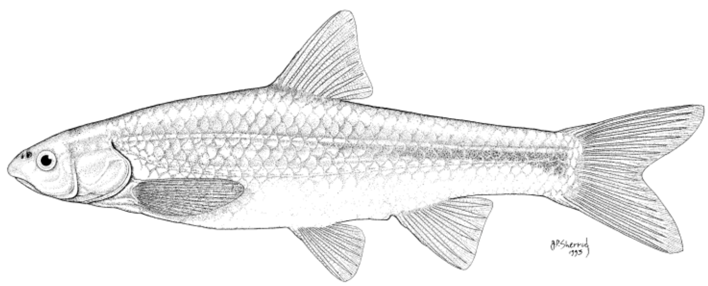
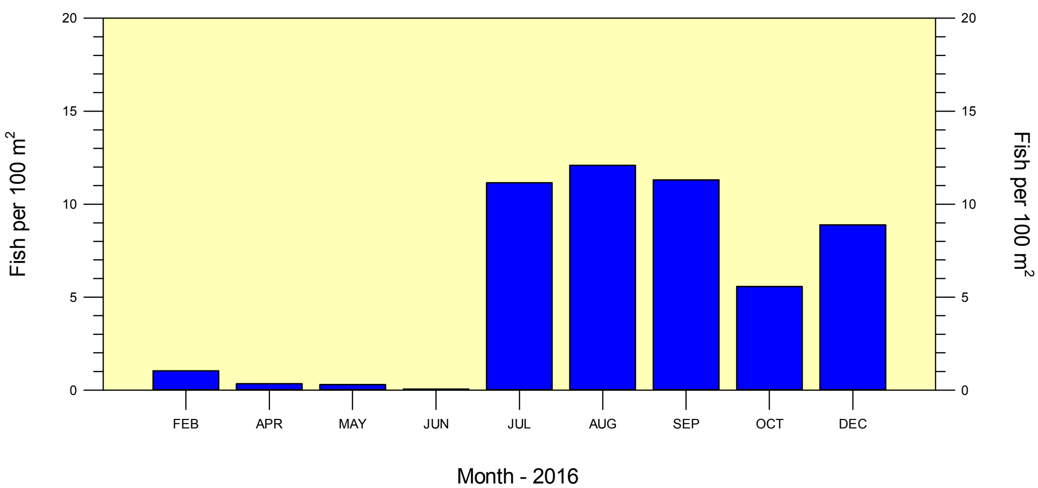
RIO GRANDE SILVERY MINNOW POPULATION MONITORING RESULTS FROM FEBRUARY TO DECEMBER 2016

A MIDDLE RIO GRANDE ENDANGERED SPECIES COLLABORATIVE PROGRAM FUNDED RESEARCH PROJECT





Robert K. Dudley[1], Steven P. Platania[1], and Gary C. White[1,2]

[1] American Southwest Ichthyological Researchers, L.L.C.
800 Encino Place NE; Albuquerque, NM 87102-2606
&
[2] Department of Fish, Wildlife, and Conservation Biology
239 Wagar; Colorado State University; Fort Collins, CO 80523-1474

28 April 2017

RIO GRANDE SILVERY MINNOW POPULATION MONITORING RESULTS FROM FEBRUARY TO DECEMBER 2016

A MIDDLE RIO GRANDE ENDANGERED SPECIES COLLABORATIVE PROGRAM FUNDED RESEARCH PROJECT

Contract GS-10F-0249X:

Order R15PD00171
U.S. Bureau of Reclamation
Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque, NM 87102-2352

submitted to:

U.S. Bureau of Reclamation
Albuquerque Area Office
555 Broadway NE, Suite 100
Albuquerque, NM 87102-2352

Robert K. Dudley[1], Steven P. Platania[1], and Gary C. White[1,2]

[1] American Southwest Ichthyological Researchers, L.L.C.
800 Encino Place NE; Albuquerque, NM 87102-2606
&
[2] Department of Fish, Wildlife, and Conservation Biology
239 Wagar; Colorado State University; Fort Collins, CO 80523-1474

28 April 2017

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The population status of Rio Grande Silvery Minnow and the associated Middle Rio Grande ichthyofaunal community has been systematically monitored since 1993. This effort is unique among ichthyofaunal research studies in the Middle Rio Grande in that it has been providing consistent sampling of fishes over a long duration. Long-term sampling studies also provide the data necessary to test specific ecological hypotheses. Thus, our primary research objective was to evaluate how seasonal and annual changes in river flows affect the distribution and abundance of Rio Grande Silvery Minnow throughout its current range.

The occurrence and density of this imperiled species has fluctuated widely over the past two decades (1993–2016). Its estimated density ($E(x)$; fish per 100 m^2), using October data, was highest in 2005 (44.84) but remained very low (< 0.20) from 2012 to 2015. While estimated densities were notably lower from 2010 to 2015 as compared with 2007 to 2009, there was a marked improvement in 2016. Population monitoring efforts in 2016 revealed a marked increase in density ($E(x)$ = 7.20), which was over 10 times higher than in 2015 and over 100 times higher than in 2013. While Rio Grande Silvery Minnow represented only 0.91% of the total fish community in 2015, it had increased to 20.87% by 2016.

Ecological models revealed that changes in the density and occurrence of Rio Grande Silvery Minnow were reliably predicted by seasonal differences in river flows across years. ***Further, our findings were consistent regardless of whether dry sampling sites were or were not included in the analyses (see Introduction).*** Out of 441 models considered, we found that extended high flows during spring were crucial (i.e., > 90% of model weight) in explaining why some years had dramatically elevated densities of Rio Grande Silvery Minnow. In contrast, we found that extended low flows during summer were key to explaining changes in the occurrence of this species across years. Thus, prolonged high flows during spring were most predictive of increased density and prolonged low flows during summer were most predictive of decreased occurrence of Rio Grande Silvery Minnow over the study period.

Additional analyses revealed that population trends in different mesohabitats (October [2002–2016]), or on different days during repeated sampling (November [2005–2016]), were remarkably similar to population trends obtained from the long-term dataset (October [1993–2016]). These results suggest that the current sampling protocols are resulting in a reliable level of sampling precision and population trend consistency, especially when considering the substantial changes in both the occurrence and abundance of Rio Grande Silvery Minnow over time. Also, the variance in estimated densities was consistently highest across years (77.01), followed distantly by sampling site (2.56), river reach (0.76), and sampling day (0.00). Thus, changes in the density and occurrence of Rio Grande Silvery Minnow were much more strongly related to seasonal flow conditions across years than to subtleties in local sampling conditions (e.g., mesohabitats, sites, reaches, or sampling days).

Site occupancy models lend further support to these findings. We found that Rio Grande Silvery Minnow occupancy probabilities declined progressively from 2010 to 2013 before increasing markedly from 2014 to 2016. While estimated extinction probabilities were highly elevated during recent drought years (i.e., 2012–2013), they have decreased substantially since 2014 as seasonal river flows have progressively improved. Likewise, estimated colonization probabilities for this species increased considerably in recent years (2014–2016). While the balance of estimated extinction and colonization probabilities from 2015–2016 was still not as favorable as it was during the earliest years of the site occupancy study (2005–2009), the conservation status of Rio Grande Silvery Minnow showed encouraging signs of improvement from 2014 to 2016.

Pronounced changes in the occurrence and abundance of Rio Grande Silvery Minnow over the past two decades appear to be closely related to the duration, magnitude, and timing of river flows during spring and summer. Prolonged and elevated spring flows result in overbank flooding of vegetated areas, formation of inundated habitats within the river channel, and creation of shoreline pools and backwaters; these habitats are characterized by low-velocity, warm, and productive waters. The early life history of this species ensures that its propagules (drifting eggs and larvae) are rapidly dispersed throughout these habitats when spring flows begin to rise. These conditions, combined with the delayed onset of low flows following spring runoff, help ensure the persistence of these nursery habitats that are required for successful growth, survival, and recruitment of newly spawned Rio Grande Silvery Minnow. As growth

from the egg through the vulnerable early larval stages (i.e., protolarvae and mesolarvae) requires about one month, the longer-term persistence of these habitats is essential to help ensure the successful recruitment of young to later life stages (i.e., metalarvae and juveniles).

Further, the occurrence and density of this species is consistently highest in the downstream-most reaches of the Middle Rio Grande. This pattern has persisted over time even though upstream reaches have been regularly augmented with large numbers of hatchery-reared fish. One explanation for this pattern is the cumulative downstream transport of propagules (drifting eggs and larvae) past instream barriers over time. Also, river channelization, habitat degradation, abandonment of the floodplain, and reductions in suspended sediments downstream of Cochiti Dam are likely limiting the amount of appropriate habitat available for the successful retention and recruitment of early life stages, especially in the Cochiti and Angostura reaches. While it is evident that seasonally elevated flows, combined with habitat restoration, should lead to increased recruitment success, the long-term efficacy of these efforts will also depend on assuring their utility and permanence by restoring a more dynamic flow regime and reestablishing river connectivity across select fragmented reaches.

While extensive management efforts over the past two decades have provided invaluable protection against the extinction of Rio Grande Silvery Minnow in the wild, continued and ongoing efforts (e.g., restoring dynamic river flows, reconnecting fragmented reaches, and reestablishing a functional floodplain) should help to promote resilient and self-sustaining populations over time. Encouragingly, both the occurrence and abundance of this imperiled species increased markedly in 2015 and 2016, as compared with recent drought years (2012–2014), following notably improved spring and summer flow conditions. Continued efforts to provide reasonable spring spawning and summer survival conditions, even if at threshold levels during consecutive drought years, will be essential for securing a self-sustaining population in the Middle Rio Grande. Additionally, the reestablishment of resilient populations of this species at other locations within its historical range would help to further ensure its long-term persistence in the wild. Future study of the relationships among fish species and seasonal river flows in the Rio Grande Basin should continue to elucidate key factors that control this complex aquatic ecosystem, which will be essential for developing and implementing successful management strategies for the long-term recovery of Rio Grande Silvery Minnow.

INTRODUCTION

Population data on Rio Grande Silvery Minnow and the associated ichthyofaunal community in the Middle Rio Grande (Rio Grande between Velarde, New Mexico and Elephant Butte Reservoir) have been gathered since 1987. Platania (1993a) conducted the first studies (1987–1992) to determine spatial and temporal changes in the Middle Rio Grande ichthyofaunal community and to provide resolution of species-specific habitat use patterns. An additional purpose of those preliminary studies was to provide information on the conservation status of Rio Grande Silvery Minnow. Sampling efforts during 1989 and 1990 revealed that Rio Grande Silvery Minnow population numbers had declined markedly since 1987 (Platania, 1993a). Based on previous samples, reduced numbers of individuals indicated a rapid decline of this species across its already reduced range. The 90–95% reduction in the range of Rio Grande Silvery Minnow and threats to its continued persistence in the Middle Rio Grande were central to this species being listed as endangered by the U.S. Fish and Wildlife Service (U.S. Department of Interior, 1994).

From 1993 until the present, the U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, New Mexico Department of Game and Fish, and U.S. Army Corps of Engineers have cooperated to fund numerous studies of the Middle Rio Grande ichthyofauna. Among those studies was the long-term systematic monitoring of the Middle Rio Grande fish community at numerous sites between Angostura Diversion Dam and Elephant Butte Reservoir. Population monitoring efforts have documented wide fluctuations (i.e., order of magnitude increases and decreases) in the abundance of Rio Grande Silvery Minnow over the past two decades. The abundance of this species has generally decreased during years with low spring discharge combined with prolonged summer low-flow/drying conditions but has generally increased following years with extended high spring flows and minimal summer low-flow/drying conditions (Dudley et al., 2009; Dudley et al., 2016a). While Rio Grande Silvery Minnow was the focus of monitoring efforts and subsequent hypothesis testing, research activities also provided information about the associated Middle Rio Grande fish community.

Based on recent recommendations (Hubert et al., 2016), we have added new text, tables, figures, and analyses to this report. While this was not required for the 2016 annual report, we decided to provide some of this information in advance so that members of the Collaborative Program could review these updates prior to additional changes that are anticipated in 2017. Key changes to the text, tables, figures, and analyses are highlighted in bold-italic font throughout the report.

The primary objective of the February to December 2016 sampling activities was to monitor temporal trends in the abundance of Rio Grande Silvery Minnow at 20 standardized sites throughout the Middle Rio Grande and evaluate how those trends were affected by changes in annual discharge patterns. Additional objectives included determining general habitat use patterns, documenting changes in relative abundance among native and nonnative fish species, determining variation in density estimates based on repeated sampling, and evaluating changes in site occupancy status across years. Seasonal and spatial differences in the population structure and abundance of native and nonnative Middle Rio Grande fishes were also examined. This study should aid natural resource managers in obtaining a more thorough understanding of the factors that influence the conservation status and population dynamics of Rio Grande Silvery Minnow, both of which are important components for the recovery of this species.

STUDY AREA

The headwaters of the Rio Grande are located in the San Juan Mountains of southern Colorado. The mainstem Rio Grande flows 750 km through New Mexico, draining an area of about 68,104 km^2 (excluding closed basins). The Rio Chama is the only major perennial tributary of the Rio Grande in New Mexico and confluences with it near the city of Española. Snowmelt from southern Colorado and northern New Mexico yields the majority of water for the Rio Grande, but transmontane diversions from the San Juan River (Colorado River Basin) supplement flow by providing water in route to downstream municipalities. The highest flow in the Rio Grande generally occurs shortly after spring snowmelt, while the lowest flow usually occurs in late summer and early autumn prior to the cessation of irrigation season (October 31). Summer rainstorms periodically augment low flows in discrete reaches but do not ensure that the river channel will remain wetted in its entirety.

Several large dams on the Rio Chama and Rio Grande, along with numerous smaller irrigation diversion dams, regulate flow in the Middle Rio Grande. A complex system of ditches, drains, and conveyance channels provides water for irrigated agriculture in the Rio Grande Valley. Cochiti Dam is the primary flood control structure that regulates discharge in the mainstem Middle Rio Grande. The construction and operation of Cochiti Dam has contributed to floodplain abandonment along with the progressive degradation, armoring, and narrowing of the river channel, particularly in areas up to about 100 km downstream of the dam (Lagasse, 1980; Massong et al., 2006).

The study area (Figure 1) is a portion of the Middle Rio Grande, from Angostura Diversion Dam to the inflow of Elephant Butte Reservoir, which encompasses most of the current range of Rio Grande Silvery Minnow (i.e., below Cochiti Dam [although additional study is required to determine if Rio Grande Silvery Minnow still persists upstream of Angostura Diversion Dam] to the inflow of Elephant Butte Reservoir). The Cochiti Reach of the Rio Grande (between Cochiti Dam and Angostura Diversion Dam) passes first through Cochiti Pueblo, then Santo Domingo Pueblo, and finally San Felipe Pueblo. The last comprehensive ichthyofaunal surveys of the Rio Grande in the Cochiti Reach documented the presence, at low abundance, of Rio Grande Silvery Minnow on Santo Domingo and San Felipe pueblos (Platania, 1995a) and its absence on Cochiti Pueblo (Platania, 1993b). While our current study does not include sampling sites within these pueblos, or the pueblos of Sandia or Isleta, the U.S. Fish and Wildlife Service conducts ongoing fish monitoring efforts in some of these areas (Archdeacon and Austring, 2016).

Reach names were derived from the diversion dam structure at the upper portion of each fragmented reach. The Angostura Reach had five sampling sites and the Isleta Reach had six sampling sites. There were nine sampling sites in the San Acacia Reach. The 20 sampling sites in the Middle Rio Grande (Appendix A) overlap the current documented range of Rio Grande Silvery Minnow.

Most of the sampling localities were selected from a list of nearly 100 Middle Rio Grande sites, which were sampled from 1987 to 1992 (Platania, 1993a); these localities have been sampled consistently since 1993. Site locations were chosen based on spatial distribution, site accessibility, relative permanence of flow (or deep pools during drought), and the presence of reasonably adequate instream habitat. While most sites have been consistently monitored over time, several localities were added (e.g., to increase the spatial coverage within or among reaches [Dudley and Platania, 1998; Dudley and Platania, 1999; Dudley and Platania, 2002]) or removed (e.g., loss of consistent land access [Dudley and Platania, 1999]).

Diel and seasonal discharge varied greatly during 2015 and 2016, especially in southern reaches of the Middle Rio Grande (Figure 2). There was a general trend of lower flow at downstream locations (e.g., U.S. Geological Survey (USGS) San Acacia Gage [#08354900] and USGS San Marcial Gage [#08358400]) compared to upstream locations (e.g., USGS Albuquerque Gage [#08330000]). During May and June 2016, flows peaked several times throughout the study area. Maximum flows in 2016 occurred during June. Flow conditions in 2015 and 2016 included periods of very low discharge from July through October, which were occasionally interrupted by elevated flows from monsoonal rains. As compared to the generalized historical spring runoff (based on mean daily discharge values from 1973 [Cochiti Dam operational] to 2016), the timing of runoff was typical in 2015 and somewhat delayed in 2016. While spring flow magnitude was low in 2015 and modest in 2016, the elevated flow duration was notably longer in 2016.

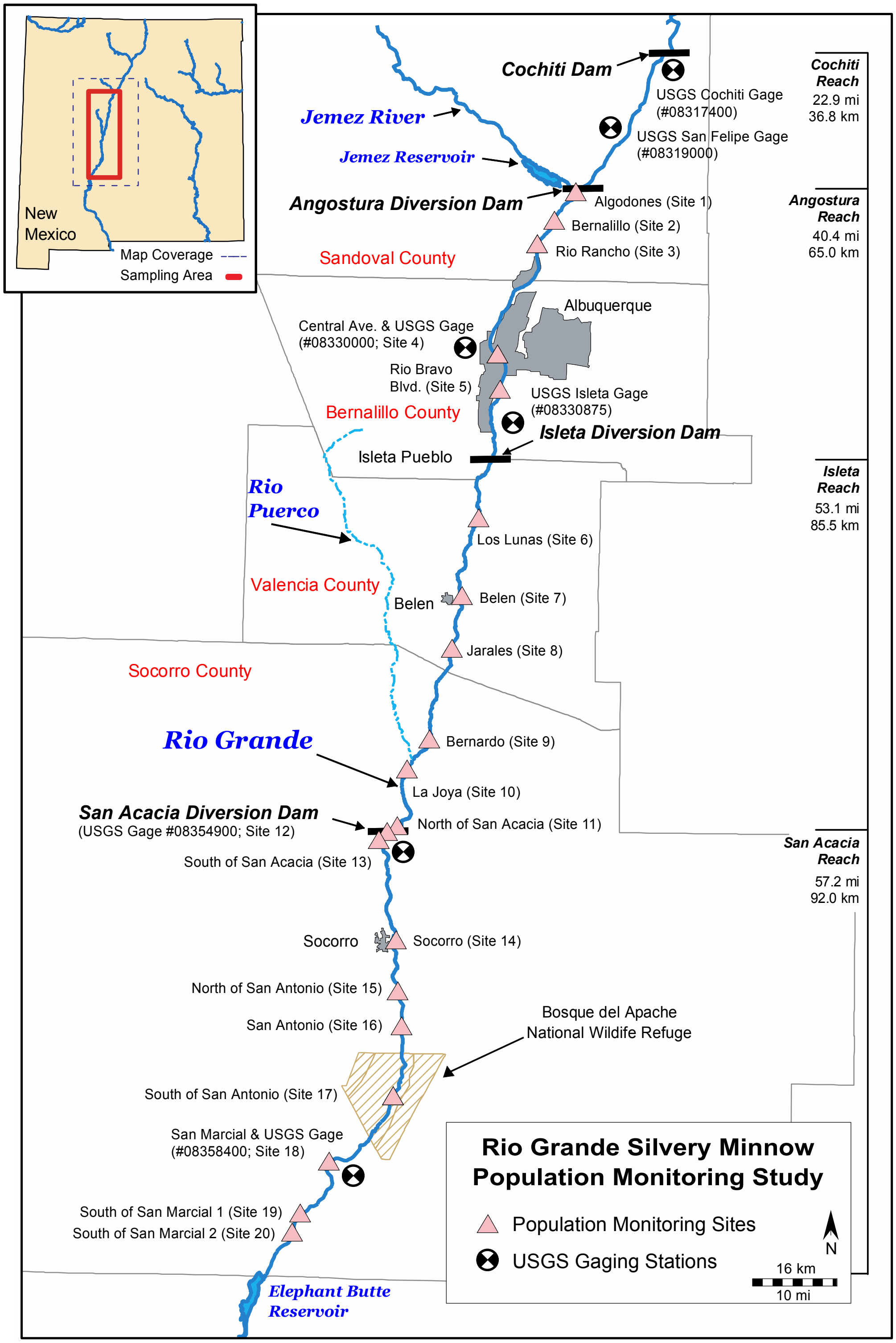


Figure 1. Map of the study area and sampling sites (numbered) for the Rio Grande Silvery Minnow population monitoring study. Sampling site descriptions are located in Appendix A.

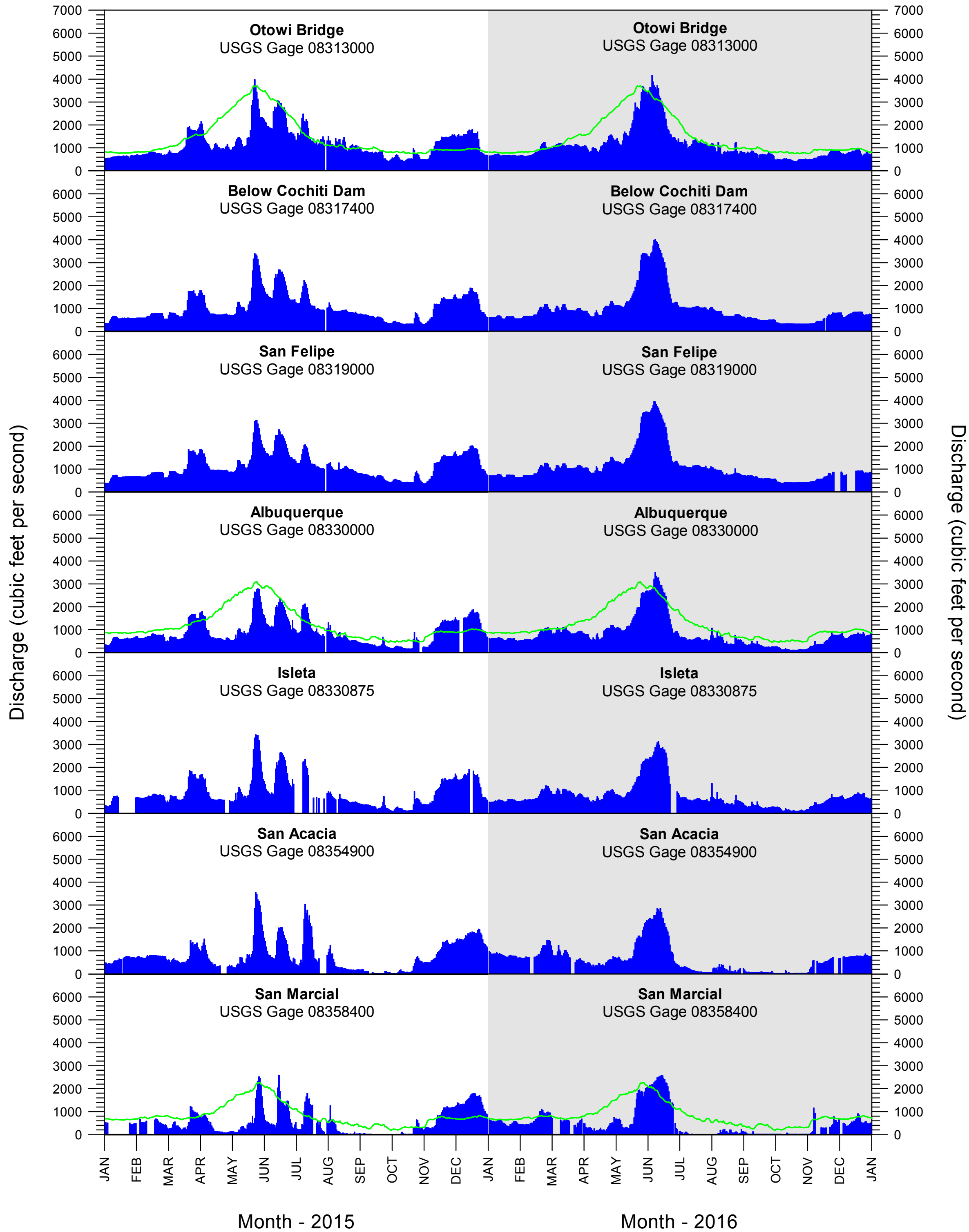


Figure 2. Rio Grande discharge from January 2015 through December 2016 at U.S. Geological Survey (USGS) gaging stations. Green lines are historical mean daily discharge values (from 1973 to 2016). Discharge data are provisional and subject to change.

MATERIALS AND METHODS

This investigation was structured to monitor the population of Rio Grande Silvery Minnow and the associated fish community in the study area over time. Monthly sampling efforts at 20 sites in 2016 allowed for ongoing determination of general spatial and temporal changes in population structure and species abundance since 1993. Sampling was conducted in February, monthly from April to October, and in December. Repeated sampling, across multiple sampling occasions, was conducted during November to estimate site occupancy rates (Appendix B) and to characterize sampling variation.

Fish were collected by rapidly drawing a two-person 3.1 m x 1.8 m small-mesh seine (ca. 5 mm) through 18 (April–October) to 20 (February and December) discrete mesohabitats (< 15 m long). Runs were sampled four times at each site, as were shoreline pools (when available); backwaters, pools, and riffles were sampled two times (when available); any remaining samples (to obtain a total of 18 to 20) were taken in shoreline runs. From April to October, a 1.0 m x 1.0 m fine-mesh seine (ca. 1.5 mm) was used to selectively sample shallow low velocity mesohabitats for larval fish (two samples/site). Mesohabitats with similar conditions, which did not exceed reasonable depths/velocities for efficient seining, were sampled regardless of flow conditions. Selected water quality parameters (Secchi depth, water temperature, salinity, dissolved oxygen, true conductivity, specific conductance, and pH) were recorded at each site (Appendix C), along with digital photographs of physical river conditions.

Fish were briefly handled for identification and enumeration purposes, kept in a submerged mesh enclosure (ca. 5 mm) during sampling, and released after sampling was completed. During November repeated sampling, fish were released after each seine haul to avoid disturbing the site for subsequent daily sampling efforts. All Rio Grande Silvery Minnow collected were examined for Visible Implant Elastomer (VIE) tags (i.e., stocked fish), measured (standard length (mm)), and identified to age-class (based on age-length relationships by reach during the same time of year [Dudley et al., 2009; Horwitz et al., 2011]). Standard length was measured because of its wide acceptance in taxonomic studies, and because it is reliable even when the caudal fin is malformed or damaged (Jennings et al., 2012). While field measures of Rio Grande Silvery Minnow total length (TL) are generally less reliable than standard length (SL), TL can be derived from SL based on a highly predictable equation (TL = 1.24(SL) + 2.27; R^2 = 0.98; n = 475; unpublished data).

Rio Grande Silvery Minnow with VIE tags were not included in data analyses of long-term population or occupancy trends but were included in the 2016 summary tables and figures. Fish too small to be accurately identified to species in the field (e.g., larval fish) were fixed in 5% buffered formalin and returned to the laboratory for processing and identification. Scientific names and common names (phylogenetic order) of fishes in this report follow Page et al. (2013; Table 1).

Density (catch-per-unit-effort [CPUE]) was computed, for each site, by dividing the total number of individuals by the total area sampled, multiplied by 100 (i.e., fish per 100 m^2). Effort was calculated by multiplying the seine width during sampling (regular = 2.5 m, larval = 0.75 m) by the length of the seine haul. ***Based on recent recommendations (Hubert et al., 2016), densities of larval fish included data from only the fine-mesh seine (ca. 1.5 mm), and densities of age-0 and age-1+ fish included data from only the small-mesh seine (ca. 5 mm). However, this change will not affect our previous results from October (1993–2015), because larval fish have never been included in that dataset.***

Mixture models (e.g., combining a binomial distribution with a lognormal distribution) have been shown to be particularly effective for modeling ecological data with multiple zeros (White, 1978; Welsh et al., 1996; Fletcher et al., 2005; Martin et al., 2005). Long-term Rio Grande Silvery Minnow sampling-site density data during October (1993–2016) were analyzed using PROC NLMIXED (SAS, 2016), a robust numerical optimization procedure similar to PROC FMM, by fitting a mixture model consisting of the binomial and lognormal distributions using the methods outlined in White (1978). ***Based on recent recommendations (Hubert et al., 2016), analyses were conducted on the full dataset and on a portion of the dataset that excluded all dry sampling sites.*** Logistic regression was used to model the probability a site was occupied, and the lognormal model was used to model the distribution of abundance given that the site was occupied. Models provided four parameter estimates for each year (δ = probability of occurrence, μ = mean of the lognormal density distribution, σ = standard deviation of the lognormal density distribution, and $E(x)$ = estimated density). Simple estimates of mean densities, using the method of moments (Zar, 2010), were added as a reference to applicable figures.

Table 1. Scientific names, common names, and species codes of fish collected in the Middle Rio Grande since 1993.

Scientific Name	Common Name	Species Code
Order Clupeiformes		
Family Clupeidae	**herrings**	
Dorosoma cepedianum	Gizzard Shad	(DORCEP)
Dorosoma petenense	Threadfin Shad	(DORPET)
Order Cypriniformes		
Family Cyprinidae	**carps and minnows**	
Campostoma anomalum	Central Stoneroller	(CAMANO)
Carassius auratus	Goldfish	(CARAUR)
Cyprinella lutrensis	Red Shiner[1]	(CYPLUT)
Cyprinus carpio	Common Carp[1]	(CYPCAR)
Gila pandora	Rio Grande Chub	(GILPAN)
Hybognathus amarus	Rio Grande Silvery Minnow[1]	(HYBAMA)
Notemigonus crysoleucas	Golden Shiner	(NOTCRY)
Pimephales promelas	Fathead Minnow[1]	(PIMPRO)
Pimephales vigilax	Bullhead Minnow	(PIMVIG)
Platygobio gracilis	Flathead Chub[1]	(PLAGRA)
Rhinichthys cataractae	Longnose Dace[1]	(RHICAT)
Family Catostomidae	**suckers**	
Carpiodes carpio	River Carpsucker[1]	(CARCAR)
Catostomus commersonii	White Sucker[1]	(CATCOM)
Ictiobus bubalus	Smallmouth Buffalo	(ICTBUB)
Order Siluriformes		
Family Ictaluridae	**North American catfishes**	
Ameiurus melas	Black Bullhead	(AMEMEL)
Ameiurus natalis	Yellow Bullhead	(AMENAT)
Ictalurus furcatus	Blue Catfish	(ICTFUR)
Ictalurus punctatus	Channel Catfish[1]	(ICTPUN)
Pylodictis olivaris	Flathead Catfish	(PYLOLI)
Order Salmoniformes		
Family Salmonidae	**trouts and salmons**	
Oncorhynchus mykiss	Rainbow Trout	(ONCMYK)
Salmo trutta	Brown Trout	(SALTRU)
Order Cyprinodontiformes		
Family Poeciliidae	**livebearers**	
Gambusia affinis	Western Mosquitofish[1]	(GAMAFF)

Table 1. Scientific names, common names, and species codes of fish collected in the Middle Rio Grande since 1993 (continued).

Scientific Name	Common Name	Species Code
Order Perciformes		
Family Moronidae	**temperate basses**	
Morone chrysops	White Bass	(MORCHR)
Morone saxatilis	Striped Bass	(MORSAX)
Family Centrarchidae	**sunfishes**	
Lepomis cyanellus	Green Sunfish	(LEPCYA)
Lepomis macrochirus	Bluegill	(LEPMAC)
Lepomis megalotis	Longear Sunfish	(LEPMEG)
Micropterus dolomieu	Smallmouth Bass	(MICDOL)
Micropterus salmoides	Largemouth Bass	(MICSAL)
Pomoxis annularis	White Crappie	(POMANN)
Pomoxis nigromaculatus	Black Crappie	(POMNIG)
Family Percidae	**perches**	
Perca flavescens	Yellow Perch	(PERFLA)
Percina macrolepida	Bigscale Logperch	(PERMAC)
Sander vitreus	Walleye	(SANVIT)

[1] = Focal taxa were the most abundant species from recent Middle Rio Grande collections.

General linear models were used to incorporate covariates to model δ, μ, and σ where a logit link was used for δ and log links were used for μ and σ. In the simplest case with no covariates and no random effects, this model can be considered a zero-inflated lognormal model for density. In all analyses, a categorical covariate for sampling year (Year) was included in a model to represent the maximum variation attributable to time effects. As no other time-effects model can explain all the variation, the Year (or global) model represents the upper limit on the amount of explainable variation and the null model represents the lower limit of that variation. Additionally, all hydrological covariates (e.g., spring and summer flows) varied across Year and were assessed individually as to their effectiveness in explaining the total time-specific variation.

Covariates considered for modeling October sampling-site density data (1993–2016) included Year and various hydrological variables at USGS Gages (#08330000 [ABQ; Rio Grande at Albuquerque, NM] and #08358400 [SAN; Rio Grande Floodway at San Marcial, NM]). The upstream gage was chosen to represent prolonged high flows during spring, whereas the downstream gage was chosen to represent prolonged low flows during summer. Maximum discharge (ABQmax) and days exceeding threshold discharge values in 1,000 cfs increments (days > 1,000 [ABQ>1,000], 2,000 [ABQ>2,000], and 3,000 [ABQ>3,000] cubic feet per second, cfs) were covariates that represented different spring runoff conditions (May–June). ***A modeled covariate (Inundation), that represented the total estimated inundation of the river channel and floodplain, was based on an average of the five peak flow days in May (U.S. Army Corps of Engineers, 2010); models of recent conditions (2000–2009) were used to estimate inundation since 2010.*** The onset of lower flows (i.e., first day with discharge < 200 cfs after 1 June [SAN1stday<200]), mean daily discharge (SANmean), and lower threshold discharge values (days < 200 [SAN<200] and < 100 [SAN<100] cfs) were covariates that represented different low flow conditions during irrigation season (March–October). Fixed-effects models for each covariate were linear models ($\beta_0 + \beta_1 \times$ covariate) with the corresponding link function. These fixed effects assume that variation in the data is explained by the covariate. For δ, there is no over-dispersion or extra-binomial variation, and for μ, no extra variation provided beyond the constant σ model. Random-effects models (*R*) were also considered for δ and μ to provide additional variation around the fitted line where a normally distributed random error with mean zero and non-zero standard deviation is used to explain deviations around the fitted covariate. Random effects were integrated out of the likelihood (see Pinheiro and Bates, 1995) during fitting of the model.

Goodness-of-fit statistics (logLike = -2[log-likelihood] and AIC_c = Akaike's information criterion [Akaike, 1973] for finite sample sizes) were generated to assess the relative fit of data to various models across all years sampled. Lower values of AIC_c indicate a better fit of the data to the model. Models were ranked by AIC_c values and the top ten models, based on AIC_c weight (w_i), were presented. As environmental covariates were only used to model a single parameter (δ or μ), potential issues of multicollinearity were avoided. Further, AIC_c model selection ranks single-variable models appropriately even if variables are highly correlated (i.e., resulting w_i values would be similar). For nested models, an analysis of deviance (ANODEV) was used to determine the proportion of deviance (i.e., similar in concept to an R^2 value) explained by the covariates for both the δ and μ models and to assess the significance ($P < 0.05$) of those values based on an *F*-test (Skalski et al., 1993).

Rio Grande Silvery Minnow detailed density data during October (i.e., using mesohabitat-specific density data from each site), have been available since 2002. Mesohabitats were simplified (i.e., combining main and side channel samples, coding debris piles as pools, and coding riffles as runs) and classified using channel-unit definitions (Armantrout, 1998) for the purpose of statistical analyses (backwaters [BW], pools [PO], runs [RU], shoreline pools [SHPO], and shoreline runs [SHRU]). The sampling unit for this analysis was mesohabitat (e.g., all shoreline run samples combined for each site), whereas the sampling unit for the long-term analysis (1993–2016) was site (e.g., all mesohabitat samples combined for each site). For example, SHRU density at Site 1 was computed based on the total number of individuals by the total area sampled in SHRU mesohabitats at that site. Rio Grande Silvery Minnow mesohabitat-specific density data recorded at all sampling sites from October (2002–2016) were analyzed using PROC NLMIXED (SAS, 2016), using the same methods outlined previously, to generate parameter estimates and assess differences among models. Categorical covariates considered to model mesohabitat-specific density data during October were Year, mesohabitat (Mesohabitat), and reach

(Reach). Both additive and multiplicative effects were considered for single combinations of the year covariate (e.g., Year+Mesohabitat and Year*Mesohabitat, respectively).

Sampling variation was evaluated using sampling-site density data from the repeated sampling efforts at each of the 20 sites during November (2005–2016). For the repeated sampling effort, sites were sampled once per day for four days, using regular population monitoring sampling protocols. The locations of all samples were flagged on the first day, and additional samples were taken at the same or similar locations on subsequent days. Sampling-site density data, from repeated sampling efforts, were analyzed using PROC NLMIXED (SAS, 2016), using the same methods outlined previously, to generate parameter estimates and assess differences among models. Categorical covariates considered to model sampling-site density data during November were Year, Reach, and sampling occasion (Occasion; the 1st, 2nd, 3rd, or 4th day of sampling). Both additive and multiplicative effects were considered for single combinations of the year covariate (e.g., Year+Occasion and Year*Occasion). A variance components model was used to assess the level of variance in estimated densities that could be attributed to Year, Reach, Occasion, and sampling site (Site). Residual maximum likelihood estimation (i.e., REML) was used to estimate the different variance components of the model parameters using PROC VARCOMP (SAS, 2016).

Kendall's *W* (Zar, 2010) was used to test for the degree of concordance among the annual rank abundance of 10 focal species, including Rio Grande Silvery Minnow, over time. This nonparametric statistical procedure was used to generate the *W* statistic, which ranges from zero (no concordance) to one (complete concordance). A Chi-Square statistic was calculated to evaluate whether the concordance (W) was significantly different ($P < 0.05$) from zero.

RESULTS

Rio Grande Silvery Minnow

Current population status

The abundance of Rio Grande Silvery Minnow (all age-classes combined), from February to December 2016, varied widely across reaches, sites, and months (Table 2). ***Densities of larval Rio Grande Silvery Minnow increased following spring spawning, reaching their highest levels in June (Angostura and Isleta) or July (San Acacia), but dropped several orders of magnitude later in the year (Figure 3). Post-spawning densities of age-0 individuals (non-larval) were modest in all three sampling reaches throughout the summer, and peak densities in different reaches occurred during different months (Figure 4). The densities of age-1+ fish, however, were persistently low for all three reaches throughout 2016 (Figure 5). Overall densities of juvenile and adult Rio Grande Silvery Minnow (age-0 and age-1+ combined), from February to December 2016, were generally highest in the Isleta Reach (Figure 6). The Isleta Reach yielded the most individuals (n = 2,296), followed by the San Acacia Reach (n = 1,703), and the Angostura Reach (n = 1,134).***

Population trends (1993–2016)

Rio Grande Silvery Minnow estimated densities ($E(x)$), using October sampling-site density data (1993–2016), were generated from the year model (δ[Year] μ[Year]). The estimated densities of Rio Grande Silvery Minnow were notably lower from 2010 to 2015 as compared with 2007 to 2009, but there was a notable increase in 2016 (Figure 7). Estimated density could not be computed in 2003 since there was only a single non-zero value recorded, which precluded mixture-model estimation of σ. October population monitoring efforts in 2016 revealed a significant increase in density ($E(x) = 7.20$), which was over 10 times higher than in 2015 ($E(x) = 0.16$; $P < 0.05$) and over 100 times higher than in 2013 ($E(x) = 0.03$; $P < 0.05$). Simple estimates of mean densities, using the method of moments, were very similar to estimated densities ($E(x)$). Combining a plot of daily discharge and $E(x)$ values (1993–2016) revealed a long-term recurrent pattern of increased densities during years with high spring runoff and decreased densities during years with low spring runoff (Figure 8). ***Estimates of E(x) increased with maximum discharge, number of days with discharge exceeding a threshold value, estimated inundation of the river channel and floodplain, delayed onset of low flows, and increased mean daily discharge (Figure 9: A–G). In contrast, there were negative relationships between the number of days with discharge below a certain threshold value (i.e., < 200 cfs and < 100 cfs) and estimates of E(x) (Figure 9: H–I).***

Rio Grande Silvery Minnow estimates of the probability of occurrence (δ) and the mean of the lognormal density distribution (μ), generated from the year model (δ[Year] μ[Year]), were also closely associated with hydrological variables over the period of study (1993–2016). Estimates of δ (Figure 10) exhibited positive relationships with variables representing higher spring flows but negative relationships with variables representing lower summer flows. Similar and consistent results were obtained for relationships between μ and the hydrological variables (Figure 11).

General linear models of Rio Grande Silvery Minnow mixture-model estimates revealed that variation in μ, as compared with variation in δ, was more reliably predicted by changes in hydrological variables over the period of study (1993–2016; Table 3). The top model (δ[Year] μ[ABQ>2,000+R]) received 62% of the AIC_c weight (w_i) out of the 441 models considered. This spring flow covariate accounted for 58% of the deviance (i.e., similar in concept to an R^2 value) explained by the μ(Year) model over the μ(Null) model ($P < 0.001$). The top three models, which accounted for most of the cumulative w_i (ca. 91%), were related to the interaction between μ and hydrological variables representing elevated spring flows in the Angostura Reach.

Table 2. Summary of the abundance of Rio Grande Silvery Minnow (all age-classes combined), by reach, site, and month (February–December), during 2016. Marked individuals are shown in parentheses.

Reach	Site	Locality	Feb	Apr	May	Jun	Jul	Aug	Sep	Oct	Dec	Total
Angostura	1	Angostura Dam	-	-	-	-	-	15(0)	-	-	-	15
Angostura	2	Bernalillo	-	1(0)	-	-	144(0)	199(0)	4(0)	2(0)	6(0)	356
Angostura	3	Rio Rancho	-	-	4(0)	209(0)	49(1)	21(0)	47(0)	13(0)	3(0)	346
Angostura	4	Central Ave.	-	4(0)	-	2(0)	207(0)	127(0)	82(0)	25(0)	260(1)	707
Angostura	5	Rio Bravo Blvd.	-	2(0)	-	42(0)	69(0)	105(0)	55(0)	39(0)	25(0)	337
Angostura Totals			*-*	*7*	*4*	*253*	*469*	*467*	*188*	*79*	*294*	*1,761*
Isleta	6	Los Lunas	-	-	8(1)	844(0)	410(0)	107(0)	71(0)	139(0)	59(0)	1,638
Isleta	7	Belen	3(1)	1(0)	2(0)	-	224(0)	59(0)	132(0)	15(0)	42(0)	478
Isleta	8	Jarales	2(1)	-	-	228(0)	21(0)	40(0)	5(0)	1(0)	102(0)	399
Isleta	9	Bernardo	6(1)	3(2)	3(2)	65(0)	138(0)	88(0)	12(0)	12(0)	37(0)	364
Isleta	10	La Joya	22(16)	1(0)	-	-	49(2)	83(0)	72(0)	28(0)	167(0)	422
Isleta	11	North of San Acacia	1(0)	-	-	-	275(0)	137(0)	31(0)	1(0)	64(0)	509
Isleta Totals			*34*	*5*	*13*	*1,137*	*1,117*	*514*	*323*	*196*	*471*	*3,810*
San Acacia	12	San Acacia Dam	1(1)	10(2)	-	-	5(1)	38(0)	162(0)	46(0)	1(0)	263
San Acacia	13	South of San Acacia	7(4)	4(1)	2(1)	3(0)	29(0)	82(0)	33(0)	9(0)	74(0)	243
San Acacia	14	Socorro	37(34)	1(1)	-	-	42(0)	60(0)	194(0)	85(0)	64(0)	483
San Acacia	15	North of San Antonio	6(4)	7(5)	1(1)	43(1)	218(2)	1(0)	105(0)	98(0)	27(0)	506
San Acacia	16	San Antonio	10(10)	-	-	-	162(0)	-	51(0)	50(0)	16(0)	289
San Acacia	17	South of San Antonio	3(2)	1(1)	5(4)	-	84(0)	-	11(0)	-	11(1)	115
San Acacia	18	San Marcial	1(0)	-	5(4)	1(1)	25(0)	48(0)	49(0)	14(0)	3(2)	146
San Acacia	19	South of San Marcial 1	14(13)	1(1)	2(2)	-	24(0)	10(0)	17(0)	5(0)	51(5)	124
San Acacia	20	South of San Marcial 2	7(5)	-	-	-	3(0)	2(0)	16(0)	2(0)	49(13)	79
San Acacia Totals			*86*	*24*	*15*	*47*	*592*	*241*	*638*	*309*	*296*	*2,248*
Monthly Totals			**120**	**36**	**32**	**1,437**	**2,178**	**1,222**	**1,149**	**584**	**1,061**	**7,819**

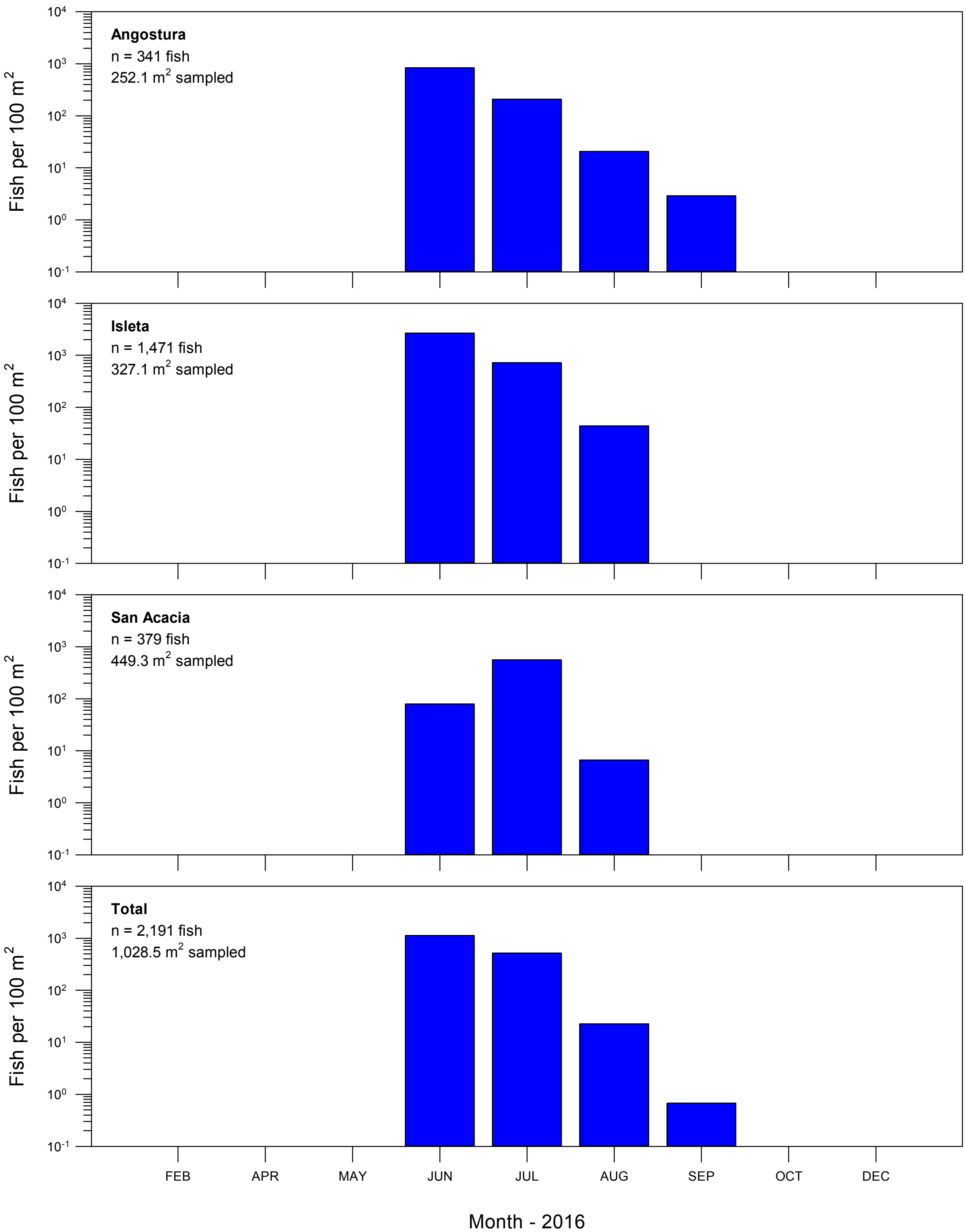


Figure 3. Rio Grande Silvery Minnow densities ***(larval fish only [fine-mesh seine])*** during 2016 for each sampling reach in the Middle Rio Grande. Note: the *y*-axis is logarithmic and larval sampling took place from April to October.

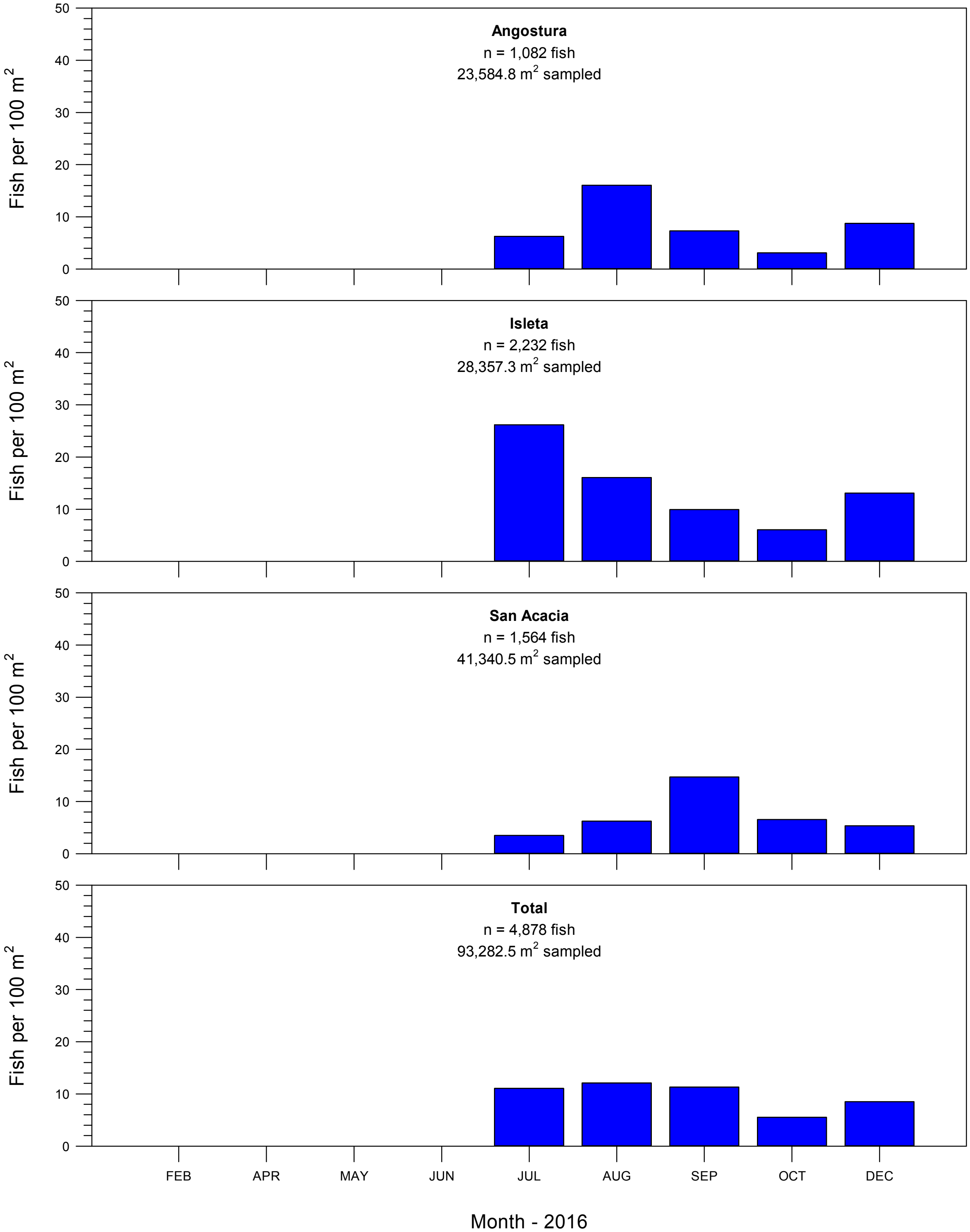


Figure 4. Rio Grande Silvery Minnow densities ***(age-0 fish only [small-mesh seine])*** from February to December 2016 for each sampling reach in the Middle Rio Grande. Note: all marked and unmarked individuals are included.

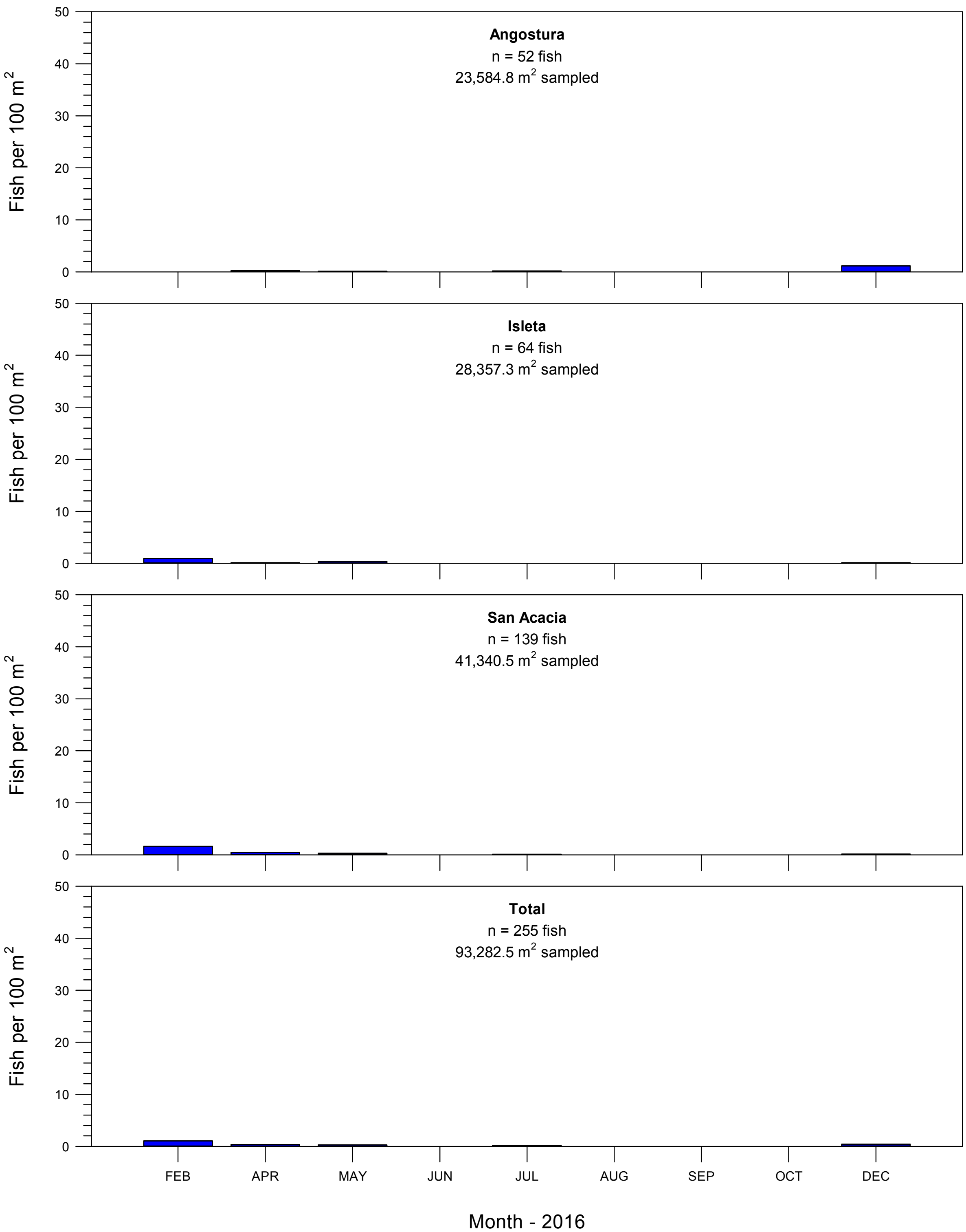


Figure 5. Rio Grande Silvery Minnow densities ***(age-1+ fish only [small-mesh seine])*** from February to December 2016 for each sampling reach in the Middle Rio Grande. Note: all marked and unmarked individuals are included.

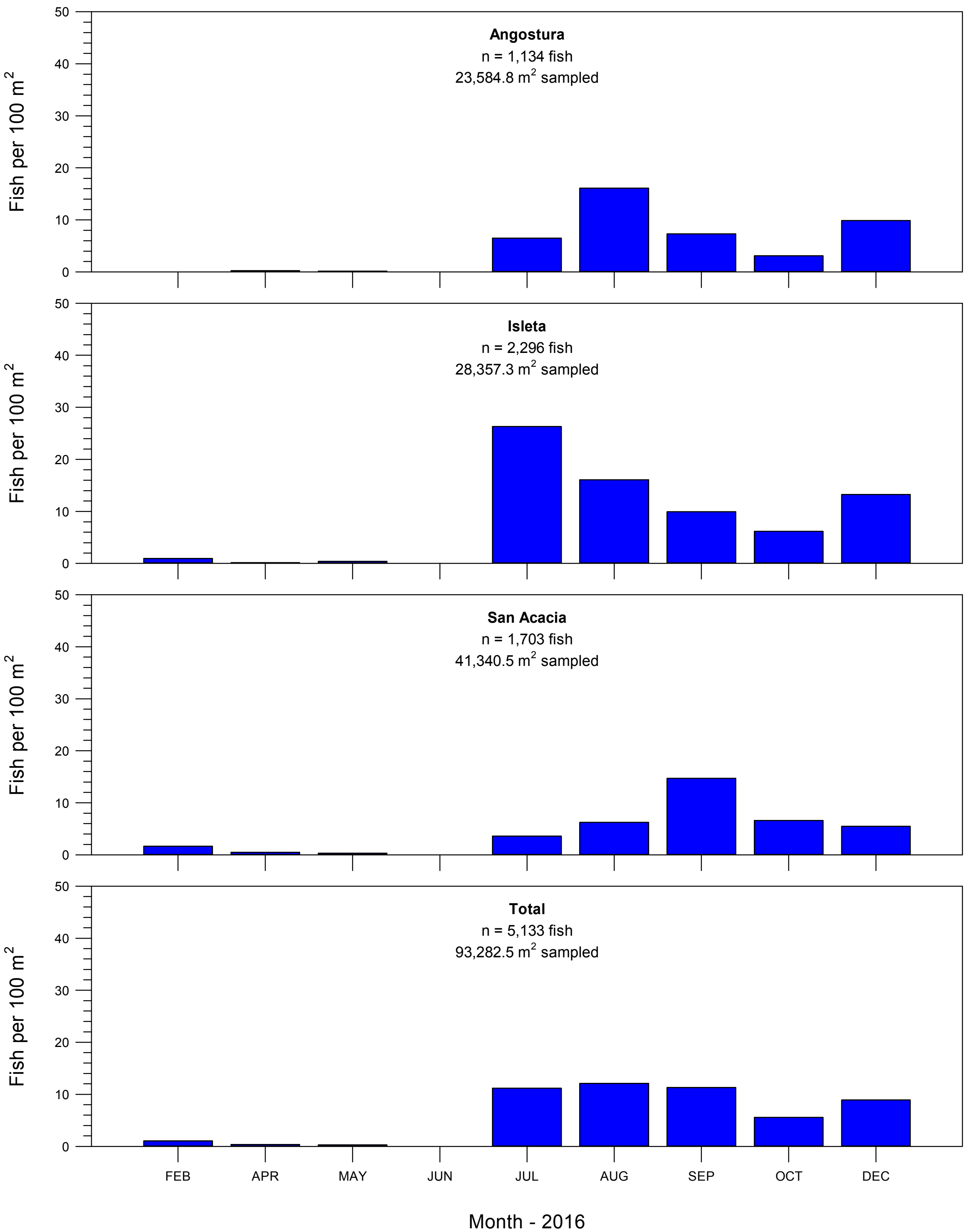


Figure 6. Rio Grande Silvery Minnow densities ***(all age-classes combined [small-mesh seine])*** from February to December 2016 for each sampling reach in the Middle Rio Grande. Note: all marked and unmarked individuals are included.

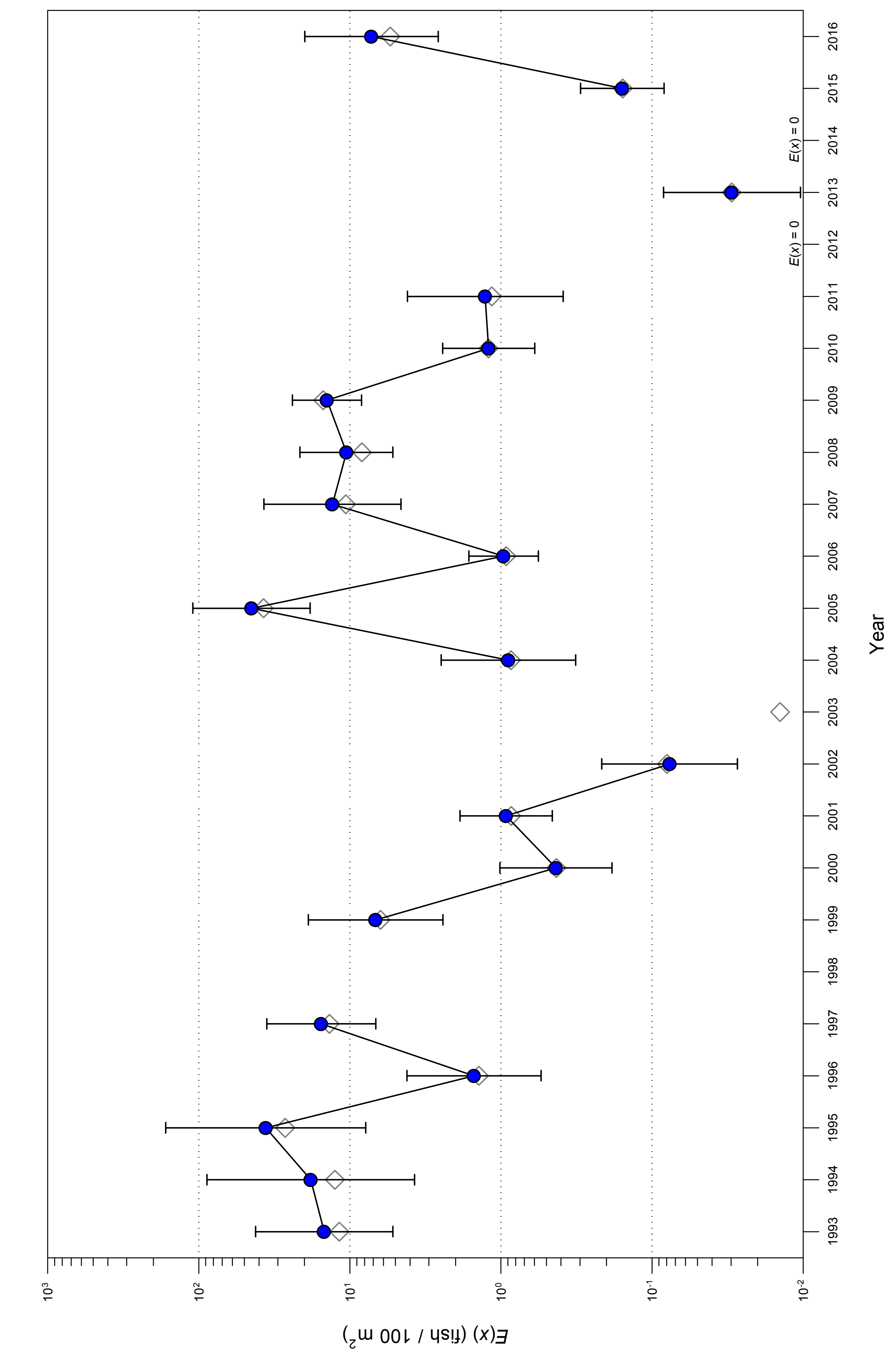


Figure 7. Rio Grande Silvery Minnow mixture-model estimates ($E(x)$), using October sampling-site density data, across years. Sampling did not occur in 1998. Modeled estimates (circles), 95% confidence intervals (bars), and simple estimates using the method of moments (diamonds) are illustrated.

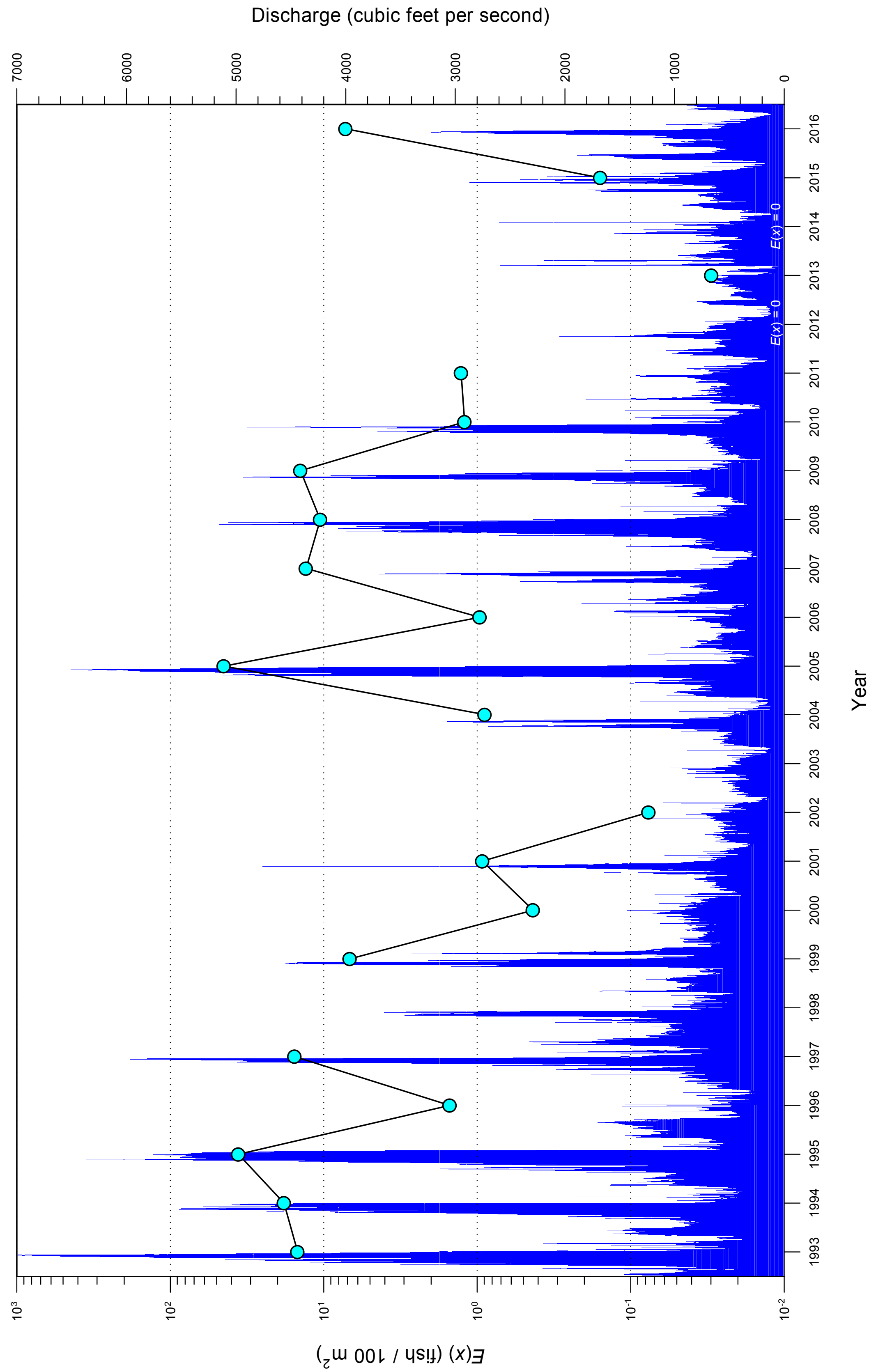


Figure 8. Rio Grande Silvery Minnow mixture-model estimates ($E(x)$), using October sampling-site density data, and mean daily discharge data from USGS Gage #0833000 across years. Sampling did not occur in 1998.

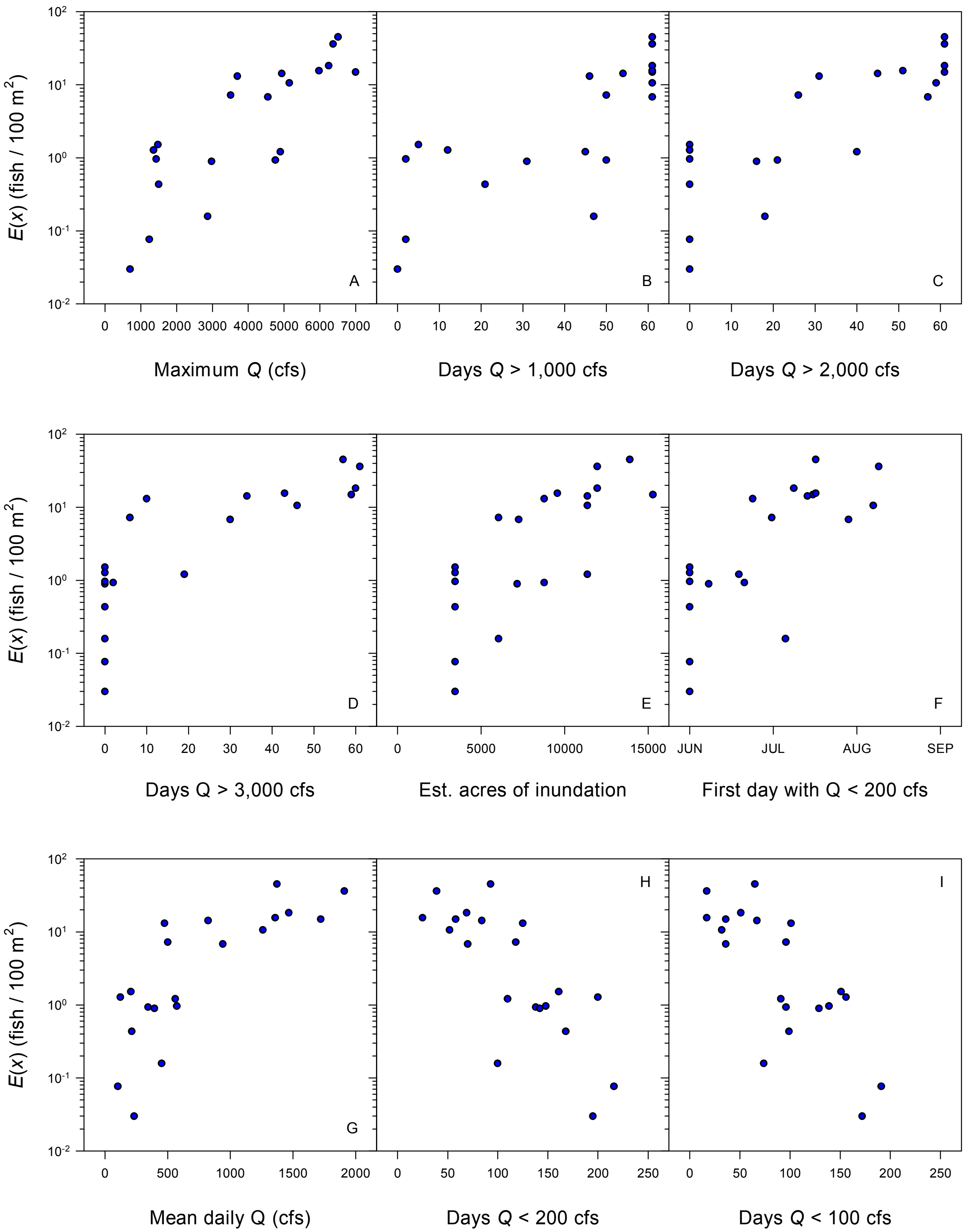


Figure 9. Bivariate plots of Rio Grande Silvery Minnow ***density estimates (E(x))***, using October sampling-site density data (1993–2016), and hydrological variables based on USGS Gage #08330000 (Figures A–E) and USGS Gage #08358400 (Figures F–I).

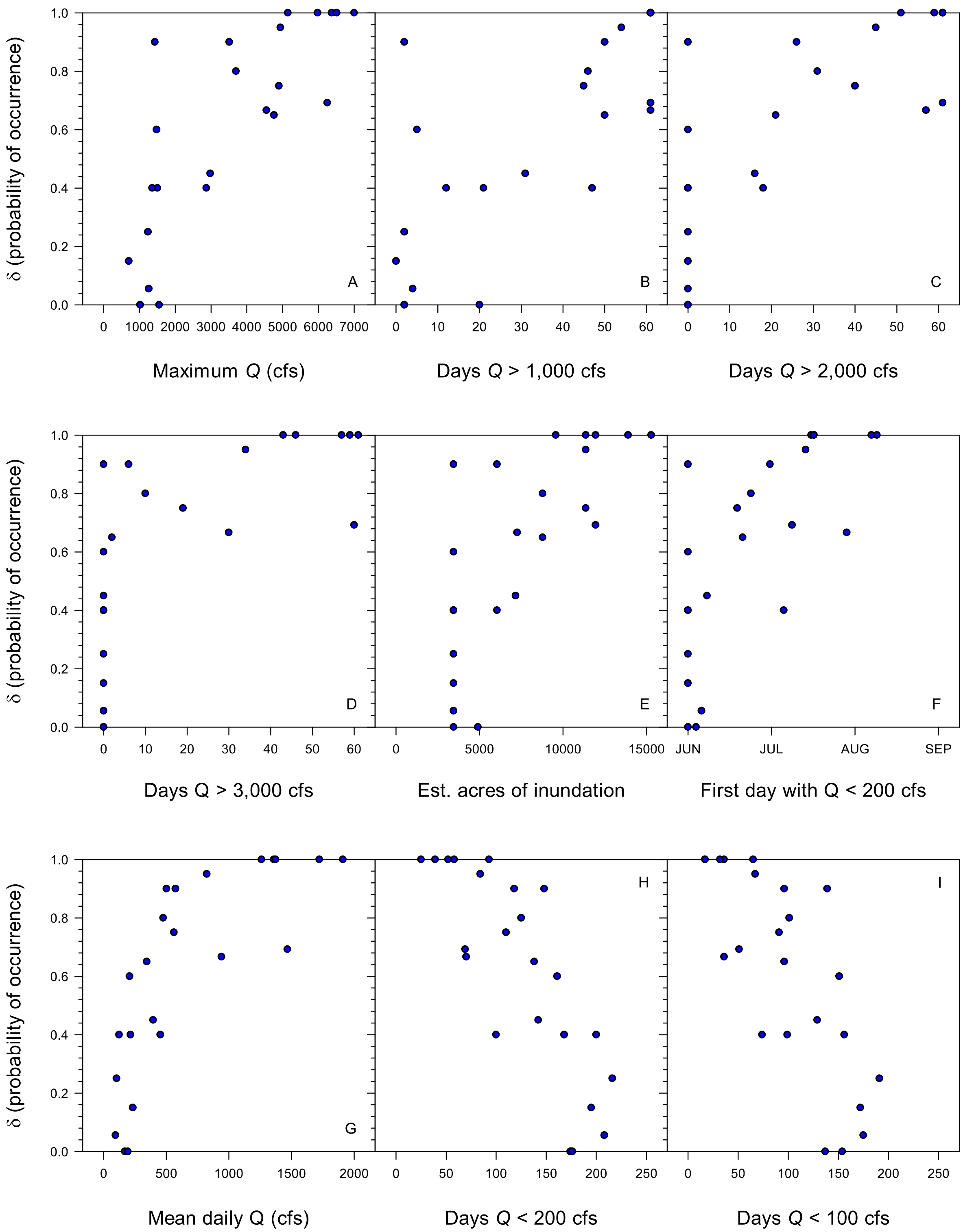


Figure 10. Bivariate plots of Rio Grande Silvery Minnow probability of occurrence estimates, using October sampling-site density data (1993–2016), and hydrological variables based on USGS Gage #08330000 (Figures A–E) and USGS Gage #08358400 (Figures F–I).

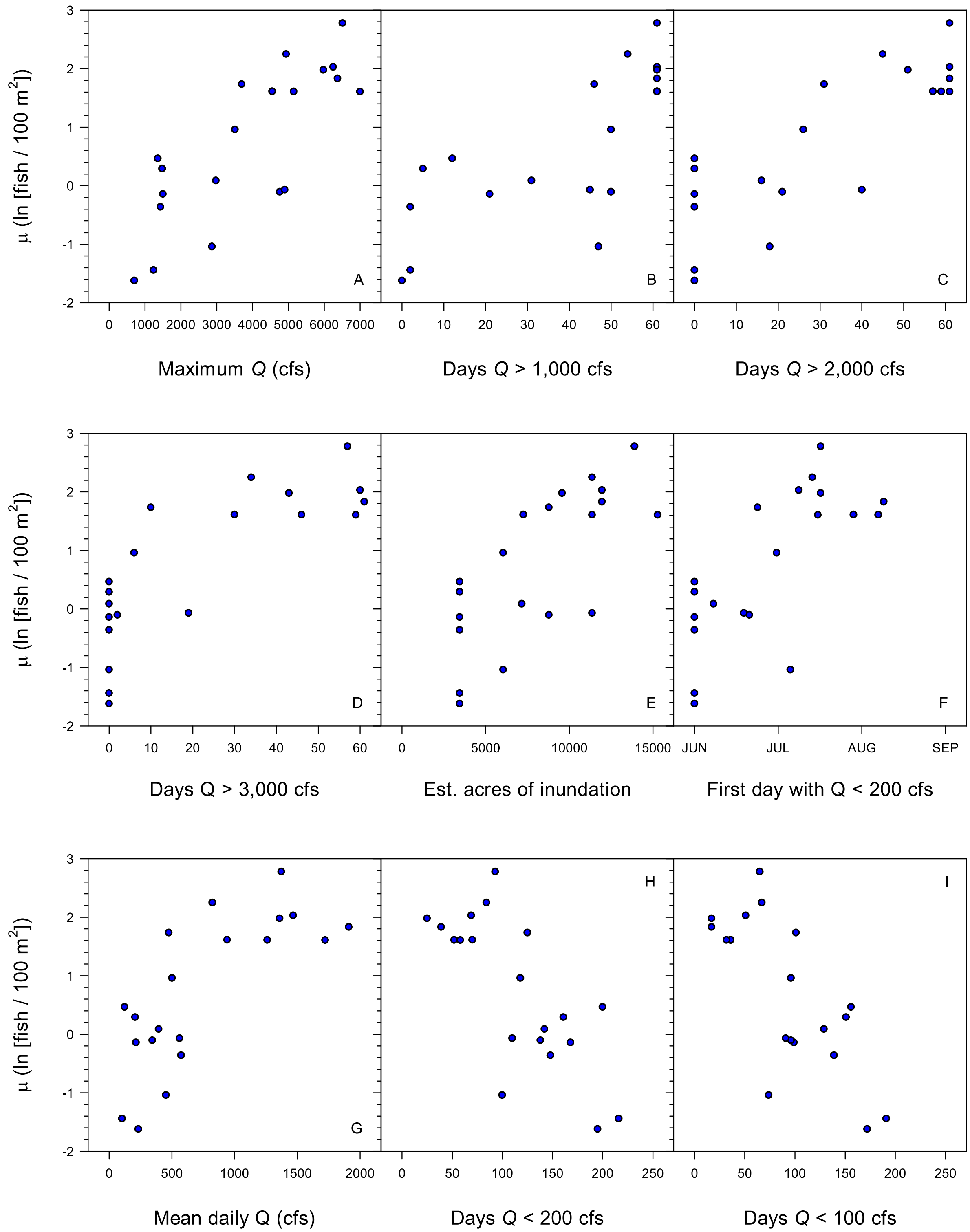


Figure 11. Bivariate plots of Rio Grande Silvery Minnow lognormal density estimates, using October sampling-site density data (1993–2016), and hydrological variables based on USGS Gage #08330000 (Figures A–E) and USGS Gage #08358400 (Figures F–I).

Table 3. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using October sampling-site density data (1993–2016).

Model[1]	**logLike**[2]	**K**[3]	**AIC$_c$**[4]	**w_i**[4]
δ(Year) μ(ABQ>2,000+*R*)	709.01	28	769.13	0.6220
δ(Year) μ(ABQ>3,000+*R*)	711.43	28	771.55	0.1848
δ(Year) μ(ABQmax+*R*)	712.66	28	772.78	0.1003
δ(Year) μ(SANmean+*R*)	714.82	28	774.94	0.0340
δ(Year) μ(ABQ>1,000+*R*)	715.17	28	775.29	0.0285
δ(Year) μ(SAN<200+*R*)	717.92	28	778.04	0.0072
δ(Year) μ(SAN1stday<200+*R*)	717.99	28	778.11	0.0070
δ(Year) μ(SAN<100+*R*)	718.00	28	778.13	0.0069
δ(Year) μ(Inundation+*R*)	719.07	28	779.19	0.0041
δ(SANmean+*R*) μ(ABQ>2,000+*R*)	762.97	9	781.40	0.0013

[1] = Model variables included year (1993–2016), estimated inundation of the river channel and floodplain, and other hydrological variables at USGS Gages (#08330000 [ABQ; Rio Grande at Albuquerque, NM] and #08358400 [SAN; Rio Grande Floodway at San Marcial, NM]), allowing for random effects (*R*).

[2] = Likelihood (-2[log-likelihood]) was estimated for each model.

[3] = Higher numbers of parameters indicate higher model complexity.

[4] = Top ten models were ranked by Akaike's information criterion (AIC$_c$) and include the AIC$_c$ weight (w_i).

In contrast, models relating to the interaction between μ and hydrological variables representing flows during irrigation season in the San Acacia Reach received a much lower cumulative value of w_i. Although models related to the interactions between δ and any of the hydrological variables received lower values of w_i, the two top models represented reduced flows during irrigation season. The top δ model, with no flow covariates on μ (δ[SANmean+*R*] μ[Year]), accounted for 78% of the deviance explained by the δ(Year) model over the δ(Null) model (P < 0.001). Thus, prolonged high flows during spring were most predictive of increased density and prolonged low flows during summer were most predictive of decreased occurrence of Rio Grande Silvery Minnow over the study period.

To evaluate the importance of including data from sites that were dry during sampling, all dry sites were excluded from a second analysis of Rio Grande Silvery Minnow estimated densities (E(x)). Similar to the first analysis, the estimates were generated from the year model (δ[Year] μ[Year]) using October sampling-site density data (1993–2016). The estimated densities of Rio Grande Silvery Minnow using this reduced dataset (Figure 12) were almost identical to those using the full dataset (Figure 7). Likewise, the general linear models of Rio Grande Silvery Minnow mixture-model estimates revealed that variation in μ, as compared with variation in δ, was more reliably predicted by changes in hydrological variables over the period of study (1993–2016; Table 4). The order of the top five models was unchanged, and the model weights were nearly identical between the first and second analyses. While there was a minor reshuffling in the order of the next five models, none of these models received > 2% of the AIC$_c$ weight.

Mesohabitat associations

Rio Grande Silvery Minnow mesohabitat-specific density data during October (2002–2016) were also used to calculate density estimates (*E*(*x*)) for different mesohabitats by year. Temporal population trends in the five mesohabitats (BW, PO, RU, SHPO, and SHRU) were quite similar over the period of study (Figure 13). The highest estimated densities were observed in 2005 for all mesohabitats, but densities had declined precipitously in all mesohabitats from 2009 until 2015. There was a notable increase in densities across all mesohabitats from 2015 to 2016. Densities in slack water mesohabitats (BW, PO, and SHPO) were generally higher as compared to densities in swift water mesohabitats (RU and SHRU). These differences were quite pronounced in years with the highest densities of Rio Grande Silvery Minnow, but were often negligible in low-density years. Also, densities for some mesohabitat/year combinations could not be estimated if there was only a single non-zero density value recorded (e.g., RU in 2015), which precluded mixture-model estimation of σ.

General linear models of Rio Grande Silvery Minnow mixture-model estimates revealed that the occurrence and density of this species was reliably predicted by differences across years and mesohabitats but much less so by reach (Table 5). The top model (δ[Year+Mesohabitat] μ[Year+Mesohabitat]) effectively received all of the AIC$_c$ weight out of the 26 models considered. A comparison of AIC$_c$ values revealed that the year model (δ[Year] μ[Year]; AIC$_c$ = 1,897.64) was more informative in explaining changes in model parameter values over time as compared with mesohabitat (δ[Mesohabitat] μ[Mesohabitat]; AIC$_c$ = 2,449.62) or reach (δ[Reach] μ[Reach]; AIC$_c$ = 2,621.31). The mesohabitat model (δ[Mesohabitat] μ[Mesohabitat]) revealed that estimated densities in the low velocity habitats (BW [41.11], SHPO [11.03], and PO [7.22]) were each significantly higher (P < 0.05) than densities in the high velocity habitats (SHRU [2.76] and RU [1.18]). Simple estimates of mean densities, using the method of moments, were similar to estimated densities (*E*(*x*)) for different mesohabitats over time.

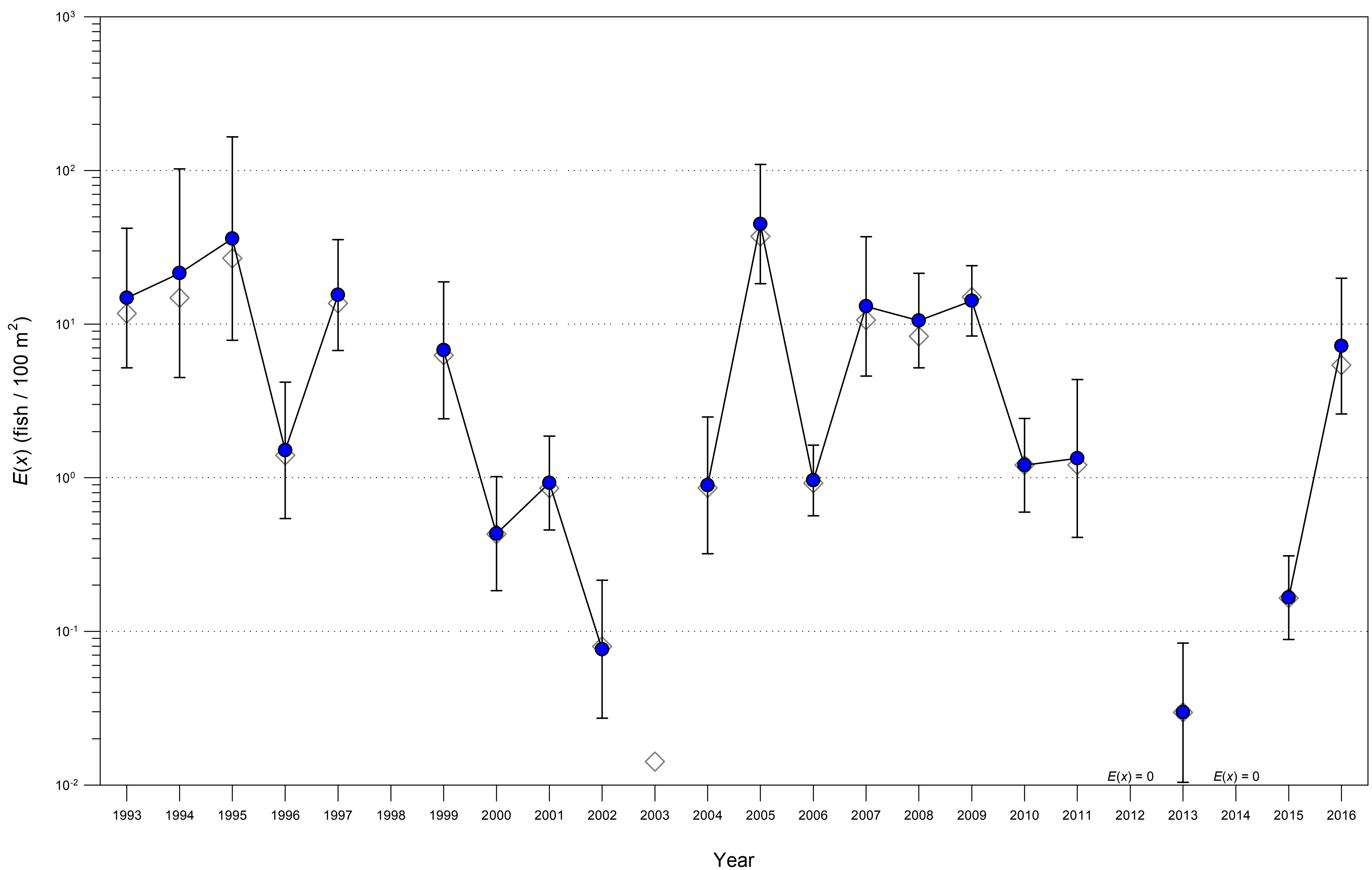


Figure 12. Rio Grande Silvery Minnow (RGSM) mixture-model estimates ($E(x)$), using October sampling-site density data, across years. Sampling did not occur in 1998. Modeled estimates (circles), 95% confidence intervals (bars), and simple estimates using the method of moments (diamonds) are illustrated. ***All dry sites were excluded from this analysis.***

Table 4. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using October sampling-site density data (1993–2016). ***All dry sites were excluded from this analysis.***

Model[1]	**logLike**[2]	**K**[3]	**AIC$_c$**[4]	***w_i***[4]
δ(Year) μ(ABQ>2,000+*R*)	701.28	28	761.49	0.5993
δ(Year) μ(ABQ>3,000+*R*)	703.70	28	763.92	0.1781
δ(Year) μ(ABQmax+*R*)	704.93	28	765.14	0.0966
δ(Year) μ(SANmean+*R*)	707.09	28	767.31	0.0327
δ(Year) μ(ABQ>1,000+*R*)	707.44	28	767.66	0.0275
δ(SANmean+*R*) μ(ABQ>2,000+*R*)	749.98	9	768.42	0.0188
δ(Year) μ(SAN<200+*R*)	710.19	28	770.41	0.0069
δ(Year) μ(SAN1stday<200+*R*)	710.26	28	770.48	0.0067
δ(Year) μ(SAN<100+*R*)	710.27	28	770.49	0.0067
δ(SANmean+*R*) μ(ABQ>3,000+*R*)	752.17	9	770.61	0.0063

[1] = Model variables included year (1993–2016), estimated inundation of the river channel and floodplain, and other hydrological variables at USGS Gages (#08330000 [ABQ; Rio Grande at Albuquerque, NM] and #08358400 [SAN; Rio Grande Floodway at San Marcial, NM]), allowing for random effects (*R*).

[2] = Likelihood (-2[log-likelihood]) was estimated for each model.

[3] = Higher numbers of parameters indicate higher model complexity.

[4] = Top ten models were ranked by Akaike's information criterion (AIC$_c$) and include the AIC$_c$ weight (w_i).

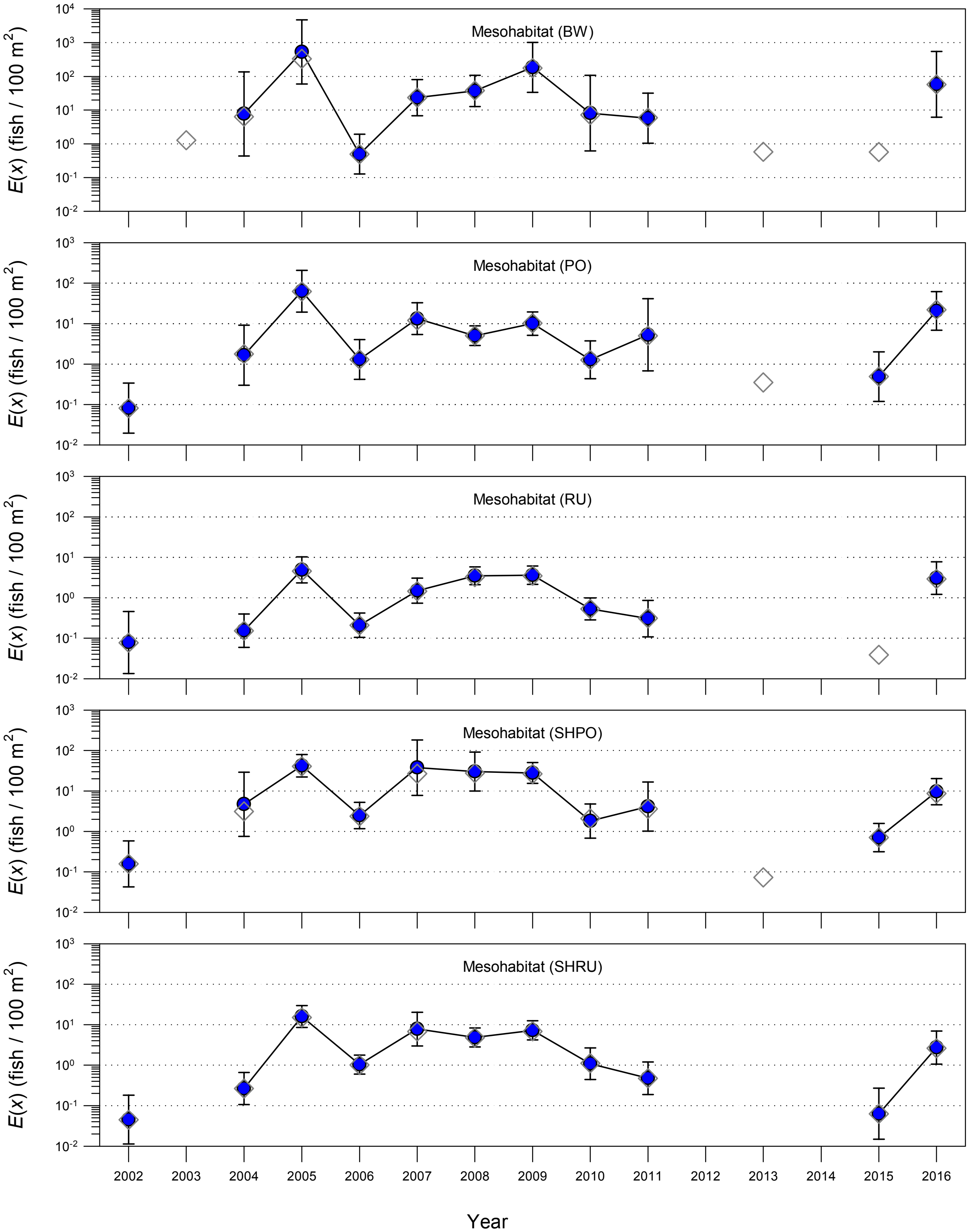


Figure 13. Rio Grande Silvery Minnow mixture-model estimates ($E(x)$), using October mesohabitat-specific density data, across years. Modeled estimates (circles), 95% confidence intervals (bars), and simple estimates using the method of moments (diamonds) are illustrated.

Table 5. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using October mesohabitat-specific density data (2002–2016).

Model[1]	**logLike**[2]	**K**[3]	**AIC$_c$**[4]	***w_i***[4]
δ(Year+Mesohabitat) μ(Year+Mesohabitat)	1,540.57	57	1,660.05	>0.9999
δ(Year) μ(Year+Mesohabitat)	1,569.18	53	1,679.91	<0.0001
δ(Year+Mesohabitat) μ(Mesohabitat)	1,743.70	29	1,803.11	<0.0001
δ(Year) μ(Mesohabitat)	1,770.92	25	1,821.97	<0.0001
δ(Year+Mesohabitat) μ(Year)	1,777.03	49	1,879.07	<0.0001
δ(Year) μ(Year+Reach)	1,781.36	49	1,883.40	<0.0001
δ(Year+Reach) μ(Year+Reach)	1,780.61	51	1,886.98	<0.0001
δ(Year+Reach) μ(Year)	1,792.76	47	1,890.47	<0.0001
δ(Year) μ(Year)	1,804.25	45	1,897.64	<0.0001
δ(Year*Mesohabitat) μ(Year*Mesohabitat)	1,361.42	225	1,909.40	<0.0001

[1] = Model variables included year (2002–2016), mesohabitat (backwater, pool, run, shoreline pool, and shoreline run), and reach (Angostura, Isleta, and San Acacia).

[2] = Likelihood (-2[log-likelihood]) was estimated for each model.

[3] = Higher numbers of parameters indicate higher model complexity.

[4] = Top ten models were ranked by Akaike's information criterion (AIC$_c$) and include the AIC$_c$ weight (w_i).

Sampling variation during repeated sampling

Rio Grande Silvery Minnow sampling-site density data during November (2005–2016) were also used to calculate density estimates ($E(x)$) across different sampling occasions by year. Temporal population trends for the four sampling occasions (sampling days 1–4) were quite similar over the period of study (Figure 14). While densities had declined precipitously for all sampling occasions since 2009, there was notable improvement in 2015–2016 as compared with 2012–2014. Densities for some sampling-occasion/year combinations could not be estimated if there was only a single non-zero density value recorded (e.g., day 1 in 2013), which precluded mixture-model estimation of σ.

General linear models of Rio Grande Silvery Minnow mixture-model estimates revealed that that the occurrence and density of this species was reliably predicted by differences across years and reaches but much less so by sampling occasion (Table 6). The top model (δ[Year*Reach] μ[Year*Reach]) received nearly all of the AIC_c weight out of the 26 models considered. A comparison of AIC_c values revealed that the year model (δ[Year] μ[Year]; AIC_c = 1,751.76) was more informative in explaining changes in model parameter values over time as compared with reach (δ[Reach] μ[Reach]; AIC_c = 2,550.66) or sampling occasion (δ[Occasion] μ[Occasion]; AIC_c = 2,585.96). Further, a variance components analysis revealed that Year accounted for the highest variance (71.15) in estimated densities, followed distantly by Site (2.56), Reach (0.76), and Occasion (0.00). There were no significant differences ($P > 0.05$) among estimated densities for the four sampling occasions. Simple estimates of mean densities, using the method of moments, were very similar to estimated densities ($E(x)$) for different sampling occasions over time.

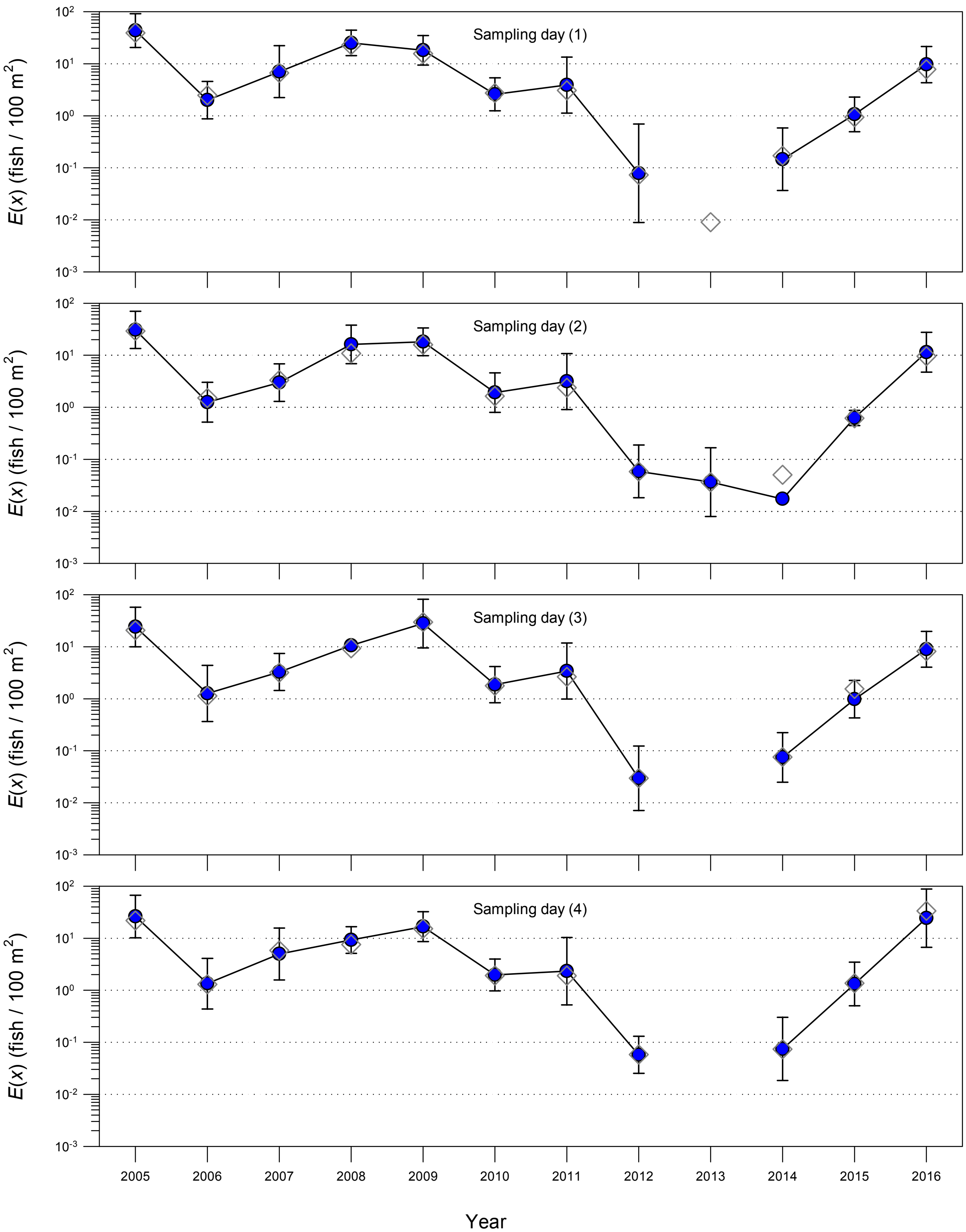


Figure 14. Rio Grande Silvery Minnow mixture-model estimates ($E(x)$), using November sampling-site density data, across years. Modeled estimates (circles), 95% confidence intervals (bars), and simple estimates using the method of moments (diamonds) are illustrated.

Table 6. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using sampling-site density data during repeated sampling in November (2005–2016).

Model[1]	logLike[2]	K[3]	AIC_c[4]	w_i[4]
δ(Year*Reach) μ(Year*Reach)	1,352.14	108	1,595.81	>0.9999
δ(Year+Reach) μ(Year+Reach)	1,567.75	42	1,655.69	<0.0001
δ(Year+Reach) μ(Year)	1,615.66	38	1,694.88	<0.0001
δ(Year) μ(Year+Reach)	1,628.57	40	1,712.14	<0.0001
δ(Year) μ(Year+Occasion)	1,662.45	42	1,750.39	<0.0001
δ(Year) μ(Year)	1,676.87	36	1,751.76	<0.0001
δ(Year+Occasion) μ(Year+Occasion)	1,659.68	45	1,754.21	<0.0001
δ(Year+Occasion) μ(Year)	1,674.10	39	1,755.49	<0.0001
δ(Year*Occasion) μ(Year*Occasion)	1,567.64	144	1,906.88	<0.0001
δ(Year+Reach) μ(Reach)	2,006.05	20	2,046.95	<0.0001

[1] = Model variables included year (2005–2016), sampling occasion (i.e., 1st, 2nd, 3rd, and 4th day of sampling), and reach (Angostura, Isleta, and San Acacia).
[2] = Likelihood (-2[log-likelihood]) was estimated for each model.
[3] = Higher numbers of parameters indicate higher model complexity.
[4] = Top ten models were ranked by Akaike's information criterion (AIC_c) and include the AIC_c weight (w_i).

Fish Community

Population status

The ichthyofaunal community in the Middle Rio Grande between Angostura Diversion Dam and Elephant Butte Reservoir was numerically dominated by cyprinids (Table 7; Appendix D). The native ichthyofauna comprised 10 species (Gizzard Shad, Red Shiner, Rio Grande Silvery Minnow, Fathead Minnow, Flathead Chub, Longnose Dace, River Carpsucker, Blue Catfish, Flathead Catfish, and Bluegill). Red Shiner was the most abundant native species collected (n = 8,196), followed by Rio Grande Silvery Minnow (n = 7,819), and Flathead Chub (n = 1,950). The nonnative ichthyofauna comprised 12 species. The most abundant introduced species were Western Mosquitofish (n = 2,508), Channel Catfish (n = 2,018), and Common Carp (n = 1,967).

Rio Grande Silvery Minnow, sampled during October, composed a higher fraction of the total ichthyofaunal community from 2005–2009 than from 2010–2015, but there was a marked improvement in its relative abundance from 2015 to 2016 (Figure 15). Notable changes in the relative abundance of this species reflected similar changes in its estimated densities across the study period. While Rio Grande Silvery Minnow represented only 0.91% of the total fish community in 2015, it had increased to 20.87% by 2016.

The magnitude of change in the relative abundance of Rio Grande Silvery Minnow during October was particularly evident when compared to other focal species over the past decade (Table 8). This species had decreased from being the 2nd most common focal species in 2009 to being the least common focal species from 2012 to 2014. Rio Grande Silvery Minnow rank abundance improved dramatically in 2016 (2nd) as compared with 2015 (7th). The coefficient of concordance (W = 0.73) for the ten focal species indicated high overall agreement among ranks over time (2007–2016; X^2= 65.9; P < 0.001) despite large changes in ranks for some taxa (e.g., Rio Grande Silvery Minnow and Longnose Dace).

There were notable seasonal changes in the relative abundance of the 10 focal fish species from February to December 2016 (Figures 16 and 17). Densities of all fish species generally increased during summer or autumn. Rio Grande Silvery Minnow abundance was elevated from July to September but declined in October. Other focal species typically reached their highest densities from June to October, following spawning.

An accounting of species-specific abundance across sampling months documented the seasonal occurrence of certain taxa (Table 9). Several nonnative fishes were relatively prevalent during summer but were extremely rare or absent during autumn (e.g., Yellow Bullhead, Blue Catfish, and Largemouth Bass). Multiple taxa were rare throughout the year, which precluded an assessment of any change in their status across months or years. However, Bullhead Minnow was collected in most sampling months in the San Acacia Reach, which further indicates that this species has recently become established in that area.

In addition to temporal variation in the relative abundance of fish species during 2016, there were also longitudinal changes in the densities of species from upstream to downstream (Figure 18). Flathead Chub, Longnose Dace, and White Sucker were most common in the Angostura Reach. The most common species in the Isleta Reach were Red Shiner, Common Carp, Rio Grande Silvery Minnow, Fathead Minnow, River Carpsucker, and Western Mosquitofish. Channel Catfish was most common in the San Acacia Reach.

Table 7. Summary of the February to December 2016 Rio Grande Silvery Minnow population monitoring results (all age-classes combined).

Family	Common Name	Residence Status[1]	Total Number of Individuals	Percent (%) of Total	Frequency of Occurrence[2]	% Frequency of Occurrence[2]
Clupeidae	Gizzard Shad	N	7	0.03	4	2.22
Clupeidae	Threadfin Shad	I	-	-	-	-
Cyprinidae	Central Stoneroller	I	-	-	-	-
Cyprinidae	Goldfish	I	-	-	-	-
Cyprinidae	Red Shiner	N	8,196	29.88	162	90.00
Cyprinidae	Common Carp	I	1,967	7.17	89	49.44
Cyprinidae	Rio Grande Chub	N	-	-	-	-
Cyprinidae	Rio Grande Silvery Minnow	N	7,819	28.51	137	76.11
Cyprinidae	Golden Shiner	I	-	-	-	-
Cyprinidae	Fathead Minnow	N	300	1.09	63	35.00
Cyprinidae	Bullhead Minnow	I	32	0.12	12	6.67
Cyprinidae	Flathead Chub	N	1,950	7.11	143	79.44
Cyprinidae	Longnose Dace	N	879	3.20	37	20.56
Catostomidae	River Carpsucker	N	588	2.14	64	35.56
Catostomidae	White Sucker	I	921	3.36	40	22.22
Catostomidae	Smallmouth Buffalo	N	-	-	-	-
Ictaluridae	Black Bullhead	I	2	0.01	2	1.11
Ictaluridae	Yellow Bullhead	I	59	0.22	18	10.00
Ictaluridae	Blue Catfish	N	11	0.04	5	2.78
Ictaluridae	Channel Catfish	I	2,018	7.36	131	72.78
Ictaluridae	Flathead Catfish	N	5	0.02	4	2.22
Salmonidae	Rainbow Trout	I	-	-	-	-
Salmonidae	Brown Trout	I	-	-	-	-
Poeciliidae	Western Mosquitofish	I	2,508	9.14	104	57.78
Moronidae	White Bass	I	-	-	-	-
Moronidae	Striped Bass	I	-	-	-	-
Centrarchidae	Green Sunfish	I	4	0.01	3	1.67
Centrarchidae	Bluegill	N	1	0.00	1	0.56
Centrarchidae	Longear Sunfish	I	-	-	-	-
Centrarchidae	Smallmouth Bass	I	-	-	-	-
Centrarchidae	Largemouth Bass	I	153	0.56	30	16.67
Centrarchidae	White Crappie	I	5	0.02	5	2.78
Centrarchidae	Black Crappie	I	-	-	-	-
Percidae	Yellow Perch	I	3	0.01	3	1.67
Percidae	Bigscale Logperch	I	1	0.00	1	0.56
Percidae	Walleye	I	-	-	-	-
Annual Total			**27,429**	**100.00**		

[1] = N (native); I (introduced)
[2] = Frequency and % frequency of occurrence were based on 180 site samples (i.e., 20 samples per month) during 2016.

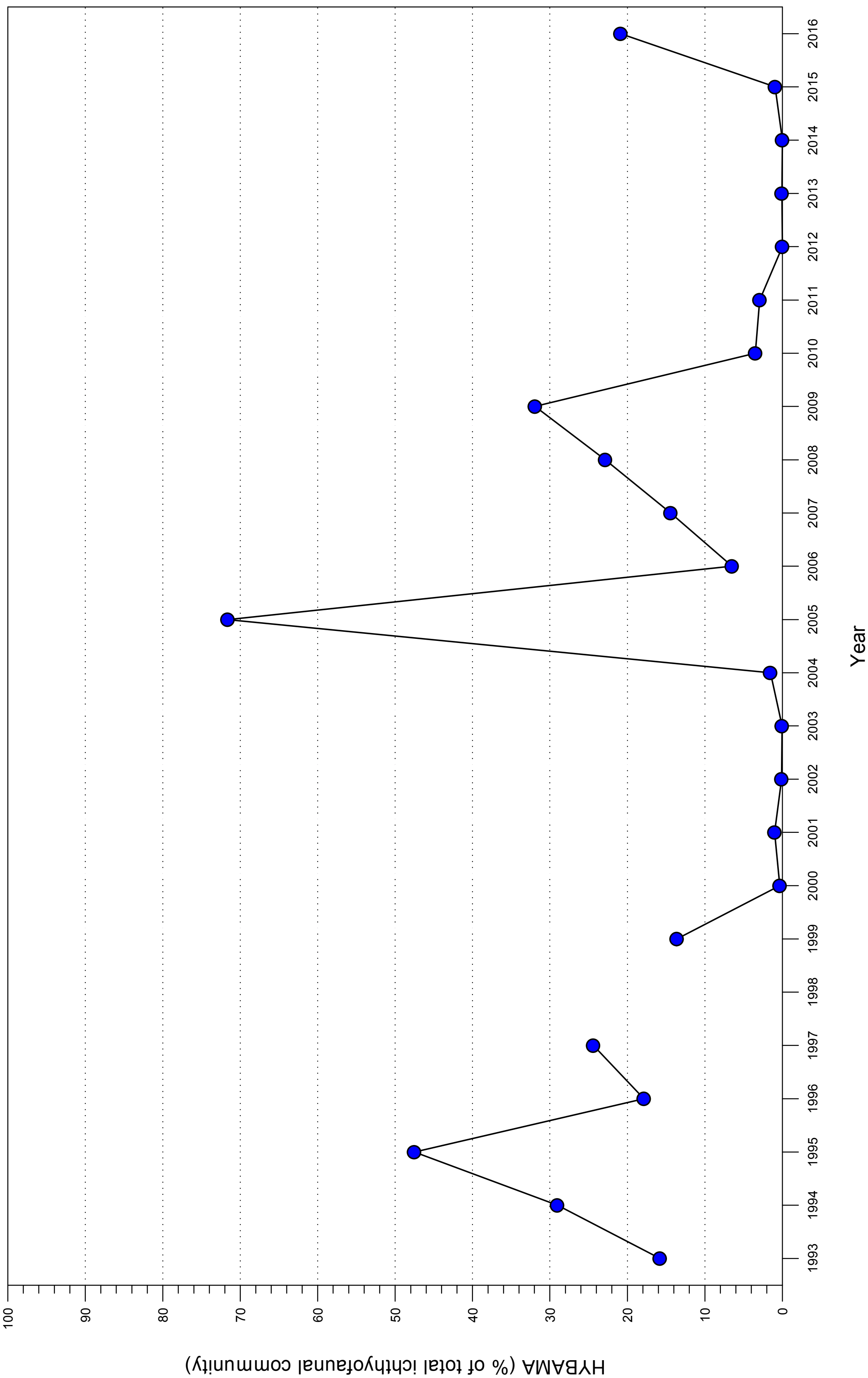


Figure 15. Relative abundance of Rio Grande Silvery Minnow as a percentage of the total ichthyofaunal community during October, at all sampling sites, across years. Sampling did not occur in 1998.

Table 8. Summary of rank abundance for focal species collected in the Rio Grande during October over the past decade (2007–2016).

Family Common Name	Sampling Year 2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cyprinidae										
Red Shiner	1	1	1	1	1	1	1	1	1	1
Common Carp	10	7	10	9	10	6	9	8	9	7
Rio Grande Silvery Minnow	2	2	2	5	4	10	10	10	7	2
Fathead Minnow	7	5	6	6	7	5	4	6	6	8
Flathead Chub	4	4	5	2	3	3	6	3	3	4
Longnose Dace	8	8	9	7	8	8	3	5	5	6
Catostomidae										
River Carpsucker	6	9	7	8	5	7	8	7	8	9
White Sucker	9	10	8	10	9	9	7	9	10	10
Ictaluridae										
Channel Catfish	5	6	4	4	6	4	5	4	4	5
Poeciliidae										
Western Mosquitofish	3	3	3	3	2	2	2	2	2	3

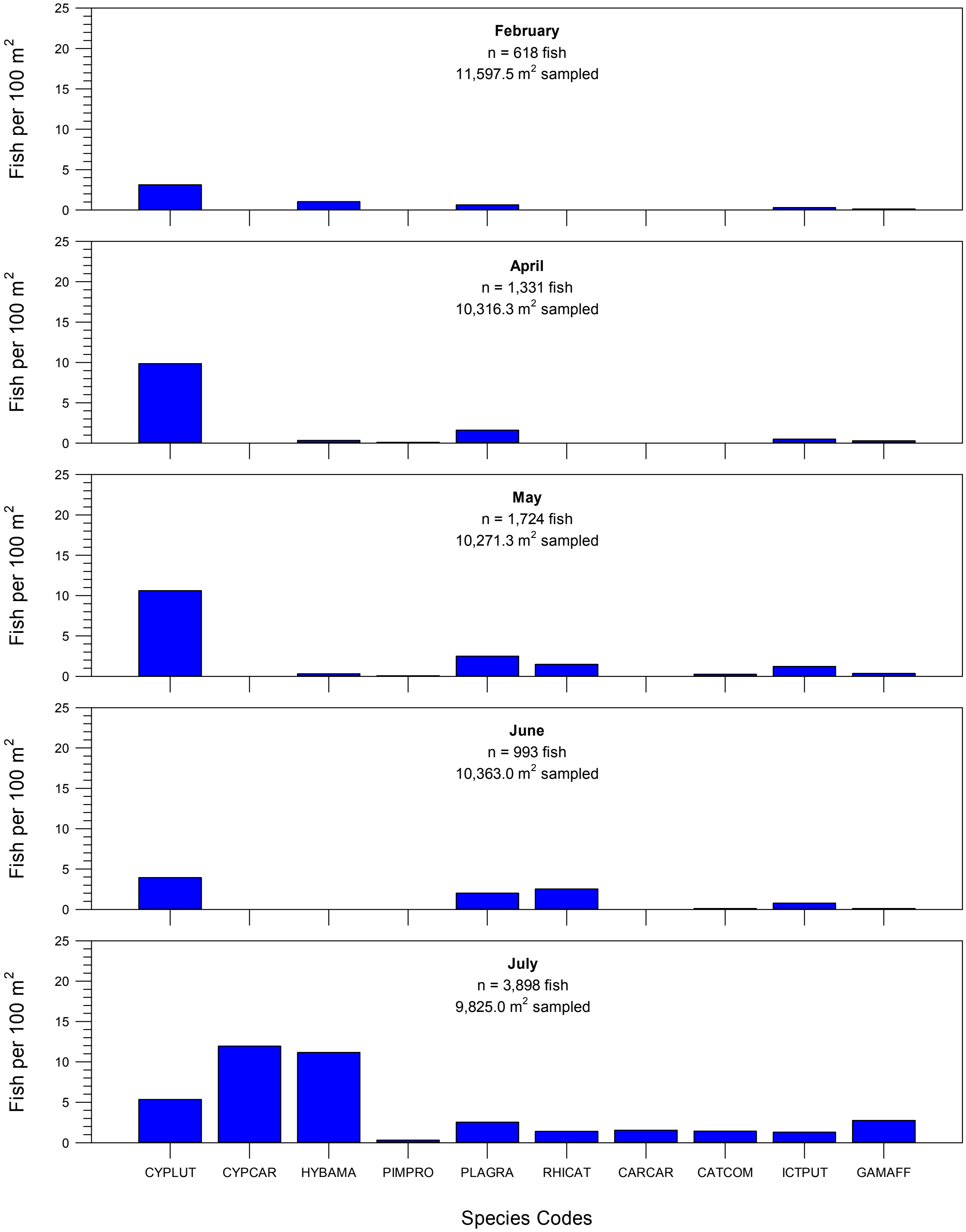


Figure 16. Fish densities ***(all age-classes combined [small-mesh seine])*** from February to July 2016 for each focal species (see Table 1 for species codes) in the Middle Rio Grande.

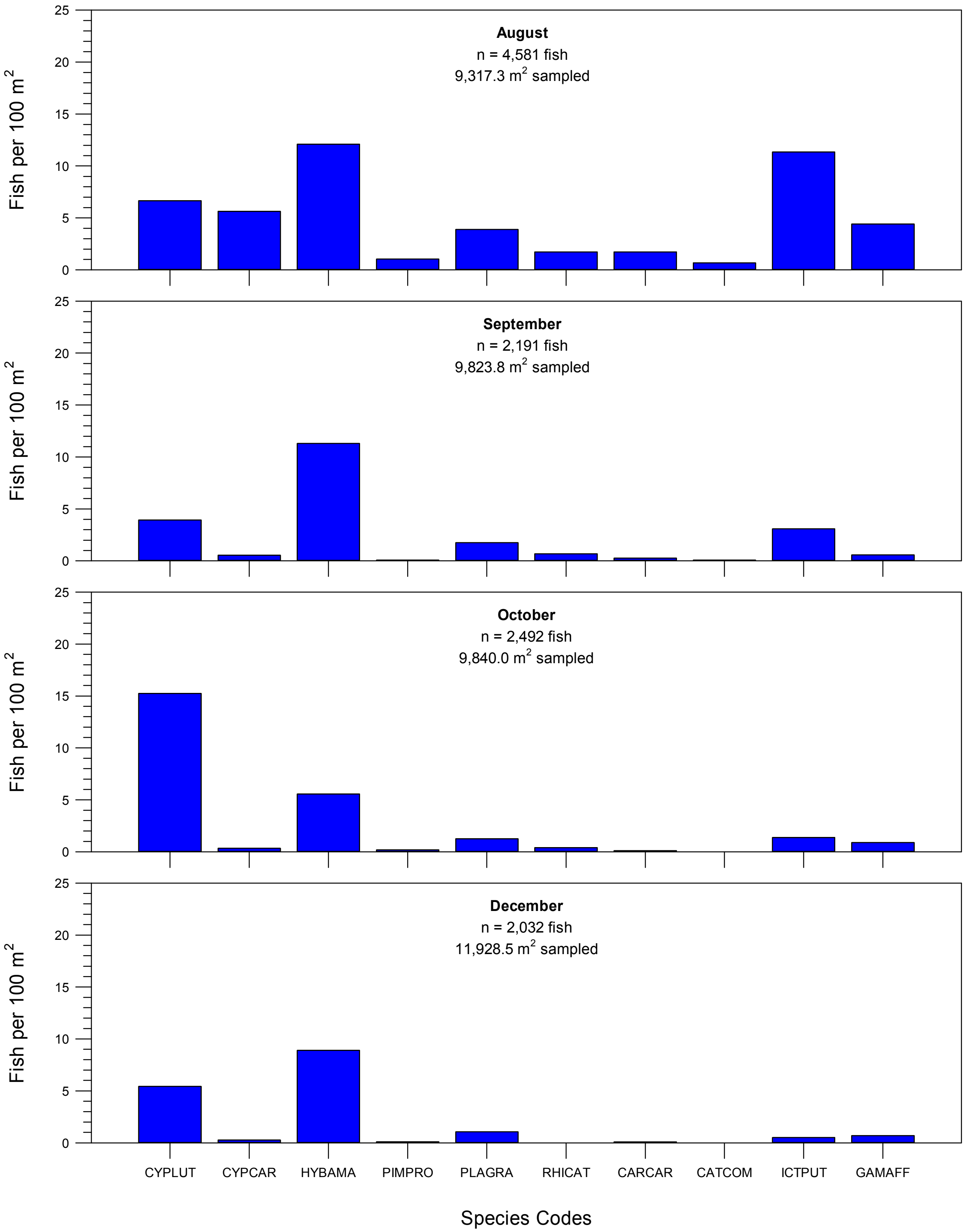


Figure 17. Fish densities ***(all age-classes combined [small-mesh seine])*** from August to December 2016 for each focal species (see Table 1 for species codes) in the Middle Rio Grande.

Table 9. Summary of the February to December 2016 Rio Grande Silvery Minnow population monitoring results by month (all age-classes combined).

Family	Common Name	Feb	Apr	May	Jun	Jul	Aug	Sep	Oct	Dec	Total
Clupeidae	Gizzard Shad	-	2	-	-	4	1	-	-	-	7
Clupeidae	Threadfin Shad	-	-	-	-	-	-	-	-	-	0
Clupeidae	Central Stoneroller	-	-	-	-	-	-	-	-	-	0
Clupeidae	Goldfish	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Red Shiner	362	1,054	1,218	439	699	1,678	524	1,574	648	8,196
Cyprinidae	Common Carp	3	5	3	71	1,232	530	54	37	32	1,967
Cyprinidae	Rio Grande Chub	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Rio Grande Silvery Minnow	120	36	32	1,437	2,178	1,222	1,149	584	1,061	7,819
Cyprinidae	Golden Shiner	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Fathead Minnow	8	11	8	70	52	115	6	18	12	300
Cyprinidae	Bullhead Minnow	-	5	9	-	1	-	-	7	10	32
Cyprinidae	Flathead Chub	73	174	313	248	268	388	179	183	124	1,950
Cyprinidae	Longnose Dace	1	8	181	272	142	166	68	39	2	879
Cyprinidae	River Carpsucker	1	3	3	55	304	178	26	9	9	588
Cyprinidae	White Sucker	1	4	654	32	157	64	6	2	1	921
Cyprinidae	Smallmouth Buffalo	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Black Bullhead	-	-	-	-	-	-	2	-	-	2
Cyprinidae	Yellow Bullhead	-	-	-	1	26	28	4	-	-	59
Cyprinidae	Blue Catfish	-	-	-	1	9	1	-	-	-	11
Cyprinidae	Channel Catfish	34	52	127	82	137	1,085	305	135	61	2,018
Cyprinidae	Flathead Catfish	-	1	-	-	1	-	2	1	-	5
Cyprinidae	Rainbow Trout	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Brown Trout	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Western Mosquitofish	15	39	64	14	621	1,229	238	206	82	2,508
Cyprinidae	White Bass	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Striped Bass	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Green Sunfish	-	-	1	-	1	2	-	-	-	4
Cyprinidae	Bluegill	-	-	-	1	-	-	-	-	-	1
Cyprinidae	Longear Sunfish	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Smallmouth Bass	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Largemouth Bass	-	-	-	-	104	42	4	3	-	153
Cyprinidae	White Crappie	1	-	1	-	2	1	-	-	-	5
Cyprinidae	Black Crappie	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Yellow Perch	-	-	-	-	2	1	-	-	-	3
Cyprinidae	Bigscale Logperch	-	-	-	-	1	-	-	-	-	1
Cyprinidae	Walleye	-	-	-	-	-	-	-	-	-	0
Monthly Totals		**619**	**1,394**	**2,614**	**2,723**	**5,941**	**6,731**	**2,567**	**2,798**	**2,042**	**27,429**

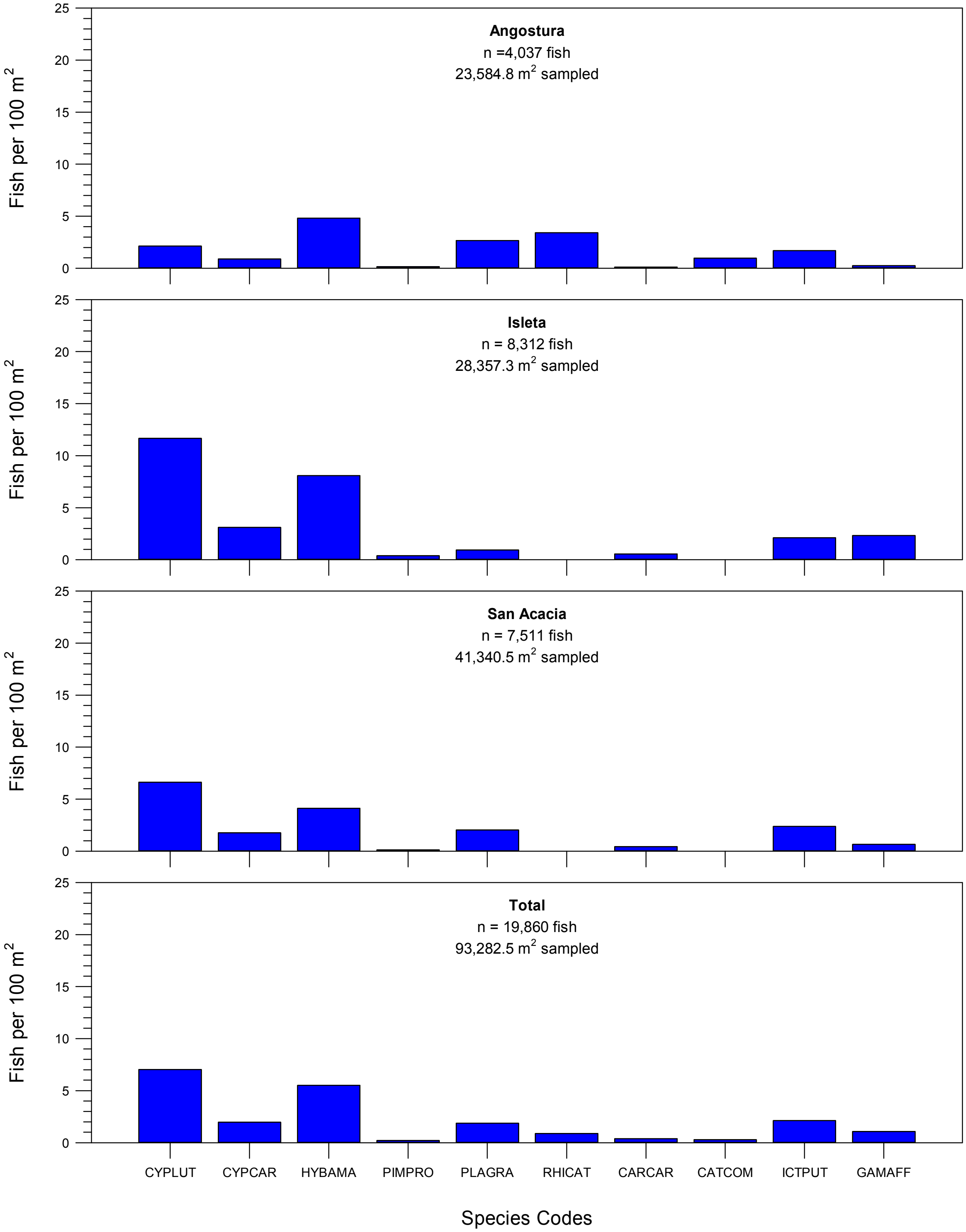


Figure 18. Fish densities ***(all age-classes combined [small-mesh seine])*** during 2016 for each focal species (see Table 1 for species codes), by sampling reach, in the Middle Rio Grande.

DISCUSSION

The population status of Rio Grande Silvery Minnow and the associated Middle Rio Grande ichthyofaunal community has been systematically monitored since 1993. This effort is unique among ichthyofaunal research studies in the Middle Rio Grande in that it has been providing consistent sampling of fishes over a long duration. Determining changes in fish population trends is best accomplished by analyzing the full suite of available data over the period of record. Long-term sampling studies also provide the data necessary to test specific ecological hypotheses. While this study was initially designed to monitor the long-term trends of fish species in the Middle Rio Grande, the scope of this project has expanded to address some of the information needs of natural resource managers. Examples of key components that were added to this project over time include: 1) Evaluating the influence of discharge patterns on population fluctuations, 2) Determining general mesohabitat use patterns, 3) Documenting the changes in relative abundance among native and nonnative fish species over time, 4) Determining variation in density estimates based on repeated sampling, and 5) Evaluating changes in site occupancy status across years.

While the primary purpose of this study was to estimate fish population trends over time using a density index (i.e., CPUE), there are important differences between estimating population trends vs. estimating population size. Both the accuracy and precision of population size estimates, based on mark-recapture or removal sampling techniques, are likely to be improved as compared with estimates based on sampling techniques that rely on a density index (Otis et al., 1978). However, the practical budgetary constraints of agencies charged with monitoring populations of imperiled species often preclude the long-term utilization of more statistically robust sampling techniques (e.g., mark-recapture or removal studies) to monitor wild populations. Despite these challenges, density indices have been shown to be robust for the purpose of determining population trends and can be a practical and cost-effective approach for single or multiple-species monitoring studies (Johnson, 2008; Al-Chokhachy et al., 2009).

Statistical analyses revealed a close relationship between the 2008–2011 population trends for Rio Grande Silvery Minnow obtained from population monitoring and population estimation studies (Dudley et al., 2012). Although monitoring data appear to be an appropriate long-term surrogate for estimate data, it could be beneficial to further validate this assumption by collecting at least some estimate data (i.e., mesohabitat-specific densities based on closed multiple-pass sampling) annually or periodically (e.g., every 2–3 years). Despite similarities in population trends obtained from these two studies, those investigations have unique objectives that address different research needs. Systematic population monitoring provides an assessment of recruitment success over short time periods, a basis for comparing the changes in recruitment success among years, and timely information about the status of the species during periods of reduced abundance. Additionally, this dataset has been used to assess seasonal survivorship rates (e.g., Dudley et al., 2009) and could be used to evaluate the effectiveness of future adaptive management activities on both native and nonnative fishes. In contrast, the population estimation study was more narrowly focused to provide statistically robust annual estimates of population size for Rio Grande Silvery Minnow. For the purpose of assessing population changes over time, this study generally resulted in a higher degree of precision and accuracy as compared to the population monitoring study (Dudley et al., 2012). Further, the substantial methodological differences between these studies (e.g., multiple-pass sampling with enclosures [estimation] vs. single-pass sampling without enclosures [monitoring]) meant that any population size estimate generated from population monitoring data would be biased. While density estimates generated from the population monitoring study should not be used to derive population size estimates, they have proven to be a reasonably reliable reflection of Rio Grande Silvery Minnow population trends over time (Dudley et al., 2012).

The mixture models used to estimate Rio Grande Silvery Minnow densities in this study employed two separate statistical components, an approach that has been shown to be particularly effective for modeling zero-inflated ecological data (White, 1978; Welsh et al., 1996; Fletcher et al., 2005; Martin et al., 2005). Logistic regression was used to model the probability that a site was occupied while a lognormal model was used to model the estimated densities given that the site was occupied. The two processes (i.e., presence-absence vs. density) that generated $E(x)$ were clearly separated when using the mixture model approach. Also, it was unnecessary to make the arbitrary addition of some positive constant onto observations of zero values as is commonly done for simple regression models using log-transformed data. Further, our approach fully accounts for over-dispersion (e.g., extra-binomial variation around δ, non-constant σ in the lognormal distribution, or additional variation around the linear covariate model). Thus, we have produced estimates using a robust, yet general, approach that avoids assumptions normally required for traditional analyses.

One relevant assumption required for our analyses is that mesohabitat-specific capture probabilities are constant across samples. As mark-recapture or depletion data were not collected as part of this study, this assumption cannot be directly evaluated. However, it seems highly unlikely that downward density trends were caused by reduced capture efficiency, as our methods have remained consistent to ensure that comparable mesohabitats (depths and velocities) were sampled across different annual flow conditions. Also, it seems reasonable that any differences in the capture efficiencies across individual seine hauls would tend to average out because of the substantial sampling effort required for this study (ca., 400 seine hauls per month). Further, environmental conditions during October (e.g., water temperature, discharge, and turbidity) have been quite stable and suitable for efficient sampling as opposed to other times of the year (i.e., spring runoff or summer monsoons), making it an ideal time of year for evaluating long-term trends in the occurrence and abundance of Rio Grande Silvery Minnow. We have also maintained a steadfast consistency in our crew leaders, training procedures, and sampling protocols for the past two decades. Finally, we found that population trends in different mesohabitats (October [2002–2016]), or on different days during repeated sampling (November [2005–2016]), were remarkably similar to population trends obtained from the long-term dataset (October [1993–2016]).

Although we used classical (frequentist) methods (i.e., mixture models and general linear models) to analyze the long-term data in our study, we also evaluated the merits of the Bayesian method of statistical inference. Classical and Bayesian approaches both use the same general analytical framework (i.e., parametric likelihood models supplemented with linear covariate models) to generate estimates and make ecological inferences from the data. However, Bayesian techniques rely on subjective assumptions about prior distributions, and require additional Markov chain Monte Carlo (MCMC) statistical analyses, to obtain model estimates (Burnham and Anderson, 2002). Therefore, conducting a Bayesian analysis in a non-hierarchical framework, as was used in this study, will not result in different conclusions, but does raise the issues of including subjective data and interpreting additional statistical results. While the Bayesian approach might seem preferable for a reach-specific analysis, using informative priors to substitute for sparse reach-specific data seems contrary to objective monitoring. Thus, we have used the classical approach to rigorously analyze range-wide changes in the annual abundance of Rio Grande Silvery Minnow.

Over the past two decades, there have been remarkable changes in the estimated densities of Rio Grande Silvery Minnow across years (i.e., more than two orders of magnitude [>10,000% increase or >99% decrease]). Despite these notable differences in the estimated densities of this species over time, the relative precision of estimates was adequate to frequently detect significant differences in estimated densities (both increases and decreases) between years. Further, analyses of sampling variation across days (based on repeated sampling during November 2005–2016) revealed that sampling occasion was far less informative in explaining changes in the density of Rio Grande Silvery Minnow over time as compared with year. Thus, it appears that the current sampling protocols are resulting in a reliable level of sampling precision and population trend consistency, especially when considering the substantial changes in both the occurrence and abundance of Rio Grande Silvery Minnow over time.

While October and November sampling efforts revealed very similar trends in the estimated densities of Rio Grande Silvery Minnow over time (2005–2016), this species' estimated densities tended to be somewhat higher in November than in October. One possible explanation for this pattern could be the tendency of Rio Grande Silvery Minnow to aggregate more in deeper and lower velocity habitats when water temperatures were cooler (Dudley and Platania, 1997). The November repeated-sampling data could be particularly useful during years when this species is rare (e.g., 2012–2014), as these data provide another metric by which to assess subtle changes in its occurrence and abundance during periods of low densities. For example, the November sampling efforts yielded at least some individuals each year from 2012 to 2014, whereas the October sampling efforts yielded no individuals in 2012 or 2014. Further, the November data are even more powerful and pertinent when considered collectively as part of the site occupancy study (see Appendix B), as that study has provided a robust annual assessment of the conservation status of Rio Grande Silvery Minnow since 2005.

A qualitative examination of the mesohabitats occupied by Rio Grande Silvery Minnow was provided to obtain general information on the habitat use patterns of this species. While the physical locations of mesohabitats shift around considerably over time, established sampling protocols for this study ensured that similar mesohabitats (depths and velocities) were sampled across years. In this study, a wide variety of mesohabitats were sampled to ensure balanced monitoring for the Middle Rio Grande ichthyofaunal community and all life stages of Rio Grande Silvery Minnow. Population trends in the five different mesohabitats (BW, PO, RU, SHPO, SHRU) were quite similar over the period of study (2002–2016), despite notable differences in the estimated densities of Rio Grande Silvery Minnow among mesohabitats. The mesohabitats most frequently occupied by Rio Grande Silvery Minnow in 2016 were comparable to those occupied in past years. Densities were typically highest in lower velocity mesohabitats and lowest in higher velocity mesohabitats. General mesohabitat use patterns observed during this study were similar to those documented during past studies (e.g., Dudley and Platania, 1997).

Encouragingly, the population trends generated from the mesohabitat-specific density data (2002–2016) and sampling-site density data (1993–2016) were remarkably consistent even though they were measured on two widely different spatial scales. While either mesohabitat-specific or sampling-site density data can be used to evaluate population trends since 2002, any evaluation of population trends from 1993 to 2001 are solely dependent on sampling-site density data. As the sampling-site density data have been collected over a much longer period (1993–2016), they are more appropriate than the mesohabitat-specific density data for modeling the effects of different seasonal flow patterns (e.g., increased spring runoff) on the October occurrence and abundance of Rio Grande Silvery Minnow.

There were notable changes in the relative and rank abundance of Middle Rio Grande fish species over the past decade. The species that changed most in rank abundance over time included Rio Grande Silvery Minnow and Longnose Dace. Despite these occasionally large changes in the abundance of individual species, the overall rank abundance of Middle Rio Grande fishes remained remarkably consistent over time. The dynamic changes in species rank abundance over time could indicate that key environmental conditions are controlling species-specific abundance over time. It is possible that changes in the timing, magnitude, and duration of flows (especially during and immediately following spawning season) could be an important factor leading to the observed differences in fish species abundance over time and space. For the purpose of this study, an intense and focused effort was made to elucidate possible flow patterns that could account for the variation observed in the densities of Rio Grande Silvery Minnow. However, additional study will be required to determine those environmental factors that most influence the spatial and temporal patterns of abundance for other Rio Grande fish species.

Comparison of changes in Rio Grande Silvery Minnow occurrence and abundance in October (1993–2016) to hydrological variables measured at two Middle Rio Grande discharge gages revealed several strong ecological relationships. Peak discharge and duration of high flows during spawning season (May–June) were related to the increased occurrence and abundance of Rio Grande Silvery Minnow. In contrast, extended low flows during summer were related to its decreased occurrence and abundance. Modeling these two separate population responses (presence-absence vs. density) provided valuable insights into the long-term population trends for this species. Our analyses strongly indicated that elevated and extended spring flows were most predictive of increased density of Rio Grande Silvery Minnow in October. Similarly, increased numbers of Rio Grande Silvery Minnow collected in isolated pools during periodic river drying events from June to October (2009–2015) were closely related to elevated mean May discharge (Archdeacon, 2016).

Prolonged and elevated spring flows result in overbank flooding of vegetated areas, formation of inundated habitats within the river channel, and creation of shoreline pools and backwaters. Shallow low-velocity habitats (e.g., shoreline pools, backwaters, overbank floodplains) are essential for the successful recruitment of early life history stages of many freshwater fish species throughout the world (Welcomme, 1979; Junk et al., 1989; Matthews, 1998). It is likely that similar processes are important for the survival and recruitment of native fishes in the Middle Rio Grande (Pease et al., 2006; Turner et al., 2010; Hoagstrom and Turner, 2013).

However, many of the endemic pelagic-spawning cyprinids that historically occupied the Rio Grande basin have been extirpated from large portions of their range (Speckled Chub, *Macrhybopsis aestivalis* and Rio Grande Shiner, *Notropis jemezanus*) or have become extinct (Phantom Shiner, *Notropis orca* and Rio Grande Bluntnose Shiner, *Notropis simus simus*) over the past century (Bestgen and Platania, 1990). Rio Grande Silvery Minnow, *Hybognathus amarus*, is the only extant pelagic-spawning cyprinid in the Middle Rio Grande (Bestgen and Platania, 1991; Platania, 1991). Historically, these fishes are all thought to have spawned neutrally buoyant eggs as a result of increases in seasonal river flows (Platania and Altenbach, 1998).

For Rio Grande Silvery Minnow, elevated and extended flows during spring runoff result in an increased likelihood of spawning and a decreased downstream transport of eggs, as compared to short-duration flow increases (Dudley et al., 2016b). High and sustained flows result in the creation of productive inundated nursery habitats, which are commonly used by early life stages of this species (Dudley and Platania, 1997; Dudley et al., 2016b). River channel and floodplain inundation, based on five-day peak flow events in May (U.S. Army Corps of Engineers, 2010), appeared related to the elevated abundance of Rio Grande Silvery Minnow in October. However, this relationship was not nearly as strong as those with flow covariates that characterized elevated flows over a much longer duration (i.e., May–June). As growth from the egg through the vulnerable early larval stages (i.e., protolarvae and mesolarvae) requires about one month (Platania, 1995b), the longer-term persistence of nursery habitats is essential to help ensure the successful recruitment of young to later life stages (i.e., metalarvae and juveniles).

Sampling efforts during October (1993–2016) indicated that the highest densities of Rio Grande Silvery Minnow were nearly always in the Isleta and San Acacia reaches. This pattern has persisted over time even though upstream reaches have been regularly augmented with large numbers of hatchery-reared fish since 2002 (Archdeacon and Austring, 2016). The exceptions to this pattern occurred in years when flows in the San Acacia Reach were unusually low during the spring and summer (e.g., 2002 and 2003) or following notable augmentation efforts in the Angostura Reach. One explanation for the typical pattern of increasing abundance in downstream reaches is the cumulative longitudinal transport of propagules (drifting eggs and larvae) past instream barriers over time (Dudley and Platania, 2007). Also, river channelization, habitat degradation, abandonment of the floodplain, and reductions in suspended sediments downstream of Cochiti Dam (Lagasse, 1980; Massong et al., 2006) are likely limiting the amount of appropriate habitat available for the successful retention and recruitment of early life stages, especially in the Cochiti and Angostura reaches. Further, it is evident that seasonal inundation of side channel and floodplain habitats, combined with extensive restoration of aquatic habitat complexity, should lead to increased propagule retention and recruitment success for this and other pelagophils in Southwestern rivers (Dudley and Platania, 2007; Widmer et al., 2012; Medley and Shirey, 2013; Gonzales et al., 2014; Dudley et al., 2016b). However, the long-term efficacy of these management and restoration efforts will also depend on assuring their utility and permanence by restoring a more dynamic flow regime and reestablishing river connectivity across select fragmented reaches (Dudley and Platania, 2007).

Age-specific sampling results suggest that some downstream movement of Rio Grande Silvery Minnow (either passive or active) occurred across sampling months during 2016. The densities of both larval fish and age-0 fish peaked one to two months later in the San Acacia Reach than in the upstream reaches. It is possible that larval fish moved downstream during sustained runoff flows in June, and that juvenile fish moved downstream during monsoonal flow spikes in August. Alternatively, spawning and recruitment could have occurred later in the San Acacia Reach as compared to the upstream reaches. This seems less likely, however, considering that water temperatures, during spring and summer, are typically warmer in the downstream reaches. Also, these reach-specific results are based on more limited and unbalanced data (e.g., Angostura Reach [5 sites] vs. San Acacia Reach [9 sites]). Thus, these preliminary assessments of age-specific seasonal population trends across reaches, which were initiated in 2016, would benefit from more sampling sites (planned for 2017) and additional years of analysis.

Based on recent recommendations (Hubert et al., 2016), we also initiated new analyses this year on the full dataset and on a portion of the dataset that excluded all dry sampling sites.

While both analyses were based on the long-term density data (1993–2016), we found that our key findings (i.e., estimated densities and ecological models) were consistent regardless of whether dry sampling sites were or were not included. It appears that densities of Rio Grande Silvery Minnow were uniformly low throughout the study area during years characterized by low flows and dry sampling sites. Thus, the removal of those data from the analysis did not change our interpretation of the long-term population trends or ecological relationships.

While this analytical exercise demonstrated the stability of our research findings using two different datasets, the exclusion of data from dry sampling sites may yield biased results, particularly in years with extensive river drying. Consider the following example: In year one, fish occupy 20 sites with an estimated density of 100. In year two, fish occupy 10 sites (e.g., the lower half of the river dried), but the estimated density at the wetted sites is still 100. It seems problematic to ignore the data from dry sites as that would lead to an ecological model (which includes both occurrence and abundance) that is unchanged from year one to two (i.e., occurrence = 1.0 and density = 100 for both years). Alternatively, the inclusion of data from dry sites would lead to an occurrence estimate of 0.5 and a density estimate of 50 for year two. Similarly, a hypothetical population estimate based on this scenario would also show a marked decline between years one and two because of the absence of fish in the lower half of the river. We find it more reasonable that zeros at dry sites are true zeros (see Martin et al. [1995]), because there is a temporary loss of suitable habitat and the organism is truly absent, and that this full dataset should form the basis of any long-term data analysis.

Despite recurring and sometimes sustained declines in the abundance of Rio Grande Silvery Minnow following periods of poor spring runoff and prolonged summer low flows (e.g., 2001–2003), it is encouraging that this species has rebounded relatively quickly following consecutive years with improved spawning and recruitment conditions (e.g., 2004–2005 and 2015–2016). Similarly, the genetic diversity of this species was extremely low during the drought years of the early 2000s (Alò and Turner, 2005), but increased markedly in later years (e.g., 2005–2010), following improved flow conditions, intense augmentation efforts, and the implementation of a robust propagation management plan (Osborne et al., 2012). While there was again a precipitous decline in Rio Grande Silvery Minnow genetic diversity from 2012 to 2014, there was a substantial improvement from 2015 to 2016 (Osborne et al., 2016). These rising and falling trends in genetic diversity closely reflect the underlying trends in population size fluctuations that we have documented in our study of this species over the past two decades. However, exceptionally low levels of genetic diversity and vastly reduced densities of Rio Grande Silvery Minnow, particularly during consecutive drought years (e.g., 2012–2014), continue to threaten the ongoing persistence of this species in the Middle Rio Grande.

While extensive management efforts over the past two decades have provided invaluable protection against the extinction of Rio Grande Silvery Minnow in the wild, continued and ongoing efforts (e.g., restoring natural river flows, reconnecting fragmented reaches, and reestablishing a functional floodplain [U.S. Fish and Wildlife Service, 2016]) should help to promote resilient and self-sustaining populations over time. Encouragingly, both the occurrence and abundance of this imperiled species increased markedly in 2015 and 2016, as compared with recent drought years (2012–2014), following notably improved spring and summer flow conditions (see Appendix B for additional analyses). Continued efforts to provide reasonable spring spawning and summer survival conditions, even if at threshold levels during consecutive drought years, will be essential for securing a self-sustaining population in the Middle Rio Grande. Future study of the relationships among fish species and seasonal river flows in the Rio Grande Basin should continue to elucidate key factors that control this complex aquatic ecosystem, which will be essential for developing and implementing successful management strategies for the long-term recovery of Rio Grande Silvery Minnow.

ACKNOWLEDGMENTS

We thank Leiah K. Atchison, W. Howard Brandenburg, Stephani L. Clark-Barkalow, Michael A. Farrington, Eliza I. Gilbert, Richard C. Keller, Jennifer L. Kennedy, Curtis A. Peralta, Rosalee A. Reese, and Alex J. Schroeder (American Southwest Ichthyological Researchers, L.L.C.; Museum of Southwestern Biology-UNM) for their assistance with the field, laboratory, and data entry portions of this study. Alexandra M. Snyder (Museum of Southwestern Biology-UNM) graciously provided ongoing assistance with all aspects of curating preserved specimens. Numerous people from a variety of local, state, and federal agencies also collaborated to make this project possible. The City of Rio Rancho (Department of Parks, Recreation, and Community Services), through the assistance of Dyane Sonier, allowed us access to Site 3. The City of Albuquerque (Open Space Division), through the assistance of Jolynn Maestas, allowed us access to multiple sampling sites throughout the Albuquerque area. The Sevilleta National Wildlife Refuge, with the assistance of Jon Erz, provided us access to Site 11. The Bosque del Apache National Wildlife Refuge, with the help of Bernard Lujan, allowed us access to Site 17. The U.S. Bureau of Reclamation (USBR), with the assistance of Susan Woods, provided us access to multiple sampling sites in the San Acacia Reach. The Middle Rio Grande Conservancy District (MRGCD), through the assistance of Ray Gomez, provided us access to multiple sampling locations in the Angostura and Isleta reaches. Jennifer A. Bachus and Frederick G. Marsh (USBR) assisted with all logistical and contract administration aspects of this project. Michael D. Porter and Dana M. Price (U.S. Army Corps of Engineers), Jennifer A. Bachus, Eric J. Gonzales, and Brian M. Hobbs (USBR), and Thomas P. Archdeacon and Joel D. Lusk (U.S. Fish and Wildlife Service) provided helpful reviews of the draft report. The U.S. Fish and Wildlife Service authorized our handling and collection of Rio Grande Silvery Minnow as part of this study (Permit TE001623-4). The N.M. Department of Game and Fish authorized our collection of all other native and nonnative fishes (Permit 1896). The Middle Rio Grande Endangered Species Collaborative Program funded this study and the USBR Area Offices (Albuquerque, New Mexico and Salt Lake City, Utah) administered all funds (Contract GS-10F-0249X: Order R15PD00171).

LITERATURE CITED

Akaike, H. 1973. Information theory as an extension of the maximum likelihood principle. Pages 267–281 *in* B. N. Petrov and F. Csáki, editors. Second international symposium on information theory, Akadémiai, Budapest.

Al-Chokhachy, R., P. Budy, and M. Conner. 2009. Detecting declines in the abundance of a bull trout (*Salvelinus confluentus*) population: understanding the accuracy, precision, and costs of our efforts. Canadian Journal of Fisheries and Aquatic Sciences 66:649–658.

Alò, D., and T. F. Turner. 2005. Effects of habitat fragmentation on effective population size in the endangered Rio Grande Silvery Minnow. Conservation Biology 19:1138–1148.

Archdeacon, T. P. 2016. Reduction in spring flow threatens Rio Grande Silvery Minnow: trends in abundance during river intermittency. Transactions of the American Fisheries Society 145:754–765.

Archdeacon, T. P., and T. J. Austring. 2016. Rio Grande Silvery Minnow augmentation in the Middle Rio Grande, NM. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA.

Armantrout, N. B. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society, Bethesda, Maryland, USA.

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

Bestgen, K. R., and S. P. Platania. 1991. Status and conservation of the Rio Grande Silvery Minnow, *Hybognathus amarus*. Southwestern Naturalist 36:225–232.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. Second edition. Springer-Verlag, New York, New York, USA.

Dudley, R. K., D. A Helfrich, and S. P. Platania. 2009. Effects of river intermittency on populations of Rio Grande Silvery Minnow. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.1.2661.2640

Dudley, R. K., and S. P. Platania. 1997. Mesohabitat use of Rio Grande Silvery Minnow. Report to the New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA and to the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.1.1874.8324

Dudley, R. K., and S. P. Platania. 1998. 1996 population monitoring of Rio Grande Silvery Minnow. Report to the U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.1.4533.1362

Dudley, R. K., and S. P. Platania. 1999. 1997 population monitoring of Rio Grande Silvery Minnow. Report to the U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.1.3758.9924

Dudley, R. K., and S. P. Platania. 2002. 2001 population monitoring of Rio Grande Silvery Minnow. Report to the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.1.5069.7127

Dudley, R. K., and S. P. Platania. 2007. Flow regulation and fragmentation imperil pelagic-spawning riverine fishes. Ecological Applications 17: 2074–2086.

Dudley, R. K., S. P. Platania, and G. C. White. 2016a. Rio Grande Silvery Minnow population monitoring program results from February to December 2015. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.2.27029.93923

Dudley, R. K., S. P. Platania, and G. C. White. 2016b. Rio Grande Silvery Minnow reproductive monitoring during 2016 in the Rio Grande and selected irrigation canals. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.2.32063.10407

Dudley, R. K., G. C. White, S. P. Platania, and D. A Helfrich. 2012. Rio Grande Silvery Minnow population estimation program results from October 2011. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.1.4201.3601

Fletcher, D., D. Mackenzie, and E. Villouta. 2005. Modelling skewed data with many zeros: A simple approach combining ordinary and logistic regression. Environmental and Ecological Statistics 12: 45–54.

Gonzales, E. J., D. Tave, and G. M. Haggerty. 2014. Endangered Rio Grande Silvery Minnow use constructed floodplain habitat. Ecohydrology 7:1087–1093.

Hoagstrom, C. W., and T. F. Turner. 2013. Recruitment ecology of pelagic-broadcast spawning minnows: paradigms from the ocean advance science and conservation of an imperilled freshwater fauna. Fish and Fisheries 16: 282–299.

Horwitz, R. J., D. H. Keller, P. F. Overbeck, S. P. Platania, and R. K. Dudley. 2011. Age and growth of Rio Grande Silvery Minnow. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA.

Hubert, W. A, M. C. Fabrizio, and R. M. Hughes. 2016. Summary of findings by the external expert panelists: Rio Grande Silvery Minnow population monitoring workshop. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA.

Jennings, C. A, B. L. Sloss, B. A. Lasee, G. J. Burtle, and G. R. Moyer. 2012. Care, handling, and examination of sampled organisms. Pages 163–221 *in* A. V. Zale, D. L. Parrish, and T. M. Sutton, editors. Fisheries techniques. Second edition. American Fisheries Society, Bethesda, Maryland, USA.

Johnson, D. H. 2008. In defense of the indices: the case of bird surveys. The Journal of Wildlife Management 72:857–868.

Junk, W. J., P. B. Bayley, and R. E. Sparks. 1989. The flood pulse concept in river-floodplain systems. Pages 110–127 *in* D. P. Dodge, editor. Proceedings of the International Large River Symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106, Department of Fisheries and Oceans, Ottawa, Canada.

Lagasse, P. F. 1980. An assessment of the response of the Rio Grande to dam construction — Cochiti to Isleta reach. Report to the U.S. Army Corps of Engineers, Albuquerque, New Mexico, USA.

Martin, T. G., B. A. Wintle, J. R. Rhodes, P. M. Kuhnert, S. A. Field, S. J. Low-Choy, A. J. Tyre, and H. P. Possingham. 2005. Zero tolerance ecology: improving ecological inference by modelling the source of zero observations. Ecology Letters 8:1235–1246.

Massong, T. M., P. J. Tashjian, and P. W. Makar. 2006. Recent channel incision and floodplain evolution within the Middle Rio Grande, NM. Joint Eighth Federal Interagency Sedimentation Conference and Third Federal Interagency Hydrologic Modeling Conference, Reno, Nevada, USA.

Matthews, W. J. 1998. Patterns in freshwater fish ecology. Chapman and Hall, London, UK.

Medley, C. N., and P. D. Shirey. 2013. Review and reinterpretation of Rio Grande Silvery Minnow reproductive ecology using egg biology, life history, hydrology, and geomorphology information. Ecohydrology 6:491–505.

Osborne, M. J., E. W. Carson, and T. F. Turner. 2012. Genetic monitoring and complex population dynamics: insights from a 12-year study of the Rio Grande Silvery Minnow. Evolutionary Applications 5:553–574.

Osborne, M. J., T. J. Pilger, and T. F. Turner. 2016. Genetic monitoring of the Rio Grande Silvery Minnow: Genetic status of wild and captive stocks in 2016. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA.

Otis, D. L., K. P. Burnham, G. C. White, and D. R. Anderson. 1978. Statistical inference from capture data on closed animal populations. Wildlife Monographs 62:3–135.

Page, L. M., H. Espinosa-Pérez, L. T. Findley, C. R. Gilbert, R. N. Lea, N. E. Mandrak, R. L. Mayden, and J. S. Nelson. 2013. Common and scientific names of fishes from the United States, Canada, and Mexico. Seventh edition. American Fisheries Society, Special Publication 34, Bethesda, Maryland, USA.

Pease, A. A., J. J. Davis, M. S. Edwards, and T. F. Turner. 2006. Habitat and resource use by larval and juvenile fishes in an arid-land river (Rio Grande, New Mexico). Freshwater Biology 51:475–486.

Pinheiro, J. C., and D. M. Bates. 1995. Approximations to the log-likelihood function in the nonlinear mixed-effects model. Journal of Computational and Graphical Statistics 4:12–35.

Platania, S. P. 1991. Fishes of the Rio Chama and Upper Rio Grande, New Mexico, with preliminary comments on their longitudinal distribution. Southwestern Naturalist 36:186–193.

Platania, S. P. 1993a. The fishes of the Rio Grande between Velarde and Elephant Butte Reservoir and their habitat associations. Report to the New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA and to the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA.

Platania, S. P. 1993b. Ichthyofaunal survey of the Rio Grande and Santa Fe River, Cochiti Pueblo, New Mexico, July 1993. Report to the U.S. Army Corps of Engineers, Albuquerque, New Mexico, USA.

Platania, S. P. 1995a. Ichthyofaunal survey of the Rio Grande, Santo Domingo and San Felipe pueblos, New Mexico, July 1994. Report to the U.S. Army Corps of Engineers, Albuquerque, New Mexico, USA.

Platania, S. P. 1995b. Reproductive biology and early life-history of Rio Grande Silvery Minnow, *Hybognathus amarus*. Report to the U.S. Army Corps of Engineers, Albuquerque, New Mexico, USA.

Platania, S. P., and C. S. Altenbach. 1998. Reproductive strategies and egg types of seven Rio Grande Basin cyprinids. Copeia 1998:559–569.

SAS software, Version 9.2 of the SAS System for Linux. Copyright © 2016 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, North Carolina, USA.

Skalski, J. R., A. Hoffmann, and S. G. Smith. 1993. Testing the significance of individual- and cohort-level covariates in animal survival studies. Pages 9–28 *in* J. D. Lebreton and P. M. North, editors. Marked individuals in the study of bird population. Birkhäuser Verlag, Basel, Switzerland.

Turner, T. F., T. J. Krabbenhoft, and A. S. Burdett. 2010. Reproductive phenology and fish community structure in an arid-land river system. Pages 427–446 *in* K. B. Gido and D. A. Jackson, editors. Community ecology of stream fishes: concepts, approaches, and techniques. American Fisheries Society, Symposium Series 73, Bethesda, Maryland, USA.

U.S. Army Corps of Engineers. 2010. Historic inundation analysis along the Middle Rio Grande for the period 1990 to 2009. Report to the Middle Rio Grande Endangered Species Collaborative Program — Population Viability Analysis Work Group, Albuquerque, New Mexico, USA.

U.S. Department of the Interior. 1994. Endangered and threatened wildlife and plants: final rule to list the Rio Grande Silvery Minnow as an endangered species. Federal Register 59:36988–36995.

U.S. Fish and Wildlife Service. 2016. Final biological and conference opinion for Bureau of Reclamation, Bureau of Indian Affairs, and non-federal water management and maintenance activities on the Middle Rio Grande, New Mexico. U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, New Mexico, USA.

Welcomme, R. L. 1979. The fisheries ecology of floodplain rivers. Longman, London, UK.

Welsh, A. H., R. B. Cunningham, C. F. Donnelly, and D. B. Lindenmayer. 1996. Modelling the abundance of rare species: statistical models for counts with extra zeros. Ecological Modelling 88:297–308.

White, G. C. 1978. Estimation of plant biomass from quadrat data using the lognormal distribution. Journal of Range Management 31:118–120.

Widmer, A. M., J. J. Fluder, J. W. Kehmeier, C. N. Medley, and R. A. Valdez. 2012. Drift and retention of pelagic spawning minnow eggs in a regulated river. River Research and Applications 28:192–203.

Zar, J. H. 2010. Biostatistical Analysis. Fifth edition. Prentice Hall Inc., Upper Saddle River, New Jersey, USA.

APPENDIX A (Sampling Sites)

Middle Rio Grande Fish Sampling Sites

Table A - 1. Sampling reaches and sites for population monitoring of Rio Grande Silvery Minnow in the Middle Rio Grande, NM.

Reach and Site	Locality
Angostura Reach	
1	New Mexico, Sandoval County, Rio Grande, downstream of Angostura Diversion Dam, Algodones. River Mile: 209.7; UTM Easting: 363811; UTM Northing: 3916006; Zone: 13S; Datum: NAD27
2	New Mexico, Sandoval County, Rio Grande, upstream of US Highway 550 bridge crossing, Bernalillo. River Mile: 203.8; UTM Easting: 358543; UTM Northing: 3909722; Zone: 13S; Datum: NAD27
3	New Mexico, Sandoval County, Rio Grande, ca. 4.0 miles downstream of US Highway 550 bridge crossing, at Rio Rancho Wastewater Treatment Plant, Rio Rancho. River Mile: 200.0; UTM Easting: 354772; UTM Northing: 3905355; Zone: 13S; Datum: NAD27
4	New Mexico, Bernalillo County, Rio Grande, upstream of Central Avenue (US Highway 66) bridge crossing, Albuquerque. River Mile: 183.4; UTM Easting: 346840; UTM Northing: 3884094; Zone: 13S; Datum: NAD27
5	New Mexico, Bernalillo County, Rio Grande, upstream of Rio Bravo Boulevard bridge crossing, Albuquerque. River Mile: 178.3; UTM Easting: 347554; UTM Northing: 3877163; Zone: 13S; Datum: NAD27
Isleta Reach	
6	New Mexico, Valencia County, Rio Grande, ca. 0.3 miles upstream of Los Lunas (NM State Highway 49) bridge crossing, Los Lunas. River Mile: 161.4; UTM Easting: 342898; UTM Northing: 3852531; Zone: 13S; Datum: NAD27
7	New Mexico, Valencia County, Rio Grande, ca. 1.0 miles upstream of NM State Highway 309/6 bridge crossing, Belen. River Mile: 151.5; UTM Easting: 339972; UTM Northing: 3837061; Zone: 13S; Datum: NAD27
8	New Mexico, Valencia County, Rio Grande, ca. 2.2 miles upstream of NM State Highway 346 bridge crossing, Jarales. River Mile: 143.2; UTM Easting: 338136; UTM Northing: 3827329; Zone: 13S; Datum: NAD27
9	New Mexico, Socorro County, Rio Grande, upstream of US Highway 60 bridge crossing, Bernardo. River Mile: 130.6; UTM Easting: 334604; UTM Northing: 3809726; Zone: 13S; Datum: NAD27
10	New Mexico, Socorro County, Rio Grande, ca. 3.5 miles downstream of US Highway 60 bridge crossing, La Joya. River Mile: 127.0; UTM Easting: 331094; UTM Northing: 3805229; Zone: 13S; Datum: NAD27
11	New Mexico, Socorro County, Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia. River Mile: 116.8; UTM Easting: 327902; UTM Northing: 3792603; Zone: 13S; Datum: NAD27

Table A - 1. Sampling reaches and sites for population monitoring of Rio Grande Silvery Minnow in the Middle Rio Grande, NM (continued).

Reach and Site	Locality
San Acacia Reach	
12	New Mexico, Socorro County, Rio Grande, downstream of San Acacia Diversion Dam, San Acacia. River Mile: 116.2; UTM Easting: 326162; UTM Northing: 3791977; Zone: 13S; Datum: NAD27
13	New Mexico, Socorro County, Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia. River Mile: 114.6; UTM Easting: 325263; UTM Northing: 3790442; Zone: 13S; Datum: NAD27
14	New Mexico, Socorro County, Rio Grande, ca. 0.5 miles upstream of the Low Flow Conveyance Channel bridge, east and upstream of Socorro Wastewater Treatment Plant, Socorro. River Mile: 99.5; UTM Easting: 327097; UTM Northing: 3771043; Zone: 13S; Datum: NAD27
15	New Mexico, Socorro County, Rio Grande, ca. 4.0 miles upstream of US Highway 380 bridge crossing, San Antonio. River Mile: 91.7; UTM Easting: 328140; UTM Northing: 3761283; Zone: 13S; Datum: NAD27
16	New Mexico, Socorro County, Rio Grande, upstream of US Highway 380 bridge crossing, San Antonio. River Mile: 87.1; UTM Easting: 328914; UTM Northing: 3754471; Zone: 13S; Datum: NAD27
17	New Mexico, Socorro County, Rio Grande, directly east of Bosque del Apache National Wildlife Refuge headquarters, San Antonio. River Mile: 79.1; UTM Easting: 327055; UTM Northing: 3740839; Zone: 13S; Datum: NAD27
18	New Mexico, Socorro County, Rio Grande, downstream of the San Marcial railroad crossing, San Marcial. River Mile: 68.6; UTM Easting: 315284; UTM Northing: 3728347; Zone: 13S; Datum: NAD27
19	New Mexico, Socorro County, Rio Grande, at its former confluence with the Low Flow Conveyance Channel and 16 miles downstream of the southern end of the Bosque del Apache National Wildlife Refuge, San Marcial. River Mile: 60.5; UTM Easting: 309487; UTM Northing: 3718178; Zone: 13S; Datum: NAD27
20	New Mexico, Socorro County, Rio Grande, ca. 10.0 miles downstream of the San Marcial Railroad Bridge crossing, San Marcial. River Mile: 58.8; UTM Easting: 307846; UTM Northing: 3716150; Zone: 13S; Datum: NAD27

APPENDIX B (Site Occupancy Analysis)

INTRODUCTION

Techniques to estimate the presence-absence and abundance of organisms, which do not require full site depletion or marking and recapture of individuals, have been shown to be reliable for a variety of species (e.g., Royle and Nichols, 2003). Statistical methods have been developed that account for the inherent heterogeneity of population abundance across different sites. Data on the presence-absence of organisms provide useful information about the probabilities that underlie spatial patterns of abundance in the environment and for detecting trends in population status (MacKenzie et al., 2003). In other words, the absence of a species during sampling does not necessarily mean that the species is truly absent from the area (MacKenzie et al., 2002; Finley et al., 2005; White, 2005). Occupancy surveys provide a way to assess the likelihood of detecting the presence or absence of a species by calculating the probability based on the detection history (i.e., previous information on presence-absence can be used to predict the likelihood of non-detection vs. absence).

As a result of our initial study to assess the variability of estimated densities of Rio Grande Silvery Minnow across multiple days of sampling, which commenced in 2005, a new dataset was created that provided an opportunity to simultaneously study the site occupancy patterns of this species over time. This dataset was based on repeated sampling efforts at our 20 long-term monitoring sites during the month of November (2005–2016). While the first few years of sampling yielded only preliminary results and relatively simplistic models, this study now includes a series of robust occupancy models that consider estimates of the probability of occupancy, extinction, and colonization for multiple age-classes. While these estimates are based on data collected at numerous sampling sites and are indicative of range-wide trends, they are not absolute measurements of conservation status (i.e., extinction refers to loss of the species from individual sites [extirpation] as opposed to complete loss of the species from the wild). Long-term trend assessments are also now possible because of the continuous and consistent monitoring of Rio Grande Silvery Minnow over the entire site-occupancy study period.

Estimates of historical patterns of site occupancy can also be used to complement data collected during the long-term population monitoring study (1993–2016). In contrast to the population monitoring study, which documents trends over multiple intervals (i.e., monthly or annual) for the entire ichthyofaunal community, this study provides targeted estimates of Rio Grande Silvery Minnow site occupancy rates across years. The objective of this study is to evaluate changes in the probability of occupancy, extinction, and colonization for different age-classes (age-0, age-1+, and all age-classes combined) of Rio Grande Silvery Minnow over the period of study.

METHODS

Repeated sampling data from population monitoring efforts (multi-day sampling efforts during November [2005–2016]) were used to generate estimates of site occupancy rates based on methods developed by MacKenzie et al. (2002, 2003, 2006). This study was conducted using the same sampling protocols and sites established for the long-term population monitoring study. Mesohabitats were sampled at the same locations on subsequent days except in rare cases (e.g., location moved slightly because of increased water velocity). Developing site occupancy rates for Rio Grande Silvery Minnow enabled assessment of the likelihood of detecting its presence or absence by calculating the detection history probability. The encounter history was based on the presence or absence of wild Rio Grande Silvery Minnow at the sampling sites based on four repeated sampling efforts. For example, an encounter history of 1101 at a particular site meant that individuals were collected on days one, two, and four but not on day three. A higher proportion of presence encounters indicated that individuals were more consistently detected at the site over time.

We constructed a multi-year statistical model based on patterns of occupancy using sampling-site data to better understand Rio Grande Silvery Minnow population dynamics over time. Site occupancy was the proportion of sites occupied relative to those surveyed. The site occupancy estimate for each site was based on the probability of detection estimate (and its associated variance) and the actual site occupancy data calculated from the raw data. In this way, the probability of occupancy was corrected using the probability of detection estimate (MacKenzie et al., 2006). A higher degree of consistency across days (either 0000 or 1111) will result in a site occupancy model that yields results that more closely match those obtained from the original estimate of site occupancy based on a single survey. We assumed that sampling sites were large enough (ca. 200 m) that it was quite unlikely that the site would change in status from occupied to unoccupied across sequential days. Additional assumptions included that there could be no false detections, that there could be sites where the species was present but undetected, and that species detection at any site was independent of species detection at other sites. The encounter history data from the 20 sampling sites allowed for a robust-design model of occupancy (MacKenzie et al., 2003), based on annual sampling efforts (i), to estimate the probability of occupancy (ψ_i, i = 1, 2, 3...), the probability of extinction given a sampling site was occupied (ε_i, i = 2, 3...), the probability of colonization given a sampling site was not occupied (γ_i, i = 2, 3...), and the detection probability (p_i, i = 1, 2, 3...).

Site occupancy models were constructed, using Program MARK (White and Burnham, 1999), for different age-classes (age-0, age-1+, and all age-classes combined) with year (Year) and sampling occasion (Occasion) as covariates. Models were considered that allowed detection probabilities to vary by site and reach. Likewise, the probability of occupancy was allowed to vary by reach. The Akaike Information Criterion, corrected for small sample sizes (AIC_c; Akaike, 1973; Burnham and Anderson, 2002), was used to select the most parsimonious site occupancy model based on the encounter history data. Annual estimates of the occupancy, extinction, and colonization probabilities, for the different age-classes, were generated based on the year model (i.e., ψ[Null] ε[Year] γ[Year] p[Year]). Associated measures of sampling variance and profile likelihood confidence intervals were generated for all parameter estimates, following the methods of MacKenzie et al. (2006).

RESULTS

Multi-year models, based on patterns of occupancy, were developed for different age-classes of Rio Grande Silvery Minnow using long-term (2005–2016) sampling-site data (Table B-1). The top AIC_c model, for age-0 fish only, had constant occupancy (psi, ψ) and colonization (gamma, γ) probabilities but extinction (epsilon, ε) and detection (p) probabilities that varied across years. For age-1+ fish only, the top AIC_c model had constant occupancy and extinction probabilities but colonization and detection probabilities that varied across years. The top AIC_c model, for all age-classes combined, had constant occupancy and colonization probabilities but extinction and detection probabilities that varied across years. Models that included sampling occasion (e.g., ψ(Null) ε(Year) γ(Year) p(Year*Occasion)) received essentially no AIC_c weight for any of the age-class analyses, indicating that the day of sampling was not informative in explaining variation in p over time.

Age-0 Fish Only

For age-0 fish only, estimates of site occupancy probability (ψ) progressively declined from 2009 to 2013 but improved markedly since 2014 (Figure B-1). While ψ declined from 1.00 in 2005 to 0.43 in 2013, it returned to an elevated level (0.90) by 2015. There was, however, increased uncertainty in site occupancy probabilities during years when individuals were absent from many sites over multiple sampling days (e.g., 2012–2014).

Extinction probability estimates were elevated from 2012 to 2014 as compared with 2005 to 2011 (Figure B-2). The most recent estimates of extinction probability (2015–2016) indicated a marked improvement as compared with previous estimates (e.g., 2012–2014). However, so few sites were occupied in 2013–2014 that there were not many sites left where the status could change from present to absent in 2015. Similarly, the estimated colonization probability could not be estimated from 2012 to 2014 because of the rarity of age-0 fish during that period. Since 2005, estimated colonization probabilities were generally highest following periods of elevated extinction probabilities. The highest colonization probabilities occurred from 2014 to 2016, as age-0 individuals were detected at many sites that were unoccupied in 2013.

Age-1+ Fish Only

For age-1+ fish only, estimates of site occupancy probability (ψ) showed a progressive decline from 2010 to 2013 but with a modest improvement since 2014 (Figure B-3). The values of ψ declined from 0.85 in 2010 to 0.0 in 2013. However, there has been an increase in site occupancy probabilities of age-1+ fish over the past few years, particularly from 2014 to 2015. There was increased uncertainty in site occupancy probabilities during years when individuals were absent from many sites over multiple sampling days (e.g., 2011–2014).

Estimates of the probability of extinction were elevated from 2011 to 2013 as compared with 2008 to 2010 (Figure B-4). The most recent estimates of extinction probability (2014–2016) indicated a marked improvement as compared with the preceding years (e.g., 2011–2013). However, so few sites were occupied in 2014 that there were not many sites left where the status could change from present to absent in 2015. Similarly, valid estimates of the extinction and colonization probabilities could not be obtained during 2013–2014 because of the absence of age-1+ fish in 2013. Colonization probabilities recently reached elevated levels in 2015, as age-1+ individuals were detected at several sites that were unoccupied in 2014.

Table B - 1. Rio Grande Silvery Minnow site occupancy analyses, for different age-classes, based on repeated site sampling efforts in November (2005–2016).

Models for age-0 fish only[1]	logLike[2]	K[3]	AIC_c[4]	w_i[4]
ψ(Null) ε(Year) γ(Null) *p*(Year)	481.75	25	315.08	0.9669
ψ(Null) ε(Null) γ(Year) *p*(Year)	488.49	25	321.83	0.0331
ψ(Null) ε(Year) γ(Year) *p*(Year)	468.26	35	380.76	<0.0001
ψ(Null) ε(Year) γ(Year) *p*(Year*Occasion)	438.50	71	383.88	<0.0001
ψ(Null) ε(Year) γ(Null) *p*(Year*Occasion)	448.45	61	390.36	<0.0001

Models for age-1+ fish only[1]	logLike[2]	K[3]	AIC_c[4]	w_i[4]
ψ(Null) ε(Null) γ(Year) *p*(Year)	833.53	25	666.86	0.8118
ψ(Null) ε(Year) γ(Null) *p*(Year)	836.57	25	669.90	0.1779
ψ(Null) ε(Year) γ(Year) *p*(Null)	867.59	24	675.59	0.0104
ψ(Null) ε(Year) γ(Year) *p*(Year*Occasion)	778.85	71	724.23	<0.0001
ψ(Null) ε(Year) γ(Year) *p*(Year)	817.22	35	729.72	<0.0001

Models for all age-classes combined[1]	logLike[2]	K[3]	AIC_c[4]	w_i[4]
ψ(Null) ε(Year) γ(Null) *p*(Year)	529.70	25	363.04	0.9758
ψ(Null) ε(Null) γ(Year) *p*(Year)	537.10	25	370.43	0.0242
ψ(Null) ε(Year) γ(Year) *p*(Year*Occasion)	474.75	71	420.13	<0.0001
ψ(Null) ε(Year) γ(Year) *p*(Year)	514.06	35	426.56	<0.0001
ψ(Null) ε(Year) γ(Null) *p*(Year*Occasion)	492.45	61	434.36	<0.0001

[1] = Model parameters included ψ = probability of occupancy, ε = probability of extinction, γ = probability of colonization, and *p* = detection probability. Model variables included year (2005–2016) and sampling occasion (i.e., the 1st, 2nd, 3rd, or 4th day of sampling).

[2] = Likelihood (-2[log-likelihood]) was estimated for each model.

[3] = Higher numbers of parameters indicate higher model complexity.

[4] = Top five models were ranked by Akaike's information criterion (AIC_c) and include the AIC_c weight (w_i).

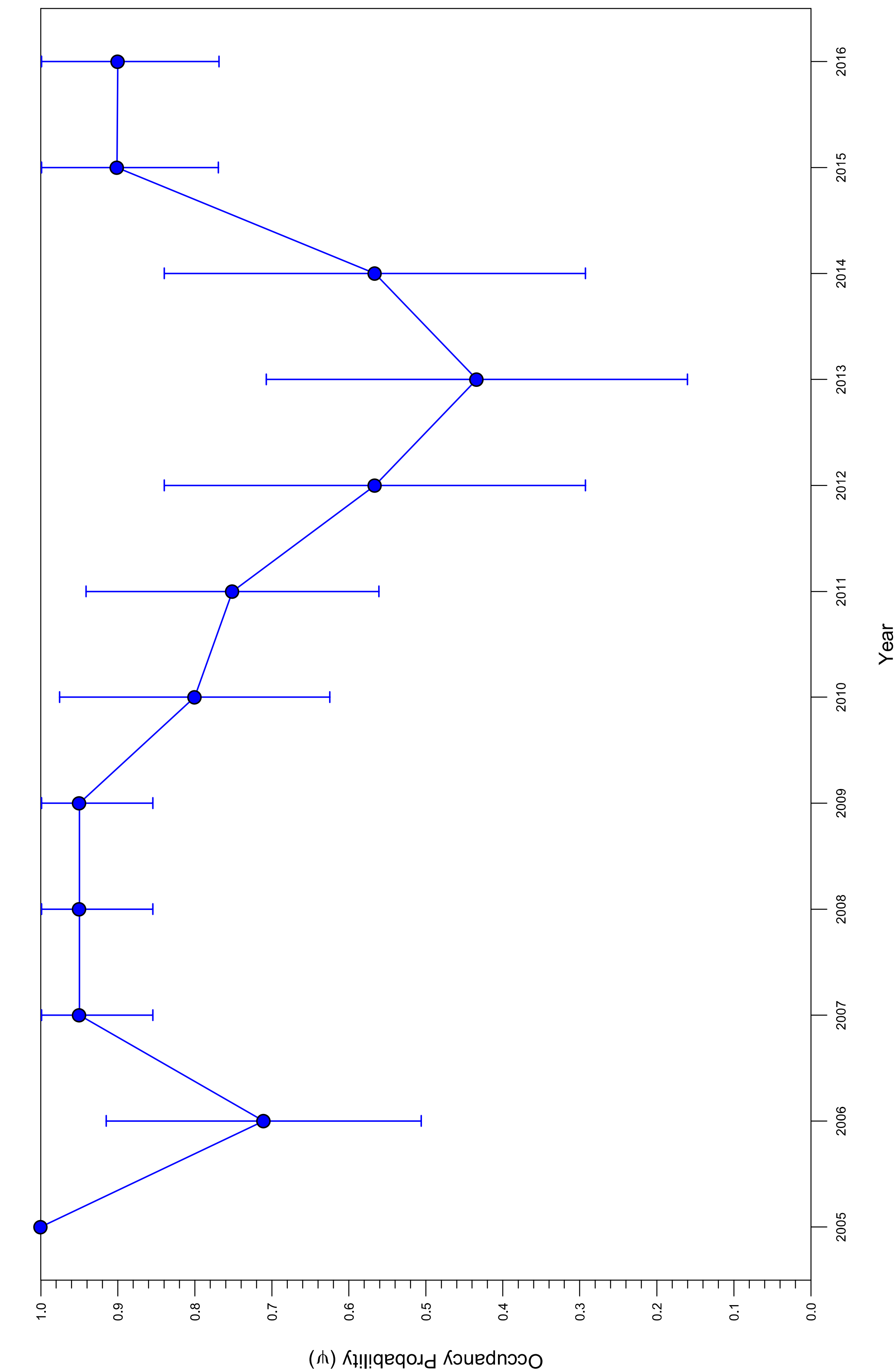


Figure B - 1. Site occupancy probability for Rio Grande Silvery Minnow (age-0 fish only) based on repeated site sampling efforts across years. Circles indicate means and capped-bars represent 95% confidence intervals.

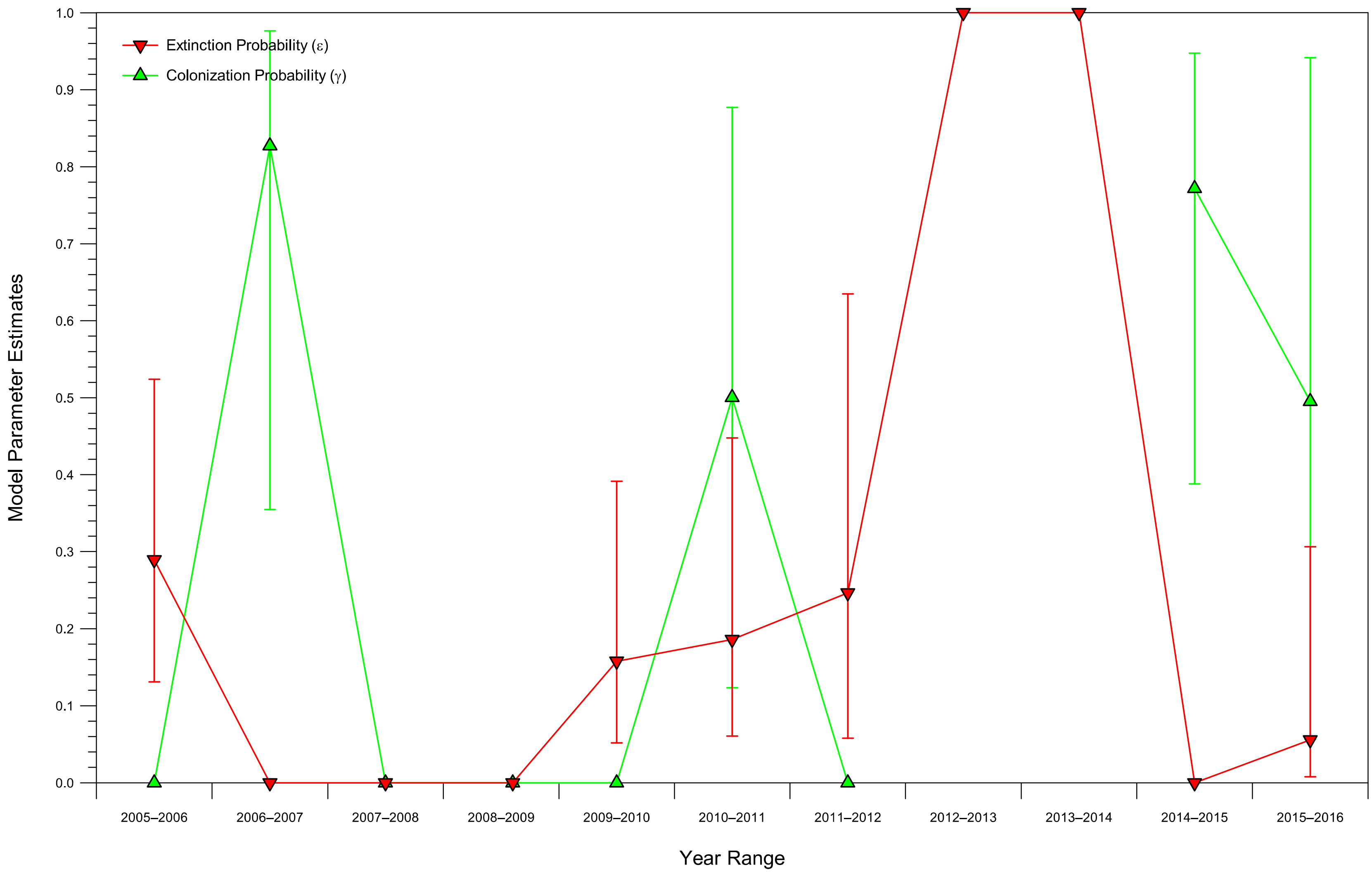


Figure B - 2. Site occupancy model estimates (extinction probability and colonization probability) for Rio Grande Silvery Minnow (age-0 fish only) based on repeated site sampling efforts across years. Symbols indicate means and capped-bars represent 95% confidence intervals.

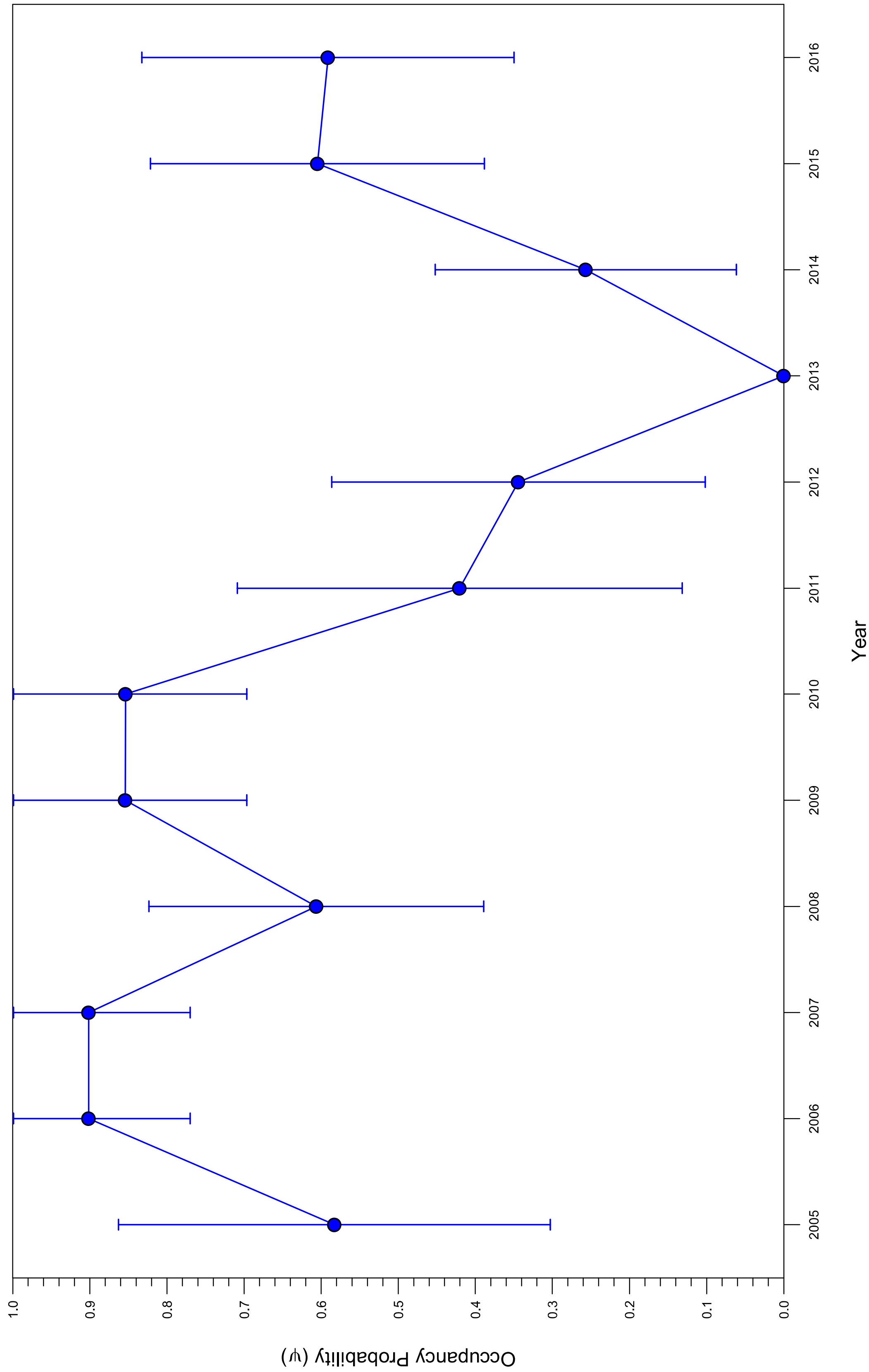


Figure B - 3. Site occupancy probability for Rio Grande Silvery Minnow (age-1+ fish only) based on repeated site sampling efforts across years. Circles indicate means and capped-bars represent 95% confidence intervals.

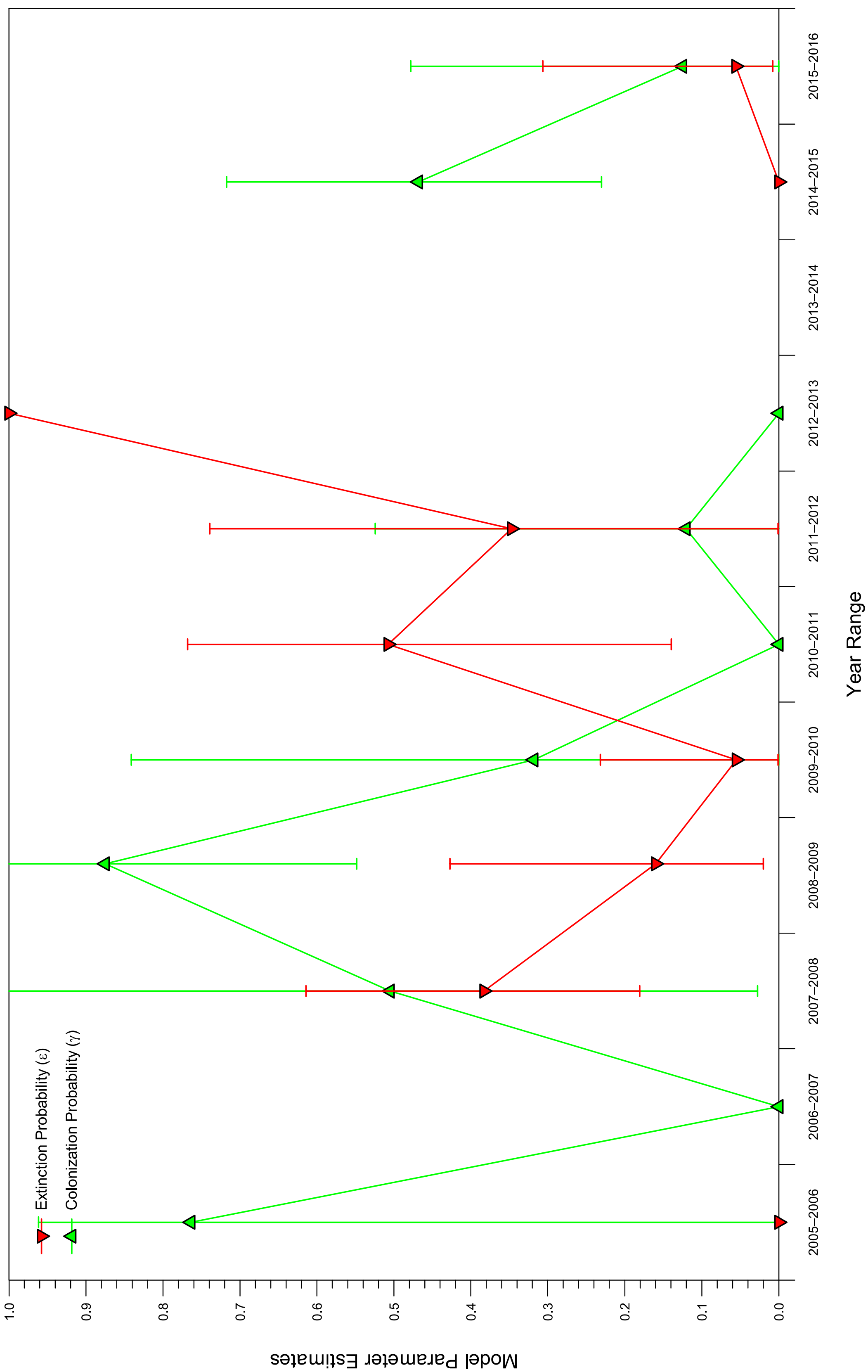


Figure B - 4. Site occupancy model estimates (extinction probability and colonization probability) for Rio Grande Silvery Minnow (age-1+ fish only) based on repeated site sampling efforts across years. Symbols indicate means and capped-bars represent 95% confidence intervals.

All Age-Classes Combined

For all age-classes combined, estimates of site occupancy probability (ψ) showed a progressive decline from 2009 to 2013 but with a marked improvement from 2014 to 2015 (Figure B-5). The values of ψ declined from 0.95 in 2009 to 0.14 in 2013 but rose again quickly by 2015 (ψ = 0.90). Similar to results obtained from the individual age-classes, there was increased uncertainty in site occupancy probabilities during years when individuals were absent from many sites over multiple sampling days (e.g., 2012–2014).

Estimates of the probability of extinction were notably elevated from 2012 to 2014 as compared with 2005 to 2011 (Figure B-6). The most recent estimates of extinction probability (2014–2016) indicated a marked improvement as compared with estimates based on data collected from 2012 to 2013. However, so few sites were occupied from 2013 to 2014 that there were not many sites left where the species status could change from present to absent in 2015. While the estimated colonization probability was very low from 2005 to 2010, it increased somewhat from 2011 to 2013 as the status of a few of the sampling sites changed from absent to present. There was a more substantial increase in the estimated colonization probability in 2014 and 2015, as Rio Grande Silvery Minnow was progressively detected at many sites that were unoccupied in 2013.

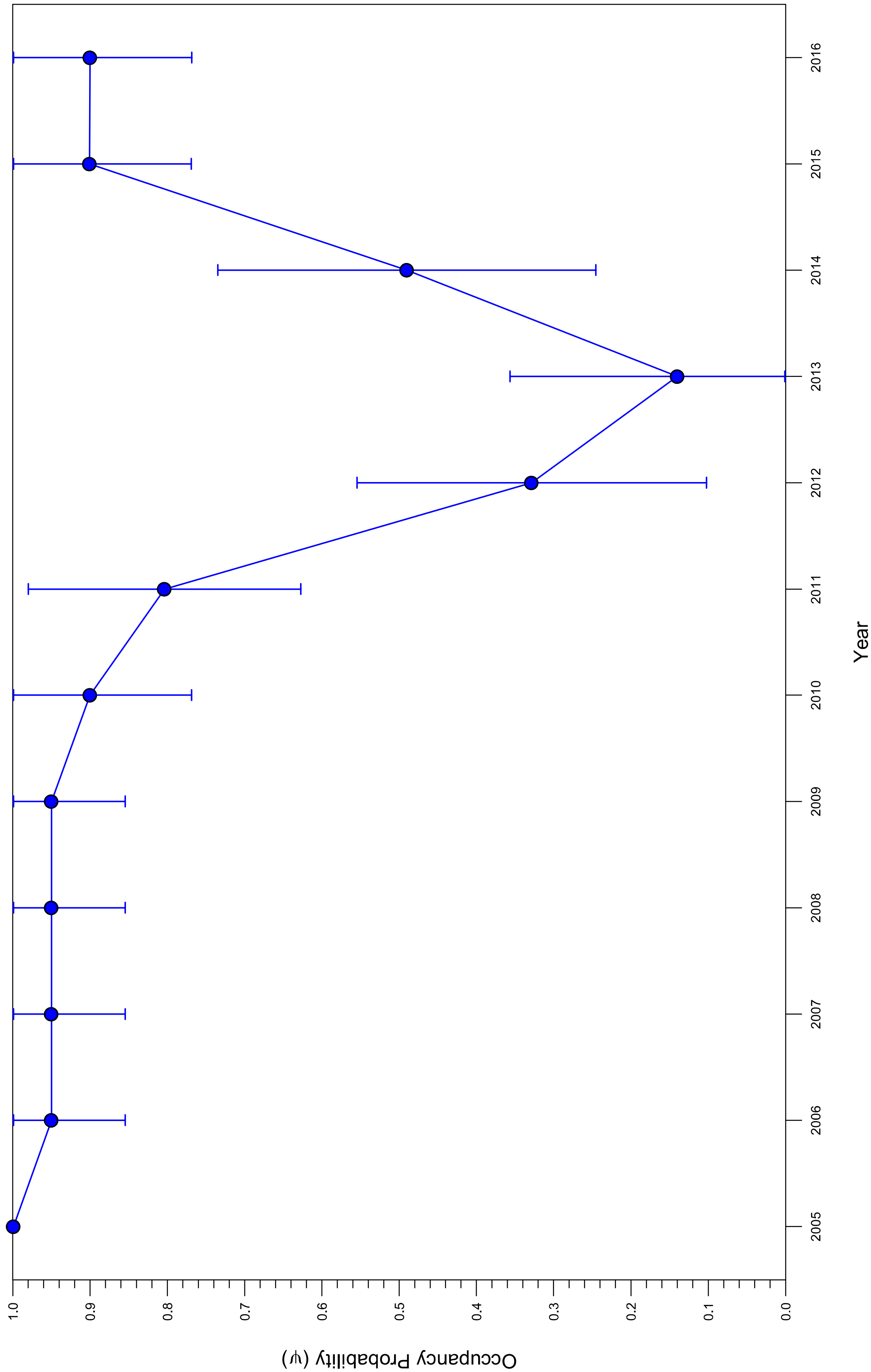


Figure B - 5. Site occupancy probability for Rio Grande Silvery Minnow (all age-classes combined) based on repeated site sampling efforts across years. Circles indicate means and capped-bars represent 95% confidence intervals.

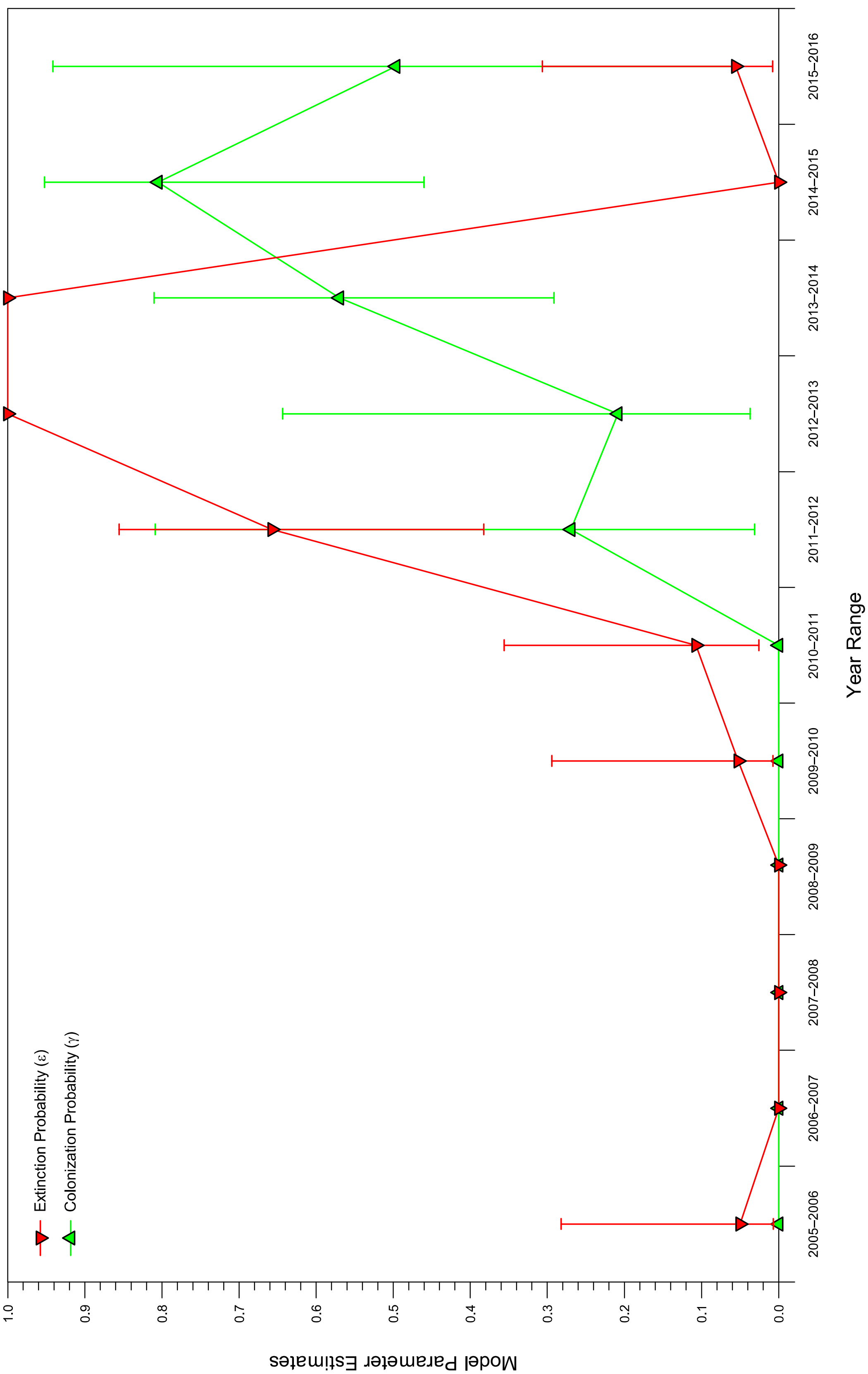


Figure B - 6. Site occupancy model estimates (extinction probability and colonization probability) for Rio Grande Silvery Minnow (all age-classes combined) based on repeated site sampling efforts across years. Symbols indicate means and capped-bars represent 95% confidence intervals.

DISCUSSION

There are numerous benefits to documenting the long-term site occupancy rates of species over time, particularly for rare species like Rio Grande Silvery Minnow, which may be difficult to detect using traditional single-survey monitoring efforts. From 2005 to 2016, we estimated the occupancy, extinction, and colonization probabilities for Rio Grande Silvery Minnow based on repeated sampling efforts in November. By evaluating trends in these probabilities over time, we were able to assess the changing conservation status of this species across a wide range of environmental conditions (e.g., high spring flows vs. low summer flows).

Multi-year statistical models suggest that occupancy, extinction, and colonization probabilities will continue to have larger confidence intervals during years when this species is rare as compared to when it is abundant. While the sampling design for this study matched that of the long-term population monitoring study, the twenty sampling sites were sampled four times during the site occupancy study vs. once during the population monitoring study. Although the site occupancy sampling intensity was quite adequate during periods of modest abundance and occurrence, the ability to precisely estimate site occupancy rates was somewhat compromised during periods of very low abundance and occurrence (e.g., during drought years [2012–2014]).

Site occupancy analyses for all age-classes combined, based on repeated sampling data (2005–2016), revealed that the most parsimonious model had extinction and detection probabilities varying by year but that estimates of the probability of occupancy and colonization remained constant over time. While the same model also received the most weight for age-0 fish, a model that included colonization and detection varying by year was most parsimonious for age-1+ fish. However, the results for age-1+ fish should be interpreted cautiously because of their relatively low numbers across the study period. Models were not averaged (i.e., only minimum AIC_c model was used) because some parameters had SE = 0, which precluded model averaging and required that profile likelihood confidence intervals (range = 0–1) be used. While site occupancy estimates, for all age-classes combined, were very low from 2012 to 2014, recent estimates indicated a substantial increase since 2014.

Extinction probabilities reached their highest levels, and colonization probabilities reached their lowest levels, during a recent period (2012–2014) that coincided with an extended drought in the Middle Rio Grande. This general pattern was true for both age-0 and age-1+ individuals and was indicative of the truncated spring runoff and low summer flows that characterized that period. In contrast, the improved spring runoff and summer flows of recent years (2015–2016) have led to increased colonization probabilities and decreased extinction probabilities.

Although the extinction and colonization probabilities of age-0 and age-1+ fish showed similar trends over time, their timing often seemed to be offset by a year. For example, although age-0 fish had elevated extinction probabilities in 2006 following poor spring runoff (i.e., poor recruitment of age-0 in 2006), age-1+ fish had elevated colonization probabilities during 2006 (i.e., good recruitment of age-0 fish in 2005). The persistence of age-1+ fish during 2006 was probably quite important, as these older fish appeared to buffer the population from an even more precipitous decline in 2006 and likely led to a relatively quick recovery of age-0 fish during 2007. This was in contrast to the multiple years of recruitment failure that characterized recent drought years (2012–2014), where both age-classes became progressively uncommon or absent throughout the study area. While the balance of extinction and colonization probabilities from 2014 to 2016 was still not as favorable as it was during the early years of this study (2005–2009), the conservation status of Rio Grande Silvery Minnow showed encouraging signs of improvement from 2014 to 2016.

The current conservation status of Rio Grande Silvery Minnow could change dramatically, however, if there are consecutive years of either persistently low or high flows during the crucial spring spawning and summer survival periods. As has been observed recently (e.g., 2011–2015), site occupancy rates can change suddenly across years depending on unforeseen changes in seasonal flow conditions. Thus, the occupancy, extinction, and colonization probabilities should be viewed as an analysis of historical data as opposed to a prediction of future trends.

The site occupancy results should also be used in combination with the population monitoring results to provide a more robust understanding of the conservation status of Rio Grande Silvery Minnow over time. Specifically, the probability of extinction is a valuable metric by which to assess the vulnerability of the population during extended periods of poor flow conditions and decreasing numbers of individuals. Consistently high extinction probabilities, low colonization probabilities, and low estimated densities across years (e.g., 2012–2014) indicate potentially imminent threats to the persistence of Rio Grande Silvery Minnow in the wild.

Although the combined results of the site occupancy and population monitoring studies should facilitate a more comprehensive assessment of the conservation status of Rio Grande Silvery Minnow, an increase in sampling effort (e.g., more sites, larger sites, or more samples per site) would increase the accuracy and precision of the resulting estimates. The strength of inference will ultimately be strongly dependent on these fundamental aspects of the overall study design (MacKenzie et al., 2006). However, we found that hypothetically doubling the number of sampling sites, as compared to doubling the sampling effort at existing sites, resulted in much more precise population estimates across years (Dudley et al., 2012). Despite inherent challenges of monitoring rare species, the current site occupancy study has provided valuable information on the occurrence of this species, even during periods of unusually low abundance (e.g., 2012–2014). It is apparent that the combination of the site occupancy and population monitoring studies, despite the practical limitations of extensively modifying the existing study designs, has improved our ability to discern trends in the occurrence and abundance of Rio Grande Silvery Minnow over the past decade.

It is well established that simply having large numbers of individuals is inadequate for ensuring the long-term persistence of a species (Groom et al., 2006). This is particularly true for short-lived species such as Rio Grande Silvery Minnow. The dramatic population fluctuations of this species, often within a short duration, underscore the need to ensure the presence of individuals over a broad geographical range. Different seasonal flow conditions often result in rapid changes in the occurrence and abundance of Rio Grande Silvery Minnow over time (Dudley et al., 2016). For example, poor spring runoff conditions sometimes inhibit spawning and limit recruitment to such a degree that densities have declined several orders of magnitude within a single year. Additionally, river drying during drought years has regularly resulted in the loss of Rio Grande Silvery Minnow over substantial portions of its occupied range in the Middle Rio Grande. The short life span of this species (Horwitz et al., 2011) means that, following periods of poor recruitment, the population is not well buffered by surviving members of older age-classes. Thus, the establishment of Rio Grande Silvery Minnow at multiple locations within its current and historical range would help ensure its long-term persistence in the wild.

The success of this project will be evaluated annually, but insight into the efficacy of estimating occupancy, colonization, and extinction probabilities of Rio Grande Silvery Minnow will require a long-term commitment to consistent and robust monitoring. Data from future year's efforts will provide additional information that will supplement current site occupancy analyses and furnish valuable information necessary to assess long-term changes in the conservation status of this species. Ultimately, those data can be used to evaluate progress towards achieving the long-term recovery of Rio Grande Silvery Minnow, following both management actions and stochastic environmental events.

LITERATURE CITED

Akaike, H. 1973. Information theory as an extension of the maximum likelihood principle. Pages 267–281 *in* B. N. Petrov and F. Csáki, editors. Second international symposium on information theory, Akadémiai, Budapest.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. Second edition. Springer-Verlag, New York, New York, USA.

Dudley, R. K., S. P. Platania, and G. C. White. 2016. Rio Grande Silvery Minnow population monitoring program results from February to December 2015. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.2.27029.93923

Dudley, R. K., G. C. White, S. P. Platania, and D. A Helfrich. 2012. Rio Grande Silvery Minnow population estimation program results from October 2011. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA. DOI: 10.13140/RG.2.1.4201.3601

Finley, D. J., G. C. White, and J. P. Fitzgerald. 2005. Estimation of swift fox population size and occupancy rates in eastern Colorado. Journal of Wildlife Management 69:861–873.

Groom, M. J., G. K. Meffe, and C. R. Carroll. 2006. Principles of Conservation Biology. Third edition. Sinauer Associates, Inc., Sunderland, Massachusetts, USA.

Horwitz, R. J., D. H. Keller, P. F. Overbeck, S. P. Platania, and R. K. Dudley. 2011. Age and growth of Rio Grande Silvery Minnow. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico, USA.

MacKenzie, D. I., J. D. Nichols, J. E. Hines, M. G. Knutson, and A. B. Franklin. 2003. Estimating site occupancy, colonization, and local extinction when a species is detected imperfectly. Ecology 84:2200–2207.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83:2248–2255.

MacKenzie, D. I., J. D. Nichols, J. A. Royle, K. H. Pollock, L. L. Bailey, and J. E. Hines. 2006. Occupancy Estimation and Modeling: Inferring Patterns and Dynamics of Species Occurrence. Elsevier, Amsterdam, Netherlands.

Royle, J. A., and J. D. Nichols. 2003. Estimating abundance from repeated presence-absence data or point counts. Ecology 84:777–790.

White, G. C. 2005. Correcting wildlife counts using detection probabilities. Wildlife Research 32:211–216.

White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46 (supplement):S120–S139.

APPENDIX C (Water Quality Summary)

Table C - 1. Water quality summary statistics, by reach and site, using data collected from February to December 2016.

Reach	Water Quality Measurements (Mean [Standard Error])[1]						
Site and Locality	Sec.	Temp.	Sal.	D.O.	Con. T.	Con. S.	pH
Angostura Reach							
1 Angostura Dam	42.8 (9.9)	15.4 (2.5)	0.1 (0)	8.5 (0.3)	184.3 (10.4)	237.9 (12.4)	8.1 (0.1)
2 Bernalillo	30.7 (5.7)	16.9 (2.5)	0.1 (0)	8.7 (0.3)	193.6 (5.3)	243.5 (11.2)	8.2 (0.1)
3 Rio Rancho	29.2 (5.2)	17.7 (2.6)	0.1 (0)	8.6 (0.3)	197.7 (7.1)	239.7 (11.4)	8.2 (0.1)
4 Central Ave.	16.3 (2.5)	16 (2.4)	0.1 (0)	8.1 (0.5)	202.8 (8.6)	282.7 (21.4)	8.2 (0.1)
5 Rio Bravo Blvd.	15.6 (2.8)	14.4 (2.6)	0.1 (0)	8.7 (0.5)	221.5 (27.8)	259.2 (12.8)	8.2 (0.1)
Isleta Reach							
6 Los Lunas	16.6 (2)	22.1 (2.9)	0.1 (0)	7.8 (0.5)	281.8 (23.8)	312.2 (16.3)	8.1 (0.1)
7 Belen	14.4 (2)	22.1 (2.9)	0.2 (0)	7.9 (0.6)	289.8 (13)	310.2 (14.7)	8.4 (0.2)
8 Jarales	14.7 (1.3)	19.9 (2.6)	0.2 (0)	8.3 (0.4)	283.4 (21.6)	351.3 (24.4)	8.2 (0.1)
9 Bernardo	15.2 (2.1)	18.4 (2.4)	0.2 (0)	8 (0.4)	320.5 (45.9)	331.5 (24.5)	8.2 (0.1)
10 La Joya	12.3 (2.1)	17.4 (2.7)	0.2 (0)	7.8 (0.3)	274.1 (11)	399.3 (51.2)	8.1 (0.1)
11 North of San Acacia	9.2 (1.9)	19.9 (2.3)	0.2 (0)	8.1 (0.4)	416.7 (NA)	410.5 (37.3)	8.2 (0.1)
San Acacia Reach							
12 San Acacia Dam	12.8 (2.6)	18.8 (2.2)	0.2 (0)	8.3 (0.3)	374.1 (NA)	443.8 (56.8)	8.2 (0.1)
13 South of San Acacia	10.9 (1.7)	18.8 (2.3)	0.2 (0)	7.8 (0.5)	344.4 (38.8)	425.3 (41.2)	8.2 (0.1)
14 Socorro	9.6 (1.7)	18.3 (2.6)	0.2 (0)	8.4 (0.4)	301.2 (75.2)	434.8 (60.1)	8.2 (0.1)
15 North of San Antonio	8.6 (1.9)	16.7 (2.5)	0.2 (0)	8.5 (0.5)	244 (NA)	419.4 (41.5)	8.4 (0.1)
16 San Antonio	8.6 (1.9)	22.6 (2.7)	0.2 (0)	7.3 (0.8)	274.1 (NA)	421.1 (50)	8.1 (0.3)
17 South of San Antonio	7.9 (1.1)	19.6 (2.7)	0.2 (0)	6.9 (0.9)	341.6 (70.2)	448.4 (45.6)	8 (0.3)
18 San Marcial	13.7 (4.7)	19.9 (3.1)	0.2 (0)	8.7 (0.4)	256.6 (6.5)	428.5 (50.6)	8.1 (0.3)
19 South of San Marcial 1	14.1 (6.3)	18.2 (2.8)	0.2 (0)	8.2 (0.5)	252.5 (4.3)	407.6 (43.4)	8 (0.3)
20 South of San Marcial 2	10.2 (2.9)	17.1 (2.8)	0.2 (0)	8 (0.5)	274.4 (19.7)	443.9 (54.7)	8 (0.3)

[1] = Water quality descriptions (Based on USGS definitions [e.g., National field manual for the collection of water-quality data]):
Sec. = Secchi depth (cm); Disk with black and white quadrants for measuring water clarity
Temp. = Water Temperature (°C); Accurate measurements taken to compute other water quality parameters
Sal. = Salinity (ppt); Concentration of dissolved salts in the water
D.O. = Dissolved Oxygen (mg/l); Concentration of dissolved oxygen in the water
Con. T. = True Conductivity (μS/cm); Electrical conductance of the water
Con. S. = Specific Conductance (μS/cm); Con. T. corrected for water temperature
pH = pH; Concentration of hydrogen ions in the water

APPENDIX D (Site-Specific Ichthyofaunal Composition)

Site-specific ichthyofaunal composition during the 2016
Rio Grande Silvery Minnow population monitoring study

Monthly and annual reports, along with raw data, are available at:
http://mrgescp.dbstephens.com

Funded by: U.S. Bureau of Reclamation

Contract GS-10F-0249X: Order R15PD00171

Rio Grande Silvery Minnow Population Monitoring
February 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-018**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 08 February 2016
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13S Datum: NAD27
RK Dudley, JL Kennedy, RC Keller Effort: 552.3 sq. m

Family	Species	Total
76	*Platygobio gracilis*	1
76	*Rhinichthys cataractae*	1
81	*Catostomus commersonii*	1

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-019**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 08 February 2016
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13S Datum: NAD27
RK Dudley, JL Kennedy, RC Keller Effort: 553.5 sq. m

Family	Species	Total
76	*Platygobio gracilis*	1

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-020**
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing, at Rio Rancho Wastewater Treatment Plant, Rio Rancho.

Site Number: 3 River Mile: 200.0 08 February 2016
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13S Datum: NAD27
RK Dudley, JL Kennedy, RC Keller Effort: 642.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	1
76	*Platygobio gracilis*	2

Rio Grande Silvery Minnow Population Monitoring
February 2016

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-017**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 08 February 2016
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13S Datum: NAD27
RK Dudley, JL Kennedy, RC Keller Effort: 566.5 sq. m

Family	Species	Total
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	1

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-016**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 08 February 2016
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13S Datum: NAD27
RK Dudley, JL Kennedy, RC Keller Effort: 576.5 sq. m

Family	Species	Total
	No Fish Collected	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-015**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 11 February 2016
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13S Datum: NAD27
MA Farrington, JL Kennedy, RC Keller Effort: 527.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	23
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	2

Rio Grande Silvery Minnow Population Monitoring
February 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-014**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 11 February 2016
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13S Datum: NAD27
MA Farrington, JL Kennedy, RC Keller Effort: 602.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	107
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	2

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	2

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-013**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 11 February 2016
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13S Datum: NAD27
MA Farrington, JL Kennedy, RC Keller Effort: 584.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	22
76	*Hybognathus amarus**	2
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	2
294	*Pomoxis annularis*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	2
age-2+	

Rio Grande Silvery Minnow Population Monitoring
February 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-012**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 11 February 2016
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13S Datum: NAD27
MA Farrington, JL Kennedy, RC Keller Effort: 547.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	6
76	*Hybognathus amarus**	6
76	*Platygobio gracilis*	4

***Hybognathus amarus* (age-classes):**

age-0	
age-1	4
age-2+	2

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-011**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 11 February 2016
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13S Datum: NAD27
MA Farrington, JL Kennedy, RC Keller Effort: 555.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	129
76	*Hybognathus amarus**	22
76	*Pimephales promelas*	5
76	*Platygobio gracilis*	1
212	*Gambusia affinis*	11

***Hybognathus amarus* (age-classes):**

age-0	
age-1	20
age-2+	2

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-010**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 10 February 2016
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13S Datum: NAD27
WH Brandenburg, JL Kennedy, RC Keller Effort: 611.3 sq. m

Family	Species	Total
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	9

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	

Rio Grande Silvery Minnow Population Monitoring
February 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-009**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 10 February 2016
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13S Datum: NAD27
WH Brandenburg, JL Kennedy, RC Keller Effort: 566.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	14
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	18

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-008**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 10 February 2016
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13S Datum: NAD27
WH Brandenburg, JL Kennedy, RC Keller Effort: 581.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	26
76	*Hybognathus amarus**	7
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	17
93	*Ictalurus punctatus*	2

***Hybognathus amarus* (age-classes):**

age-0	
age-1	6
age-2+	1

Rio Grande Silvery Minnow Population Monitoring
February 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-007**
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Socorro Wastewater Treatment Plant, Socorro.

Site Number: 14 River Mile: 99.5 10 February 2016
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13S Datum: NAD27
WH Brandenburg, JL Kennedy, RC Keller Effort: 602.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	1
76	*Hybognathus amarus**	37
76	*Platygobio gracilis*	6

***Hybognathus amarus* (age-classes):**

age-0	
age-1	37
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-006**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 10 February 2016
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13S Datum: NAD27
WH Brandenburg, JL Kennedy, RC Keller Effort: 578.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	3
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	6
76	*Platygobio gracilis*	4
93	*Ictalurus punctatus*	4

***Hybognathus amarus* (age-classes):**

age-0	
age-1	6
age-2+	

Rio Grande Silvery Minnow Population Monitoring
February 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-005**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 09 February 2016
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13S Datum: NAD27
JL Kennedy, SL Clark Barkalow, RC Keller Effort: 622.5 sq. m

Family	Species	Total
76	*Hybognathus amarus**	10
76	*Platygobio gracilis*	3
93	*Ictalurus punctatus*	2

***Hybognathus amarus* (age-classes):**

age-0	
age-1	10
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-004**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 09 February 2016
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13S Datum: NAD27
JL Kennedy, SL Clark Barkalow, RC Keller Effort: 579.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	3
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	10

***Hybognathus amarus* (age-classes):**

age-0	
age-1	3
age-2+	

Rio Grande Silvery Minnow Population Monitoring
February 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-003**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 09 February 2016
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13S Datum: NAD27
JL Kennedy, SL Clark Barkalow, RC Keller Effort: 561.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	5
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	2

***Hybognathus amarus* (age-classes):**

age-0	
age-1	
age-2+	1

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-002**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 09 February 2016
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13S Datum: NAD27
JL Kennedy, SL Clark Barkalow, RC Keller Effort: 578.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	21
76	*Hybognathus amarus**	14
93	*Ictalurus punctatus*	7

***Hybognathus amarus* (age-classes):**

age-0	
age-1	14
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-001**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 09 February 2016
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13S Datum: NAD27
JL Kennedy, SL Clark Barkalow, RC Keller Effort: 606.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Hybognathus amarus**	7
93	*Ictalurus punctatus*	5

***Hybognathus amarus* (age-classes):**

age-0	
age-1	6
age-2+	1

Rio Grande Silvery Minnow Population Monitoring
April 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-038**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 04 April 2016
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 476.4 sq. m

Family	Species	Total
76	*Platygobio gracilis*	4
76	*Rhinichthys cataractae*	5
81	*Catostomus commersonii*	1

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-039**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 04 April 2016
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 556.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	18
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	41
76	*Rhinichthys cataractae*	2
81	*Catostomus commersonii*	2

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-040**
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing, at Rio Rancho Wastewater Treatment Plant, Rio Rancho.

Site Number: 3 River Mile: 200.0 04 April 2016
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 555.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	4
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	7
93	*Ictalurus punctatus*	1

Rio Grande Silvery Minnow Population Monitoring
April 2016

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-037**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 04 April 2016
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 529.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	5
76	*Hybognathus amarus**	4
76	*Pimephales promelas*	5
76	*Platygobio gracilis*	13
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	1
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	4
age-2+	

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-036**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 04 April 2016
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 542.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	3
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	2
age-2+	

Rio Grande Silvery Minnow Population Monitoring
April 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-035**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 07 April 2016
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A.J. Schroeder Effort: 512.1 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	101
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	1

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-034**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 07 April 2016
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A.J. Schroeder Effort: 526.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	69
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	3

***Hybognathus amarus* (age-classes):**

age-0	
age-1	
age-2+	1

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-033**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 07 April 2016
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A.J. Schroeder Effort: 510.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	107
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	2

Rio Grande Silvery Minnow Population Monitoring
April 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-032**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 07 April 2016
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A.J. Schroeder Effort: 521.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	194
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	4
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	18

***Hybognathus amarus* (age-classes):**

age-0	
age-1	3
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-031**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 07 April 2016
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A.J. Schroeder Effort: 490.6 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	19
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	

Rio Grande Silvery Minnow Population Monitoring
April 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-030**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 06 April 2016
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 526.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	7
76	*Platygobio gracilis*	22
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	2

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-029**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 06 April 2016
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 528.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	147
76	*Hybognathus amarus**	10
76	*Platygobio gracilis*	44
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	5

***Hybognathus amarus* (age-classes):**

age-0	
age-1	9
age-2+	1

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-028**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 06 April 2016
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 514.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	120
76	*Hybognathus amarus**	4
76	*Platygobio gracilis*	19
93	*Ictalurus punctatus*	11

***Hybognathus amarus* (age-classes):**

age-0	
age-1	4
age-2+	

Rio Grande Silvery Minnow Population Monitoring
April 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-027**
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Socorro Wastewater Treatment Plant, Socorro.

Site Number: 14 River Mile: 99.5 06 April 2016
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 555.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	31
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	12
93	*Ictalurus punctatus*	8

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-026**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 06 April 2016
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 493.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	7
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	4

***Hybognathus amarus* (age-classes):**

age-0	
age-1	6
age-2+	1

Rio Grande Silvery Minnow Population Monitoring
April 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-025**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 05 April 2016
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 550.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	14
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	2
76	*Rhinichthys cataractae*	1
93	*Ictalurus punctatus*	2

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-024**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 05 April 2016
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 467.8 sq. m

Family	Species	Total
69	*Dorosoma cepedianum*	2
76	*Cyprinella lutrensis*	46
76	*Hybognathus amarus**	1
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	2

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-023**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 05 April 2016
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 556.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	72
93	*Ictalurus punctatus*	2

Rio Grande Silvery Minnow Population Monitoring
April 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-022**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 05 April 2016
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 489.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	57
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	2
76	*Pimephales vigilax*	1
93	*Ictalurus punctatus*	4
93	*Pylodictis olivaris*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-021**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 05 April 2016
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 561.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	38
76	*Pimephales vigilax*	4
93	*Ictalurus punctatus*	3

Rio Grande Silvery Minnow Population Monitoring
May 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-058**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 10 May 2016
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13S Datum: NAD27
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 508.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	7
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	4
76	*Rhinichthys cataractae*	52
81	*Catostomus commersonii*	185

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-059**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 10 May 2016
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13S Datum: NAD27
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 534.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	8
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	105
76	*Rhinichthys cataractae*	71
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	397
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	1

Rio Grande Silvery Minnow Population Monitoring
May 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-060**
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing, at Rio Rancho Wastewater Treatment Plant, Rio Rancho.

Site Number: 3 River Mile: 200.0 10 May 2016
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13S Datum: NAD27
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 524.8 sq. m

Family	Species	Total
76	*Hybognathus amarus**	4
76	*Pimephales promelas*	5
76	*Platygobio gracilis*	27
76	*Rhinichthys cataractae*	54
81	*Catostomus commersonii*	12
93	*Ictalurus punctatus*	3

***Hybognathus amarus* (age-classes):**

age-0	
age-1	4
age-2+	

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-057**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 10 May 2016
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13S Datum: NAD27
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 525.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	26
76	*Platygobio gracilis*	4
76	*Rhinichthys cataractae*	4
81	*Catostomus commersonii*	15

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-056**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 10 May 2016
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13S Datum: NAD27
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 501.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	10
76	*Platygobio gracilis*	2
81	*Catostomus commersonii*	12
93	*Ictalurus punctatus*	1

Rio Grande Silvery Minnow Population Monitoring
May 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-055**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 09 May 2016
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13S Datum: NAD27
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 477.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	68
76	*Hybognathus amarus**	8
76	*Platygobio gracilis*	2
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	6
age-2+	2

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-054**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 09 May 2016
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13S Datum: NAD27
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 566.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	126
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	1
81	*Catostomus commersonii*	6
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	8

***Hybognathus amarus* (age-classes):**

age-0	
age-1	2
age-2+	

Rio Grande Silvery Minnow Population Monitoring
May 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-053**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 09 May 2016
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13S Datum: NAD27
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 568.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	155
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	2

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-052**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 09 May 2016
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13S Datum: NAD27
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 518.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	83
76	*Hybognathus amarus**	3
76	*Platygobio gracilis*	6
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	16

***Hybognathus amarus* (age-classes):**

age-0	
age-1	3
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-051**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 09 May 2016
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13S Datum: NAD27
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 475.6 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	84
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	13
294	*Lepomis cyanellus*	1

Rio Grande Silvery Minnow Population Monitoring
May 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-050**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 03 May 2016
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 536.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	141
76	*Platygobio gracilis*	45
81	*Catostomus commersonii*	4
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	2

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-049**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 03 May 2016
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 513.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	76
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	17
93	*Ictalurus punctatus*	22
212	*Gambusia affinis*	2
294	*Pomoxis annularis*	1

Rio Grande Silvery Minnow Population Monitoring
May 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-048**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 03 May 2016
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 519.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	93
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	49
81	*Catostomus commersonii*	8
93	*Ictalurus punctatus*	21
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	1

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-047**
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Socorro Wastewater Treatment Plant, Socorro.

Site Number: 14 River Mile: 99.5 03 May 2016
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 552.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	11
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	36
93	*Ictalurus punctatus*	4

Rio Grande Silvery Minnow Population Monitoring
May 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-046**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 03 May 2016
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 476.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	1
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	1
81	*Catostomus commersonii*	3
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	2

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-045**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 02 May 2016
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 580.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	7
76	*Platygobio gracilis*	8
93	*Ictalurus punctatus*	1

Rio Grande Silvery Minnow Population Monitoring
May 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-044**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 02 May 2016
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 468.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	54
76	*Hybognathus amarus**	5
76	*Pimephales vigilax*	2
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	7
212	*Gambusia affinis*	14

***Hybognathus amarus* (age-classes):**

age-0	
age-1	5
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-043**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 02 May 2016
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 517.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	92
76	*Hybognathus amarus**	5
76	*Pimephales vigilax*	2
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	8
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	5
age-2+	

Rio Grande Silvery Minnow Population Monitoring
May 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-042**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 02 May 2016
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 532.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	128
76	*Hybognathus amarus**	2
76	*Pimephales vigilax*	4
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	4
93	*Ictalurus punctatus*	29
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	2
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-041**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 02 May 2016
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13S Datum: NAD27
R.K. Dudley, W.H. Brandenburg, J.L. Kennedy Effort: 539.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	48
76	*Pimephales vigilax*	1
93	*Ictalurus punctatus*	17

Rio Grande Silvery Minnow Population Monitoring
June 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-078**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 09 June 2016
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 486.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	13
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	5
76	*Rhinichthys cataractae*	188
81	*Catostomus commersonii*	1
294	*Lepomis macrochirus*	1

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-079**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 09 June 2016
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 483.7 sq. m

Family	Species	Total
76	*Platygobio gracilis*	79
76	*Rhinichthys cataractae*	28
81	*Catostomus commersonii*	9

Rio Grande Silvery Minnow Population Monitoring
June 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-080**
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing,
at Rio Rancho Wastewater Treatment Plant, Rio Rancho.

Site Number: 3 River Mile: 200.0 09 June 2016
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 523.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	15
76	*Cyprinus carpio*	19
76	*Hybognathus amarus**	209
76	*Pimephales promelas*	34
76	*Platygobio gracilis*	13
76	*Rhinichthys cataractae*	54
81	*Carpiodes carpio*	2
81	*Catostomus commersonii*	16

***Hybognathus amarus* (age-classes):**

age-0	208
age-1	1
age-2+	

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-077**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 09 June 2016
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 517.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	16
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	7
76	*Rhinichthys cataractae*	1
81	*Catostomus commersonii*	2

***Hybognathus amarus* (age-classes):**

age-0	2
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
June 2016

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-076**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 09 June 2016
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 512.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	24
76	*Cyprinus carpio*	3
76	*Hybognathus amarus**	42
76	*Pimephales promelas*	10
76	*Platygobio gracilis*	17
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	7
93	*Ictalurus punctatus*	2

***Hybognathus amarus* (age-classes):**

age-0	42
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-075**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 08 June 2016
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, R.A. Reese Effort: 512.6 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	16
76	*Cyprinus carpio*	23
76	*Hybognathus amarus**	844
76	*Pimephales promelas*	17
76	*Platygobio gracilis*	2
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	844
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
June 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-074**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 08 June 2016
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, R.A. Reese Effort: 507.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	1
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	1

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-073**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 08 June 2016
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, R.A. Reese Effort: 530.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	14
76	*Cyprinus carpio*	17
76	*Hybognathus amarus**	228
76	*Pimephales promelas*	5
81	*Carpiodes carpio*	27
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	2

***Hybognathus amarus* (age-classes):**

age-0	228
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
June 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-072**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 08 June 2016
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, R.A. Reese Effort: 497.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	13
76	*Cyprinus carpio*	4
76	*Hybognathus amarus**	65
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	8
81	*Carpiodes carpio*	13
93	*Ictalurus punctatus*	1

***Hybognathus amarus* (age-classes):**

age-0	65
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-071**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 08 June 2016
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, R.A. Reese Effort: 412.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	5
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	1

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-070**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 07 June 2016
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 530.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	44
76	*Platygobio gracilis*	28
81	*Catostomus commersonii*	3
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	4

Rio Grande Silvery Minnow Population Monitoring
June 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-069**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 07 June 2016
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 471.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	102
81	*Carpiodes carpio*	1
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	12
212	*Gambusia affinis*	7

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-068**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 07 June 2016
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 556.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	51
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	3
76	*Platygobio gracilis*	52
93	*Ictalurus punctatus*	7

***Hybognathus amarus* (age-classes):**

age-0	1
age-1	2
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-067**
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Socorro Wastewater Treatment Plant, Socorro.

Site Number: 14 River Mile: 99.5 07 June 2016
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 540.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	16
76	*Platygobio gracilis*	19
93	*Ictalurus punctatus*	2

Rio Grande Silvery Minnow Population Monitoring
June 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-066**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 07 June 2016
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 494.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	1
76	*Cyprinus carpio*	4
76	*Hybognathus amarus**	43
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	5
93	*Ictalurus furcatus*	1
93	*Ictalurus punctatus*	4

***Hybognathus amarus* (age-classes):**

age-0	42
age-1	1
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-065**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 06 June 2016
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 541.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	7
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	9

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-064**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 06 June 2016
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 542.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	7
76	*Platygobio gracilis*	7
93	*Ictalurus punctatus*	12

Rio Grande Silvery Minnow Population Monitoring
June 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-063**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 06 June 2016
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 688.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	22
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	1

***Hybognathus amarus* (age-classes):**

age-0	
age-1	1
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-062**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 06 June 2016
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 576.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	63
76	*Platygobio gracilis*	3
93	*Ictalurus punctatus*	13

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-061**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 06 June 2016
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 564.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	9
93	*Ictalurus punctatus*	12

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-098**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 08 July 2016
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 494.1 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	30
76	*Platygobio gracilis*	16
76	*Rhinichthys cataractae*	76
81	*Catostomus commersonii*	55
212	*Gambusia affinis*	7
294	*Lepomis cyanellus*	1
294	*Micropterus salmoides*	2
294	*Pomoxis annularis*	1
295	*Perca flavescens*	1

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-099**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 08 July 2016
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 516.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	17
76	*Cyprinus carpio*	21
76	*Hybognathus amarus**	144
76	*Platygobio gracilis*	13
76	*Rhinichthys cataractae*	50
81	*Carpiodes carpio*	7
81	*Catostomus commersonii*	44
212	*Gambusia affinis*	2
294	*Micropterus salmoides*	2

***Hybognathus amarus* (age-classes):**

age-0	141
age-1	3
age-2+	

Funded by: U.S. Bureau of Reclamation

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-100**
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing, at Rio Rancho Wastewater Treatment Plant, Rio Rancho.

Site Number: 3 River Mile: 200.0 08 July 2016
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 531.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	24
76	*Cyprinus carpio*	17
76	*Hybognathus amarus**	49
76	*Pimephales promelas*	6
76	*Platygobio gracilis*	23
76	*Rhinichthys cataractae*	10
81	*Catostomus commersonii*	9

***Hybognathus amarus* (age-classes):**

age-0	48
age-1	1
age-2+	

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-097**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 08 July 2016
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 480.6 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	24
76	*Cyprinus carpio*	86
76	*Hybognathus amarus**	207
76	*Pimephales promelas*	6
76	*Platygobio gracilis*	2
76	*Rhinichthys cataractae*	2
81	*Catostomus commersonii*	34
212	*Gambusia affinis*	20
294	*Micropterus salmoides*	7
294	*Pomoxis annularis*	1

***Hybognathus amarus* (age-classes):**

age-0	206
age-1	1
age-2+	

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-096**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 08 July 2016
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.C. Keller, A.J. Schroeder Effort: 545.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Cyprinus carpio*	15
76	*Hybognathus amarus**	69
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	13
81	*Carpiodes carpio*	123
81	*Catostomus commersonii*	4

***Hybognathus amarus* (age-classes):**

age-0	69
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-095**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 07 July 2016
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 532.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	17
76	*Cyprinus carpio*	30
76	*Hybognathus amarus**	410
76	*Pimephales promelas*	4
76	*Platygobio gracilis*	7
81	*Carpiodes carpio*	8
81	*Catostomus commersonii*	4
212	*Gambusia affinis*	12
294	*Micropterus salmoides*	2

***Hybognathus amarus* (age-classes):**

age-0	410
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-094**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 07 July 2016
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 482.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	32
76	*Cyprinus carpio*	92
76	*Hybognathus amarus**	224
76	*Pimephales promelas*	6
76	*Platygobio gracilis*	10
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	3
212	*Gambusia affinis*	63
294	*Micropterus salmoides*	4

***Hybognathus amarus* (age-classes):**

age-0	224
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-093**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 07 July 2016
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 525.6 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	65
76	*Cyprinus carpio*	54
76	*Hybognathus amarus**	21
76	*Pimephales promelas*	4
76	*Platygobio gracilis*	2
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	5
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	92
294	*Micropterus salmoides*	46

***Hybognathus amarus* (age-classes):**

age-0	21
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-092**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 07 July 2016
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 508.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	72
76	*Cyprinus carpio*	156
76	*Hybognathus amarus**	138
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	4
81	*Carpiodes carpio*	19
93	*Ameiurus natalis*	4
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	74
294	*Micropterus salmoides*	10

***Hybognathus amarus* (age-classes):**

age-0	138
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-091**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 07 July 2016
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13S Datum: NAD27
R.K. Dudley, R.C. Keller, A.J. Schroeder Effort: 475.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	38
76	*Cyprinus carpio*	128
76	*Hybognathus amarus**	49
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	14
93	*Ameiurus natalis*	5
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	35
294	*Micropterus salmoides*	17
295	*Perca flavescens*	1

***Hybognathus amarus* (age-classes):**

age-0	47
age-1	2
age-2+	

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-090**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 06 July 2016
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 469.1 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	45
76	*Cyprinus carpio*	135
76	*Hybognathus amarus**	275
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	9
81	*Catostomus commersonii*	2
93	*Ameiurus natalis*	12
93	*Ictalurus punctatus*	58
212	*Gambusia affinis*	26
294	*Micropterus salmoides*	2

***Hybognathus amarus* (age-classes):**

age-0	274
age-1	1
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-089**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 06 July 2016
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 525.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	117
76	*Cyprinus carpio*	45
76	*Hybognathus amarus**	5
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	70
76	*Rhinichthys cataractae*	1
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	63
294	*Micropterus salmoides*	1

***Hybognathus amarus* (age-classes):**

age-0	4
age-1	1
age-2+	

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-088**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 06 July 2016
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 525.7 sq. m

Family	Species		Total
76	*Cyprinella lutrensis*		39
76	*Cyprinus carpio*		31
76	*Hybognathus amarus**		29
76	*Pimephales promelas*		3
76	*Platygobio gracilis*		50
81	*Carpiodes carpio*		2
93	*Ictalurus punctatus*		5
212	*Gambusia affinis*		9
294	*Micropterus salmoides*		3
	***Hybognathus amarus* (age-classes):**		
		age-0	29
		age-1	
		age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-087**
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Socorro Wastewater Treatment Plant, Socorro.

Site Number: 14 River Mile: 99.5 06 July 2016
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 606.0 sq. m

Family	Species		Total
76	*Cyprinella lutrensis*		29
76	*Cyprinus carpio*		12
76	*Hybognathus amarus**		42
76	*Platygobio gracilis*		9
76	*Rhinichthys cataractae*		1
81	*Carpiodes carpio*		20
93	*Ameiurus natalis*		2
93	*Ictalurus punctatus*		5
212	*Gambusia affinis*		48
294	*Micropterus salmoides*		6
	***Hybognathus amarus* (age-classes):**		
		age-0	42
		age-1	
		age-2+	

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-086**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 06 July 2016
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 528.4 sq. m

Family	Species	Total
69	*Dorosoma cepedianum*	2
76	*Cyprinella lutrensis*	39
76	*Cyprinus carpio*	106
76	*Hybognathus amarus**	218
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	26
81	*Carpiodes carpio*	73
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	54
294	*Micropterus salmoides*	1

***Hybognathus amarus* (age-classes):**

age-0	215
age-1	3
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-085**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 05 July 2016
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 531.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	11
76	*Cyprinus carpio*	119
76	*Hybognathus amarus**	162
76	*Platygobio gracilis*	15
81	*Carpiodes carpio*	10
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	28
212	*Gambusia affinis*	20

***Hybognathus amarus* (age-classes):**

age-0	162
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-084**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 18 July 2016
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 86.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	31
76	*Cyprinus carpio*	61
76	*Hybognathus amarus**	84
76	*Pimephales promelas*	9
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	7
93	*Ictalurus furcatus*	1
93	*Ictalurus punctatus*	19
93	*Pylodictis olivaris*	1
212	*Gambusia affinis*	32

***Hybognathus amarus* (age-classes):**

age-0	84
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-083**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 05 July 2016
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 528.0 sq. m

Family	Species	Total
69	*Dorosoma cepedianum*	2
76	*Cyprinella lutrensis*	43
76	*Cyprinus carpio*	72
76	*Hybognathus amarus**	25
76	*Pimephales promelas*	1
81	*Carpiodes carpio*	3
212	*Gambusia affinis*	19
294	*Micropterus salmoides*	1

***Hybognathus amarus* (age-classes):**

age-0	25
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
July 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-082**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 05 July 2016
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 523.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	5
76	*Cyprinus carpio*	30
76	*Hybognathus amarus**	24
76	*Pimephales promelas*	5
76	*Pimephales vigilax*	1
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	4
93	*Ictalurus furcatus*	2
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	16

***Hybognathus amarus* (age-classes):**

age-0	24
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-081**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 05 July 2016
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 548.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	19
76	*Cyprinus carpio*	22
76	*Hybognathus amarus**	3
81	*Carpiodes carpio*	1
93	*Ictalurus furcatus*	6
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	29
295	*Percina macrolepida*	1

***Hybognathus amarus* (age-classes):**

age-0	3
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-118**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 04 August 2016
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A. J. Schroeder Effort: 510.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	4
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	15
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	18
76	*Rhinichthys cataractae*	65
81	*Catostomus commersonii*	22
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	18
212	*Gambusia affinis*	61
294	*Micropterus salmoides*	19
295	*Perca flavescens*	1

***Hybognathus amarus* (age-classes):**

age-0	15
age-1	
age-2+	

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-119**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 04 August 2016
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A. J. Schroeder Effort: 487.6 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	42
76	*Cyprinus carpio*	9
76	*Hybognathus amarus**	199
76	*Pimephales promelas*	6
76	*Platygobio gracilis*	30
76	*Rhinichthys cataractae*	71
81	*Catostomus commersonii*	20
93	*Ameiurus natalis*	7
93	*Ictalurus punctatus*	87
212	*Gambusia affinis*	10
294	*Micropterus salmoides*	1

***Hybognathus amarus* (age-classes):**

age-0	199
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-120**
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing, at Rio Rancho Wastewater Treatment Plant, Rio Rancho.

Site Number: 3 River Mile: 200.0 04 August 2016
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A. J. Schroeder Effort: 523.6 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	61
76	*Cyprinus carpio*	11
76	*Hybognathus amarus**	21
76	*Platygobio gracilis*	68
76	*Rhinichthys cataractae*	22
81	*Catostomus commersonii*	12
93	*Ameiurus natalis*	2
93	*Ictalurus punctatus*	81
212	*Gambusia affinis*	1
294	*Micropterus salmoides*	1

***Hybognathus amarus* (age-classes):**

age-0	21
age-1	
age-2+	

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-117**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 04 August 2016
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A. J. Schroeder Effort: 507.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	42
76	*Cyprinus carpio*	16
76	*Hybognathus amarus**	127
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	22
76	*Rhinichthys cataractae*	1
81	*Catostomus commersonii*	8
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	40
212	*Gambusia affinis*	30

***Hybognathus amarus* (age-classes):**

age-0	126
age-1	1
age-2+	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-116**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 04 August 2016
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13S Datum: NAD27
M.A. Farrington, R.C. Keller, A. J. Schroeder Effort: 506.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	43
76	*Cyprinus carpio*	19
76	*Hybognathus amarus**	105
76	*Pimephales promelas*	9
76	*Platygobio gracilis*	18
81	*Carpiodes carpio*	9
81	*Catostomus commersonii*	2
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	147
212	*Gambusia affinis*	71

***Hybognathus amarus* (age-classes):**

age-0	105
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-115**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 03 August 2016
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13S Datum: NAD27
W.H. Brandenburg, A.J. Schroeder, R.C. Keller Effort: 495.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	213
76	*Cyprinus carpio*	6
76	*Hybognathus amarus**	107
76	*Pimephales promelas*	6
76	*Platygobio gracilis*	4
81	*Carpiodes carpio*	6
93	*Ictalurus punctatus*	10
212	*Gambusia affinis*	59

***Hybognathus amarus* (age-classes):**

age-0	107
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-114**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 03 August 2016
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13S Datum: NAD27
W.H. Brandenburg, A.J. Schroeder, R.C. Keller Effort: 514.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	59
76	*Cyprinus carpio*	18
76	*Hybognathus amarus**	59
76	*Pimephales promelas*	12
76	*Platygobio gracilis*	5
81	*Carpiodes carpio*	32
93	*Ictalurus punctatus*	13
212	*Gambusia affinis*	103
294	*Lepomis cyanellus*	2
294	*Micropterus salmoides*	3

***Hybognathus amarus* (age-classes):**

age-0	59
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-113**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 03 August 2016
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13S Datum: NAD27
W.H. Brandenburg, A.J. Schroeder, R.C. Keller Effort: 538.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	269
76	*Cyprinus carpio*	81
76	*Hybognathus amarus**	40
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	8
93	*Ictalurus punctatus*	10
212	*Gambusia affinis*	214
294	*Micropterus salmoides*	8
294	*Pomoxis annularis*	1

***Hybognathus amarus* (age-classes):**

age-0	40
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-112**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 03 August 2016
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13S Datum: NAD27
W.H. Brandenburg, A.J. Schroeder, R.C. Keller Effort: 490.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	200
76	*Cyprinus carpio*	35
76	*Hybognathus amarus**	88
76	*Pimephales promelas*	2
81	*Carpiodes carpio*	22
93	*Ictalurus punctatus*	21
212	*Gambusia affinis*	213
294	*Micropterus salmoides*	2

***Hybognathus amarus* (age-classes):**

age-0	88
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-111**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 03 August 2016
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13S Datum: NAD27
W.H. Brandenburg, A.J. Schroeder, R.C. Keller Effort: 501.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	77
76	*Cyprinus carpio*	45
76	*Hybognathus amarus**	83
76	*Pimephales promelas*	14
76	*Platygobio gracilis*	7
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	49
212	*Gambusia affinis*	148
294	*Micropterus salmoides*	1

***Hybognathus amarus* (age-classes):**

age-0	83
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-110**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 02 August 2016
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A. J. Schroeder Effort: 537.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	106
76	*Cyprinus carpio*	97
76	*Hybognathus amarus**	137
76	*Pimephales promelas*	42
76	*Platygobio gracilis*	5
81	*Carpiodes carpio*	34
93	*Ameiurus natalis*	11
93	*Ictalurus punctatus*	298
212	*Gambusia affinis*	88
294	*Micropterus salmoides*	3

***Hybognathus amarus* (age-classes):**

age-0	137
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-109**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 02 August 2016
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A. J. Schroeder Effort: 486.6 sq. m

Family	Species	Total
69	*Dorosoma cepedianum*	1
76	*Cyprinella lutrensis*	60
76	*Cyprinus carpio*	56
76	*Hybognathus amarus**	38
76	*Pimephales promelas*	7
76	*Platygobio gracilis*	107
76	*Rhinichthys cataractae*	7
93	*Ictalurus punctatus*	48
212	*Gambusia affinis*	25
294	*Micropterus salmoides*	2

***Hybognathus amarus* (age-classes):**

age-0	38
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-108**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 02 August 2016
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A. J. Schroeder Effort: 591.1 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	39
76	*Cyprinus carpio*	19
76	*Hybognathus amarus**	82
76	*Platygobio gracilis*	32
81	*Carpiodes carpio*	4
93	*Ictalurus punctatus*	46
212	*Gambusia affinis*	32
294	*Micropterus salmoides*	2

***Hybognathus amarus* (age-classes):**

age-0	82
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-107**
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Socorro Wastewater Treatment Plant, Socorro.

Site Number: 14 River Mile: 99.5 02 August 2016
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A. J. Schroeder Effort: 558.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	308
76	*Cyprinus carpio*	26
76	*Hybognathus amarus**	60
76	*Pimephales promelas*	9
76	*Platygobio gracilis*	59
81	*Carpiodes carpio*	40
93	*Ameiurus natalis*	5
93	*Ictalurus punctatus*	168
212	*Gambusia affinis*	105

***Hybognathus amarus* (age-classes):**

age-0	60
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-106**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 02 August 2016
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A. J. Schroeder Effort: 506.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Cyprinus carpio*	14
76	*Hybognathus amarus**	1
81	*Carpiodes carpio*	13
93	*Ictalurus punctatus*	37
212	*Gambusia affinis*	15

***Hybognathus amarus* (age-classes):**

age-0	1
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-105**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 01 August 2016
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13S Datum: NAD27
R.K. Dudley, R.A. Reese, A.J. Schroeder Effort: 103.7 sq. m

Family	Species	Total
	No Fish Collected	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-104**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 01 August 2016
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13S Datum: NAD27
R.K. Dudley, R.A. Reese, A.J. Schroeder Effort: 0.0 sq. m

Family	Species	Total
	Site Not Sampled (Site Dry)	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-103**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 01 August 2016
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13S Datum: NAD27
R.K. Dudley, R.A. Reese, A.J. Schroeder Effort: 519.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	70
76	*Cyprinus carpio*	27
76	*Hybognathus amarus**	48
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	8
81	*Carpiodes carpio*	6
93	*Ictalurus punctatus*	7
212	*Gambusia affinis*	6

***Hybognathus amarus* (age-classes):**

age-0	48
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-102**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 01 August 2016
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13S Datum: NAD27
R.K. Dudley, R.A. Reese, A.J. Schroeder Effort: 520.1 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	56
76	*Cyprinus carpio*	28
76	*Hybognathus amarus**	10
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	1
93	*Ictalurus furcatus*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	16

***Hybognathus amarus* (age-classes):**

age-0	10
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
August 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-101**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 01 August 2016
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13S Datum: NAD27
R.K. Dudley, R.A. Reese, A.J. Schroeder Effort: 560.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	27
76	*Cyprinus carpio*	21
76	*Hybognathus amarus**	2
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	32

***Hybognathus amarus* (age-classes):**

age-0	2
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-138**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 09 September 2016
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13S Datum: NAD27
J.L. Kennedy, A.J. Schroeder, R.A. Reese Effort: 460.5 sq. m

Family	Species	Total
76	*Platygobio gracilis*	14
76	*Rhinichthys cataractae*	10
212	*Gambusia affinis*	5
294	*Micropterus salmoides*	1

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-139**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 09 September 2016
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13S Datum: NAD27
J.L. Kennedy, A.J. Schroeder, R.A. Reese Effort: 486.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	26
76	*Cyprinus carpio*	4
76	*Hybognathus amarus**	4
76	*Platygobio gracilis*	26
76	*Rhinichthys cataractae*	54
81	*Catostomus commersonii*	2
93	*Ameiurus melas*	1
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	5

***Hybognathus amarus* (age-classes):**

age-0	4
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-140**
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing, at Rio Rancho Wastewater Treatment Plant, Rio Rancho.

Site Number: 3 River Mile: 200.0 09 September 2016
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 563.6 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	9
76	*Hybognathus amarus**	47
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	16
76	*Rhinichthys cataractae*	3
81	*Catostomus commersonii*	3
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	2
294	*Micropterus salmoides*	1

***Hybognathus amarus* (age-classes):**

age-0	47
age-1	
age-2+	

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-137**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 09 September 2016
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13S Datum: NAD27
J.L. Kennedy, A.J. Schroeder, R.A. Reese Effort: 517.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	77
76	*Hybognathus amarus**	82
76	*Platygobio gracilis*	15
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	47

***Hybognathus amarus* (age-classes):**

age-0	82
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-136**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 09 September 2016
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13S Datum: NAD27
J.L. Kennedy, A.J. Schroeder, R.A. Reese Effort: 495.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	8
76	*Hybognathus amarus**	55
76	*Platygobio gracilis*	14
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	13

***Hybognathus amarus* (age-classes):**

age-0	55
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-135**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 08 September 2016
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 526.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	41
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	71
76	*Platygobio gracilis*	18
93	*Ictalurus punctatus*	17
212	*Gambusia affinis*	54

***Hybognathus amarus* (age-classes):**

age-0	71
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-134**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 08 September 2016
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 499.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	22
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	132
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	4
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	4

***Hybognathus amarus* (age-classes):**

age-0	132
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-133**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 08 September 2016
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 536.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	39
76	*Cyprinus carpio*	5
76	*Hybognathus amarus**	5
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	18
212	*Gambusia affinis*	6
294	*Micropterus salmoides*	1

***Hybognathus amarus* (age-classes):**

age-0	5
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-132**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 08 September 2016
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 528.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	24
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	12
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	29

***Hybognathus amarus* (age-classes):**

age-0	12
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-131**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 08 September 2016
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 520.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	78
76	*Cyprinus carpio*	14
76	*Hybognathus amarus**	72
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	11
212	*Gambusia affinis*	37
294	*Micropterus salmoides*	1

***Hybognathus amarus* (age-classes):**

age-0	72
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-130**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 07 September 2016
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.A. Reese, R.C. Keller Effort: 575.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	11
76	*Hybognathus amarus**	31
76	*Platygobio gracilis*	17
93	*Ictalurus punctatus*	15
212	*Gambusia affinis*	14

***Hybognathus amarus* (age-classes):**

age-0	31
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-129**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 07 September 2016
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.A. Reese, R.C. Keller Effort: 540.1 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	120
76	*Cyprinus carpio*	4
76	*Hybognathus amarus**	162
76	*Platygobio gracilis*	17
81	*Carpiodes carpio*	1
93	*Ameiurus natalis*	2
93	*Ictalurus punctatus*	54
212	*Gambusia affinis*	7

***Hybognathus amarus* (age-classes):**

age-0	162
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-128**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 07 September 2016
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.A. Reese, R.C. Keller Effort: 536.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	11
76	*Hybognathus amarus**	33
76	*Platygobio gracilis*	3
93	*Ictalurus punctatus*	6
212	*Gambusia affinis*	2

***Hybognathus amarus* (age-classes):**

age-0	33
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-127**
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Socorro Wastewater Treatment Plant, Socorro.

Site Number: 14 River Mile: 99.5 07 September 2016
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.A. Reese, R.C. Keller Effort: 523.1 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Hybognathus amarus**	194
76	*Platygobio gracilis*	11
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	18

***Hybognathus amarus* (age-classes):**

age-0	194
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-126**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 07 September 2016
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13S Datum: NAD27
W.H. Brandenburg, R.A. Reese, R.C. Keller Effort: 525.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	11
76	*Cyprinus carpio*	4
76	*Hybognathus amarus**	105
76	*Platygobio gracilis*	19
81	*Carpiodes carpio*	3
93	*Ameiurus melas*	1
93	*Ictalurus punctatus*	42
212	*Gambusia affinis*	14

***Hybognathus amarus* (age-classes):**

age-0	105
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-125**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 06 September 2016
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13S Datum: NAD27
M.A. Farrington, J.L. Kennedy, R.A. Reese Effort: 460.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	9
76	*Cyprinus carpio*	11
76	*Hybognathus amarus**	51
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	48
212	*Gambusia affinis*	2

***Hybognathus amarus* (age-classes):**

age-0	51
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-124**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 06 September 2016
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13S Datum: NAD27
M.A. Farrington, J.L. Kennedy, R.A. Reese Effort: 160.3 sq. m

Family	Species	Total
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	11
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	7
212	*Gambusia affinis*	2

***Hybognathus amarus* (age-classes):**

age-0	11
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-123**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 06 September 2016
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13S Datum: NAD27
M.A. Farrington, J.L. Kennedy, R.A. Reese Effort: 497.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	12
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	49
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	17
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	49
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
September 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-122**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 06 September 2016
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13S Datum: NAD27
M.A. Farrington, J.L. Kennedy, R.A. Reese Effort: 517.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	15
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	17
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	1
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	16
93	*Pylodictis olivaris*	2
212	*Gambusia affinis*	2

***Hybognathus amarus* (age-classes):**

age-0	17
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-121**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 06 September 2016
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13S Datum: NAD27
M.A. Farrington, J.L. Kennedy, R.A. Reese Effort: 503.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	9
76	*Cyprinus carpio*	3
76	*Hybognathus amarus**	16
76	*Pimephales promelas*	2
93	*Ictalurus punctatus*	21
212	*Gambusia affinis*	5

***Hybognathus amarus* (age-classes):**

age-0	16
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-158**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 06 October 2016
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13S Datum: NAD27
J.L. Kennedy, A.J. Schroeder, C.A. Peralta Effort: 491.1 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	11
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	14
76	*Rhinichthys cataractae*	22
294	*Micropterus salmoides*	1

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-159**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 06 October 2016
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13S Datum: NAD27
J.L. Kennedy, A.J. Schroeder, C.A. Peralta Effort: 525.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	31
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	17
76	*Rhinichthys cataractae*	8
81	*Catostomus commersonii*	2
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	2

***Hybognathus amarus* (age-classes):**

age-0	2
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-160**
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing,
at Rio Rancho Wastewater Treatment Plant, Rio Rancho.

Site Number: 3 River Mile: 200.0 06 October 2016
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13S Datum: NAD27
J.L. Kennedy, A.J. Schroeder, C.A. Peralta Effort: 531.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	36
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	13
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	41
76	*Rhinichthys cataractae*	3

***Hybognathus amarus* (age-classes):**

age-0	13
age-1	
age-2+	

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-157**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 06 October 2016
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13S Datum: NAD27
J.L. Kennedy, A.J. Schroeder, C.A. Peralta Effort: 525.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	28
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	25
76	*Platygobio gracilis*	18
93	*Ictalurus punctatus*	7
212	*Gambusia affinis*	35

***Hybognathus amarus* (age-classes):**

age-0	25
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-156**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 06 October 2016
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13S Datum: NAD27
J.L. Kennedy, A.J. Schroeder, C.A. Peralta Effort: 497.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	6
76	*Cyprinus carpio*	6
76	*Hybognathus amarus**	39
76	*Pimephales promelas*	4
76	*Platygobio gracilis*	6
81	*Carpiodes carpio*	3
93	*Ictalurus punctatus*	2

***Hybognathus amarus* (age-classes):**

age-0	39
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-155**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 05 October 2016
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13S Datum: NAD27
R.K. Dudley, A.J. Schroeder, R.A. Reese Effort: 544.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	179
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	139
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	9
93	*Ictalurus punctatus*	21
212	*Gambusia affinis*	16

***Hybognathus amarus* (age-classes):**

age-0	136
age-1	3
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-154**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 05 October 2016
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13S Datum: NAD27
R.K. Dudley, A.J. Schroeder, R.A. Reese Effort: 506.4 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	86
76	*Cyprinus carpio*	5
76	*Hybognathus amarus**	15
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	49

***Hybognathus amarus* (age-classes):**

age-0	15
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-153**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 05 October 2016
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13S Datum: NAD27
R.K. Dudley, A.J. Schroeder, R.A. Reese Effort: 569.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	182
76	*Hybognathus amarus**	1
212	*Gambusia affinis*	59
294	*Micropterus salmoides*	2

***Hybognathus amarus* (age-classes):**

age-0	1
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-152**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 05 October 2016
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13S Datum: NAD27
R.K. Dudley, A.J. Schroeder, R.A. Reese Effort: 557.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	250
76	*Hybognathus amarus**	12
76	*Rhinichthys cataractae*	1
212	*Gambusia affinis*	3

***Hybognathus amarus* (age-classes):**

age-0	12
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-151**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 05 October 2016
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13S Datum: NAD27
R.K. Dudley, A.J. Schroeder, R.A. Reese Effort: 512.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	28
76	*Hybognathus amarus**	28

***Hybognathus amarus* (age-classes):**

age-0	28
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-150**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 04 October 2016
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13S Datum: NAD27
W.H. Brandenburg, E.I. Gilbert, A.J. Schroeder Effort: 539.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	7
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	17
93	*Ictalurus punctatus*	8
212	*Gambusia affinis*	8

***Hybognathus amarus* (age-classes):**

age-0	1
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-149**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 04 October 2016
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13S Datum: NAD27
W.H. Brandenburg, E.I. Gilbert, A.J. Schroeder Effort: 485.9 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	413
76	*Cyprinus carpio*	4
76	*Hybognathus amarus**	46
76	*Pimephales promelas*	6
76	*Platygobio gracilis*	19
76	*Rhinichthys cataractae*	5
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	10

***Hybognathus amarus* (age-classes):**

age-0	46
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-148**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 04 October 2016
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13S Datum: NAD27
W.H. Brandenburg, E.I. Gilbert, A.J. Schroeder Effort: 529.7 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	15
76	*Cyprinus carpio*	3
76	*Hybognathus amarus**	9
76	*Platygobio gracilis*	17
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	7

***Hybognathus amarus* (age-classes):**

age-0	9
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-147**
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Socorro Wastewater Treatment Plant, Socorro.

Site Number: 14 River Mile: 99.5 04 October 2016
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13S Datum: NAD27
W.H. Brandenburg, E.I. Gilbert, A.J. Schroeder Effort: 513.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	10
76	*Hybognathus amarus**	85
76	*Platygobio gracilis*	5
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	36
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	85
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-146**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 04 October 2016
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13S Datum: NAD27
W.H. Brandenburg, E.I. Gilbert, A.J. Schroeder Effort: 552.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	20
76	*Cyprinus carpio*	6
76	*Hybognathus amarus**	98
76	*Platygobio gracilis*	14
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	25
212	*Gambusia affinis*	16

***Hybognathus amarus* (age-classes):**

age-0	98
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-145**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 03 October 2016
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 435.2 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	5
76	*Cyprinus carpio*	3
76	*Hybognathus amarus**	50
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	3

***Hybognathus amarus* (age-classes):**

age-0	50
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-144**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 03 October 2016
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 95.8 sq. m

Family	Species	Total
	No Fish Collected	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-143**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 03 October 2016
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 512.1 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	57
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	14
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	1

***Hybognathus amarus* (age-classes):**

age-0	12
age-1	2
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-142**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 03 October 2016
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 532.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	151
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	5
76	*Pimephales vigilax*	4
76	*Platygobio gracilis*	2
212	*Gambusia affinis*	1

***Hybognathus amarus* (age-classes):**

age-0	5
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
October 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-141**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 03 October 2016
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, R.A. Reese Effort: 537.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	59
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	2
76	*Pimephales vigilax*	3
93	*Ictalurus punctatus*	14
93	*Pylodictis olivaris*	1
212	*Gambusia affinis*	3

***Hybognathus amarus* (age-classes):**

age-0	2
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-258**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 08 December 2016
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13S Datum: NAD27
R.A. Reese, R.C. Keller, A. J. Schroeder Effort: 545.5 sq. m

Family	Species	Total
	No Fish Collected	

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-259**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 08 December 2016
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13S Datum: NAD27
R.A. Reese, R.C. Keller, A. J. Schroeder Effort: 628.8 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Hybognathus amarus**	6
76	*Platygobio gracilis*	2

***Hybognathus amarus* (age-classes):**

age-0	6
age-1	
age-2+	

NEW MEXICO: SANDOVAL County, RIO GRANDE Drainage **RKD16-260**
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing, at Rio Rancho Wastewater Treatment Plant, Rio Rancho.

Site Number: 3 River Mile: 200.0 08 December 2016
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13S Datum: NAD27
R.A. Reese, R.C. Keller, A. J. Schroeder Effort: 621.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Hybognathus amarus**	3
76	*Platygobio gracilis*	5

***Hybognathus amarus* (age-classes):**

age-0	3
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-257**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 08 December 2016
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13S Datum: NAD27
R.A. Reese, R.C. Keller, A. J. Schroeder Effort: 625.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	47
76	*Cyprinus carpio*	3
76	*Hybognathus amarus**	260
76	*Platygobio gracilis*	12
81	*Carpiodes carpio*	2
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	3

***Hybognathus amarus* (age-classes):**

age-0	227
age-1	22
age-2+	11

NEW MEXICO: BERNALILLO County, RIO GRANDE Drainage **RKD16-256**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 08 December 2016
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13S Datum: NAD27
R.A. Reese, R.C. Keller, A. J. Schroeder Effort: 546.3 sq. m

Family	Species	Total
76	*Hybognathus amarus**	25
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	2

***Hybognathus amarus* (age-classes):**

age-0	24
age-1	
age-2+	1

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-255**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 07 December 2016
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13S Datum: NAD27
J.L. Kennedy, R.A. Reese, A.J. Schroeder Effort: 545.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	1
76	*Hybognathus amarus**	59
76	*Platygobio gracilis*	1

***Hybognathus amarus* (age-classes):**

age-0	59
age-1	
age-2+	

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-254**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 07 December 2016
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13S Datum: NAD27
J.L. Kennedy, R.A. Reese, A.J. Schroeder Effort: 553.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	142
76	*Cyprinus carpio*	5
76	*Hybognathus amarus**	42
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	3
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	5

***Hybognathus amarus* (age-classes):**

age-0	41
age-1	1
age-2+	

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: VALENCIA County, RIO GRANDE Drainage **RKD16-253**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 07 December 2016
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 643.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	214
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	102
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	40

***Hybognathus amarus* (age-classes):**

age-0	101
age-1	1
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-252**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 07 December 2016
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13S Datum: NAD27
J.L. Kennedy, R.A. Reese, A.J. Schroeder Effort: 634.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	78
76	*Cyprinus carpio*	3
76	*Hybognathus amarus**	37
76	*Pimephales promelas*	1
81	*Carpiodes carpio*	2
212	*Gambusia affinis*	19

***Hybognathus amarus* (age-classes):**

age-0	37
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-251**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 07 December 2016
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13S Datum: NAD27
J.L. Kennedy, R.A. Reese, A.J. Schroeder Effort: 575.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	50
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	167
76	*Pimephales promelas*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	6
212	*Gambusia affinis*	10

***Hybognathus amarus* (age-classes):**

age-0	163
age-1	4
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-250**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 06 December 2016
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 597.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	7
76	*Hybognathus amarus**	64
76	*Platygobio gracilis*	27
81	*Carpiodes carpio*	2
212	*Gambusia affinis*	3

***Hybognathus amarus* (age-classes):**

age-0	64
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-249**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 06 December 2016
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 594.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	13
76	*Rhinichthys cataractae*	1
93	*Ictalurus punctatus*	1

***Hybognathus amarus* (age-classes):**

age-0	1
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-248**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 06 December 2016
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 587.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	51
76	*Hybognathus amarus**	74
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	49
212	*Gambusia affinis*	2

***Hybognathus amarus* (age-classes):**

age-0	74
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-247**
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Socorro Wastewater Treatment Plant, Socorro.

Site Number: 14 River Mile: 99.5 06 December 2016
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 545.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	3
76	*Hybognathus amarus**	64
76	*Platygobio gracilis*	6
93	*Ictalurus punctatus*	1

***Hybognathus amarus* (age-classes):**

age-0	64
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-246**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 06 December 2016
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 569.8 sq. m

Family	Species	Total
76	*Hybognathus amarus**	27

***Hybognathus amarus* (age-classes):**

age-0	27
age-1	
age-2+	

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-245**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 05 December 2016
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 601.5 sq. m

Family	Species	Total
76	*Cyprinus carpio*	6
76	*Hybognathus amarus**	16
76	*Platygobio gracilis*	2
76	*Rhinichthys cataractae*	1
93	*Ictalurus punctatus*	16

***Hybognathus amarus* (age-classes):**

age-0	16
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-244**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 05 December 2016
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 549.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	1
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	11
93	*Ictalurus punctatus*	2

***Hybognathus amarus* (age-classes):**

age-0	10
age-1	1
age-2+	

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-243**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 05 December 2016
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 663.5 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	2
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	3
76	*Pimephales vigilax*	2
93	*Ictalurus punctatus*	9

***Hybognathus amarus* (age-classes):**

age-0	3
age-1	
age-2+	

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-242**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 05 December 2016
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 686.0 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	15
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	51
76	*Pimephales vigilax*	3
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	1

***Hybognathus amarus* (age-classes):**

age-0	46
age-1	5
age-2+	

Rio Grande Silvery Minnow Population Monitoring
December 2016

NEW MEXICO: SOCORRO County, RIO GRANDE Drainage **RKD16-241**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 05 December 2016
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13S Datum: NAD27
J.L. Kennedy, R.C. Keller, A.J. Schroeder Effort: 615.3 sq. m

Family	Species	Total
76	*Cyprinella lutrensis*	31
76	*Cyprinus carpio*	8
76	*Hybognathus amarus**	49
76	*Pimephales promelas*	1
76	*Pimephales vigilax*	5
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	14

***Hybognathus amarus* (age-classes):**

age-0	48
age-1	1
age-2+	