



# United States Department of the Interior

FISH AND WILDLIFE SERVICE  
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Cons. 02ENNM00-2015-F-0363

Cons. 02ENNM00-2012-F-0005

Jennifer J. Lillard, Regulatory Project Manager  
U.S. Army Corps of Engineers, Albuquerque District  
4101 Jefferson Plaza NE  
Albuquerque, New Mexico 87109

Dear Ms. Lillard:

Enclosed is the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) on the effects of U.S. Army Corps of Engineers, Albuquerque District (Corps) proposed authorization (Corps Action Number **SPA-2015-00147-ABQ**; USACE 2015a) of the discharge of dredged and fill material into the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) North Diversion Channel (NDC) Earthwork and Grade Control Structures area (Embayment Project; Figure 1) on endangered Rio Grande Silvery Minnow (*Hybognathus amarus*; silvery minnow), endangered southwestern willow flycatcher (*Empidonax traillii extimus*; flycatcher), and threatened distinct population segment of western yellow-billed cuckoo (*Coccyzus americanus*; cuckoo). We prepared this BO pursuant to section 7(a)(2) of the Endangered Species Act, as amended (ESA; 16 U.S.C. 1531 et seq.).

On January 12, 2012, the Corps and the Service consulted on a similar dredge and fill project (Corps Action Number SPA-2010-00435-ABQ; USACE 2011) in the AMAFCA NDC Embayment Project area that was similar in its scope and effects to federally listed species (USFWS 2012). Because the proposed Corps 2015 Action and its effects to federally listed species are similar to the Corps 2012 Action, we have abbreviated the framework and the extent of the analyses in this BO. This BO incorporates, by reference, the Service's previous BOs (USFWS 2012, 2014), the Corps Biological Assessments (BAs; SWCA 2011, 2015), conversations and communications between the Corps, AMAFCA, the Pueblo of Sandia, and the Service; 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 at the above address.

For the 2015 proposed action, the Corps found (SWCA 2015, USACE 2015a) that the proposed Embayment Project "may affect, but is not likely to adversely affect" flycatchers or cuckoos due to project activities occurring *outside* of these riparian birds seasonal occupancy (that is, from April 15 to September 1) of the project area. The Service concurs with Corps "may affect, not likely to adversely affect" findings on the flycatcher and cuckoo based on the rationales the

Corps provided. In addition, the Corps found (USACE 2015a) that the proposed Embayment Project would have *no effect* on New Mexico meadow jumping mouse (*Zapus hudsonius luteus*), on critical habitat of silvery minnow and flycatcher, or on proposed critical habitat of the cuckoo.

The Corps correspondence to the Service (USACE 2015a) found that the proposed Embayment Project “may affect, but is not likely to adversely affect” silvery minnow or silvery minnow critical habitat based on: 1) construction activities occurring outside of the silvery minnow synchronous spawning season (May through June); 2) the Service and Pueblo of Sandia will rescue silvery minnows from project dewatering activities; 3) silt fences will be installed to prevent silvery minnow movement into the Embayment Project area as well as decrease turbidity in the Rio Grande downstream; and 4) “because the Pueblo of Sandia must certify” the proposed action will comply with Pueblo of Sandia water quality standards. Note that the Corps BA (SWCA 2015; page 32) correctly concludes that the proposed Embayment Project action, “may affect, is likely to adversely affect” the silvery minnow.

The Service reviewed the proposed Embayment Project action and its associated activities, the Corps BA, the proposed conservation measures, and other available information, and we determined that the proposed action “may affect, is likely to adversely affect” the silvery minnow during construction activities. During the proposed Embayment Project action, we expect that there will be adverse effects to any silvery minnows that may be trapped in the Embayment Project area, or that will be harassed or killed during installation of silt fences, coffer dams, or during construction activities. Some silvery minnows will certainly flee the areas of construction activities due to the noise and vibrations, some may be trapped behind the silt fence or coffer dam, some may die due to dewatering activities, some will flee or be stressed by water quality degradation and the fill material placement. While the proposed action may have some beneficial effects, the proposed activities will also harass or trap silvery minnows, will harm silvery minnows by alteration which kills or injures them, and will significantly impair their natural feeding or sheltering activities, or engage in such conduct (50 CFR 17.3). Therefore, the Service concluded that the proposed Embayment Project action “may affect, and is likely to adversely affect” silvery minnows that occur in or near the construction activities.

The Corps also assumed that rescue of any sick or dying silvery minnows by staff of the Service and the Pueblo of Sandia from proposed trapping (behind a coffer dam) or during pool dewatering activities was a Corps conservation measure to offset those impacts from the proposed Embayment Project action (BA, page 37). However, only employees or agents of the Service or other Federal land management agencies, or a Tribal conservation agency, *who are designated by his/her agency for such purposes, may, when acting in the course of his official duties*, aid a sick, injured or orphaned specimen (50 CFR 17.21(c)(3)(i)). Therefore, rescue of trapped, sick or dying silvery minnows cannot be part of the Corps proposed action as those actions are not currently within the Corps authority.

On July 21, 2015, AMAFCA offered an additional conservation measure that would provide a final finished sloping grade to reduce the potential for silvery minnow entrapment in the Embayment Project area (L.B. Sumrall, Weston Solutions, Inc., July 21, 2015, email communication). With that conservation measure, and the project’s small area and short duration, it is the Service’s opinion that the Corps authorization to fill (SPA-2015-00147-ABQ) the Embayment Project area (Figure 2) is not likely to jeopardize the continued existence of the

endangered silvery minnow. The Pueblo of Sandia has requested, and the Service has agreed, to employ the Service's New Mexico Fish and Wildlife Conservation Office (NMFWCO) to rescue trapped, sick, or dying silvery minnows adversely affected by Embayment Project dewatering or other construction activities. Working with the Corps, AMAFCA, NMFWCO and Pueblo of Sandia, we have identified conservation measures that have been incorporated into the Embayment Project (BA, pages 1, and 36-38), and we have provided reasonable and prudent measures as well as terms and conditions necessary to minimize the incidental take of silvery minnows associated with the proposed Embayment Project action.

Thank you for your concern for endangered species and New Mexico's wildlife habitats. The Service appreciates Corps, AMAFCA, and Pueblo of Sandia coordination associated with this proposed Embayment Project to minimize adverse effects to the Rio Grande silvery minnows as well as avoid adverse effects to other federally listed species and their critical habitats. If you have any questions regarding this BO, please contact Joel D. Lusk of my staff at the letterhead address, by email at joel\_lusk@fws.gov, or by telephone at (505) 761-4709.

Sincerely,

Wally Murphy  
Field Supervisor

cc:

Executive Engineer, AMAFCA, Albuquerque, New Mexico (Attn. J. Lovato).

Governor, Pueblo of Sandia, Bernalillo, New Mexico (Attn. S. Bulgrin).

Office of the Superintendent, Bureau of Indian Affairs, Southern Pueblos Agency, Albuquerque, New Mexico.

Project Leader, USFWS, New Mexico Fish and Wildlife Conservation Office, Albuquerque, New Mexico (Attn. J. Davis).

## BIOLOGICAL OPINION

### I. DESCRIPTION OF THE PROPOSED ACTION

The Corps BA (SWCA 2015) describes the proposed Embayment Project action in detail and it is incorporated here by reference. The Corps proposes to authorize AMAFCA to discharge 29,000 cubic yards of fill material and ~2,400 cubic yards of rip-rap for grade control structures into the Embayment located at approximately latitude 35.211174 and longitude -106.610300, in Bernalillo County, New Mexico (Figures 1-2). Construction is anticipated to begin sometime in fall 2015 and last approximately 60 days, but not further than April 15, 2016. The purpose of the fill is to regrade the Embayment so as to reduce the volume of anoxic water that accumulates there in warm months due to oxygen consuming materials in stormwater, sediment, groundwater, stagnant water, and with its reduced circulation (Van Horn 2008; DBS&A 2009; USFWS 2011c USFWS 2012, 2014, SWCA 2015).

The AMAFCA North Diversion Channel (NDC) is an outfall structure designed to convey most of the stormwater from the Albuquerque metropolitan area to the Rio Grande. It is lined with concrete and trapezoidal in shape, except for the Settling Basin and the Embayment (Figure 1). The Embayment is an earthen, 1,400 foot long by 260 foot wide, backwater inlet containing open water, riparian vegetation, and wetlands that occurs at the confluence of the Rio Grande and NDC, which connect at a retaining feature called the Equipment Crossing (Figure 1).

The proposed action is to proceed in three different plans of actions depending on the nature and extent of surface water in the Embayment Project area at the commencement of construction. The three plans are:

- A. **Plan A.** If there is surface water in the Embayment when construction starts, traditional heavy equipment (e.g., frontend loaders, backhoes, tractors, trucks) will be used to discharge fill material into the Embayment water so as to push that water slowly (~70 feet/day over 20 days) into the Rio Grande and fill the Embayment to a final grade. The quality of the fill is considered suitable for this purpose by the Corps and the Pueblo of Sandia.
- B. **Plan B.** If the Embayment dries naturally or isolated pools form when construction starts, then a silt fence will be deployed at the westernmost end, followed by an earthen coffer dam, so as to prevent flooding of Embayment Project area. Standing pools of water would be pumped from the Embayment to the Settling Basin area upstream of the Equipment Crossing over 3 to 5 days. Fine mesh, silt fence-screened water intakes will be installed around the pumps to prevent fish and other larger vertebrates from entering the hose intake and pump.
- C. **Plan C.** If there is no surface water in the Embayment when construction starts, then a silt fence will be deployed at the westernmost end, followed by an earthen coffer dam, so as to prevent flooding of Embayment Project area as well as fish access to construction.

During implementation of any of these three plans, riprap grade control structures would be built, fine grading would be conducted, revegetation would occur, and all equipment and fences would be removed. [Afterwards, but not part of the proposed action, scheduled maintenance mowing (up to twice per year will be conducted outside the flycatcher nesting season) along the banks of the Embayment and will reduce aboveground biomass and riparian habitat from interfering with flood conveyance]. All plant materials for revegetation have been selected to reduce introduction of invasive species.

To prevent water from scouring and pooling and potentially entrapping silvery minnows there (after the proposed Embayment Project regrading), AMAFCA considered and designed a west-sloping grade back towards the Rio Grande (L.B. Sumrall, Weston Solutions, Inc., July 21, 2015, email communication). [Though not part of the proposed action, Corps may authorize maintenance of the Embayment including authorization of additional riprap, or the repair, rehabilitation, replacement of NDC structures, and AMAFCA maintenance of the grade, and revegetation, if these are destroyed by storms, floods, or other discrete events. Corps may also authorize removal of accumulated sediments or debris to restore the NDC and Embayment to the final design dimensions or for flood safety, but these actions are not part of the proposed action.]

#### *Action Area*

This BO uses the term “Middle Rio Grande” to refer to the river channel and its floodplain (within the levees) in the Rio Grande-Albuquerque Watershed (USGS Hydrologic Cataloging Unit 13020203; Seaber et al. 1987) in central New Mexico. The Middle Rio Grande is often divided into river reaches identified by an upstream diversion dam. Therefore, we refer to the Angostura Reach as that portion of the Middle Rio Grande between the Angostura and Isleta Diversion Dams (USFWS 2012). The Embayment Project occurs in the Angostura Reach.

The action area includes all areas to be affected directly or indirectly by the proposed action (50 CFR 402.02). We find that the Action Area includes the Embayment, the Embayment Project Area (SWCA 2105), and a portion of the Angostura Reach of the Middle Rio Grande beginning at the Equipment Crossing and the Embayment confluence with the Rio Grande and downstream as far as mixing may occur (perhaps this mixing area is approximately 70ft x 250ft = 18,200ft<sup>2</sup>). The Action Area also includes any temporary storage areas, fill materials, or sediment disposal areas and haul routes (SWCA 2015). With installation of silt fences at outfall of the Embayment, as well as the installation of the coffer dams, the Corps found that no detrimental water quality impacts to the Rio Grande would be anticipated. The Service agrees that some silvery minnows (in the mixing area next to the Embayment outfall) may be startled and flee the noise, vibrations, and water quality alterations associated with the proposed construction activities, and those that remain in or near the Embayment area (approximately 35,500 m<sup>2</sup>) will be adversely affected.

Silvery minnows swim within the Angostura Reach. Standard surveys of silvery minnow are routinely conducted at only 5 to 10 discrete locations within the Angostura Reach during long term monitoring (Dudley et al. 2015, Dudley and Platania 2015) and during augmentation monitoring (Austring 2015). Although habitat (e.g., substrate, velocity, depth, fish community, etc.) within the Embayment may differ from habitat at the survey sites, we assume that silvery minnows occupy the Embayment at densities similar to those at the survey sites. Additionally, as silvery minnows swim, any silvery minnow has the potential to move into the Embayment.

Therefore, while the Embayment Project activities will likely only affect the Embayment and a small mixing zone adjacent in the Rio Grande, we assume that silvery minnows in the Angostura Reach could be affected by the proposed action should they swim into the Action Area.

## II. STATUS OF THE SPECIES

The proposed Embayment Project action may adversely affect the endangered silvery minnow (USFWS 1994) in the Action Area including those silvery minnows in the Angostura Reach. The Service (USFWS 1994, 2003, 2010, 2011, 2012, 2014), U. S. Bureau of Reclamation (Reclamation) (USBR 2015) and SWCA (2015) have all provided updates on the status of the silvery minnow in the Action Area, including its descriptions, life history, genetics, demography, habitat, distribution, the threats of extinction, goals for recovery, and the physical and biological features of its critical habitat in the Angostura Reach, which are incorporated here by reference.

An updated status of silvery minnow abundance in the Angostura Reach is provided below. This status informs our effects analysis because we assume (in this case) that the abundance (as reflected by the 75<sup>th</sup> percentile of the average density of RGSM per unit area) of silvery minnows surveyed in the Angostura Reach will be the same as those affected by the proposed Embayment Project activities in the Action Area. Estimated silvery minnow densities are often expressed as “catch-per-unit effort” (CPUE) or number of RGSM per 100 square meters (RGSM/100m<sup>2</sup>) (e.g., Dudley and Platania 2015).

### *Rio Grande Silvery Minnow Status and Abundance in the Angostura Reach*

Long-term, standardized monitoring of silvery minnows began in 1993 and has continued annually, except for portions of 1998, 2009, and 2013 (Dudley et al. 2015). Long-term monitoring of silvery minnows has recorded substantial fluctuations (orders of magnitude increases and decreases) in the overall population abundance (Figure 4). Silvery minnow abundance is highly correlated with hydrologic conditions, particularly the magnitude, duration and timing of spring runoff (Dudley et al. 2015). There is also negative relationship between flow discharge below a certain threshold value and estimates of the probability of occurrence of silvery minnow during sampling (i.e., less water, less fish). Dudley et al. (2015) also show that silvery minnows tend to exhibit a heterogeneous spatial distribution (i.e., they may shoal or swim in an aggregation) most likely indicative of different micro- and macro-habitat conditions throughout the river reaches (Dudley et al. 2015). Thus, prolonged high flows during spring are most predictive of increased silvery minnow abundance and prolonged low flows during summer were most predictive of decreased silvery minnow occurrence over the 22 year study period.

For the period between September 2009 and September 2015, we summarized in Table 1 (and see Lusk 2015) the available data on silvery minnow densities in the Angostura Reach collected during long term population monitoring (Dudley et al. 2015) and augmentation monitoring (Austring 2015) by month (for those months occurring during the proposed Embayment Project action from September 2015 through March 2016). For the purposes of this BO, we used the average of the monthly 75<sup>th</sup> percentile silvery minnow densities from the five years of monitoring efforts in the Angostura Reach (Table 1). That is, we used a density of 2.1 RGSM/100m<sup>2</sup> for all estimates of incidental take and silvery minnow population estimates within the Embayment Project Action Area (Table 1, and see Lusk 2015). Available information

from August 2015 indicates that silvery minnow densities are moderate at 3.6 RGSM/100m<sup>2</sup> in the Angostura Reach, but are declining monthly (Dudley and Platania 2015). In 2012, when the Embayment was dewatered (USFWS 2012), we observed that the 75<sup>th</sup> percentile density was appropriate for estimating the total number of silvery minnows that were adversely affected.

Data Source	RGSM / 100m <sup>2</sup> in Sept.	RGSM / 100m <sup>2</sup> in Oct.	RGSM / 100m <sup>2</sup> in Nov.	RGSM / 100m <sup>2</sup> in Dec.	RGSM / 100m <sup>2</sup> in Jan.	RGSM / 100m <sup>2</sup> in Feb.	RGSM / 100m <sup>2</sup> in Mar.	Average RGSM / 100m <sup>2</sup> from Sept to March
Dudley et al. 2009	3.9	6.0	5.3	5.8	na	na	na	5.2
NMFWCO 2009	15.3	na	0.3	1.4	2.1	0.0	3.5	3.8
Dudley et al. 2010	0.6	0.7	0.4	0.3	na	0.2	na	0.4
NMFWCO 2010	0.9	na	2.5	0.0	2.1	4.2	2.2	2.0
Dudley et al. 2011	0.6	1.3	na	0.6	na	0.2	na	0.7
NMFWCO 2011	0.0	3.1	0.0	2.1	0.0	0.1	0.0	0.8
Dudley et al. 2012	0.2	0.0	na	na	na	0.0	na	0.1
NMFWCO 2012	na	na	na	na	na	na	na	na
Dudley et al. 2013	na	0.0	na	na	na	na	na	0.0
NMFWCO 2013	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
Dudley et al. 2014	na	0.0	0.4	2.8	na	na	na	1.0
NMFWCO 2014	0.0	1.0	0.0	0.2	0.0	0.0	0.0	0.2
Dudley et al. 2015	na	na	na	na	na	0.6	na	0.6
NMFWCO 2015	na	na	na	na	0.0	na	na	0.0
Monthly Average	2.4	1.3	1.1	1.5	0.7	0.6	1.2	1.3
Monthly 75th%ile	2.4	2.2	2.0	2.4	2.1	0.4	2.9	<b>2.1</b>

### III. ENVIRONMENTAL BASELINE

Under section 7(a)(2) of the ESA, when considering the effects of the action on federally listed species, we are required to take into consideration the environmental baseline. Regulations implementing the ESA (50 FR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area; the anticipated impacts of all proposed Federal actions in the action area that have already undergone formal or early section 7 consultation; and the impact of State and private actions that are contemporaneous with the consultation in process. The environmental baseline defines the effects of these activities in the action area on the current status of the species and its habitat to provide a platform to assess the effects of the action now under consultation. The Service (USFWS 2003, 2010, 2011, 2012, 2014) and Reclamation (USBR 2015) have described the environmental baseline, which are incorporated here by reference, and as updated below, informs the jeopardy analysis for the proposed Embayment Project activities.

The remaining wild population of silvery minnows is restricted to approximately seven percent of its historic range in the Rio Grande. Several activities have contributed to the current status of the silvery minnow and its habitat in the action area, and are believed to affect the survival and recovery of silvery minnows in the wild. Many of these activities are broader than the action area but have effects that extend into the action area. These include past and present projects that affect Rio Grande streamflow and riparian habitat such as water management, flood regulation, channelization, diversions for agriculture and drinking water, land use changes, pollution, nonnative species invasion, ground water drainage, climate change, drought, salinization, and trans-basin diversions of water. The reduction in the magnitude, frequency, duration, and timing of flooding (particularly overbank flooding during spring) has disrupted the functional integrity of aquatic and riparian habitats in the Rio Grande. With the exception of 2008, every year since 1996 has exhibited at least one drying event that has negatively affected silvery minnows. Silvery minnows are unable to expand their distribution in the wild because poor habitat quality and diversion dams and reservoir environments prevent movement (USFWS 2010).

Augmentation of silvery minnows with captive-reared fish has been ongoing, and monitoring and evaluation of these fish provide information regarding the survival and movement of individuals. An experimental population of silvery minnows has been introduced in the Rio Grande near Big Bend, Presidio, Texas, with limited success. Habitat conservation and restoration, captive propagation and augmentation, genetics management, silvery minnow salvage and relocation, and research activities remain needed to reduce the risk of loss of silvery minnow in the wild and maintain the conservation value of critical habitat.

### IV. EFFECTS OF THE ACTION

Regulations implementing the ESA (50 FR 402.02) define the *effects of the action* as the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or 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. Interrelated actions are those that are part



of a larger action and depend on the larger action for their justification; interdependent actions are those that have no independent utility apart from the action under consideration.

### *Effects on Silvery Minnow*

Although some silvery minnows (especially in the mixing area next to the Rio Grande) may be started and flee the noise, vibrations, and water quality alterations associated with the proposed construction activities, those that remain in the Embayment area and exposed to construction activities will be adversely affected. The Service anticipates that as many as 746 silvery minnows in the 35,500 m<sup>2</sup> Embayment Project area will be adversely affected, and several hundred of those may die during dewatering or construction activities, but a large proportion of those entrapped can be rescued by the Service (though a portion of those rescued may also die as a result of the cumulative stress during their capture and translocation to the river nearby). Adverse effects to silvery minnows can be expected from their entrapment in the Embayment between the silt fences and coffer dams that will significantly impair their behavioral patterns and their ability to disperse to the river. There will be additional stress associated from harassment that may occur during various mechanical activities, noise, and vibrations associated with operation of heavy equipment and installation of silt fences and coffer dams. During any water pumping activities (dewatering the Embayment during Plan B), there can be death and injury to the health of silvery minnows associated with the stress of confinement, as well as from the reduction of their sheltering and feeding habitat, and degradation of the water quality remaining in the isolated pools that may form prior to drying. Construction activities are expected to create noise, vibration, disturb sediment and release the oxygen demanding substances and thereby degrade water quality (Plan A and B). Other sediment disturbing activities, including the startle response activities of fish, and fish rescue crew operations, as well as dewatering, are also expected to further degrade water quality, and adversely affect those silvery minnows that remain in water of degraded quality.

We assumed that the maximum density of silvery minnows in the Embayment Project area during the proposed activities was equal to the 75<sup>th</sup> percentile of all monitoring data conducted during fall and winter months over 5 years of sampling, or 2.1 RGSM/100m<sup>2</sup>. Using the area of Embayment (35,500 m<sup>2</sup>), times the density of 2.1 silvery minnows per 100 m<sup>2</sup>; we have determined that the number of silvery minnows in the Embayment is likely to be 746 (2.1 RGSM/100m<sup>2</sup> x 35,500 = 746). If the number of silvery minnows found in the Embayment turns out to be greater than those described in this BO (i.e., ≥746 silvery minnows), this consultation should be reinitiated.

### *Beneficial Effects*

The proposed action is anticipated to have beneficial effects on silvery minnows in the long-term by enhancing their habitat and water quality conditions (i.e., reducing low DO events) in the Embayment and downstream (USFWS 2012, SWCA 2015). The Embayment currently provides silvery minnow habitat (but not critical habitat) with slow velocities that silvery minnows prefer and that support egg retention and larval recruitment (Porter and Massong 2004). Corps mitigation requirements for aquatic habitats may offset the impacts to this important silvery minnow habitat.

### *Effects of Mechanical Activities*

Short-term adverse effects on silvery minnows may occur due to disturbance during reconnaissance, and installation of the silt fences and coffer dams. We expect silvery minnows will be present during the closure of the Embayment and will be harassed temporarily as a direct effect of the proposed activities (e.g., installation of the silt fences and coffer dams). Silvery minnows are expected to exhibit an avoidance response to these activities and given the operating speed and location of equipment, as well as the small area affected, we do not expect fish will be directly injured. Avoidance behavior, or fleeing from the disturbance, represents a disruption in normal behaviors and an expenditure of energy that an individual silvery minnows would not have experienced in the absence of the proposed action. However, this form of harassment is expected to be short in duration, with pre-exposure behaviors to resume after fleeing the disturbance.

#### *Effects of Noise and Vibration*

Heavy equipment operations will generate noise and vibration. There is no information provided in the BA on sound and vibration frequencies of project noise in the Embayment or Rio Grande. Therefore, we assumed noise levels associated with the proposed action may range from 54 decibels equivalent (dBeq) to perhaps 78 dBeq. The level at which fish can detect noise from construction activities sound depends upon the level of ambient noise at a site. We assume that ambient noise near the Rio Grande would have characteristic noise similar to that in nearby unaffected sites (perhaps ~35 dBeq, with peak noise 55 dBeq). There are several factors used to estimate the conductance of noise over distance in air and its transfer to the water column. We assumed that activity that generates noise levels over 65 dBeq would enter the water column and may startle silvery minnows from their normal feeding and sheltering behaviors. Using Nedwell et al. (2007), and injury guidelines developed by Popper et al. (2014), we determined that silvery minnows would likely have behavioral effects associated with noise (within its hearing and vibrational frequencies), when noise levels increased 5 to 30 dBeq above ambient noise levels in water column (> 15 to 60 dBeq). Behavioral avoidance and injury can occur when noise becomes unbearably loud (> 90 dBeq) within silvery minnow acoustic habitat.

#### *Effects of Construction Activities and Effects by Water Quality Degradation*

During Embayment Project activity Plans (A, B, and C) major construction activities will begin to the east of the river, but may affect those silvery minnows that remain in the Embayment or in the mixing zone immediately proximal to the Embayment outfall with the Rio Grande. The potential number of silvery minnows affected within the immediate vicinity of the equipment should be small, as we expect an initial flight response at the onset of activities, and sustained avoidance during the duration of construction work. However, additional adverse effects are likely to occur due to construction activities on the quality of the water in the Embayment.

Adverse effects on silvery minnows may occur during sediment disturbance by equipment when installing the coffer dam and especially during construction activities to install the control structures and regrade the Embayment. Sediment disturbance during construction activities will affect water quality, causing localized increases in turbidity and suspended sediments, as well as various pollutant concentrations. Direct effects from excess suspended sediments on a variety of fish species have included alarm reactions, abandonment of cover, avoidance responses,

reduced feeding rates, increased respiration, physiological stress, poor condition, and subsequently reduced growth, or mortality (Newcombe and Jensen 1996). In addition, indirect effects from sediment mobilization are possible, including the potential smothering and mortality of silvery minnow prey such as algae and aquatic invertebrates, which can result in depressed rates of growth, and reduced physiological function of silvery minnows.

Some adverse effects from sediment disturbance may also be associated with decreased oxygen content of the Embayment water and its volume reduction during dewatering as well as during the disturbance of sediment by construction (Fillos and Molof 1972; Kreutzberger et al. 1980; Wang 1980; Walker and Snodgrass 1986, Veenstra and Nolen 1991, Caldwell and Doyle 1995). When encountering low oxygen, fish can attempt to compensate by behavioral responses, such as increased use of aquatic surface respiration, changes in activity level or habitat use, or avoidance behaviors, though these activities are known to come at a higher energy cost (Kramer 1987; BCME 1997). Below some threshold oxygen saturation, fish will be expending excess energy to maintain homeostasis and that some degree of physiological stress will occur (Heath 1995). Low oxygen conditions may also cause a wide range of additional chronic effects and behavior responses in fish (Downing and Merckens 1957; Kramer 1987; Breitburg 1992), which are potentially adverse to silvery minnow.

We expect that silvery minnows in water with inadequate oxygen will begin to experience mortality. They will also experience adverse effects such as changes in their ventilation rates, increased use of surface water respiration, reduced feeding activity, and experience altered metabolism. As their condition or position changes and they are at an increased risk of predation. We expect that silvery minnows will exhibit a stress response to the changes in water depth and volume, and due to the loss of oxygen by the disturbance of sediments during construction activities in the Embayment. During construction oxygen concentrations will likely continue to plummet given the high oxygen demand there (USFWS 2014), though temperatures will be low.

Those silvery minnows that are not removed quickly from the Embayment, or that remain during construction activities, given the amount and variety of pollutants present, combined with other physical stressors, will likely die or would be expected to have their health compromised and fitness impaired such that their behavior, immune response, and metabolic state would be adversely affected (Heath 1995). The cumulative stress response from silvery minnows associated with elevated turbidity, reduced oxygen, and increased concentrations of other pollutants, could be expected to kill or indirectly affect the health of some of the silvery minnows that remain in the Embayment during construction activities.

#### *Effects of Confinement during Dewatering Activities (see also Water Quality Degradation)*

As dewatering activities commence during Plan B, the volume of water will be reduced, and isolated pools may form along the Embayment bottom. Caldwell et al. (2009) assessed the physiological responses of wild silvery minnows subjected to isolation in pools (as well as their collection and transport associated with silvery minnow rescue). Caldwell et al. (2009) evaluated silvery minnows for primary (plasma cortisol), secondary (plasma glucose and osmolality), and tertiary indices (parasite and incidence of disease) and concluded that the effects of stressors associated with isolation in pools as well as rescue activities resulted in a cumulative stress response in wild silvery minnows. Caldwell et al. (2009) concluded that fish in isolated

pools experienced a greater exposure and greater vulnerability to pathogens (parasites and bacteria), than fish in perennial waters, although the stress response and subsequent disease effects were reduced after silvery minnows were returned to perennial water.

Some of the adverse effects associated with degraded water quality may occur during dewatering activities during Plan B, and are associated with those described during confinement in isolated pools. In addition to increases in suspended solids, reduced oxygen, other constituents are present and may affect the water quality of the Embayment during dewatering or construction activities. These include nutrients such as nitrates and phosphorus, ammonia, dissolved metals, and other pollutants. As the Embayment is dewatered, and sediment is disturbed, various pollutants (e.g., ammonia, hydrocarbons, oxygen demanding substances, pesticides) will become mobilized into the water column to elevated concentrations, or concentrated through dewatering activities, and reach levels that adversely affect those silvery minnows that remain. Some of these pollutants would be expected to cause the immediate death of silvery minnows (e.g., ammonia) when elevated concentrations are reached.

There are water quality effects on fish species, their health, abundance and assemblage structure when their habitats are reduced to isolated pools. Some of the effects have been attributed to stochastic events such as transient periods of high water temperature or low dissolved oxygen concentration (Meyerhoff and Lind 1987; Mundahl 1990; Ostrand and Marks 2000). In addition, as pools evaporated, specific conductance increased and volume and turbidity are decreased (Ostrand and Wilde 2004). Decreases in cyprinid presence and abundance occurred concurrently with increases in specific conductance and decreases in volume in pools (Ostrand and Wilde 2004). As the volume of water is reduced, and amount of suspended solids, salts, and nutrients in the water column increases, the degraded water quality may affect silvery minnow osmoregulatory function, plasma glucose and osmolality, increase their stress response, and alter their behavior. Depending on the duration, magnitude and frequency of exposure to degraded water quality conditions in pools, those exposures may eventually immobilize or kill silvery minnows. Also, as pools recede, cover for silvery minnows may be reduced thereby exposing individuals to aquatic or avian predators. Daily survivorship of silvery minnows in isolated pools (during summer, however) ranged from 58 to 87 percent and averaged 76 percent (Valdez 2011) beginning 1 day after their isolation (during summer). As the proposed activities occur in fall and winter months with lower temperatures, higher oxygen content and perhaps fewer predators, we divided the mortality rate in half (i.e., 38 percent) for estimating effects to silvery minnows affected by Embayment Project Plan B activities and dewatering.

#### *Effects of Capture, Handling, and Transfer to the Rio Grande*

The Service has defined take by harassment as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering (see 50 CFR 17.3). Intentional capture of silvery minnows by the Corps, AMAFCA, or others during Embayment Project activities is prohibited under section 9 of the ESA.

However, during discussions of the proposed project, staff from AMAFCA and the Pueblo of Sandia expressed a desire that silvery minnows (and other fish and wildlife) be rescued to reduce their mortalities. The Service's New Mexico Fish and Wildlife Conservation Office has a

cooperative agreement with the Pueblo of Sandia to assist with fish monitoring and assessment, and it implements the Service's mission to conserve, protect, and enhance fish, wildlife, and their habitats, as well as has the staff with training, equipment, and personnel, and ESA section 10(a)(1)(A) permits necessary to collect silvery minnows for the purpose of rescue and salvage. Therefore, the intentional collection, handling, transport, and transfer to the Rio Grande of silvery minnows in order to rescue them from the suite of adverse effects that will occur during Embayment Project activities was identified early by all parties as a measure implemented by the Service that could reduce the adverse effects to silvery minnow, as is necessary.

However, we have identified that the physical stressors associated with the capture, handling and transport of the rescue efforts, will also result in stress that increases the vulnerability of silvery minnows to opportunistic pathogens and predation, possibly decreasing post transfer survival of some individuals in the Rio Grande. We expect that the physiological stress response to standard rescue practices subjecting the fish to individual stressors of approximately 30 seconds (s) of handling may result in moderate changes in plasma glucose, plasma osmolality, and moderate osmoregulatory dysfunction in silvery minnows (Cho et al. 2009). After transfer of silvery minnows to the river nearby, we expect that silvery minnows will recover physiologically to unstressed levels within 48 hr (Cho et al. 2009) as long as the stressors are reasonable in duration and intensity. Caldwell et al. (2009) described that 94 percent of silvery minnows handled in such fashion would survive if rescue operations were conducted within 24 hr of confinement, but that isolation in pools for greater than 48 hours would reduce survival to 82 percent. Therefore, rescue efforts would need to be conducted within 24 hours of any isolation of silvery minnows in pools that occur during dewatering of the Embayment. Silvery minnows that are harmed or that die because of the Service's rescue efforts shall not be attributed to the Corps Embayment Project incidental take statement.

With provision of the Service's rescue operations during the Embayment Project activities, especially during dewatering and prior to construction, the number of silvery minnows that may die will be reduced. In isolated pools, the Service's rescue activities can retrieve anywhere from 50 to 99 percent of the silvery minnows that may inhabit the isolated pool (USFWS 2012), with success rates varying according to pool complexity. We assumed that the rescue rate would be 80% of silvery minnows affected (604; Table 2). As the Embayment is a large, it is possible that several isolated pools may form (we assumed there could be as many as five pools). We assumed that as many as 142 silvery minnows that avoid capture by rescue efforts will likely remain in the pools of water at the bottom of the Embayment and will likely perish (Table 2).

### *Summary*

The Service has defined take by harassment as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering (see 50 CFR 17.3). Silvery minnows are expected to exhibit an avoidance response to construction activities, and given the operating speed of equipment we expect only a few fish will be directly injured or their movement impeded by the equipment. However, additional adverse effects to water quality or acoustic habitat may occur during construction activities. Silvery minnow avoidance behaviors represent a disruption in normal behaviors and an expenditure of energy that an individual silvery minnow would not have experienced in the

absence of the proposed action. However, this form of harassment is expected to be short in duration, with pre-exposure behaviors to resume after fleeing the disturbance. Table 2 depicts our expectation of the number of silvery minnows that may be adversely affected by the Embayment Project activities under the different Plans or that may die during construction, dewatering or rescue activities. If Plan A is implemented, up to 746 silvery minnows may be adversely affected and of those, as many as 298 may die. If Plan B is implemented, up to 746 silvery minnows may be adversely affected and of those, as many as 270 may die. Should the Service implement rescue operations during dewatering activities and confinement of silvery minnows in isolated pools, then up to 604 silvery minnows (or more) will likely be rescued. We expect that approximately 142 silvery minnows will escape all capture attempts, and will remain in the water at the bottom of the Embayment during construction activities, and may subsequently die due to water quality degradation. Even if silvery minnows rescued, as many as 142 may die due to cumulative and handling stress. The numbers of silvery minnows used in these estimates are based on the best scientific information available; however, actual daily catch rates may vary due to the size of pool, environmental conditions in the pool, and the logistics of fish rescue operations. If Plan C is implemented then only those 36 silvery minnows at the very edge of the Embayment outfall with the Rio Grande would be adversely affected in the mixing zone and none would die.

If more mortalities of silvery minnows occur in the Embayment during project activities that are greater than expected (i.e., 298 silvery minnows), then this consultation should be reinitiated as described below. Subsequent adverse effects that occur to silvery minnows that are captured during the Service's rescue operations (as many as 604 individuals), as well as any subsequent mortalities that may occur due to cumulative and handling stress (up to 142 silvery minnows), are not attributed to the proposed Embayment Project, but will be attributed to the intentional rescue and salvage activities that are covered by the Service's 10(a)(1)(A) permit.

To summarize adverse effects to the silvery minnow: 1) 746 silvery minnows in the Embayment will be entrapped by the installation of the silt fences and coffer dams or affected by construction and water quality impacts; 2) Dewatering will confine silvery minnows into isolated pools and reduce their health as well as degrade water quality that will stress 746 silvery minnows that remain in the Embayment during dewatering and will likely result in mortality of as many as 270 silvery minnows; and, 3) the Service's rescue efforts may stress as many as 604 silvery minnows during their pursuit, capture, and subsequent transfer to Rio Grande nearby. Of those captured during rescue operations, as many as 142 silvery minnows may also die due to cumulative stress and handling. However, without rescue, adverse effects associated with Embayment Project activities would be expected to result in mortality of all silvery minnows in the Embayment. Given the timeframe for construction, we do not expect any eggs or larval silvery minnows will be harassed or otherwise taken during construction.

Table 2. Estimated Embayment Project activities per day, portion of Embayment affected per day, and number of Rio Grande Silvery Minnow (RGSM) adversely affected (take) or that may die during implementation of the various Embayment Activity Plans.

Construction distance (feet) from Equipment Crossing per activity day	Embayment Portion Area (*100m <sup>2</sup> )	Number RGSM based on the 5-year, 75th percentile average density = 2.1 RGSM/100m <sup>2</sup>	Number RGSM affected by Plan A disturbance, noise, vibration, water quality impacts	Number RGSM that may die due to Plan A (~ 40% of RGSM affected)	Number RGSM affected by Plan B disturbance, noise, vibration, water quality in 5 isolated pools	Number RGSM that may die (~38% using Valdez 2011) by Plan B	Number RGSM likely rescued by USFWS (~80% of RGSM affected by Plan B)	Number RGSM that may die during USFWS rescue (~20%)	Number RGSM affected by Plan C disturbances
70	16.9	36	36	14					
140	16.9	36	36	14					
210	16.9	36	36	14	71	27			
280	16.9	36	36	14	71	27	114	23	
350	16.9	36	36	14					
420	16.9	36	36	14					
490	16.9	36	36	14	71	27			
560	16.9	36	36	14	71	27	114	23	
630	16.9	36	36	14					
700	16.9	36	36	14					
770	16.9	36	36	14	71	27			
840	16.9	36	36	14	71	27	114	23	
910	16.9	36	36	14					
980	16.9	36	36	14					
1050	16.9	36	36	14	71	27			
1120	16.9	36	36	14	71	27	114	23	
1190	16.9	36	36	14					
1260	16.9	36	36	14					
1330	16.9	36	36	14	71	27			
1400	16.9	36	36	14	71	27	114	23	
1470	16.9	36	36	14	71				36
Assumed activities at 70 feet per day	Affected Embayment area per day	Estimated ~746 RGSM total in the Embayment area	Plan A: up to 746 RGSM may be affected	Plan A: up to 298 RGSM may die	Plan B: up to 781 RGSM may be affected	Plan B: up to 270 RGSM may die	Plan B: likely USFWS to rescue 568	Plan B: up to 114 may die during rescue	Plan C: up to 36 RGSM may be affected

## **V. CUMULATIVE EFFECTS**

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur within the action area considered in this biological opinion (50 FR 402.02). 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. The Service (USFWS 2003, 2010, 2011, 2012, 2014) and Reclamation (USBR 2015) have described cumulative effects, which are incorporated here by reference, along with a summary of the cumulative effects below, inform the jeopardy analysis for the proposed Embayment Project.

The Service expects that cumulative human activities will continue to affect silvery minnow habitat, the quality, availability, and timing of silvery minnow prey, its predator and competitor relationships, the incidence of disease, the conditions that exceed the physiological tolerances of the silvery minnow, or that alter their rates of metabolic and biochemical processes, to continue to occur either individually or in combination, in the action area and to affect the status of the silvery minnow in the Angostura Reach. The Service considered these cumulative impacts as well as the effects of climate change and determined that cumulative effects would not be measurable at the scale of Embayment Project activities (6 months). However, these cumulative effects will continue to reduce the quality and quantity of silvery minnow habitat and continue to contribute to threaten the survival and recovery of the silvery minnow.

## **V. CONCLUSION**

After reviewing the current status of the silvery minnow, the environmental baseline for the action area, the anticipated effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the proposed Embayment Project, is not likely to jeopardize the continued existence of the silvery minnow. We expect the level and type of take associated with this project is unlikely to appreciably diminish the population in the Angostura Reach of the Middle Rio Grande, nor diminish the species as a whole. We expect harassment of minnows may occur due to construction activities; however, we do not expect this to result in any significant long-term effects on their status in the Angostura Reach or for the species as a whole.



## 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, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited 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 Corps (and/or AMAFCA as an ESA Applicant) so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. Corps has a continuing duty to regulate the activity covered by this incidental take statement. If Corps (1) fails to assume and implement the terms and conditions or (2) fails to require adherence to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Corps 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 Embayment Project will be implemented as proposed (SWCA 2015, as amended on July 21, 2015). Take of silvery minnows is expected in the form of harassment, harm, and mortality due trapping, noise, disturbance, construction activities, dewatering, and water quality degradation in the Embayment area as proposed. If actual incidental take meets or exceeds the predicted level, Corps must reinitiate consultation.

Based on the best available information concerning the silvery minnow, the habitat needs of this species, the project description, and information furnished in Corps BA and this BO, take is considered likely for the silvery minnow during the proposed action. The Service anticipates that take in the form of harassment may affect up to 746 silvery minnows. We base these figures on the best available information on minnow density in the area to be disturbed by the proposed activities during the project implementation. The Service notes that this represents a best estimate of the extent of take that is likely during the proposed action.

### **Effect of Take**

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the silvery minnow. The Embayment Project is likely to have adverse effects on individual

silvery minnows but those effects are not anticipated to result in any long-term consequences on individuals in the Angostura Reach or on the population. Incidental take will result from harassment, harm, or mortality of minnows during construction activities.

### **Reasonable and Prudent Measure**

The Service believes the following reasonable and prudent measure is necessary and appropriate to minimize impacts of incidental take of the silvery minnow resulting from the proposed action:

1. Minimize take of silvery minnows due to Embayment Project activities.

During Plan A, minimize construction impacts by isolating the Embayment Project and proceed filling slowly (~70 to 100 feet per day) in an east-to-westerly fashion (so as to allow silvery minnows to escape towards the Rio Grande). During Plan B, after coffer dam construction, water from the Embayment will be mechanically pumped to the settling basin upstream of the Equipment Crossing in the NDC where it will stand (and infiltrate into the ground or it may be diverted into an irrigation ditch) until project activities conclude. Fine mesh (i.e., ¼ inch or less diameter), screened water intakes will be installed around the pumps to prevent fish and other larger vertebrates from entering the hose intake and pump. Some water may remain in the Embayment as construction activities will occur at the control structures and coffer dams and will not occur across the entire bottom surface of the Embayment. Water pumping activities are anticipated to last no longer than one week (based on water volume and pump rates), and can be controlled to reflect the needs of the project as well as the needs of Service biologists to rescue silvery minnows or other animals that may become stranded in pools or at the edges of the receding pool of water remaining in the Embayment. During pumping and construction activities, daily observations of fish behavior or mortality should be made by any authorized biologist or onsite managers. Authorized biologists may attempt silvery minnow capture for observation only, or collect and enumerate dead silvery minnows, provided they are authorized to do so under an appropriate Federal Fish and Wildlife Permit. As appropriate to the rescue of any stranded fish and wildlife species, the AMAFCA Embayment Project manager(s) and/or staff will coordinate with the Service's New Mexico Fish and Wildlife Conservation Office in conjunction with the Pueblo of Sandia to commence seining, netting, capture, and translocation of fish (and other aquatic organisms) to the Rio Grande during dewatering activities in order to minimize the mortalities of silvery minnows.

### **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 Reasonable and Prudent Measure described above. These terms and conditions are non-discretionary.

To implement RPM 1, Corps shall:

1. Ensure that all Embayment Project activities are conducted within the timeframes described in the BA and this biological opinion (not between April 15 and August 15).

2. Ensure that conservation measures described in the BA or in this biological opinion are implemented, including those pertaining to equipment and operations, staging and access, water quality monitoring, dust abatement, pollution prevention, spill response readiness, clean riprap materials, reduced project footprint, et cetera;
3. Avoid existing wetlands and require appropriate mitigation for aquatic habitat impacts;
4. Obtain all applicable permits, certifications and authorizations prior to construction;
5. Ensure that silvery minnows are visually or otherwise monitored in the Embayment Project area by an authorized biologist (with an active ESA Section 10(a)(1)(A) federal fish and wildlife permit) who communicates daily with an Embayment Project Manager, which has authority to stop work should the number of dead silvery minnows exceed the incidental take enumerated in this biological opinion;
6. Report to the Service all findings of enumerated, injured, or dead silvery minnows;
7. If Plan B is implemented, Corps, through AMAFCA, shall coordinate with the Service's New Mexico Fish and Wildlife Conservation Office for any rescue efforts along with the Pueblo of Sandia and Embayment Project managers to ensure those rescue efforts are successful, effective, and efficiently timed for all parties and so as to maximize silvery minnow survival; and,
8. Monitor and provide a written report on implementation of RPM 1 and its associated Terms and Conditions by December 30, 2016.

### **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 Service (USFWS 2011, 2012, 2014) provided conservation recommendations in previous BOs incorporated here by reference

### **RE-INITIATION NOTICE**

This concludes formal consultation on the action described in the Corps BA. 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 BO; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this BO; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease.

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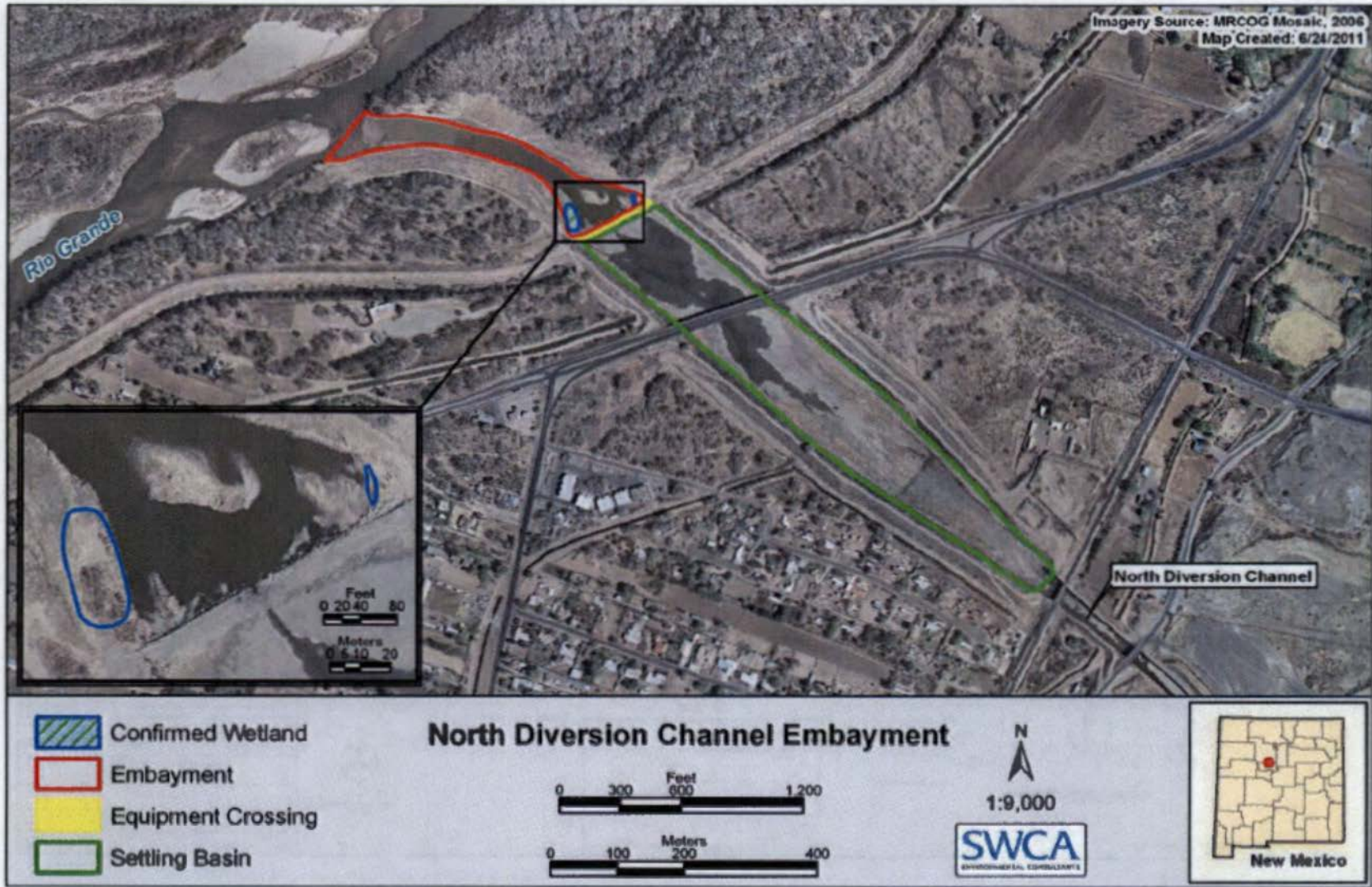


Figure 1. Location of the AMAFCA North Diversion Channel including the sediment settling basin (outlined in green), the Equipment Crossing (in yellow), wetlands (in red and blue), and Embayment (in red) areas. Source: SWCA (2011).



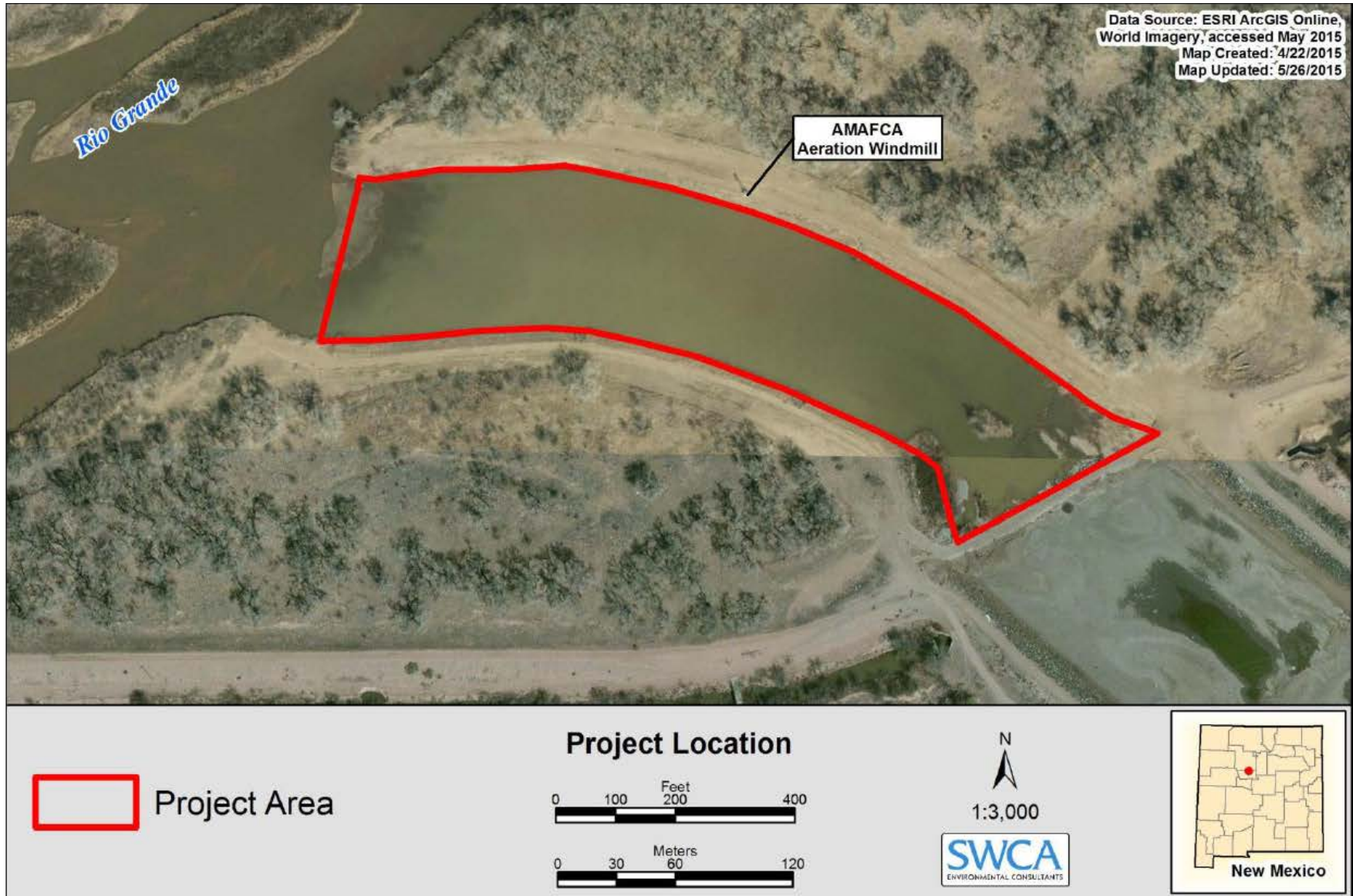
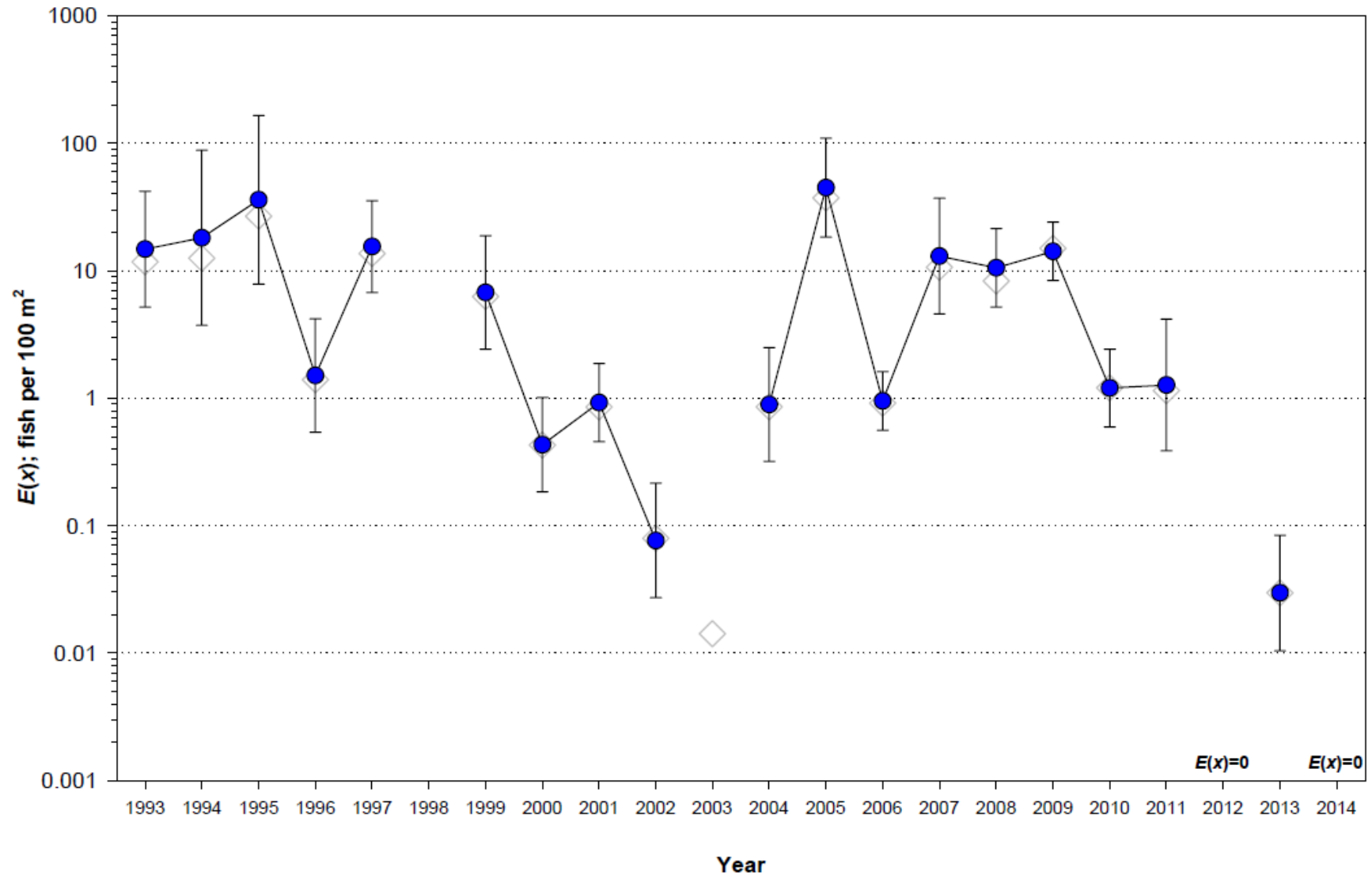


Figure 2 Location of the AMAFCA Embayment Project area (in red). (SWCA 2015).





**Figure 4. Yearly silvery minnow mixture model estimates of density ( $E(x)$ ), using October sampling-site data (1993-2014). Solid circles indicate modeled estimates and bars represent 95% confidence intervals. Dotted horizontal lines represent orders of magnitude. Gray diamonds indicated simple estimated of mean densities using the method of moments. (Dudley et al. 2015a).**