AUGMENTATION AND MONITORING PLAN FOR RIO GRANDE SILVERY MINNOW IN THE MIDDLE RIO GRANDE, NEW MEXICO

December 2001

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INTRODUCTION

The Rio Grande silvery minnow (*Hybognathus amarus*) was historically found in the mainstem Rio Grande and its larger tributaries (Chama River and Jemez River) from near Española to the Gulf of Mexico, and in the Pecos River from Santa Rosa downstream to its confluence with the Rio Grande (Bestgen and Platania 1991). Currently, *H. amarus* has been found in the middle Rio Grande, New Mexico, between Cochiti Dam and Elephant Butte Reservoir, representing 283 km (176 mi) or 5-7% of the historical range. The species has declined and it is estimated that more than 70% of the known population of *H. amarus* inhabits the reach from the San Acacia diversion dam downstream to Elephant Butte Reservoir (U.S. Fish and Wildlife Service 1999).

Throughout much of its historic and current range, the decline of *H. amarus* may be attributed in part to modification of stream discharge patterns and sediment loads, channel dessication, obstructions to upstream movement (e.g., impoundments and diversion dams), channelization, competition and predation by introduced nonnative species, and water quality degradation. One factor of considerable importance is the loss of nursery habitat. During spawning, fertilized eggs could passively drift up to 390 km downstream before being able to move out of the drift (Platania 2000). If spawning were to occur at the uppermost location (Cochiti Dam), many larvae could be transferred past Angostura and Isleta diversion dams before being able to actively seek out low-flow nursery areas given current uniform channel conditions. In a more natural channel, eggs may only drift as much as 100 m downstream in a day (W. L. Minckley pers. comm.). It is likely that some or all of the factors may have contributed to the decline of *H. amarus* which ultimately resulted in the listing of this endemic cyprinid as a federal endangered species (U.S. Department of the Interior 1999).

The middle Rio Grande, New Mexico, is separated into four reaches, each designated by its upstream structure: Cochiti, Angostura, Isleta, and San Acacia. Cochiti Reach has not been monitored since 1994, when *H. amarus* was present on Santo Domingo and San Felipe Pueblos. *Hybognathus amarus* was last collected on Cochiti Pueblo in 1988 downstream of Cochiti Dam (Platania 1993) and may still be present in Cochiti Reach although reduced in abundance compared with historic collections (Platania 1995). Status and distribution of *H. amarus* in Cochiti Reach must be further documented to accurately assess the status of the species within its current range. This will require permission from and cooperation with the Cochiti, Santo Domingo, and San Felipe Pueblos.

Recent surveys indicated that populations in Angostura, Isleta, and San Acacia reaches are still declining, but the majority of *H. amarus* are found in the San Acacia reach. Recent decline of *H. amarus* from Angostura and Isleta reaches was most likely related to sediment and flow modifications caused by Cochiti Dam (Bestgen and Platania 1991), as well as possible water quality degradation. Once Cochiti Dam was closed (1973), the river below the dam changed from a warmwater, sand-bed dominated substrate river to a cool-water, gravel-sand dominated and armored bed substrate river. This effectively changed the river to one that was less than ideal for *H. amarus* to sustain population levels (Platania 1995).

Relationship to recovery plan

In accordance with the Rio Grande silvery minnow recovery plan (U.S. Fish and Wildlife Service 1999) to stabilize and enhance populations within its historic range, information is needed to determine the biological responses of *H. amarus* to altered habitat and define augmentation

requirements. To ensure survival of *H. amarus* and maximize the probability of its successful recovery, it is necessary to reestablish viable populations upstream of San Acacia and throughout its historic range. The first priority should be augmentation from captive propagation as well as translocation of wild-caught eggs to enhance populations in the Angostura and Isleta reaches as identified in items 2, 2.5, and 2.6 (inset below) in the Rio Grande Silvery Minnow Recovery Plan (U.S. Fish and Wildlife Service 1999).

> 2. Reestablish Rio Grande silvery minnow into suitable habitat within its historic range.
>
> To ensure survival of the Rio Grande silvery minnow and maximize the probability of its successful recovery, it is necessary to reestablish populations from available fish. This can be done by transplant of wild stock from the middle Rio Grande directly to areas designated for reintroduction or removal to a fish culture facility for development of a broodstock. The first priority should be transplant of fish from peripheral habitat to enhance populations in the Angostura and Albuquerque reaches and into other historically occupied areas. The development of a captive broodstock and propagation techniques will allow for the maintenance of species genetic integrity and survival, the provision of material for various studies, and for the reestablishment of Rio Grande silvery minnow into areas historically occupied. National Environmental Policy Act and Endangered Species Act compliance will be completed for all reestablishment efforts.
>
> 2.5. Identify and evaluate potential reestablishment sites.
>
> Those stream reaches or segments of reaches which best meet the criteria for reestablishment, including requisite habitat or the ability to restore habitats, should be considered for reestablishment. The principal criteria used in determination of reestablishment potential are: an understanding of reasons for the species extirpation from the selected reach, the presence of other members of the reproductive guild (pelagic spawner: non-adhesive, semibuoyant eggs:, habitat conditions (including susceptibility to river drying and presence of diversion structures), presence of congeners (i.e., other species of *Hybognathus*). An investigation should be made into the role that water quality degradation, the impact of nonnative specie sand the impact that channel modification on habitat may have had on the loss of Rio Grande silvery minnow in the reaches selected for reestablishment. The relative costs of improving habitat in reaches selected for reestablishment will also be considered.

2.6. Reestablish Rio Grande silvery minnow at appropriate locations within its historic range.

Develop a Rio Grande silvery minnow reestablishment plan which would describe the purposes, implementation schedule and costs based upon the specific site selected for recovery, identify the source of fish used for reestablishment and establish target levels of both fish and habitat necessary for recovery. Reestablishment of Rio Grande silvery minnow in areas of historic range is subject to compliance with the provisions of the National Environmental Policy Act and the Endangered Species Act.

Emergency salvage in 1996, 1998, and 1999 relocated 11,019 individuals (adults and juveniles) from isolated pools below San Acacia Dam (San Acacia Reach), upstream to several locations within Isleta and Angostura reaches. However, the small number of individuals salvaged in emergency efforts (Table 1) was relatively minor compared to the extent of impacted Rio Grande habitats. Thus, salvage activities of adult *H. amarus* may not contribute substantially to reestablishment and long-term population viability within permanently flowing reaches.

In May-June 2000, 203,600 larval and 414 adult *H. amarus* were stocked by personnel of the Museum of Southwestern Biology personnel near the New Mexico Highway 6/49 Bridge in Los Lunas and New Mexico Highway 44 Bridge in Bernalillo (Table 1). These larval fish were the result of captively spawning wild-caught adults from the San Acacia Reach. After captive spawning, the remaining adults were then returned to the river. However, the effectiveness of these and other stockings attempts resulted in limited numbers of *H. amarus* collected near or downstream of these locations after stocking. Therefore, it is crucial to fully document translocations and other stocking attempts for future management. Similarly, annual monitoring of augmented populations is specifically identified as item 2.7 (inset below) for recovery of *H. amarus* in the Rio Grande Silvery Minnow

Recovery Plan (U.S. Fish and Wildlife Service 1999).

2.7. Conduct annual monitoring of reestablished populations of Rio Grande silvery minnow and their habitat.

Develop a plan for the long-term monitoring of reestablished populations and their habitat in coordination with a basin-wide data collection and monitoring program. Monitoring should continue for at least the duration of the five year review period and data will be used to refine population goals for Rio Grande silvery minnow. The monitoring plan should describe the procedures, protocol, frequency and subject of monitoring ans ensure that monitoring efforts at all reestablishment sites are integrated.

Objectives

Clearly, augmentation activities for *H. amarus* should be considered one part of the solution to prevent extinction of the species. Propagation and augmentation activities cannot reduce the need for restoration of long-term habitat conditions in the middle Rio Grande, New Mexico. The ultimate goal of this augmentation plan is to reestablish self-sustaining populations of *H. amarus* in the middle Rio Grande, New Mexico, to preserve the balance of the native fish community as well as acquiring information necessary for possible reintroductions into additional areas of historical distribution deemed suitable for stocking.

The objectives of this augmentation and monitoring plan are to: 1) determine success of stocking transplanted *H. amarus* (wild-caught, captive hatching of wild-caught eggs, captive propagation of wild-caught individuals, and propagation of captively bred individuals); 2) determine downstream dispersal of transplanted *H. amarus* between reaches; 3) determine habitat use of transplanted *H. amarus* in the wild; 4) determine habitat use and retention of *H. amarus* in specific river reaches with ongoing channel restoration activities; 5) identify and characterize river reaches where

retention and survival of stocked *H. amarus* are maximized; and, 6) refine augmentation activities to maximize survival of *H. amarus*. These actions will allow better management decisions to be made in regard to the future transplant of *H. amarus* throughout its current and historical range.

AUGMENTATION AND MONITORING

This plan outlines augmentation and monitoring activities for *H. amarus* to be performed by New Mexico Fishery Resources Office personnel. The initial stocking of age-0 *H. amarus* could take place in fall-winter 2001-02 with subsequent stockings continuing each year. Spring stockings of overwintered age-0 and mature age-1 individuals prior to elevated flows may be used as an additional strategy. Fish will be stocked at vehicle access points and by raft in specific low velocity/nursery habitats within the Angostura and Isleta reaches. All stocked fish will be externally marked for future identification. Currently, Museum of Southwestern Biology personnel are conducting monthly fish community monitoring at 20 sites from Angostura Diversion Dam downstream to Elephant Butte Reservoir. Efforts should be focused on the evaluation of stocking success of *H. amarus* reared in captive propagation facilities and released in the Angostura and Isleta reaches. Population numbers may be estimated with the future collection of marked individuals. The combination of these monitoring efforts in the middle Rio Grande, New Mexico should provide a better understanding of the stocking efforts for future management decisions.

METHODS

Source of Fish

All transplanted fish will come from either Dexter National Fish Hatchery and Technology Center, Mora National Fish Hatchery and Technology Center, New Mexico State University, New Mexico Department of Game and Fish - Rock Lake Facility, Albuquerque Biological Park, or the New Mexico Fishery Resources Office. Wild populations of *H. amarus* can be augmented by: 1)direct transplanting of wild-caught individuals from hatched from wild-caught eggs; 2)transplanting of wild-caught individuals that were reared in captivity; 3)stocking of captive-reared offspring artificially spawned from wild-caught individuals; and, 4)stocking of captive-reared offspring artificially spawned from captive-reared individuals.

Marking Techniques

All fish stocked will be marked based on best marking techniques available. Granular pigment has proven successful in marking large numbers of fish with minimal handling time (Nielson 1992), including small fish such as pupfish (Douglas et al. 2001) and cyprinids (Andrews 1972) for periods up to 2 years. Another marking technique that is being evaluated is the injection of an elastomer tag into individual fish. This method may be more time consuming, but overall effectiveness (lowered mortality and higher tag retention) necessitate its consideration. Injected elastomer tags have been recently tested with *H. amarus,* with minimal immediate mortality. Delayed effects of elastomer tagging are also a concern and will be evaluated. Fish released in the Angostura reach will be marked with a different color from those released in the Isleta reach. Each of these two lots will be marked differently from

those used in other mark-recapture studies to determine differential movement past diversion dams. Fish released in the second and subsequent years of stocking, alternate colors will be used to differentiate between year classes. In addition, fish that are released in spring will be marked with different colors to differentiate between spring and fall stockings. Few *H. amarus* are thought to survive past age-2 in the wild (U.S. Fish and Wildlife Service, 1999), but different colors will ensure differentiation among age classes.

Release

Fish raised by captive propagation will be stocked out each fall (age-0) with a goal of 500,000 individuals per year. In order for these stocked fish to effectively contribute to the various populations, they must survive to reproduce in the following years. The added cost and space constraints associated with keeping large numbers of captively-spawned *H. amarus* overwinter necessitates their stocking as soon as habitat conditions allow. Also, any other fish that were collected during rescue operations and not immediately returned to the river or maintained for propagation can be released along with captively-reared fish. If space and numbers are available, a portion of *H. amarus* will be overwintered for stocking in late spring prior to elevated flows.

All fish will be stocked between fall (after water diversions for irrigation has stopped) and the following spring. The fall stocking period will allow captive-reared individuals to reach maximum size while avoiding predation, competition, and habitat degradation during summer low-flow periods when age-0 fish are most susceptible. Also, this will allow stocked individuals several months to acclimate to the river before higher flows (and spawning) occurs the following spring. Stocking of mature individuals

in the spring may provide an additional opportunity for increasing the numbers of naturally spawning *H. amarus* in the river immediately before the increase in flows due to spring runoff.

Release Locations

Fish will be released primarily within the Angostura and Isleta reaches both at vehicle access points and by raft in specific low velocity/nursery habitats. Every effort will be made to stock each site with the same number of fish. Augmentation efforts will focus on multiple locations within the Angostura reach. If the number of *H. amarus* available for release is very high (as determined by the research biologists) release into the Isleta reach will be considered. In the event that excess numbers of *H. amarus* are available for release after all potential sites in the Angostura and Isleta reaches have been stocked, remaining fish may be released at similar locations within the San Acacia reach.

Potential sites in the Angostura reach include Coronado State Park, NM Hwy. 44 Bridge, Bernalillo wastewater treatment plant outflow, Corrales siphon, Lomatas Negras confluence, Dixon road, Sandia Pueblo south boundary, Alameda bridge, Paseo del Norte bridge, La Orilla drain return, Campbell Avenue, Interstate Hwy. 40 bridge, Central Avenue bridge, Barelas bridge (Bridge Boulevard), Overbank project, Rio Bravo Bridge, Powerline crossing, and Interstate Hwy. 25 bridge. Potential sites in the Isleta reach include Isleta Diversion Dam, Isleta drain return, Los Lunas bridge (NM Hwy, 49), Tomé, Calle del Rio, Belen Bridge (NM Hwy, 6), Feeder drain #3 confluence, Abo Arroyo confluence, Pino Draw confluence, Maes Arroyo confluence, and Rio Puerco confluence. These access sites, along with specific low velocity/nursery habitat identified from raft within each of these reaches will be used as stocking sites.

Specific locations that contain available habitat that are of special interest for possible stocking locations in both the Angostura and Isleta reaches include Jemez River confluence, Rio Puerco confluence, and Los Lunas Bridge. The lower Jemez River, which includes a 4.5 km stretch from the Jemez Canyon Dam downstream to the confluence with the Rio Grande, is known to hold *H. amarus* for at least some periods during the year. These fish were collected between 1998-2000 during a survey of the Jemez River. Twenty-one *H. amarus* were captured in one collection, while a total of 22 individuals was collected during that same time from the mainstem Rio Grande in Angostura and Isleta reaches. The Los Lunas bridge site is known to contain quality low-velocity habitat. In February 2001, personnel from the Musuem of Southwestern Biology collected 246 *H. amarus*, including 204 age-2 or older fish, during a monitoring survey at this site.

Final site selection for several of the above identified localities will require permission and cooperation of Santa Ana, Sandia, and Isleta Pueblos before stocking and monitoring can proceed.

Monitoring

Monitoring of stocked fish will include specific post-stocking surveys at 1-week, 2-week, and 1-month intervals to determine dispersal aspects (direction, rate) and habitat use. Thereafter, monthly sampling will follow to determine success of stocking efforts as well as dispersal patterns and habitat use. Also, estimates of population size within the Isleta and Angostura reaches may be calculated if adequate numbers of marked fish are recaptured during monitoring. Estimates of survival, growth, and mortality may also be calculated with the data obtained during monitoring.

Fish will be collected with a 3 m X 1 m X 3 mm seine. Each seine haul will be measured to the

nearest 0.1 meter. All habitat types will be sampled within each reach with a minimum of 20 seine hauls at each sampling location. A qualitative description will be made of the habitat within each seine haul, along with measurements of depth and velocity. Water quality parameters will be recorded including pH, conductivity, water temperature, air temperature, total dissolved solids, and salinity. All fish captured will be identified and enumerated in the field and subsequently released. When identification of fish to species in the field is not assured, they will be preserved for later identification in the New Mexico Fishery Resources Office lab.

In addition to standard monitoring with seine, additional data will be collected by setting small-mesh hoop nets (3 mm) directly after stocking to assess the immediate dispersal of *H. amarus* from the stocking site. Prior to stocking, nets will be placed 100 m, 500 m, and 1000 m downstream and upstream of the release site. Three nets will be placed across the river at each survey transect (6 sites, 18 nets) to adequately sample the varying habitats at each site. Nets will be oriented with the mouth facing the stocking site. Hoop nets will be examined and cleaned every 15 minutes for the first 6 hours after release, thereafter at 6 hour intervals for a period of 48 hours post-stocking. Similar methods have been used to assess dispersal of stocked fish in other lotic systems (Siegwarth and Johnson 1998; Brooks, et al. 1986).

Monitoring sites and dates will be coordinated with standard Rio Grande water quality sampling performed by personnel from U.S. Fish and Wildlife Service, Ecological Services Field Office in Albuquerque. This will ensure that *H. amarus* and water quality monitoring data will be comparable for future use.

Reporting

To effectively inform interested and cooperating parties on the progress of augmentation and monitoring, quarterly and annual reports will be prepared by New Mexico Fishery Resources Office personnel. This will also allow for comments and suggestions for future refinement of methods to maximize the effectiveness of this project. The long-term benefits of this study will not only augment populations within the middle Rio Grande, New Mexico, but to evaluate stocking efforts and provide a better understanding for propagation methods, stocking times and methods, and monitoring efforts needed for establishing *H. amarus* throughout its historical range.

RISK

Releasing captive-reared fish into the wild is not without risks. Genetic and ecological risks must be evaluated against the possible benefits of the augmentation efforts. Stocking in the Angostura and Isleta reaches will be determined after genetic analyses by personnel at the University of New Mexico. Further genetic concerns are fully addressed in the Rio Grande silvery minnow propagation plan (U.S. Fish and Wildlife Service, in review) and therefore are not included in this augmentation and monitoring plan.

Ecological concerns associated with stocking captive-reared *H. amarus* in the wild include passive downstream movement, pathogen and parasite transmission, intra- and interspecific competition, and predation. By allowing fish to reach maximum size before stocking, the natural downstream drift associated with larval *H. amarus* is bypassed, therefore possibly increasing the

chance of retention within the reach originally stocked. Samples from all sources of stocked fish will be analyzed for presence and extent of pathogens and parasites before transfer or stocking into Rio Grande habitats. Due to low numbers of *H. amarus* located during monitoring surveys, competition between wild and captive-reared individuals should be minimal.

Several species of native and introduced fish have been collected in areas within the known distribution of *H. amarus*, including fathead minnow (*Pimephales promelas*), river carpsucker (*Carpiodes carpio*), white sucker (*Catostomus commersoni*), western mosquitofish (*Gambusia affinis*), red shiner (*Cyprinella lutrensis*), common carp (*Cyprinus carpio*), flathead chub (*Platygobio gracilis*), longnose dace (*Rhinichthys cataractae*), and gizzard shad (*Dorosoma cepedianum*). The effects that any or all of these species may have on *H. amarus* are unknown but may share habitat requirements.

Several non-native piscivorous species of fish are present in varying densities within the middle Rio Grande, New Mexico including black bullhead (*Ameiurus melas*), yellow bullhead (*Ameiurus natalis*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictus olivaris*), rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), white bass (*Morone chrysops*), green sunfish (*Lepomis cyanellus*), longear sunfish (*Lepomis megalotis*), spotted bass (*Micropterus punctatus*), largemouth bass (*Micropterus salmoides*), white crappie (*Pomoxis annularis*), black crappie (*Pomoxis nigromaculatus*), yellow perch (*Perca flavescens*), and walleye *(Stizostedion vitreum*). Native piscivorous species of fish are also present including blue catfish (*Ictalurus furcatus*), and bluegill (*Lepomis macrochirus*). All of these fish may pose a predation threat to *H. amarus*. These interspecific interactions may be increased during periods of low flows (Power, et al. 1985).

Table 1. Experimental stockings and translocation of Rio Grande silvery minnow (*Hybognathus amarus*) in the middle Rio Grande, New Mexico, 1996-2000. For Age; L=larval, J=juvenile, A=adult. For Source; S=salvaged, WCS=spawn from wild-caught adults, WCE=reared from wild caught eggs, SWCA=spawned wild-caught adults. For Reach; ANG=Angostura, ISL=Isleta.

Date	Number Released	Age	Source[a]	Reach	Site
May 1996	10,000	A/J	S	ANG	Corrales
July 1998	200	J	S	ANG	Bernalillo
April 1999	819	A	S	ANG	Alameda Bridge
5 May 2000	58	A	SWCA	ANG	Bernalillo
9 May 2000	24,600	L	WCS	ANG	Bernalillo
11 May 2000	22	A	SWCA	ANG	Bernalillo
15 May 2000	20	A	SWCA	ANG	Bernalillo
23 May 2000	31,000	L	WCS	ANG	Bernalillo
30 May 2000	104	A	SWCA	ANG	Bernalillo
2 June 2000	36,000	L	WCS	ANG	Bernalillo
2 June 2000	36,000	L	WCS	ISL	Los Lunas
6 June 2000	210	A	SWCA	ISL	Los Lunas
9 June 2000	76,000	L	WCS	ISL	Los Lunas
21 July 2000	2,108	L	WCS	ANG	Alameda Bridge
21 July 2000	1,323	L	WCE	ANG	Alameda Bridge
21 July 2000	53	A	SWCA	ANG	Alameda Bridge
Total	**218,517**				

a = All wild-caught fish were originally captured in the San Acacia Reach.

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