New Mexico. Circular 1222.

U.S. Geologic Survey. 2001. Selected Findings and Current Perspectives on Urban and Agricultural Water Quality by the National Water-Quality Assessment Program, FS-047-http://water.usgs.gov/pubs/FS/fs-047-01//pdf/fs047-01.pdf

Watts, H.E., C.W. Hoagstrom, and J.R. Smith. 2002. Observations on Habitat Associated with Rio Grande Silvery Minnow, *Hybognathus amarus* (Girard). Submitted to U.S. Army Corps of Engineers, Albuquerque District and City of Albuquerque Water Resources Division, June 28, 2002.