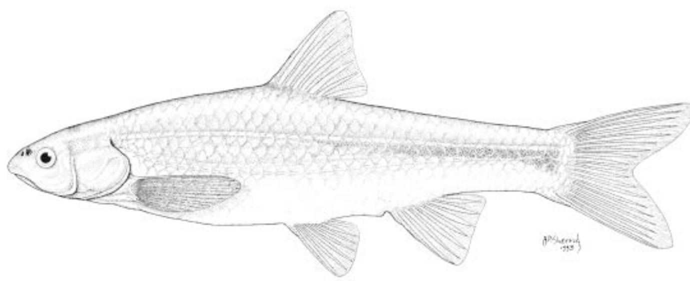
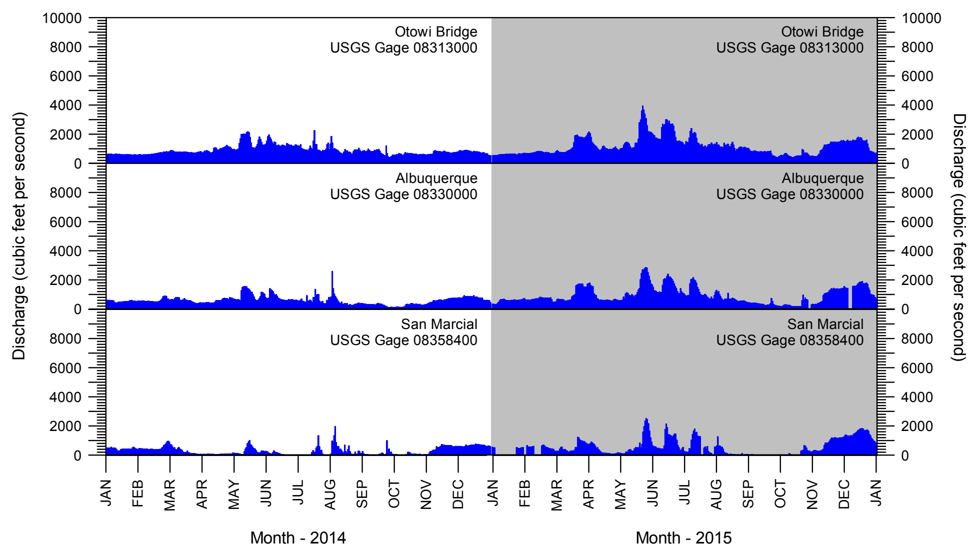
Rio Grande Silvery Minnow Population Monitoring Results from February to December 2015

A Middle Rio Grande Endangered Species Collaborative Program Funded Research Project





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EXECUTIVE SUMMARY

The occurrence and abundance of Rio Grande Silvery Minnow has fluctuated widely over the past two decades (1993–2015). Estimated densities ($E(x)$) derived from mixture models, using October data (i.e., fish per 100 m^2), were highest in 2005 (44.84) but reached a recent low in 2012 (0.00) and again in 2014 (0.00). While estimated densities of Rio Grande Silvery Minnow were notably lower from 2010–2014 as compared with 2007–2009, there was an improvement in 2015 ($E(x) = 0.16$).

General linear models of Rio Grande Silvery Minnow mixture-model estimates revealed that variation in the mean of the lognormal density distribution (μ), as compared with variation in the probability of occurrence (δ), was more reliably predicted by changes in hydraulic variables over time. The top three models, which accounted for most of the cumulative AIC_c weight (ca. 93%), were related to the interaction among μ and hydraulic variables representing elevated spring flows in the Angostura Reach. Although models related to the interactions among δ and any of the hydraulic variables received much lower model weight, the two top models represented flows during irrigation season in the San Acacia Reach along with elevated spring flows for μ in the Angostura Reach. 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 mixture-model analyses of October mesohabitat data (2002–2015) and November repeated sampling data (2005–2015) revealed that population trends in different mesohabitats or on different sampling occasions, respectively, were quite similar to those obtained from the long-term dataset (1993–2015). A variance components analysis revealed that year accounted for the highest variance (77.01) in estimated densities, followed distantly by site (5.99) and sampling occasion (1.32). Thus, 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 distribution and abundance of Rio Grande Silvery Minnow across years.

Multi-year statistical models, based on patterns of occupancy for all age-classes combined, indicated that estimates of site occupancy probabilities progressively declined over the past decade but increased from 2014 to 2015. Detection probability estimates were generally lowest during years when Rio Grande Silvery Minnow was extremely rare (e.g., 2012–2014) and highest when this species was more common (e.g., 2007–2009). Estimated extinction probabilities were elevated during recent years (i.e., since 2011) but showed signs of improvement from 2014 to 2015. Similarly, estimated colonization probabilities increased in the most recent time frame (2014–2015). While the balance of estimated extinction and colonization probabilities from 2014–2015 was still not as favorable as it was during the early years of this study (2005–2010), the conservation status of Rio Grande Silvery Minnow showed signs of improvement from 2013 to 2015.

Pronounced changes in the occurrence and abundance of Rio Grande Silvery Minnow over the past two decades appear to be closely related to the timing, magnitude, and duration of flows during spring and summer. The physical conditions produced by prolonged and elevated spring flows result in overbank flooding of vegetated areas, formation of inundated habitats within the river channel, and creation of shoreline and island backwaters. These conditions, combined with the delayed onset of low flows following spring runoff, appear to help ensure successful recruitment by prolonging the persistence of warm and productive nursery habitats required by larvae to complete their life history.

While diligent and ongoing management efforts in the Middle Rio Grande over the past two decades have provided invaluable protection against the extinction of Rio Grande Silvery Minnow, additional efforts (e.g., ensuring adequate annual spring and summer flows for successful spawning and recruitment) will be required to yield resilient and self-sustaining populations over time. Encouragingly, both the occurrence and abundance of this imperiled species increased in 2015, as compared with recent years (2012–2014), following notably improved spring and summer flow conditions. However, securing the recovery and long-term persistence of Rio Grande Silvery Minnow in the wild will depend on attaining self-sustaining populations in multiple locations within its historical range. Future study of the ecological interactions among fish species and their environment in the Rio Grande Basin should further elucidate the factors that control this complex aquatic ecosystem, which will be essential in providing the information required to develop and implement successful management strategies for the long-term recovery of Rio Grande Silvery Minnow.

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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 from 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 in 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 1992 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 (initiated in 1993). 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., 2015a). 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.

The primary objective of the February to December 2015 sampling activities was to monitor temporal trends in the abundance of Rio Grande Silvery Minnow at 20 standardized sites throughout the Middle Rio Grande. Additional objectives included evaluating the influence of discharge patterns on population fluctuations, determining general habitat use patterns, documenting changes in relative abundance among fish species over time, and determining variation in density estimates based on repeated sampling. 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 agricultural users and 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. Precipitation in the region is low, averaging < 25 cm/year (Gold and Denis, 1985).

Several large dams on the Rio Chama and Rio Grande and 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, that 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).

Reach names were derived from the diversion structure at the upper portion of the reach. The Angostura Reach (Angostura Diversion Dam to Isleta Diversion Dam) had five sampling sites and the Isleta Reach (Isleta Diversion Dam to San Acacia Diversion Dam) had six sampling sites. There were nine sampling sites in the San Acacia Reach (San Acacia Diversion Dam to inflow of Elephant Butte Reservoir). 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 adequate instream habitat. While most sites have been consistently monitored over time, several localities were added (e.g., to increase the spatial coverage within and among reaches) or removed (e.g., loss of consistent land access), primarily during the first decade of the study.

Diel and seasonal discharge varied greatly during 2014 and 2015, 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]). Mean annual discharge in the southern reaches was low in 2014 and modest in 2015. During May and June 2015, flows peaked several times throughout the study area. Peak flows in 2015 occurred during May. Flow conditions in 2014 and 2015 included periods of very low discharge from July through October, which were interrupted by elevated flows from periodic rains. As compared with the generalized historical spring runoff (based on mean daily discharge values from 1973 [Cochiti Dam operational] to 2015), the timing of this event was typical in 2014 and 2015. The spring flow magnitude was low in 2014 and modest in 2015, but the duration was highly truncated in both years.

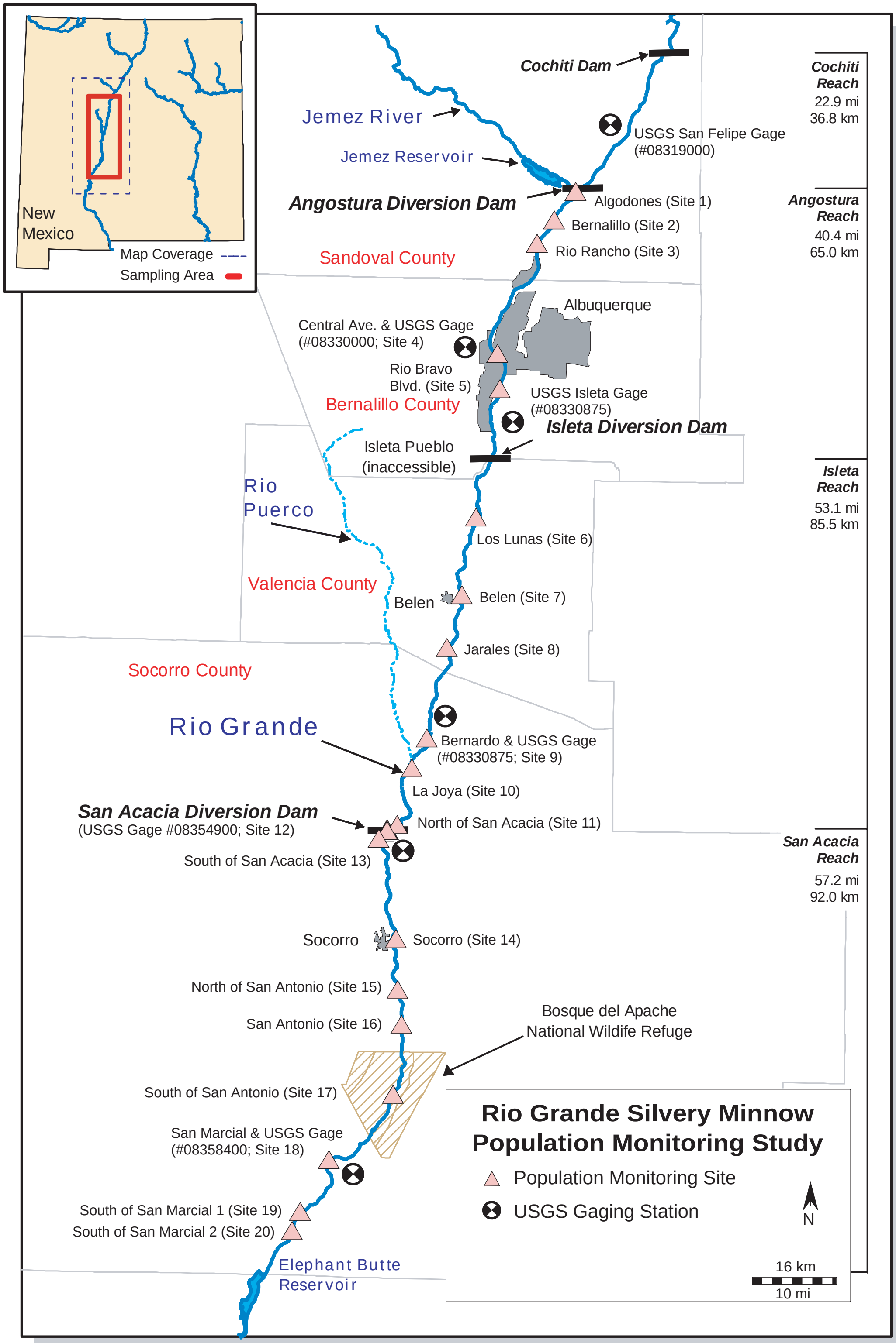

Figure 1. Map of the study area and sampling sites (numbered) for the Rio Grande Silvery Minnow population monitoring study. Sampling site information and detailed maps are provided in Appendix A.

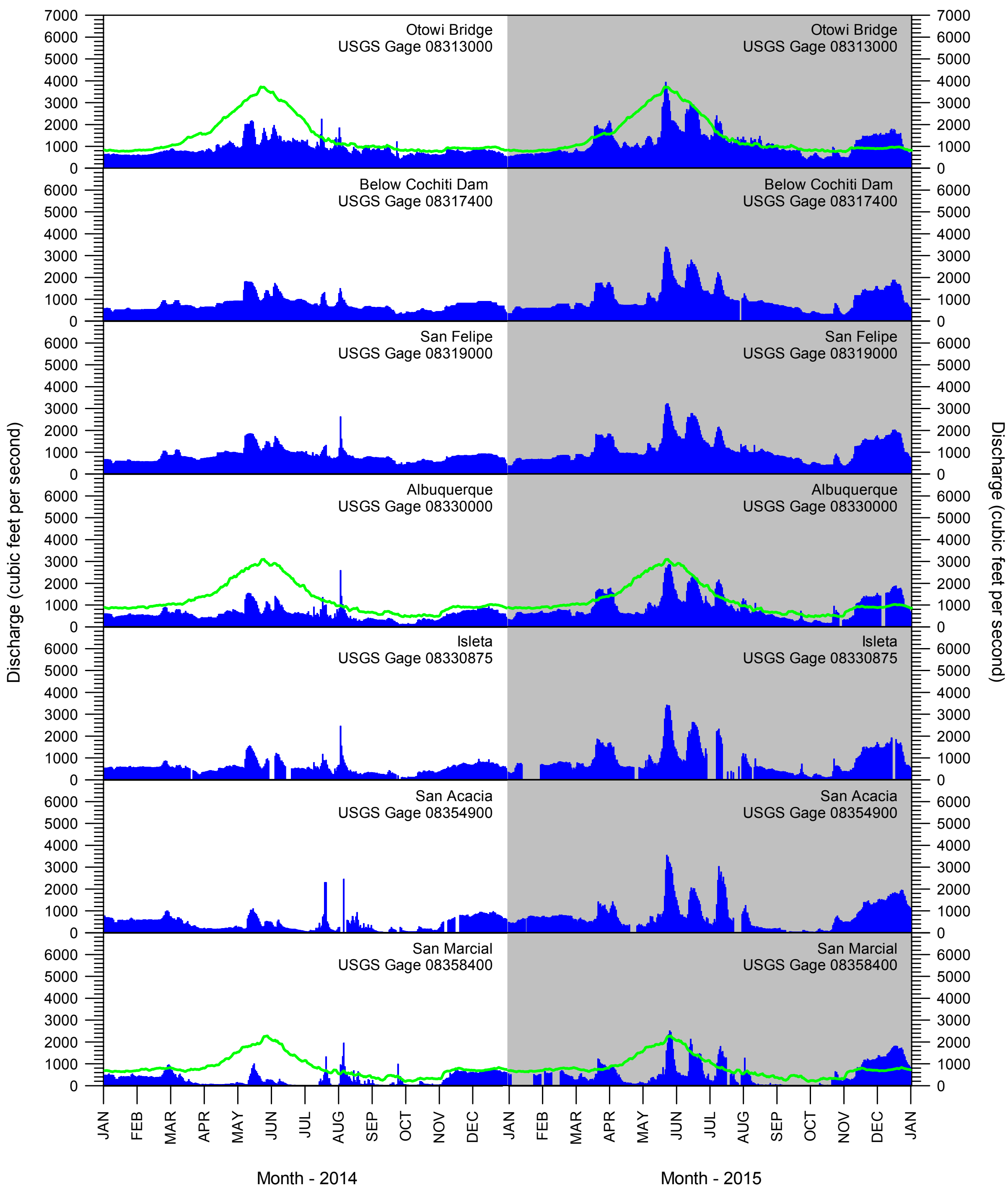

Figure 2. Discharge in the Rio Grande from January 2014 through December 2015 based on data from seven U.S. Geological Survey (USGS) gaging stations. Solid green lines are historical mean daily discharge values (from 1973 [Cochiti Dam operational] through 2015) from the upper, middle, and lower portions of the study area. 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 2015 allowed for ongoing determination of general spatial and temporal changes in population structure and species abundance since 1993 (except for 1998). Sampling was conducted in February, monthly from April to October, and in December. Additional repeated sampling was conducted during November to generate estimates of 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 (ca. 5 mm) seine 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 (ca. 1.5 mm) seine was used to selectively sample shallow low velocity mesohabitats for larval fish (two samples). Mesohabitats with similar conditions, which did not exceed reasonable depths/velocities for efficient seining, were sampled regardless of flow conditions. Density was estimated by dividing the number of individuals by the area sampled (i.e., fish per 100 m^2). Effort was calculated by multiplying the seine width during sampling (regular = 2.5 m, larval = 0.25 m) by the length of the seine haul. Samples obtained from isolated pools were not included in data analyses as densities in these confined mesohabitats were often artificially elevated. Prior to release, all Rio Grande Silvery Minnow collected were examined for Visible Implant Elastomer (VIE) tags (i.e., stocked fish), measured (standard length range), and identified to age-class (based on reach-specific standard length and age-length relationships during the same time of year [Dudley et al., 2009; Horwitz et al., 2011]). Rio Grande Silvery Minnow with VIE tags were not included in data analyses of long-term population trends, sampling variation, or site occupancy but were included in the 2015 summary tables and figures. Selected water quality parameters (Secchi depth, temperature, salinity, dissolved oxygen, true conductivity, specific conductance, and pH) were recorded (see Appendix C) as well as digital photographs of physical river conditions. Scientific names and common names (phylogenetic order) of fishes in this report follow Page et al. (2013; Table 1).

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 (1993–2015) were analyzed using PROC NLMIXED (SAS, 2015), a numerical optimization procedure, by fitting a mixture model consisting of the binomial and lognormal distributions using the methods outlined in White (1978). 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 reference to applicable figures.

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. Covariates considered for modeling October sampling-site density data (1993–2015) included sampling year (Year) and various hydraulic variables at USGS Gages (#08330000 [ABQ; Rio Grande at Albuquerque, NM] and #08358400 [SAN; Rio Grande Floodway at San Marcial, NM]). 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) represented the typical range of spring runoff conditions (May–June). A similar covariate [ABQ>4,000] was dropped from consideration in 2015 since only four of the past 14 years had spring flows that exceeded 4,000 cfs. A new covariate [Inundation] was added in 2015 that represented the total estimated inundation of the river channel and floodplain (U.S. Army Corps of Engineers, 2010) based on an average of the five peak flow days in May; 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)

Table 1. Scientific and common names and species codes of fish collected in the Middle Rio Grande from 1993 to 2015.

Scientific Name	Common Name	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)

Table 1. Scientific and common names and species codes of fish collected in the Middle Rio Grande from 1993 to 2015 (continued).

Scientific Name	Common Name	Code
Order Cyprinodontiformes		
Family Poeciliidae	**livebearers**	
Gambusia affinis	Western Mosquitofish[1]	(GAMAFF)
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 represent the most abundant species present in recent Middle Rio Grande collections; these species are illustrated in monthly plots of data.

represented some general characteristics of 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. That is, 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. Adaptive Gaussian quadrature as described in Pinheiro and Bates (1995) was used to integrate out these random effects in fitting the model using the SAS NLMIXED procedure.

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 among 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 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 sampling 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], shoreline pools [SHPO], shoreline runs [SHRU], and runs [RU]). 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 (1993–2015) was site (e.g., all mesohabitat samples combined for each site). Rio Grande Silvery Minnow mesohabitat-specific density data recorded at all sampling sites from October (2002–2015) were analyzed using PROC NLMIXED (SAS, 2013), using the same methods outlined previously, to generate parameter estimates and assess differences among models. Covariates considered to model mesohabitat-specific density data during October were year (Year) and mesohabitat (Mesohabitat). Both additive and multiplicative effects were considered for single combinations of the year covariate (i.e., Year+Mesohabitat and Year*Mesohabitat, respectively).

Sampling variation was evaluated using mesohabitat-specific density data from the repeated sampling efforts at each of the 20 sites during November (2005–2015). For the repeated sampling effort, sites were sampled once per day for four days, using regular population monitoring sampling protocols. Fish samples were taken at the same or similar locations on subsequent days. Mesohabitat-specific density data from repeated sampling efforts were analyzed using PROC NLMIXED (SAS, 2015), using the same methods outlined previously, to generate parameter estimates and assess differences among models. Covariates considered to model mesohabitat-specific density data during November were year (Year) and sampling occasion (Occasion; the 1^{st}, 2^{nd}, 3^{rd}, or 4^{th} day of sampling). Both additive and multiplicative effects were considered for single combinations of the year covariate (i.e., Year+Occasion and Year*Occasion). A variance component model was used to assess the level of variance in estimated densities that could be attributed to year (Year), sampling site (Site), and sampling occasion (Occasion). Maximum likelihood estimation, using minimum variance quadratic unbiased estimators (i.e., MIVQUE), was used to estimate the different variance components using PROC VARCOMP (SAS, 2015).

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 February to December 2015 densities of Rio Grande Silvery Minnow varied widely across months, reaches, and sampling sites (Figures 3 and 4; Table 2). The density of age-0 Rio Grande Silvery Minnow increased following spring spawning, but dropped rapidly from August to October. Post-spawning densities of age-0 individuals were modest in all three sampling reaches. Relatively large numbers of Rio Grande Silvery Minnow (n = 229; 41.5% stocked) were collected during December 2015.

Densities of Rio Grande Silvery Minnow from February to December 2015 were generally highest in the Isleta and San Acacia reaches (Figure 5). The Isleta Reach yielded the most individuals (n = 511; 3.5% stocked), followed by the San Acacia (n = 498; 42.8% stocked), and the Angostura Reach (n = 412; 6.1% stocked). Age-0 individuals composed a large proportion of the monthly totals from June through December (Figure 6).

Population trends (1993–2015)

Rio Grande Silvery Minnow estimated densities ($E(x)$), using October sampling-site density data (1993–2015), were generated from the year model (δ[Year] μ[Year]). The estimated densities of Rio Grande Silvery Minnow were notably lower from 2010–2014 as compared with 2007–2009, but there was a modest increase in 2015 (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. Sampling did not occur in 1998. October population monitoring efforts in 2015 yielded relatively low densities of Rio Grande Silvery Minnow ($E(x) = 0.16$) yet improved as compared with 2012–2014. Simple estimates of mean densities, using the method of moments, were very similar to estimated densities ($E(x)$) over time.

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 closely associated with hydraulic variables over the period of study (1993–2015). Estimates of δ 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 8). However, 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 δ. Estimates of μ and $E(x)$ (Figures 9 and 10) exhibited similar relationships with hydraulic variables (i.e., positive relationships with variables representing higher spring flows but negative relationships with variables representing lower summer flows).

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 hydraulic variables over the period of study (1993–2015; Table 3). The top model (δ[Year] μ[ABQ>3,000+R]) received 51% of the AIC_c weight (w_i), with this spring flow covariate accounting for 60% of the deviance 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. 93%), were related to the interaction among μ and hydraulic variables representing elevated spring flows in the Angostura Reach. In contrast, models relating to the interaction among μ and hydraulic 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 among δ and any of the hydraulic variables received much lower values of w_i, the two top models represented flows during irrigation season in the San Acacia Reach along with elevated spring flows for μ in the Angostura Reach. The top δ model with no flow covariates on μ (δ[SANmean+R] μ[Year]) accounted for 79% 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.

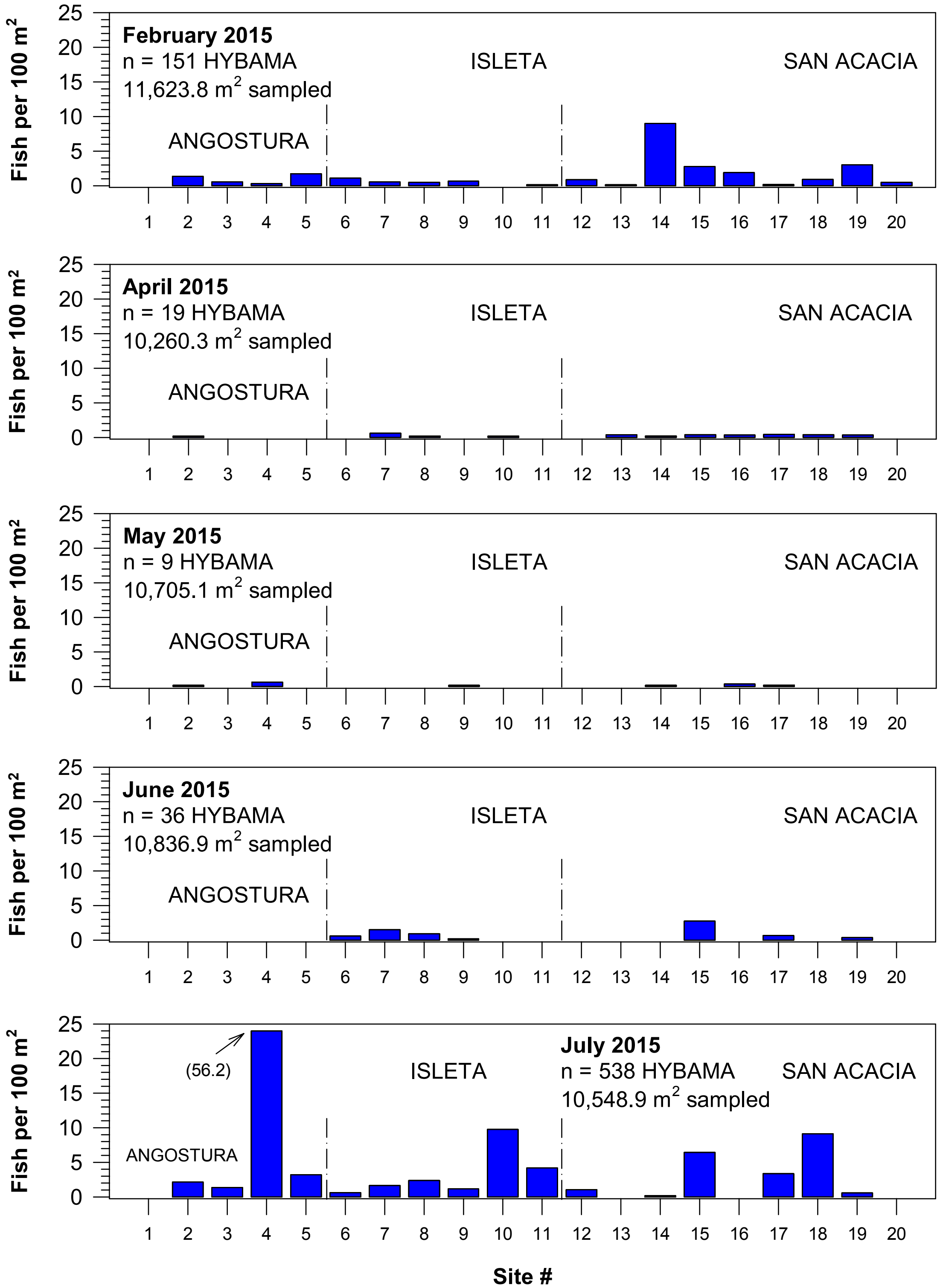

Figure 3. Rio Grande Silvery Minnow densities from February to July 2015 for each sampling site in the Middle Rio Grande.

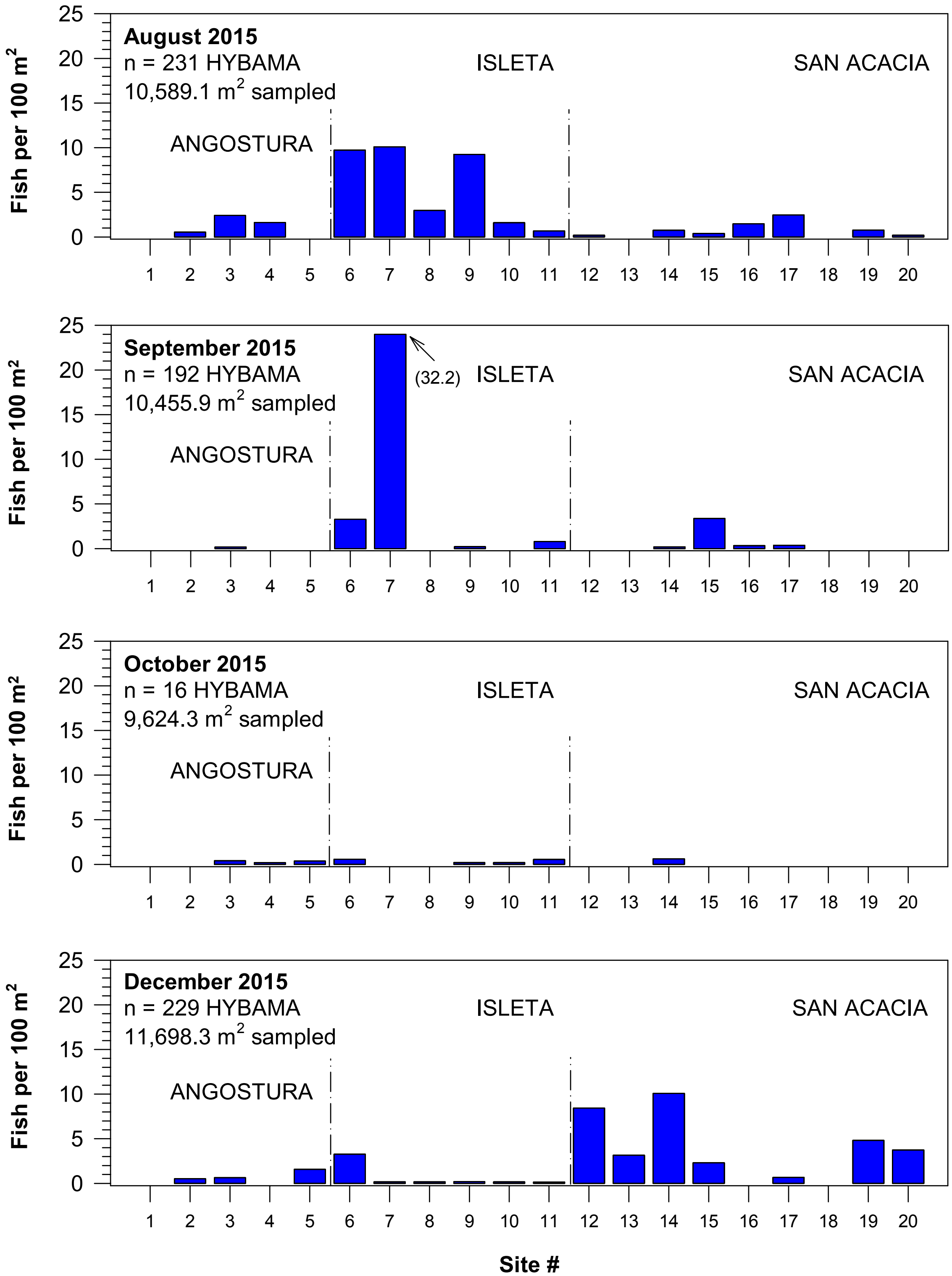

Figure 4. Rio Grande Silvery Minnow densities from August to December 2015 for each sampling site in the Middle Rio Grande.

Table 2. Summary of the monthly catch of Rio Grande Silvery Minnow, by site and reach, from February to December 2015. All marked individuals at a site are shown in parentheses (subset of the total).

REACH	SITE #	SITE NAME	FEB	APR	MAY	JUN	JUL	AUG	SEP	OCT	DEC	TOTAL
Angostura	1	Angostura Dam	-	-	-	-	-	-	-	-	-	0(0)
Angostura	2	Bernalillo	8(5)	1(0)	1(0)	-	12(0)	3(0)	-	-	3(0)	28(5)
Angostura	3	Rio Rancho	3(2)	-	-	-	8(0)	14(0)	1(0)	2(0)	4(0)	32(2)
Angostura	4	Central Ave.	2(2)	-	3(3)	-	297(0)	9(0)	-	1(0)	-	312(5)
Angostura	5	Rio Bravo Blvd.	10(10)	-	-	-	18(0)	-	-	2(0)	10(3)	40(13)
Angostura Totals			23(19)	1(0)	4(3)	-	335(0)	26(0)	1(0)	5(0)	17(3)	412(25)
Isleta	6	Los Lunas	6(1)	-	-	3(1)	3(0)	47(0)	16(0)	3(0)	19(0)	97(2)
Isleta	7	Belen	3(3)	3(3)	-	8(0)	9(0)	51(0)	148(2)	-	1(0)	223(8)
Isleta	8	Jarales	3(1)	1(0)	-	5(0)	11(0)	16(0)	-	-	1(0)	37(1)
Isleta	9	Bernardo	4(3)	-	1(1)	1(1)	6(0)	46(0)	1(0)	1(0)	1(0)	61(5)
Isleta	10	La Joya	-	1(1)	-	-	48(0)	8(0)	-	1(0)	1(0)	59(1)
Isleta	11	North of San Acacia	1(1)	-	-	-	21(0)	4(0)	4(0)	3(0)	1(0)	34(1)
Isleta Totals			17(9)	5(4)	1(1)	17(2)	98(0)	172(0)	169(2)	8(0)	24(0)	511(18)
San Acacia	12	San Acacia Dam	5(0)	-	-	-	5(0)	1(0)	-	-	46(7)	57(7)
San Acacia	13	South of San Acacia	1(0)	2(2)	-	-	-	-	-	-	19(14)	22(16)
San Acacia	14	Socorro	52(52)	1(1)	1(1)	-	1(0)	4(0)	1(0)	3(0)	60(22)	123(76)
San Acacia	15	North of San Antonio	15(15)	2(1)	-	14(3)	32(0)	2(0)	17(0)	-	12(9)	94(28)
San Acacia	16	San Antonio	11(7)	2(2)	2(2)	-	-	8(1)	2(0)	-	-	25(12)
San Acacia	17	South of San Antonio	1(1)	2(2)	1(0)	3(3)	16(0)	13(0)	2(0)	-	4(2)	42(8)
San Acacia	18	San Marcial	5(5)	2(2)	-	-	48(1)	-	-	-	-	55(8)
San Acacia	19	South of San Marcial 1	18(15)	2(2)	-	2(2)	3(0)	4(0)	-	-	27(20)	56(39)
San Acacia	20	South of San Marcial 2	3(1)	-	-	-	-	1(0)	-	-	20(18)	24(19)
San Acacia Totals			111(96)	13(12)	4(3)	19(8)	105(1)	33(1)	22(0)	3(0)	188(92)	498(213)
MONTHLY TOTALS			**151(124)**	**19(16)**	**9(7)**	**36(10)**	**538(1)**	**231(1)**	**192(2)**	**16(0)**	**229(95)**	**1,421(256)**

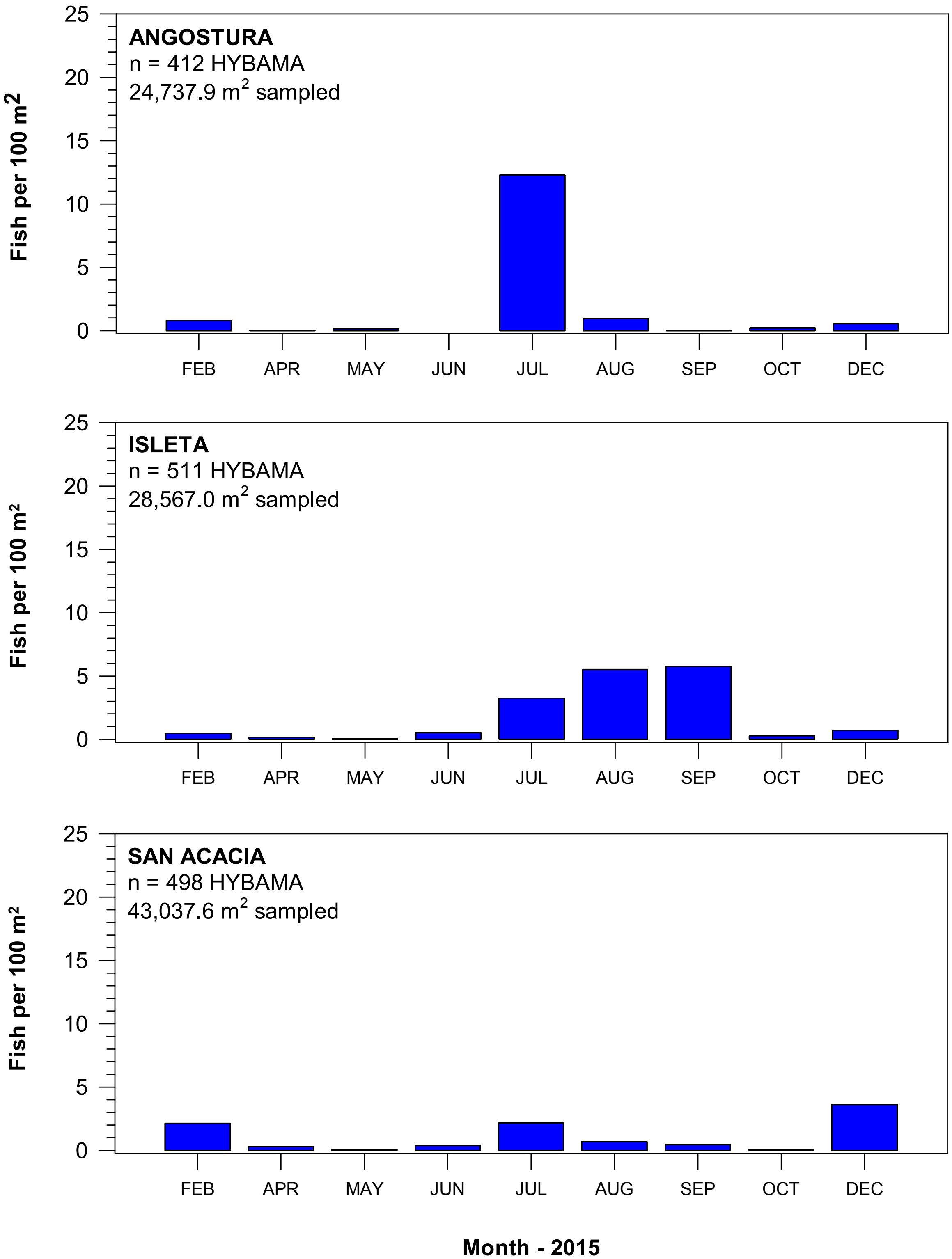

Figure 5. Rio Grande Silvery Minnow densities from February to December 2015 for each sampling reach in the Middle Rio Grande.

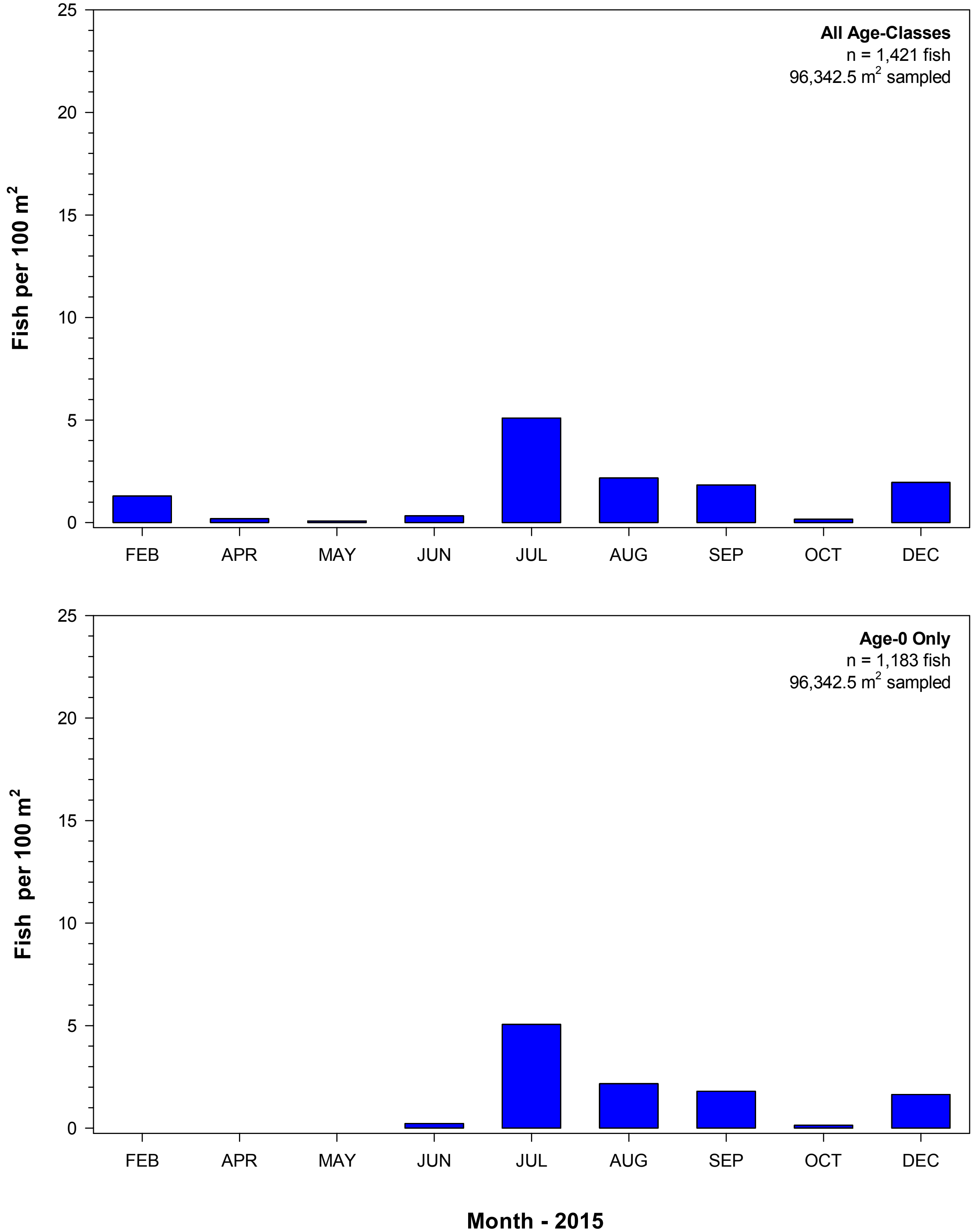

Figure 6. Inter-month fluctuations in densities of Rio Grande Silvery Minnow from February to December 2015 (A = all age-classes; B = age-0 only).

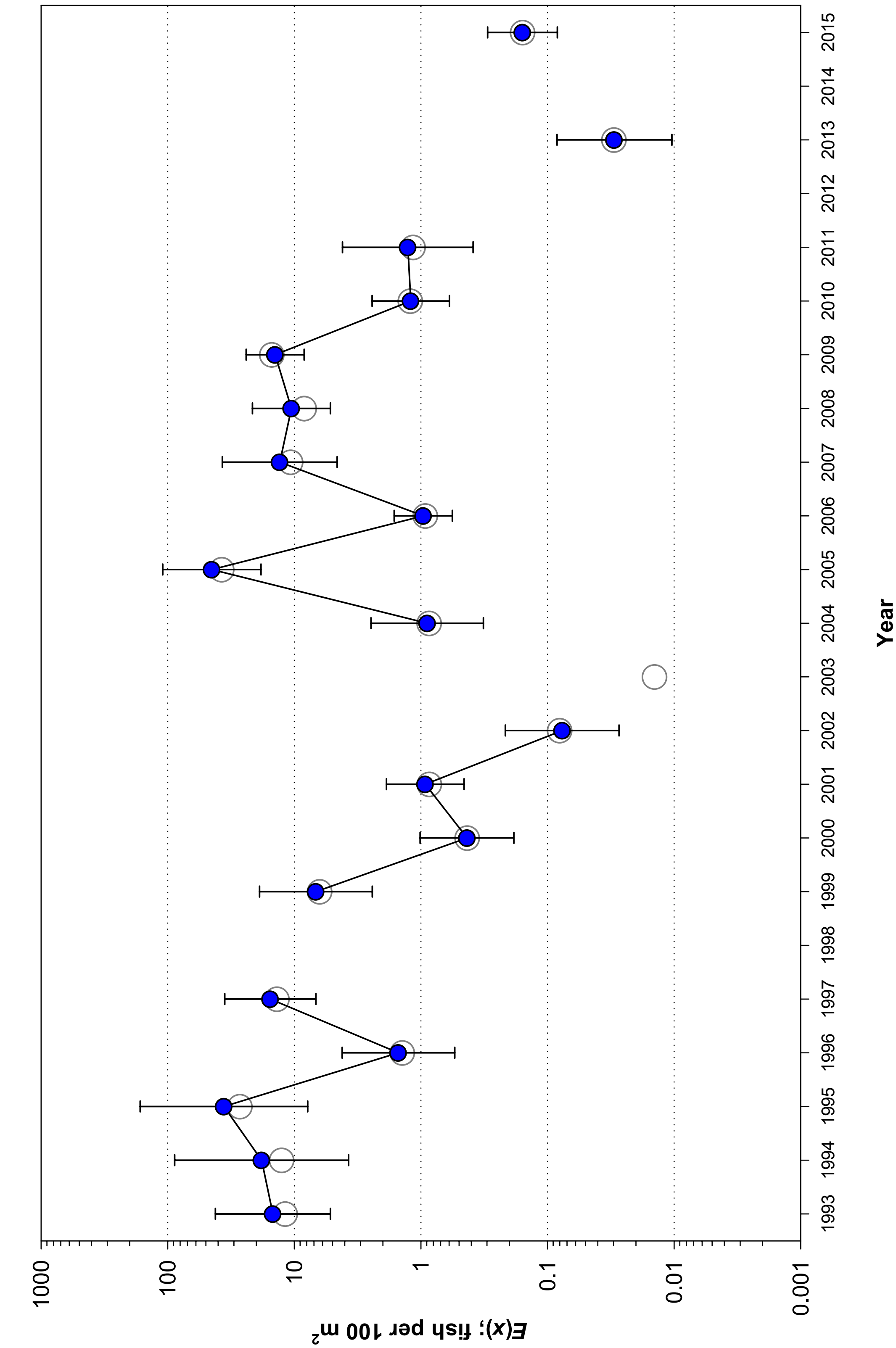

Figure 7. Rio Grande Silvery Minnow mixture-model (δ[Year] µ[Year]) estimates of density (*E*(*x*)), using October sampling-site density data (1993–2015). Sampling did not occur in 1998. Solid circles indicate modeled estimates and bars represent 95% confidence intervals. Hollow circles indicate simple estimates (method of moments) of mean densities.

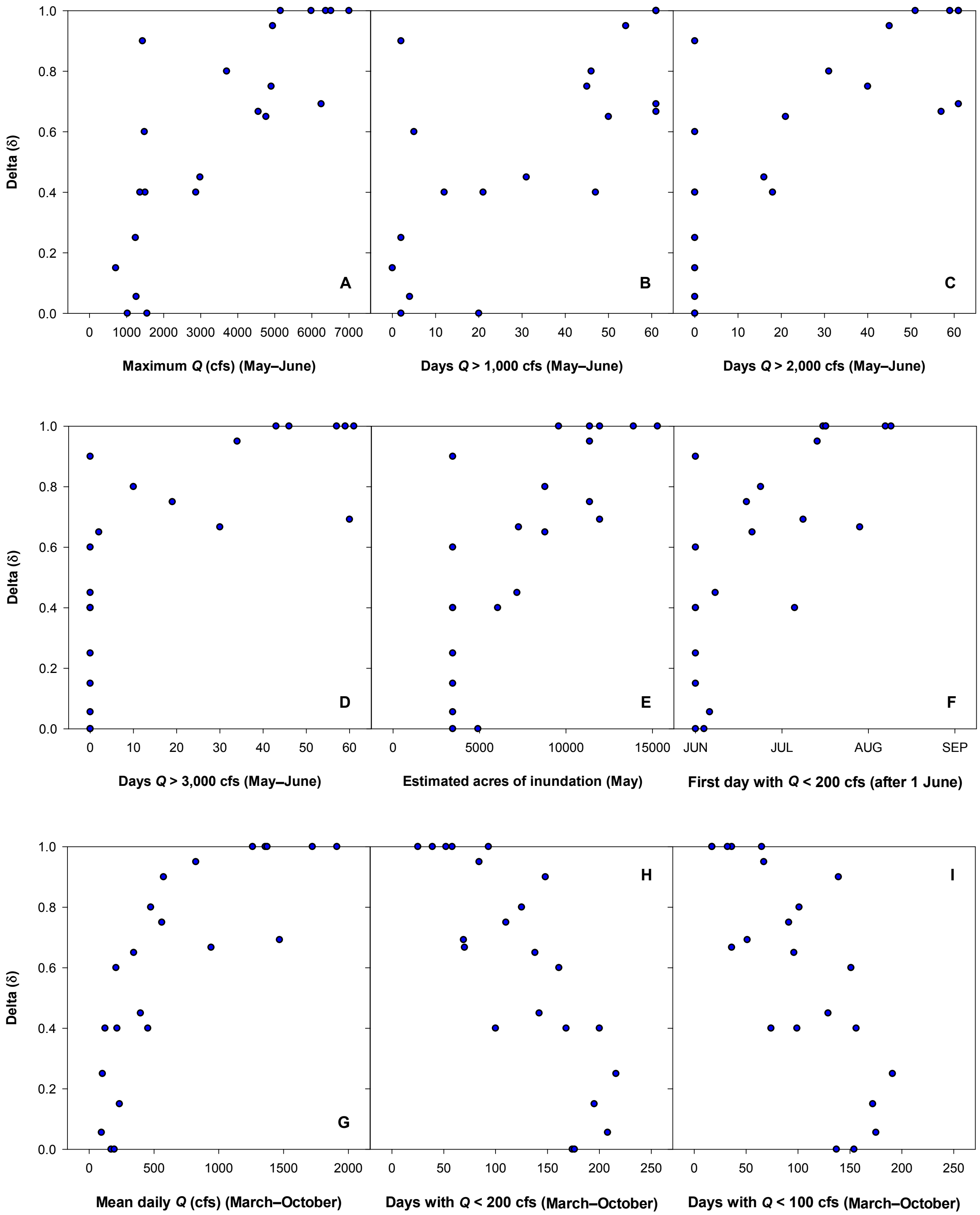

Figure 8. Bivariate relationships among Rio Grande Silvery Minnow estimates of the probability of occurrence (δ), using October sampling-site density data (1993–2015), and hydraulic variables based on data measured at USGS Gage #08330000 (Figures A–E) and USGS Gage #08358400 (Figures F–I).

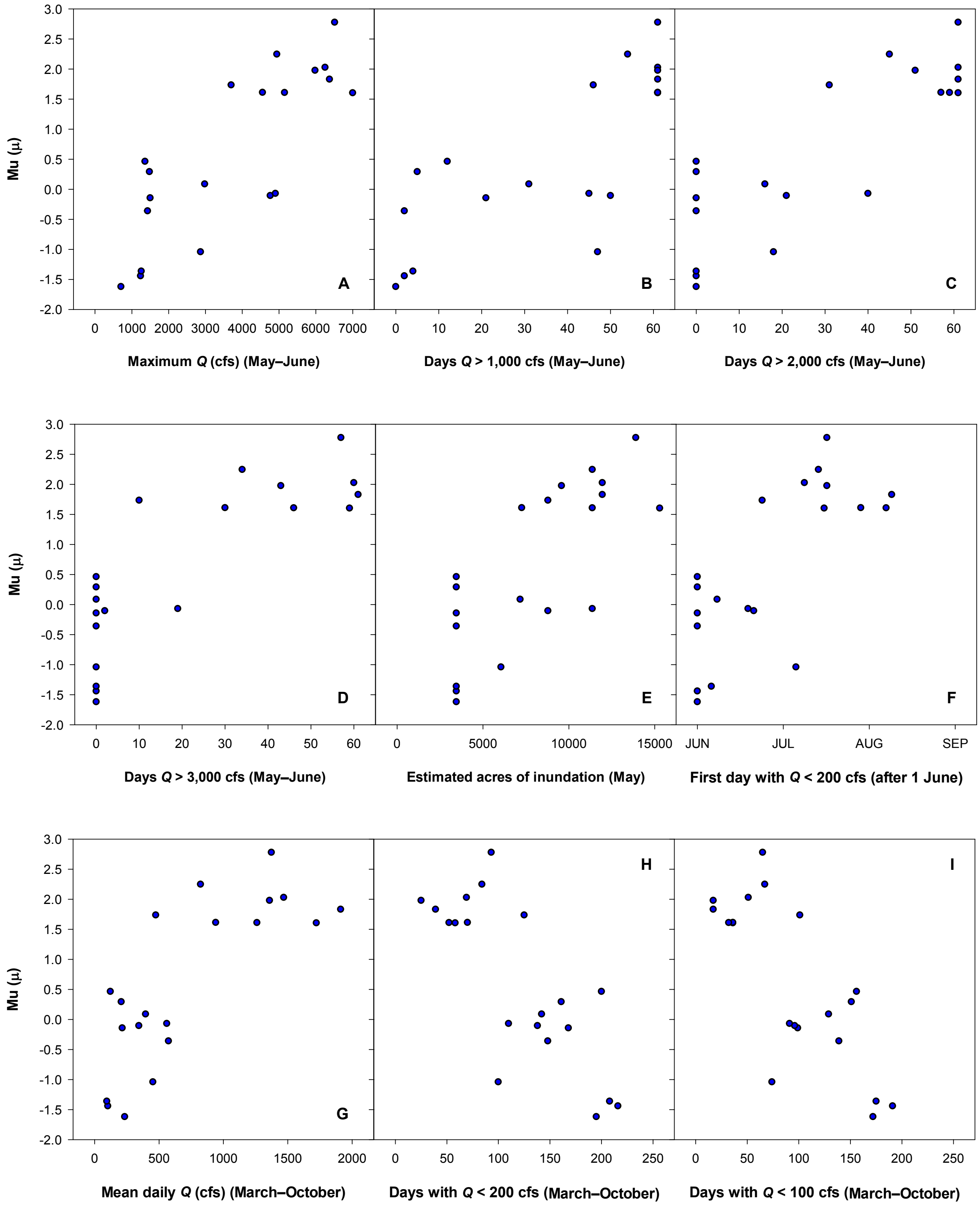

Figure 9. Bivariate relationships among Rio Grande Silvery Minnow estimates of the mean of the lognormal density distribution (μ), using October sampling-site density data (1993–2015), and hydraulic variables based on data measured at USGS Gage #08330000 (Figures A–E) and USGS Gage #08358400 (Figures F–I).

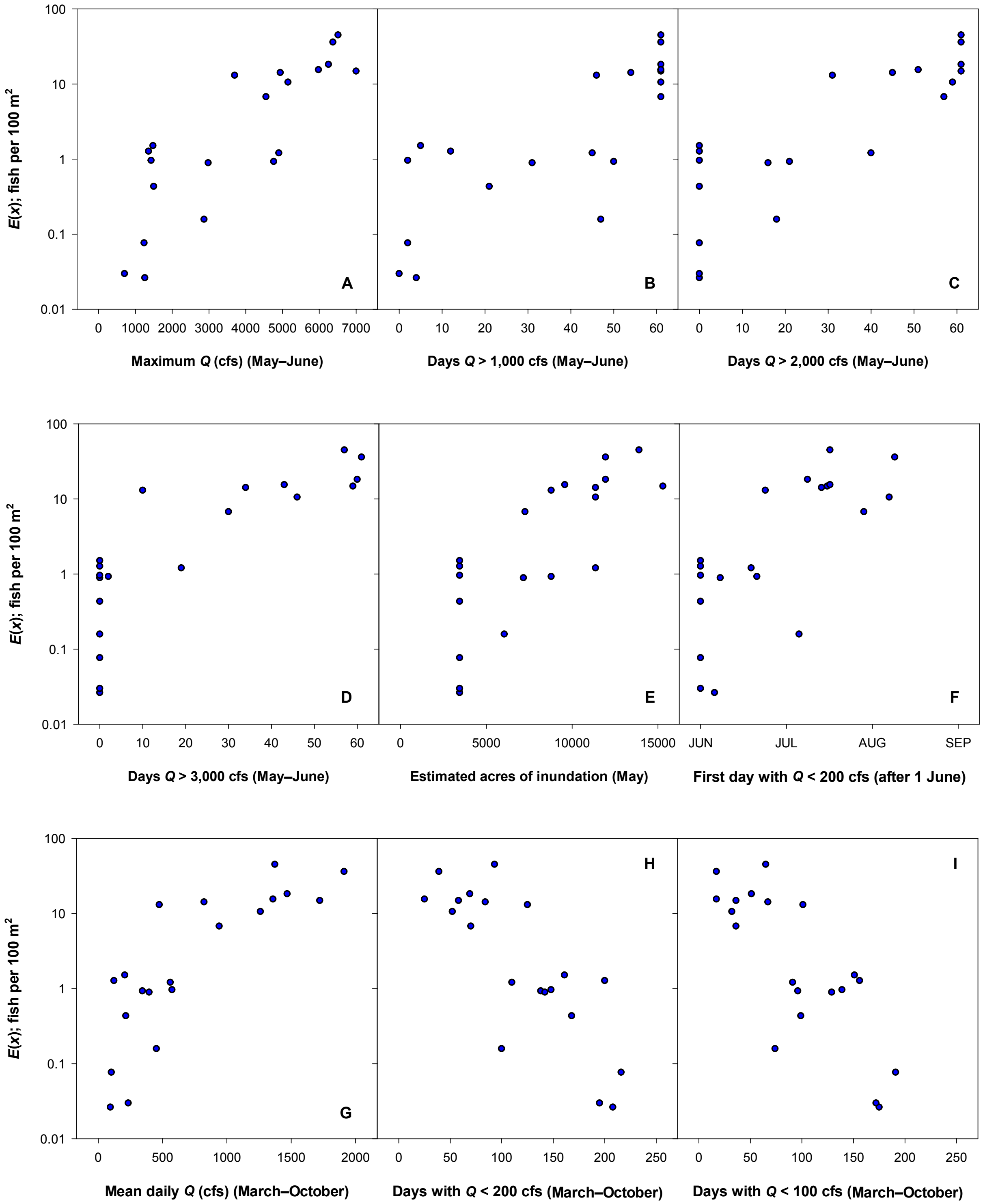

Figure 10. Bivariate relationships among Rio Grande Silvery Minnow estimates of density ($E(x)$), using October sampling-site density data (1993–2015), and hydraulic variables based on data measured at USGS Gage #08330000 (Figures A–E) and USGS Gage #08358400 (Figures F–I).

Table 3. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using October sampling-site density data (1993–2015) and different hydraulic variables, allowing for random effects (*R*). The top ten models are ranked by Akaike's information criterion (AIC_c) and include the AIC_c weight (w_i).

Model[1]	**logLike**[2]	**K**[3]	**AIC_c**	**w_i**
δ(Year) μ(ABQ>3,000+*R*)	658.05	27	716.08	0.5097
δ(Year) μ(ABQ>2,000+*R*)	658.76	27	716.79	0.3574
δ(Year) μ(ABQmax+*R*)	662.30	27	720.33	0.0608
δ(Year) μ(SANmean+*R*)	662.79	27	720.82	0.0475
δ(Year) μ(Inundation+*R*)	666.91	27	724.94	0.0061
δ(Year) μ(ABQ>1,000+*R*)	667.05	27	725.09	0.0056
δ(Year) μ(SAN<100+*R*)	668.31	27	726.34	0.0030
δ(Year) μ(SAN<200+*R*)	668.44	27	726.47	0.0028
δ(Year) μ(SAN1stday<200+*R*)	669.06	27	727.09	0.0021
δ(SANmean+*R*) μ(ABQ>3,000+*R*)	708.83	9	727.28	0.0019

[1] = Model variables included sampling year during October (1993–2015), estimated inundation of the river channel and floodplain, and other hydraulic variables at USGS Gages (#08330000 [ABQ; Rio Grande at Albuquerque, NM] and #08358400 [SAN; Rio Grande Floodway at San Marcial, NM]).
[2] = -2[log-likelihood] of the model
[3] = Number of parameters in the model

Mesohabitat associations

General linear models of Rio Grande Silvery Minnow mixture-model estimates, using October mesohabitat-specific density data (2002–2015), revealed that variation in δ and μ was reliably predicted by differences among years and mesohabitats (Table 4). The top model (δ[Year+Mesohabitat] μ[Year+Mesohabitat]) effectively received all of the AIC_c weight. Year alone was particularly informative for explaining variation in δ over time, which explains its inclusion in the second ranked model (δ[Year] μ[Year+Mesohabitat]). A comparison of AIC_c values revealed that the year model (δ[Year] μ[Year]) was more informative in explaining changes in model parameter values over time as compared with mesohabitat (δ[Mesohabitat] μ[Mesohabitat]).

Rio Grande Silvery Minnow mesohabitat-specific density data during October (2002–2015) were also used to calculate density estimates ($E(x)$) for different mesohabitats by year. Temporal population trends in the five mesohabitats (BW, PO, SHPO, SHRU, and RU) were quite similar over the period of study (Figure 11). The highest estimated densities were observed in 2005 for all mesohabitats, but densities have declined precipitously in all mesohabitats over the past decade. However, 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., BW in 2003), which precluded mixture-model estimation of σ. The mesohabitat model (δ[Mesohabitat] μ[Mesohabitat]) revealed that overall estimated densities in BW (40.19) and SHPO (11.36) were significantly higher ($P < 0.05$) than in SHRU (2.74) and RU (1.06). Simple estimates of mean densities, using the method of moments, were very similar to estimated densities for different mesohabitats over time.

Sampling variation during repeated sampling

General linear models of Rio Grande Silvery Minnow mixture-model estimates, using sampling-site density data during repeated sampling in November (2005–2015), revealed that variation in δ and μ was predicted by differences among years but much less so by sampling occasion (Table 5). The top model (δ[Year] μ[Year+Occasion]) received most of the AIC_c weight as compared to the other models. Year alone was particularly informative for explaining variation in δ and μ over time, which explains its sole inclusion in the second ranked model (δ[Year] μ[Year]). A comparison of AIC_c values revealed that the year model (δ[Year] μ[Year]) was more informative in explaining changes in model parameter values over time as compared with sampling occasion (δ[Occasion] μ[Occasion]). Further, a variance components analysis revealed that Year accounted for the highest variance (77.01) in estimated densities, followed distantly by Site (5.99) and Occasion (1.32). The Year*Site estimate was 148.55, highlighting that estimated densities at sites were not consistent across years, with the error variance estimate of 164.71.

Rio Grande Silvery Minnow sampling-site density data during November (2005–2015) were also used to calculate density estimates ($E(x)$) for 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 12). While densities have declined precipitously for all sampling occasions over the past decade, there was improvement in 2015 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. 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 for different sampling occasions over time.

Table 4. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using October mesohabitat-specific density data (2002–2015), allowing for random effects (*R*). The top ten models are ranked by Akaike's information criterion (AIC_c) and include the AIC_c weight (w_i).

Model[1]	**logLike**[2]	**K**[3]	**AIC_c**	**w_i**
δ(Year+Mesohabitat) µ(Year+Mesohabitat)	1,360.69	54	1,473.95	0.9996
δ(Year) µ(Year+Mesohabitat)	1,385.15	50	1,489.65	0.0004
δ(Year+Mesohabitat) µ(Mesohabitat)	1,564.27	28	1,621.67	<0.0001
δ(Year) µ(Mesohabitat)	1,587.31	24	1,636.35	<0.0001
δ(Year+Mesohabitat) µ(Year)	1,577.75	46	1,673.55	<0.0001
δ(Year) µ(Year)	1,600.80	42	1,687.96	<0.0001
δ(Year*Mesohabitat) µ(Year*Mesohabitat)	1,196.30	210	1,707.29	<0.0001
δ(Year) µ(Null)	1,746.47	16	1,778.94	<0.0001
δ(Mesohabitat) µ(Year+Mesohabitat)	2,020.02	41	2,105.03	<0.0001
δ(Mesohabitat) µ(Mesohabitat)	2,214.00	15	2,244.41	<0.0001

[1] = Model variables included year (2002–2015) and mesohabitat (backwater, pool, run, shoreline pool, and shoreline run).
[2] = -2[log-likelihood] of the model
[3] = Number of parameters in the model

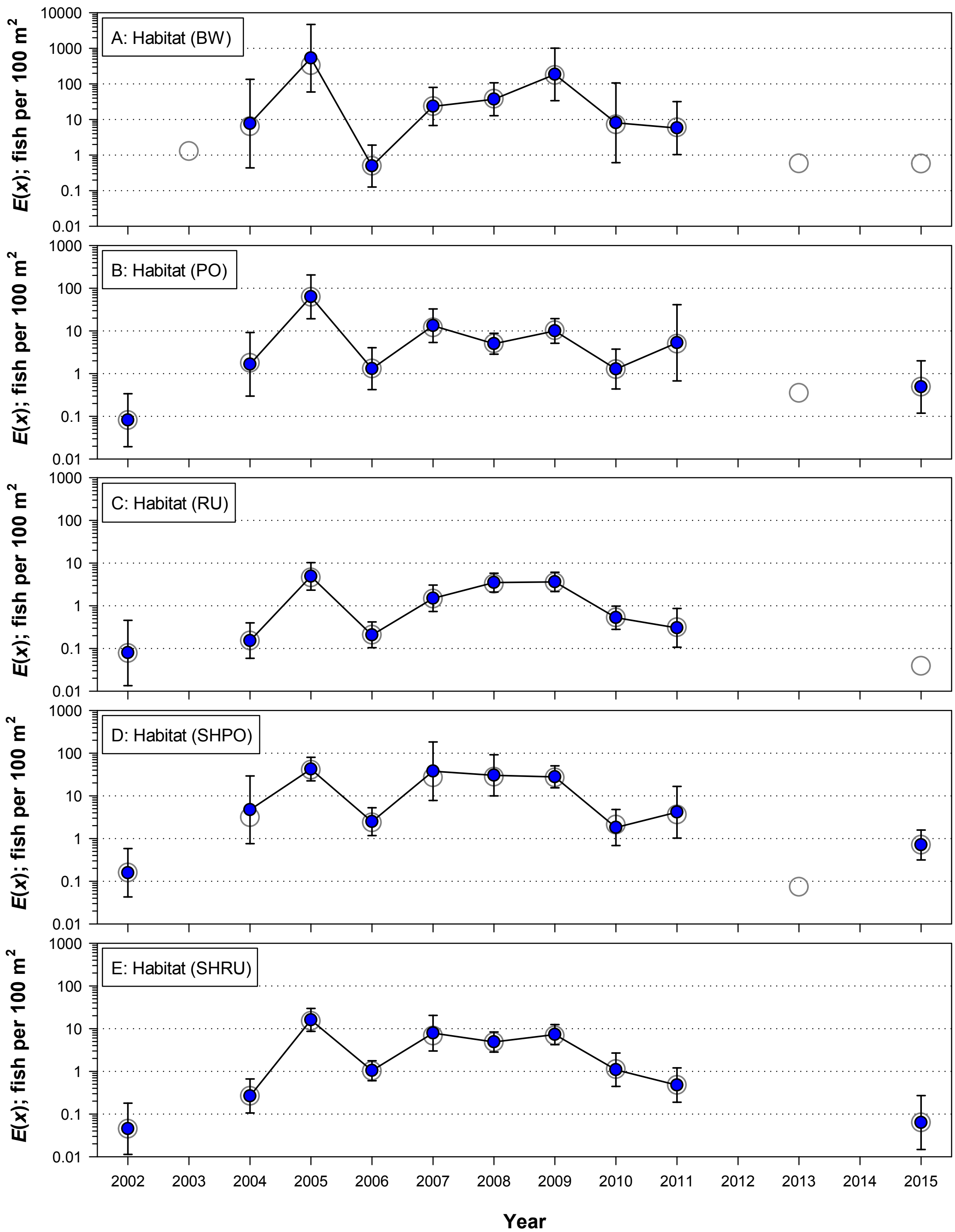

Figure 11. Rio Grande Silvery Minnow mixture-model (δ[Year*Mesohabitat] μ[Year*Mesohabitat]) estimates of density ($E(x)$) by mesohabitat, using October mesohabitat-specific density data (2002–2015). Solid circles indicate modeled estimates and bars represent 95% confidence intervals. Hollow circles indicate simple estimates (method of moments) of mean densities. Gaps indicate periods when individuals were not present in sampled mesohabitats.

Table 5. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using sampling-site density data during repeated sampling in November (2005–2015). The top ten models are ranked by Akaike's information criterion (AIC_c) and include the AIC_c weight (w_i).

Model[1]	**logLike**[2]	**K**[3]	**AIC_c**	**w_i**
δ(Year) µ(Year+Occasion)	1,486.58	39	1,568.29	0.6695
δ(Year) µ(Year)	1,501.93	33	1,570.86	0.1858
δ(Year+Occasion) µ(Year+Occasion)	1,483.62	42	1,571.93	0.1085
δ(Year+Occasion) µ(Year)	1,498.97	36	1,574.13	0.0362
δ(Year*Occasion) µ(Year*Occasion)	1,395.81	132	1,712.46	<0.0001
δ(Year) µ(Null)	1,884.64	13	1,911.06	<0.0001
δ(Year) µ(Occasion)	1,875.98	19	1,914.87	<0.0001
δ(Year+Occasion) µ(Occasion)	1,873.02	22	1,918.20	<0.0001
δ(Null) µ(Year)	1,971.66	23	2,018.95	<0.0001
δ(Occasion) µ(Year+Occasion)	1,954.76	32	2,021.25	<0.0001

[1] = Model variables included year (2005–2015) and sampling occasion (i.e., the 1st, 2nd, 3rd, or 4th day of sampling).
[2] = -2[log-likelihood] of the model
[3] = Number of parameters in the model

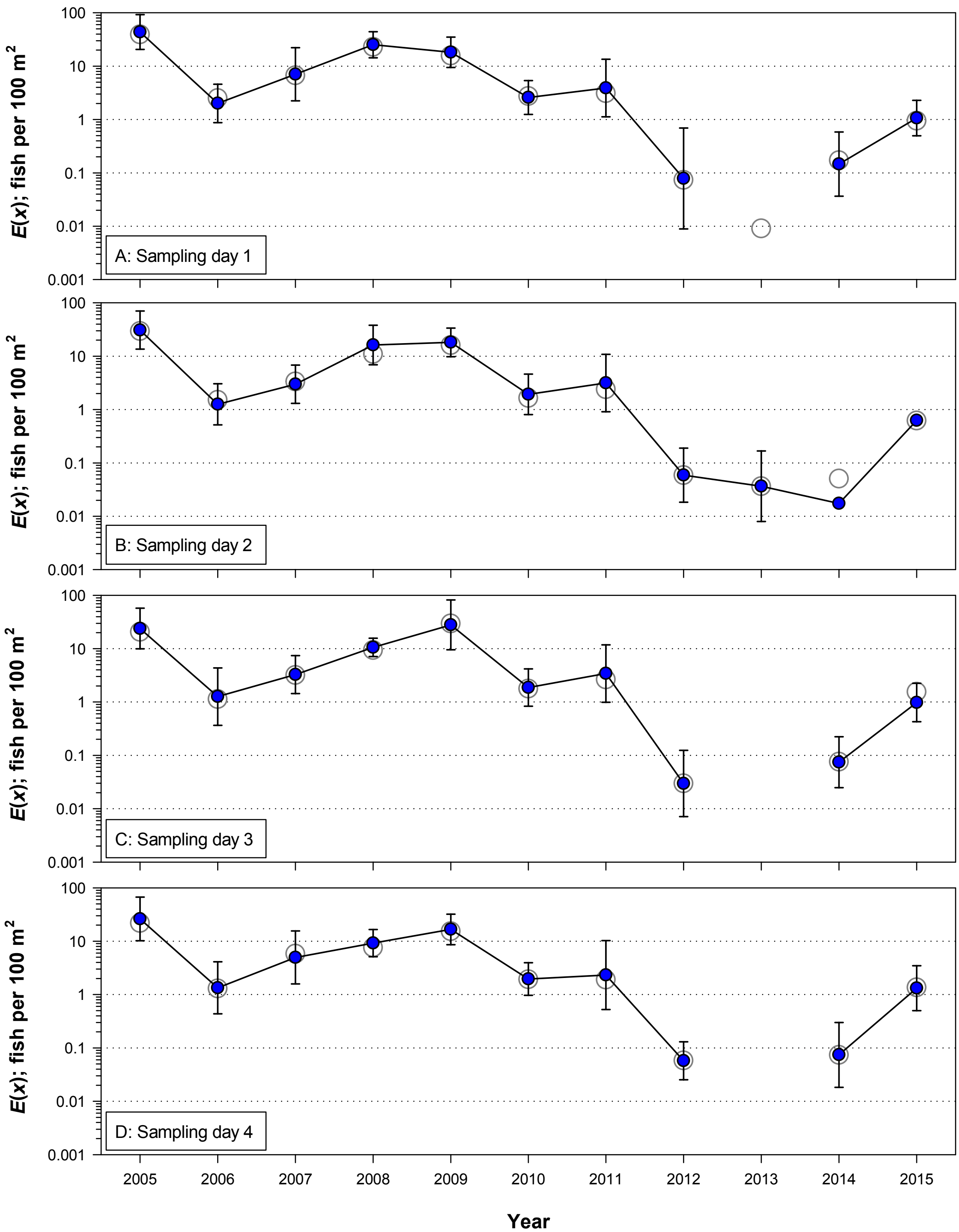

Figure 12. Rio Grande Silvery Minnow mixture-model (δ[Year*Occasion] μ[Year*Occasion]) estimates of density (*E*(*x*)) by sampling occasion, using sampling-site density data during November (2005–2015). Solid circles indicate modeled estimates and bars represent 95% confidence intervals. Hollow circles indicate simple estimates of mean densities (method of moments). Gaps indicate periods when individuals were not present in samples.

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 6; Appendix D). The native ichthyofauna comprised 12 species (Gizzard Shad, Red Shiner, Rio Grande Chub, Rio Grande Silvery Minnow, Fathead Minnow, Flathead Chub, Longnose Dace, River Carpsucker, Smallmouth Buffalo, Blue Catfish, Flathead Catfish, and Bluegill). Red Shiner was the most abundant native species collected (n = 13,805), followed by Flathead Chub (n = 2,929), and Rio Grande Silvery Minnow (n = 1,421). The nonnative ichthyofauna comprised 14 species. The most abundant introduced species were Channel Catfish (n = 2,964), Western Mosquitofish (n = 1,893), and Common Carp (n = 332).

Rio Grande Silvery Minnow, sampled during October, composed a higher fraction of the total ichthyofaunal community from 2005–2009 than from 2010–2015 (Figure 13). The relative abundance of this species declined rapidly after 2009 and remained exceptionally low from 2012 to 2014. Rio Grande Silvery represented only 0.91% of the total ichthyofaunal community in October 2015.

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 7). This species had decreased from being the 2nd most common focal species in 2009 to being the least common focal species by 2012. While the rank abundance of Rio Grande Silvery Minnow increased from 2006 (4th) to 2007–2009 (2nd), it dropped again in 2010 (5th). Rio Grande Silvery Minnow rank abundance improved in 2015 (7th) as compared with recent years (2012–2014; 10th). The coefficient of concordance (W = 0.73) for the ten focal species indicated high overall agreement among ranks over time (2006–2015; X^2= 65.8; P < 0.001) despite large changes in ranks for some taxa (e.g., Rio Grande Silvery Minnow).

There were notable seasonal changes in the relative abundance of the 10 focal fish species from February to December 2015 (Figures 14 and 15). Density of all fish species generally increased during spring or summer. However, Rio Grande Silvery Minnow abundance was highest during July but rapidly declined from August to October. Other focal species typically reached their highest densities from June to September, following spawning. An accounting of species-specific abundance across sampling months documented the seasonal occurrence of certain taxa (e.g., Gizzard Shad, Smallmouth Buffalo, and Blue Catfish; Table 8).

In addition to temporal variation in the relative abundance of fish species during 2015, there were also longitudinal changes in the densities of species from upstream to downstream (Figure 16). Fathead Minnow, 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, River Carpsucker, Channel Catfish, and Western Mosquitofish. None of the focal species were most common in the San Acacia Reach.

Table 6. Summary of the February to December 2015 Rio Grande Silvery Minnow population monitoring results (species list is based on fish collected since 1993).

FAMILY	SPECIES COMMON NAME	RESIDENCE STATUS[1]	TOTAL NUMBER OF SPECIMENS	PERCENT (%) OF TOTAL	FREQUENCY OF OCCURRENCE[2]	% FREQUENCY OCCURRENCE[2]
Clupeidae	Gizzard Shad	N	36	0.14	12	6.67
Clupeidae	Threadfin Shad	I	-	-	-	-
Cyprinidae	Central Stoneroller	I	-	-	-	-
Cyprinidae	Goldfish	I	-	-	-	-
Cyprinidae	Red Shiner	N	13,805	54.93	170	94.44
Cyprinidae	Common Carp	I	332	1.32	60	33.33
Cyprinidae	Rio Grande Chub	N	4	0.02	1	0.56
Cyprinidae	Rio Grande Silvery Minnow	N	1,421	5.65	107	59.44
Cyprinidae	Golden Shiner	I	-	-	-	-
Cyprinidae	Fathead Minnow	N	297	1.18	68	37.78
Cyprinidae	Bullhead Minnow	I	23	0.09	9	5.00
Cyprinidae	Flathead Chub	N	2,929	11.65	153	85.00
Cyprinidae	Longnose Dace	N	882	3.51	36	20.00
Catostomidae	River Carpsucker	N	162	0.64	53	29.44
Catostomidae	White Sucker	I	221	0.88	32	17.78
Catostomidae	Smallmouth Buffalo	N	6	0.02	4	2.22
Ictaluridae	Black Bullhead	I	2	0.01	2	1.11
Ictaluridae	Yellow Bullhead	I	55	0.22	16	8.89
Ictaluridae	Blue Catfish	N	67	0.27	21	11.67
Ictaluridae	Channel Catfish	I	2,964	11.79	150	83.33
Ictaluridae	Flathead Catfish	N	11	0.04	8	4.44
Salmonidae	Rainbow Trout	I	-	-	-	-
Salmonidae	Brown Trout	I	-	-	-	-
Poeciliidae	Western Mosquitofish	I	1,893	7.53	100	55.56
Moronidae	White Bass	I	3	0.01	2	1.11
Moronidae	Striped Bass	I	-	-	-	-
Centrarchidae	Green Sunfish	I	1	0.00	1	0.56
Centrarchidae	Bluegill	N	4	0.02	4	2.22
Centrarchidae	Longear Sunfish	I	-	-	-	-
Centrarchidae	Smallmouth Bass	I	-	-	-	-
Centrarchidae	Largemouth Bass	I	1	0.00	1	0.56
Centrarchidae	White Crappie	I	12	0.05	9	5.00
Centrarchidae	Black Crappie	I	-	-	-	-
Percidae	Yellow Perch	I	1	0.00	1	0.56
Percidae	Bigscale Logperch	I	-	-	-	-
Percidae	Walleye	I	1	0.00	1	0.56
MONTHLY TOTALS			25,133	100.00		

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on 180 site samples (i.e., 20 samples per month) during 2015.

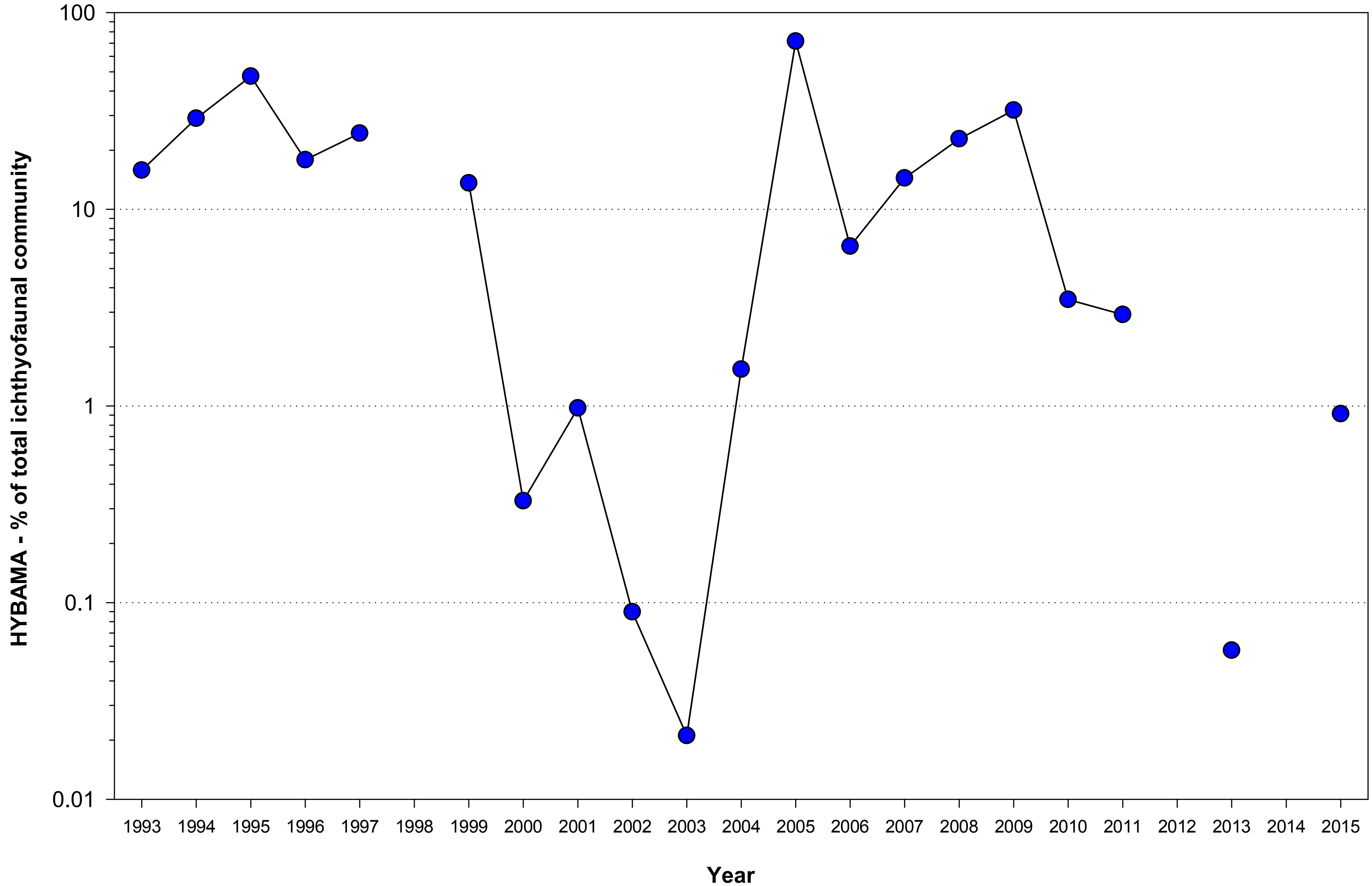

Figure 13. Relative abundance of Rio Grande Silvery Minnow as a percentage of the total ichthyofaunal community during October, at all sampling sites, by sampling year (1993–2015). Sampling did not occur in 1998.

Table 7. Summary of rank abundance for focal species collected in the Rio Grande during October over the past decade (2006–2015).

FAMILY **Common Name**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
CYPRINIDAE										
Red Shiner	1	1	1	1	1	1	1	1	1	1
Common Carp	10	10	7	10	9	10	6	9	8	9
Rio Grande Silvery Minnow	4	2	2	2	5	4	10	10	10	7
Fathead Minnow	6	7	5	6	6	7	5	4	6	6
Flathead Chub	2	4	4	5	2	3	3	6	3	3
Longnose Dace	7	8	8	9	7	8	8	3	5	5
CATOSTOMIDAE										
River Carpsucker	8	6	9	7	8	5	7	8	7	8
White Sucker	8	9	10	8	10	9	9	7	9	10
ICTALURIDAE										
Channel Catfish	5	5	6	4	4	6	4	5	4	4
POECILIIDAE										
Western Mosquitofish	3	3	3	3	3	2	2	2	2	2

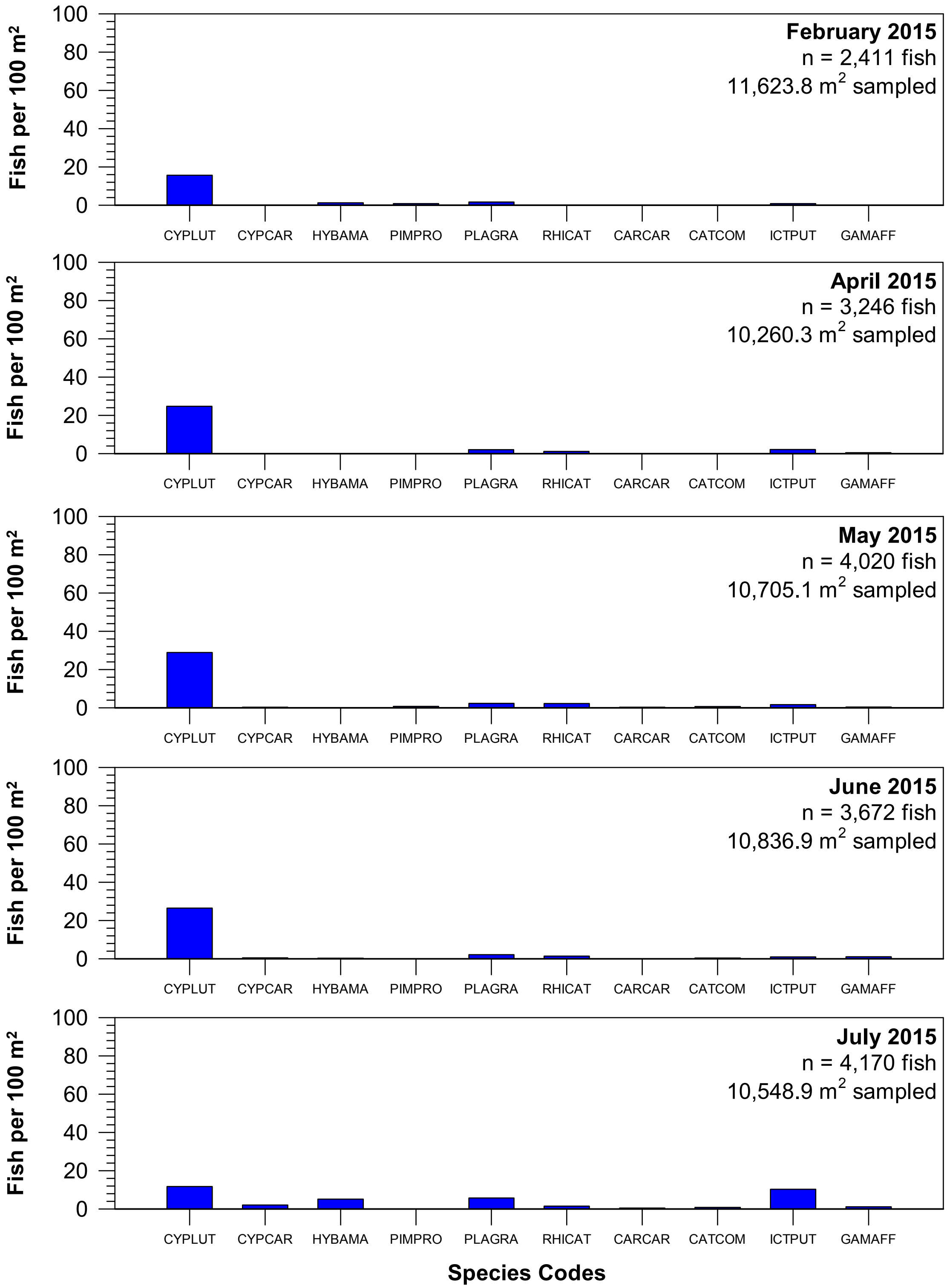

Figure 14. Fish densities from February to July 2015 for each focal species (see Table 1 for species codes) in the Middle Rio Grande.

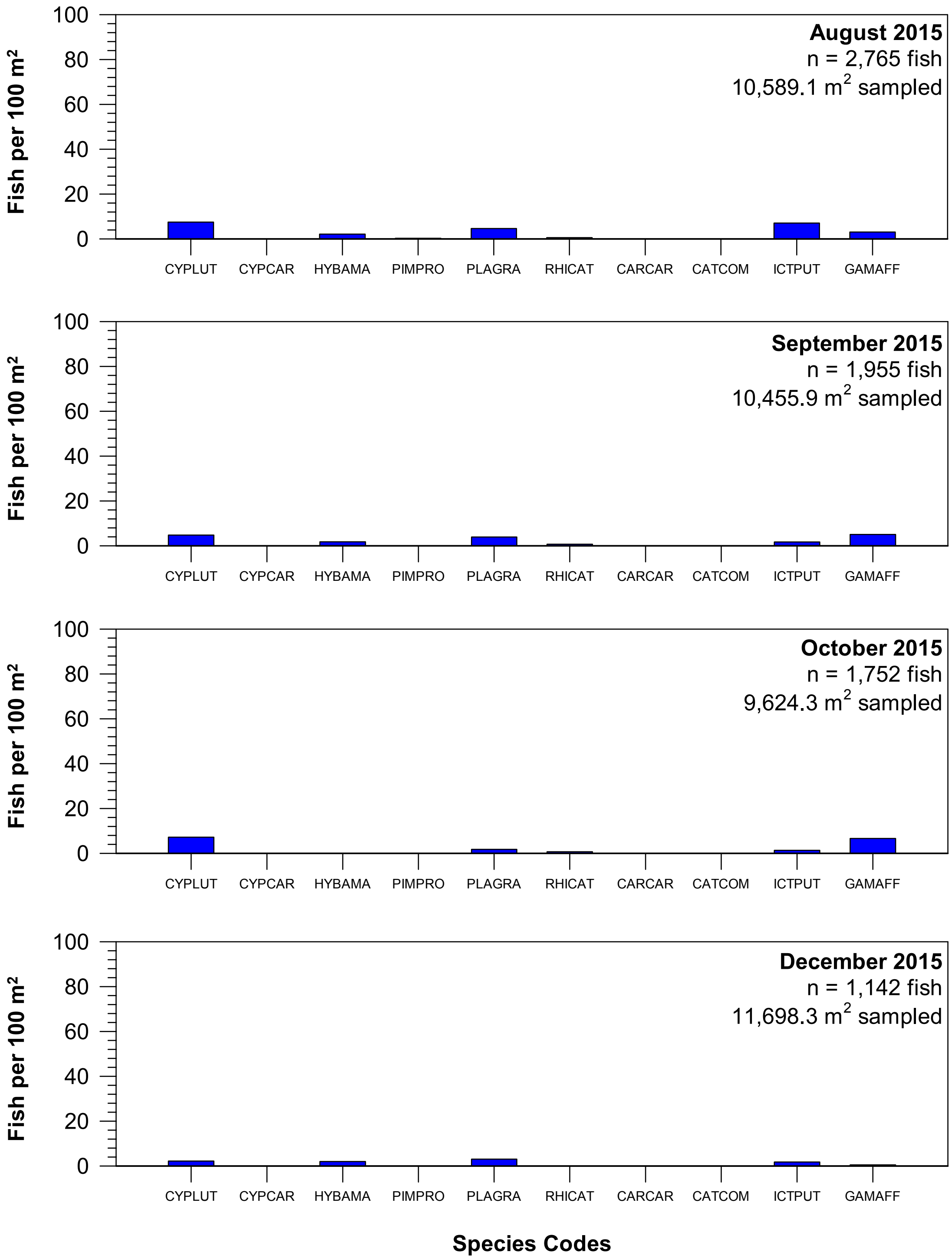

Figure 15. Fish densities from August to December 2015 for each focal species (see Table 1 for species codes) in the Middle Rio Grande.

Table 8. Summary of the February to December 2015 Rio Grande Silvery Minnow population monitoring fish samples.

FAMILY	SPECIES COMMON NAME	FEB	APR	MAY	JUN	JUL	AUG	SEP	OCT	DEC	TOTAL
Clupeidae	Gizzard Shad	-	7	21	5	1	2	-	-	-	36
Clupeidae	Threadfin Shad	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Central Stoneroller	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Goldfish	-	-		-	-	-	-	-	-	0
Cyprinidae	Red Shiner	1,828	2,540	3,088	2,871	1,235	797	502	690	254	13,805
Cyprinidae	Common Carp	1	3	27	50	213	18	9	6	5	332
Cyprinidae	Rio Grande Chub	-	-	-	4	-	-	-	-	-	4
Cyprinidae	Rio Grande Silvery Minnow	151	19	9	36	538	231	192	16	229	1,421
Cyprinidae	Golden Shiner	-	-	-	-	-	-	-	-	-	0
Cyprinidae	Fathead Minnow	103	17	72	11	18	36	18	18	4	297
Cyprinidae	Bullhead Minnow	1	1	1	2	2	-	-	-	16	23
Cyprinidae	Flathead Chub	195	222	241	233	598	496	417	169	358	2,929
Cyprinidae	Longnose Dace	4	124	233	152	158	62	77	68	4	882
Catostomidae	River Carpsucker	10	15	31	22	51	6	9	12	6	162
Catostomidae	White Sucker	7	13	68	43	81	6	1	-	2	221
Catostomidae	Smallmouth Buffalo	-	-	-	5	-	1	-	-	-	6
Ictaluridae	Black Bullhead	-	-	-	-	1	1	-	-	-	2
Ictaluridae	Yellow Bullhead	-	-	1	-	34	18	1	1	-	55
Ictaluridae	Blue Catfish	-	-	13	20	29	5	-	-	-	67
Ictaluridae	Channel Catfish	102	223	173	106	1,088	751	185	129	207	2,964
Ictaluridae	Flathead Catfish	-	-	-	-	1	3	6	1	-	11
Salmonidae	Rainbow Trout	-	-	-	-	-	-	-	-	-	0
Salmonidae	Brown Trout	-	-	-	-	-	-	-	-	-	0
Poeciliidae	Western Mosquitofish	8	57	36	111	120	330	535	639	57	1,893
Moronidae	White Bass	1	2	-	-	-	-	-	-	-	3
Moronidae	Striped Bass	-	-	-	-	-	-	-	-	-	0
Centrarchidae	Green Sunfish	-	-	-	-	-	-	-	1	-	1
Centrarchidae	Bluegill	-	-	1	-	-	1	1	1	-	4
Centrarchidae	Longear Sunfish	-	-	-	-	-	-	-	-	-	0
Centrarchidae	Smallmouth Bass	-	-	-	-	-	-	-	-	-	0
Centrarchidae	Largemouth Bass	-	1	-	-	-	-	-	-	-	1
Centrarchidae	White Crappie	-	2	4	1	1	1	2	1	-	12
Centrarchidae	Black Crappie	-	-	0	-	-	-	-	-	-	0
Percidae	Yellow Perch	-	-	-	-	1	-	-	-	-	1
Percidae	Bigscale Logperch	-	-	-	-	-	-	-	-	-	0
Percidae	Walleye	-	-	1	-	-	-	-	-	-	1
MONTHLY TOTALS		2,411	3,246	4,020	3,672	4,170	2,765	1,955	1,752	1,142	25,133

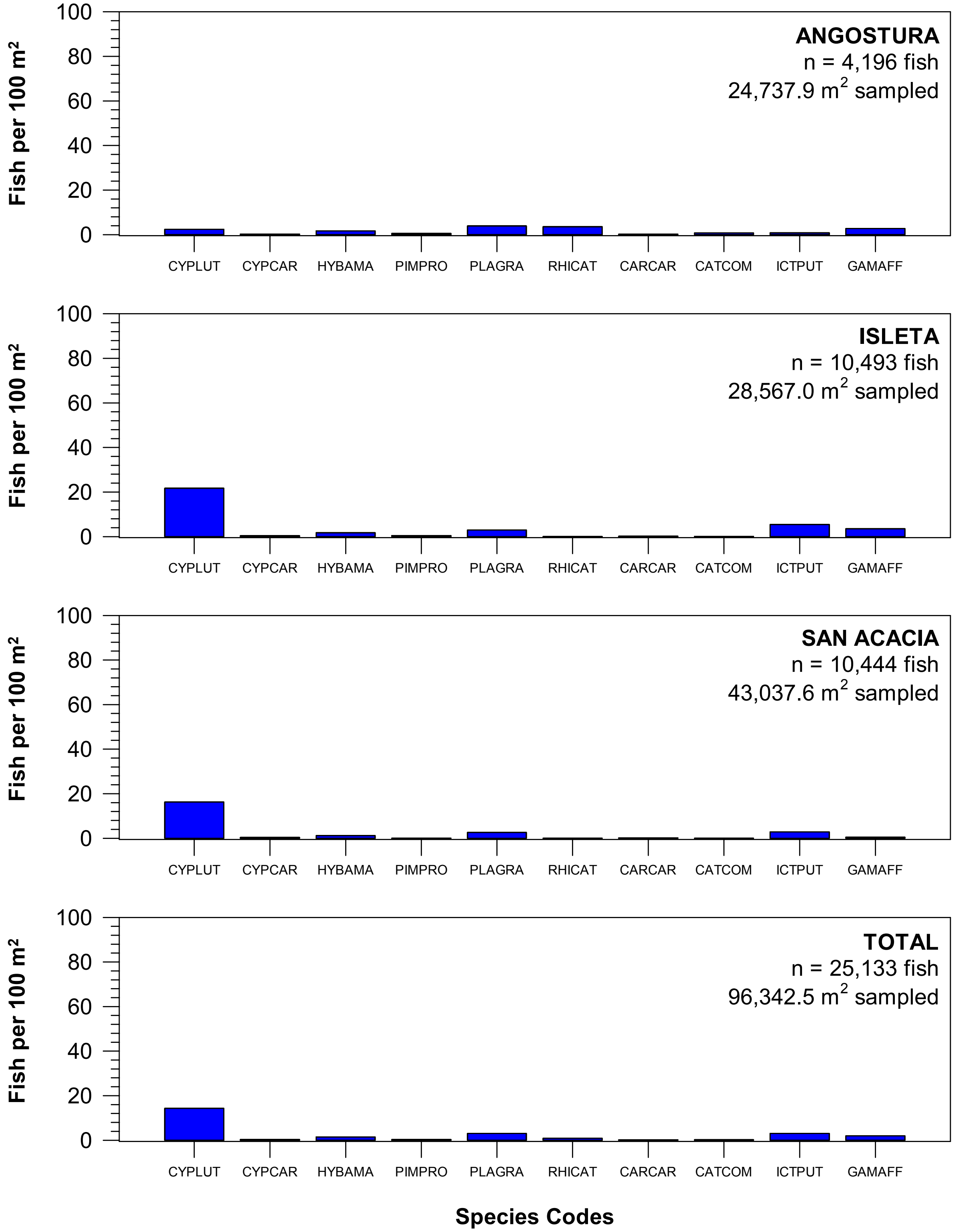

Figure 16. Fish densities by river reach for each focal species (see Table 1 for species codes) in the Middle Rio Grande from February to December 2015.

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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 fish species over time, and 4) Examining seasonal and spatial differences in population structure and abundance of native and nonnative Middle Rio Grande fishes.

While the primary purpose of this study was to estimate fish population trends over time using a density index, there are important differences between estimating population trends vs. estimating population size. Both the accuracy and precision of 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). Despite similarities in population trends obtained from the population monitoring and population estimation 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, insight to seasonal mortality rates, timely information about the status of the species during periods of reduced abundance, and a valuable tool to assess the real-time effectiveness of adaptive management activities. In contrast, population estimation provided a statistically robust annual estimate of the Rio Grande Silvery Minnow population that proved vital as a metric by which to compare trends obtained from the population monitoring study. While density estimates generated from the population monitoring study should not be used to derive population size estimates, they have proven to be an accurate and 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. For the simplest models, without covariates or random effects, they can be considered zero-inflated lognormal models. While the trends in estimated densities ($E(x)$) of Rio Grande Silvery Minnow over time were similar to those calculated during previous years using log-transformed data (Dudley et al., 2015a), 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 strictly caused by reduced capture efficiency, as methods have remained consistent to ensure that comparable mesohabitats (depths and velocities) were sampled across different annual flow conditions. Further, discharge during October has been remarkably consistent and suitable for 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.

There have been remarkable changes in the estimated densities of Rio Grande Silvery Minnow across years over the past two decades (i.e., more than two orders of magnitude [>10,000% increase or >99% decrease]). Despite these notable differences in the estimated densities of Rio Grande Silvery Minnow across sampling years, 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 2005–2015) 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 distribution and abundance of Rio Grande Silvery Minnow across years.

Additionally, both the October and November sampling efforts, based on the first day of sampling (i.e., no site disturbance), revealed very similar trends in the estimated densities of Rio Grande Silvery Minnow over time (2005–2015). However, estimated densities tended to be somewhat higher in November and December than in October, particularly during periods when this species was less common. 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 are cooler (Dudley and Platania, 1997). The sampling occasion data could be especially useful during years when this species is quite rare (e.g., 2012–2014), as they provide another metric by which to assess subtle changes in its occurrence and abundance during periods of low abundance. 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 sampling occasion data are even more powerful and pertinent when considered collectively (e.g., all sampling occasions) as part of the site occupancy study (see Appendix B), as that intensive research effort provides a more robust assessment of Rio Grande Silvery Minnow conservation status, as compared with single-survey sampling, especially during periods of extreme rarity.

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 among 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, SHPO, SHRU, and RU) were quite similar over the period of study (2002–2015), despite notable differences in the estimated densities of Rio Grande Silvery Minnow among mesohabitats. The mesohabitat types most frequently occupied by Rio Grande Silvery Minnow in 2015 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 (2002–2015) or sampling-site density data (1993–2015) were quite 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. Also, the sampling-site density data are more appropriate than are 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 since those data have been collected over a much longer period (1993–2015).

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 Rio Grande Silvery Minnow mixture-model estimates during October (1993–2015) to hydraulic variables measured at two Middle Rio Grande discharge gages revealed several strong relationships. Peak discharge and duration of high flows during spawning season (May–June) were positively related to Rio Grande Silvery Minnow occurrence and abundance. In contrast, early and extended low flows were negatively related to occurrence and abundance. Modeling these two separate population responses (presence-absence vs. density) provided valuable insights to the relative importance of multiple hydraulic covariates in explaining the variability of Rio Grande Silvery Minnow occurrence and abundance trends over time. Analyses suggested that extended and elevated spring flows were most predictive of increased abundance of Rio Grande Silvery Minnow as compared to any of the other hydraulic variables analyzed.

The physical conditions produced by prolonged and elevated spring flows result in overbank flooding of vegetated areas in the floodplain, formation of inundated habitats within the river channel, and creation of shoreline and island backwaters. Shallow low-velocity habitats (e.g., shoreline pools, backwaters, overbank floodplains etc.) are well known to be essential for the successful recruitment of early life history stages of many freshwater fish species throughout the world (Welcomme, 1979). It is quite likely that similar processes are important for the survival and recruitment of the native Middle Rio Grande ichthyofaunal community (Pease et al., 2006; Turner et al., 2010, Hoagstrom and Turner, 2013). Increased discharge from spring runoff, combined with rising water temperatures, appear to be the primary spawning stimuli for Rio Grande Silvery Minnow (Dudley and Platania, 2015b). During years with an adequate spring runoff, these elevated and warmer flows result in the creation of productive inundated nursery habitats that are used by early life stages of this species (Dudley and Platania, 1997; Dudley and Platania, 2015b). Extensive river channel and floodplain inundation, based on a five day peak flow event in May (U.S. Army Corps of Engineers, 2010), appeared related to the elevated autumnal abundance of Rio Grande Silvery Minnow. However, this relationship was not as strong as those with flow covariates that characterized elevated flows over an extended period (e.g., May–June). It appears that sustaining flows for floodplain inundation over a longer duration will be necessary to maximize their benefits as nursery habitats. Since successful growth and survival of Rio Grande Silvery Minnow from the egg through the early larval stages requires at least three weeks (Platania, 1995b), the persistence of these nursery habitats throughout this critical phase of development would likely lead to improved recruitment success.

Sampling efforts during October indicated that the highest densities of Rio Grande Silvery Minnow were generally in the Isleta and San Acacia reaches. The exceptions to this pattern occurred in years when there was poor runoff or extended low flows in the San Acacia Reach (e.g., 2002 and 2003) or following notable augmentation efforts in the Angostura and Isleta reaches. One possible explanation for this apparent upstream to downstream pattern of abundance is the cumulative longitudinal transport of some portion of Rio Grande Silvery Minnow propagules (drifting eggs and larvae) below instream barriers (i.e., Angostura, Isleta, and San Acacia diversion dams) or into irrigation networks (Dudley and Platania, 2007). Also, the extensive river channelization, habitat degradation, abandonment of the floodplain, and associated 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 early recruitment of this species, especially in the Cochiti and Angostura reaches. Our long-term population monitoring results illustrate the benefits of maintaining elevated and extended flows, during spring, for Rio Grande Silvery Minnow. Further, it is evident that annual inundation and restoration of floodplain habitats, combined with the restoration of river channel and habitat complexity, would likely lead to increased spawning 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). However, the long-term efficacy of these management efforts would also be dependent on assuring their utility and permanence through concerted efforts to restore a more natural flow regime and to reestablish river connectivity across select fragmented reaches (Dudley and Platania, 2007).

Rio Grande Silvery Minnow augmentation efforts in the Angostura Reach apparently reversed this trend from 2002–2007 (i.e., October densities were highest in the Angostura Reach during five of six of those years). Recent stocking efforts in the Angostura Reach (since 2014) could again shift the population structure among reaches, but this question remains to be answered. Further, the total overwinter mortality for the Rio Grande Silvery Minnow population, which is composed almost entirely of augmented individuals, could again result in substantial losses of individuals by the following spring (Dudley et al., 2015a). In light of this recurring pattern, there may be merit in experimentally stocking fish during late winter or early spring (prior to spawning) to assess whether this change in the timing of augmentation would help increase the spawning success of Rio Grande Silvery Minnow.

Shifting the timing of stocking to spring would also alleviate the issue of hatchery-origin Rio Grande Silvery Minnow being introduced during any portion of the autumn monitoring efforts (October and November), which are essential for assessing the annual status of the wild population. While VIE tags are generally considered reliable for marking smaller fish (Leblanc and Noakes, 2012; Neufeld et al., 2015), tag retention and visibility have been identified as concerns by researchers (e.g., Bailey et al., 1998; Reeves and Buckmeier, 2009). We recently documented several hatchery-origin Rio Grande Silvery Minnow, collected in 2014 and 2015, that apparently lost nearly all of their original tag or were marked improperly (i.e., small fragment of tag remained in the flesh) during a microscopic examination of preserved individuals thought to be of wild-origin. The low abundance of this species during certain years (e.g., 2012–2015) could magnify the impact of any issues with VIE tag loss or visibility because of the large number of fish stocked annually (ca. 200,000 in 2015; Thomas P. Archdeacon, New Mexico Fish and Wildlife Conservation Office, pers. comm.). While the magnitude of this issue is unknown, it could warrant additional study in the future.

Despite periodic and sometimes sustained declines in the abundance of Rio Grande Silvery Minnow, it is encouraging that this species can apparently rebound so quickly following years with good spawning/recruitment conditions. The dramatic increase in the abundance of Rio Grande Silvery Minnow from 2003 to 2005 (over two orders of magnitude) is indicative of the ability of this species to rebound quickly following favorable conditions. However, the rapid increases in abundance documented after consecutive years of good spring runoff contrast with the equally rapid decreases in abundance documented after consecutive years of poor spring runoff and prolonged summer low-flow/drying conditions. Despite large fluctuations in the occurrence and abundance of Rio Grande Silvery Minnow, the overall genetic diversity of this species was reasonably well maintained in the wild population from 1999–2010, probably as a result of the implementation of the current propagation management plan (Alò and Turner, 2005; Osborne et al., 2012). However, Rio Grande Silvery Minnow has been absent or rare in October samples taken during the past few years (2012–2015), and an associated decline in genetic diversity has been recently documented (Osborne et al., 2015).

While diligent and ongoing management efforts in the Middle Rio Grande over the past two decades have provided invaluable protection against the extinction of Rio Grande Silvery Minnow, additional efforts (e.g., ensuring adequate annual spring and summer flows for successful spawning and recruitment) will be required to yield resilient and self-sustaining populations over time. Encouragingly, both the occurrence and abundance of this imperiled species increased in 2015, as compared with recent years (2012–2014), following notably improved spring and summer flow conditions. However, securing the recovery and long-term persistence of Rio Grande Silvery Minnow in the wild will depend on attaining self-sustaining populations in multiple locations within its historical range. Future study of the ecological interactions among fish species and their environment in the Rio Grande Basin should further elucidate the factors that control this complex aquatic ecosystem, which will be essential in providing the information required to develop and implement successful management strategies for the long-term recovery of Rio Grande Silvery Minnow.

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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. 451 pp.

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.

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

Bailey, R. E., J. R. Irvine, F. C. Dalziel, and T. C. Nelson. 1998. Evaluations of visible implant fluorescent tags for marking Coho Salmon smolts. North American Journal of Fisheries Management 18:191–196.

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. 55 pp.

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, and U.S. Bureau of Reclamation (Albuquerque Projects Office), Albuquerque, NM. 96 pp.

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. 2015a. Rio Grande Silvery Minnow population monitoring program results from February to December 2014. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico. 185 pp.

Dudley, R. K., and S. P. Platania. 2015b. Monitoring of the Rio Grande Silvery Minnow reproductive effort during 2015 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. 37 pp.

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. 87 pp.

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.

Gold, R. L., and L. P. Denis. 1985. National water summary-New Mexico surface-water resources. U.S. Geological Survey water-supply paper 2300:341–346.

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. doi: 10.1111/faf.12054

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. Final report to the Middle Rio Grande Endangered Species Collaborative Program & the U.S. Bureau of Reclamation, Albuquerque, New Mexico. 74 pp.

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

Lagasse, P. F. 1980. An assessment of the response of the Rio Grande to dam construction-Cochiti to Isleta reach. A technical report for the U.S. Army Engineer District, Albuquerque, Corps of Engineers, Albuquerque, New Mexico. 133 pp.

Leblanc, C. A., and D. L. Noakes. 2012. Visible implant elastomer (VIE) tags for marking small Rainbow Trout. North American Journal of Fisheries Management 32:716–719.

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., P. Tashjian, and P. Makar. 2006. Recent Channel Incision and Floodplain Evolution within the Middle Rio Grande, NM. Joint 8th Federal Interagency Sedimentation Conference and 3rd Federal Interagency Hydrologic Modeling Conference, Reno, NV.

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.

Neufeld, K., S. Blair, and M. Poesch. 2015. Retention and stress effects of visible implant tags when marking Western Silvery Minnow and its application to other cyprinids (family Cyprinidae). North American Journal of Fisheries Management 35:1070–1076.

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. 2015. Genetic monitoring of the Rio Grande Silvery Minnow: Genetic status of wild and captive stocks in 2015. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico. 34 pp.

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

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 (7th ed.). American Fisheries Society, Special Publication 34, Bethesda, Maryland. 384 pp.

Pease, A. A., J. J. Davis, M. S. Edwards, and T. F. Turner. 2006. Mesohabitatitat 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. 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, and U.S. Bureau of Reclamation (Albuquerque Projects Office), Albuquerque, NM. 188 pp.

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, NM. 28 pp.

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, NM. 56 pp.

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

Reeves, K. S., and D. L. Buckmeier. 2009. Mortality, predation, and tag visibility of fish marked with visible implant elastomer tags. North American Journal of Fisheries Management 29:323–329.

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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. 397 pp.

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, MD. 664 pp.

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. 29 pp.

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.

Welcomme, R. L. 1979. The fisheries ecology of floodplain rivers. Longman, London. 317 pp.

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. 944 pp.

APPENDIX A (Sampling Sites)

Middle Rio Grande Fish Sampling Sites

Table A - 1. Sampling sites for population monitoring of Rio Grande Silvery Minnow.

Site #	Site Locality
ANGOSTURA REACH SITES	
SITE #	
1	New Mexico, Sandoval County, Rio Grande, downstream of Angostura Diversion Dam, Algodones.
2	New Mexico, Sandoval County, Rio Grande, upstream of US Highway 550 bridge crossing, Bernalillo.
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.
4	New Mexico, Bernalillo County, Rio Grande, upstream of Central Avenue (US Highway 66) bridge crossing, Albuquerque.
5	New Mexico, Bernalillo County, Rio Grande, upstream of Rio Bravo Boulevard bridge crossing, Albuquerque.
ISLETA REACH SITES	
SITE #	
6	New Mexico, Valencia County, Rio Grande, ca. 0.3 miles upstream of Los Lunas (NM State Highway 49) bridge crossing, Los Lunas.
7	New Mexico, Valencia County, Rio Grande, ca. 1.0 miles upstream of NM State Highway 309/6 bridge crossing, Belen.
8	New Mexico, Valencia County, Rio Grande, ca. 2.2 miles upstream of NM State Highway 346 bridge crossing (near Transwestern Natural Gas Pipeline crossing), Jarales.
9	New Mexico, Socorro County, Rio Grande, upstream of US Highway 60 bridge crossing, Bernardo.
10	New Mexico, Socorro County, Rio Grande, ca. 3.5 miles downstream of US Highway 60 bridge crossing, La Joya.
11	New Mexico, Socorro County, Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia.
SAN ACACIA REACH SITES	
SITE #	
12	New Mexico, Socorro County, Rio Grande, downstream of San Acacia Diversion Dam, San Acacia.

Table A - 1. Sampling sites for population monitoring of Rio Grande Silvery Minnow (continued).

Site #	Site Locality

SAN ACACIA REACH SITES (continued)
SITE #

13	New Mexico, Socorro County, Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.
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.
15	New Mexico, Socorro County, Rio Grande, ca. 4.0 miles upstream of US Highway 380 bridge crossing, San Antonio.
16	New Mexico, Socorro County, Rio Grande, upstream of US Highway 380 bridge crossing, San Antonio.
17	New Mexico, Socorro County, Rio Grande, directly east of Bosque del Apache National Wildlife Refuge headquarters, San Antonio.
18	New Mexico, Socorro County, Rio Grande, downstream of the San Marcial railroad crossing, San Marcial.
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.
20	New Mexico, Socorro County, Rio Grande, ca. 10.0 miles downstream of the San Marcial Railroad Bridge crossing, San Marcial.

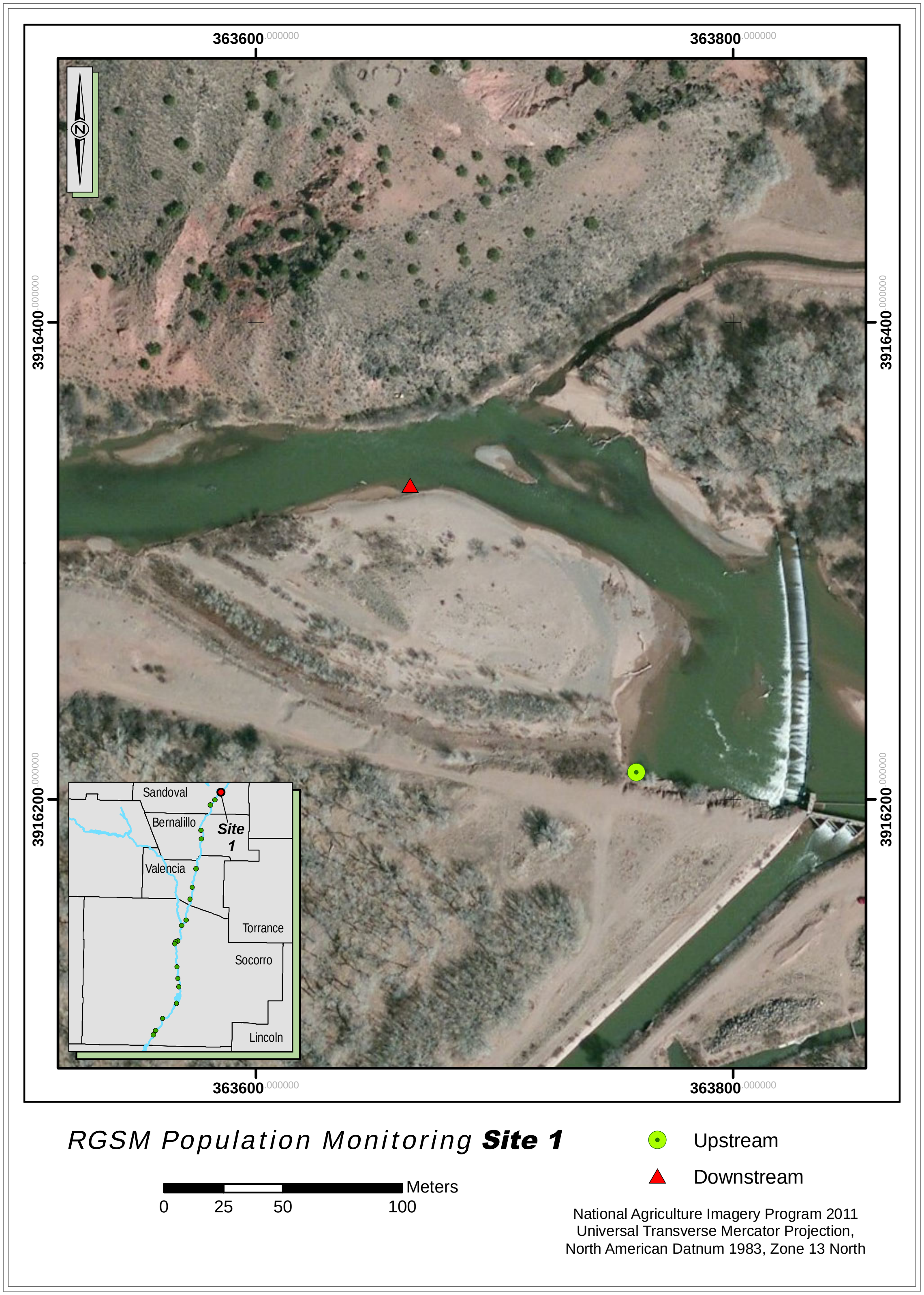

Figure A - 1. Map of population monitoring Site 1 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

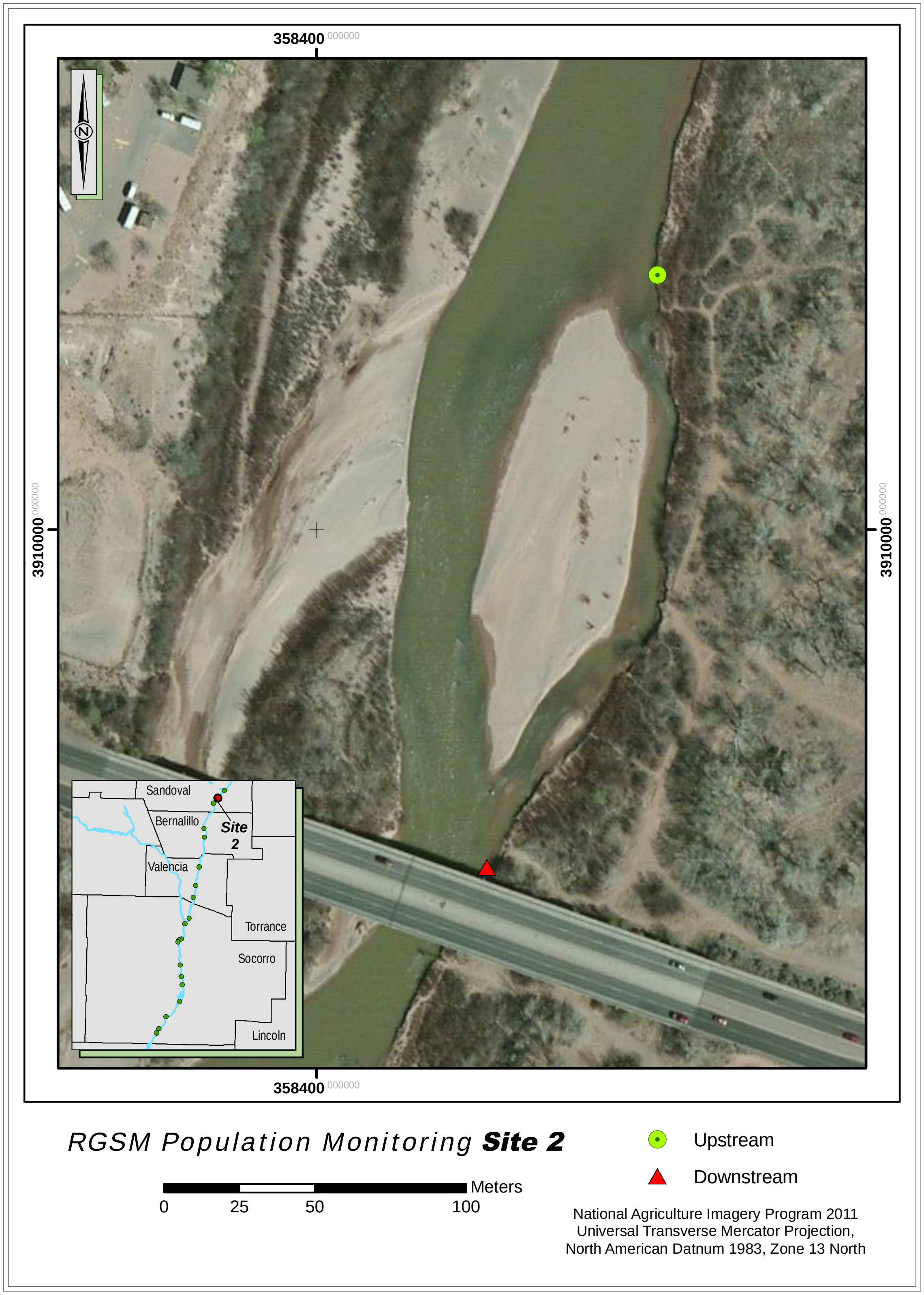

Figure A - 2. Map of population monitoring Site 2 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

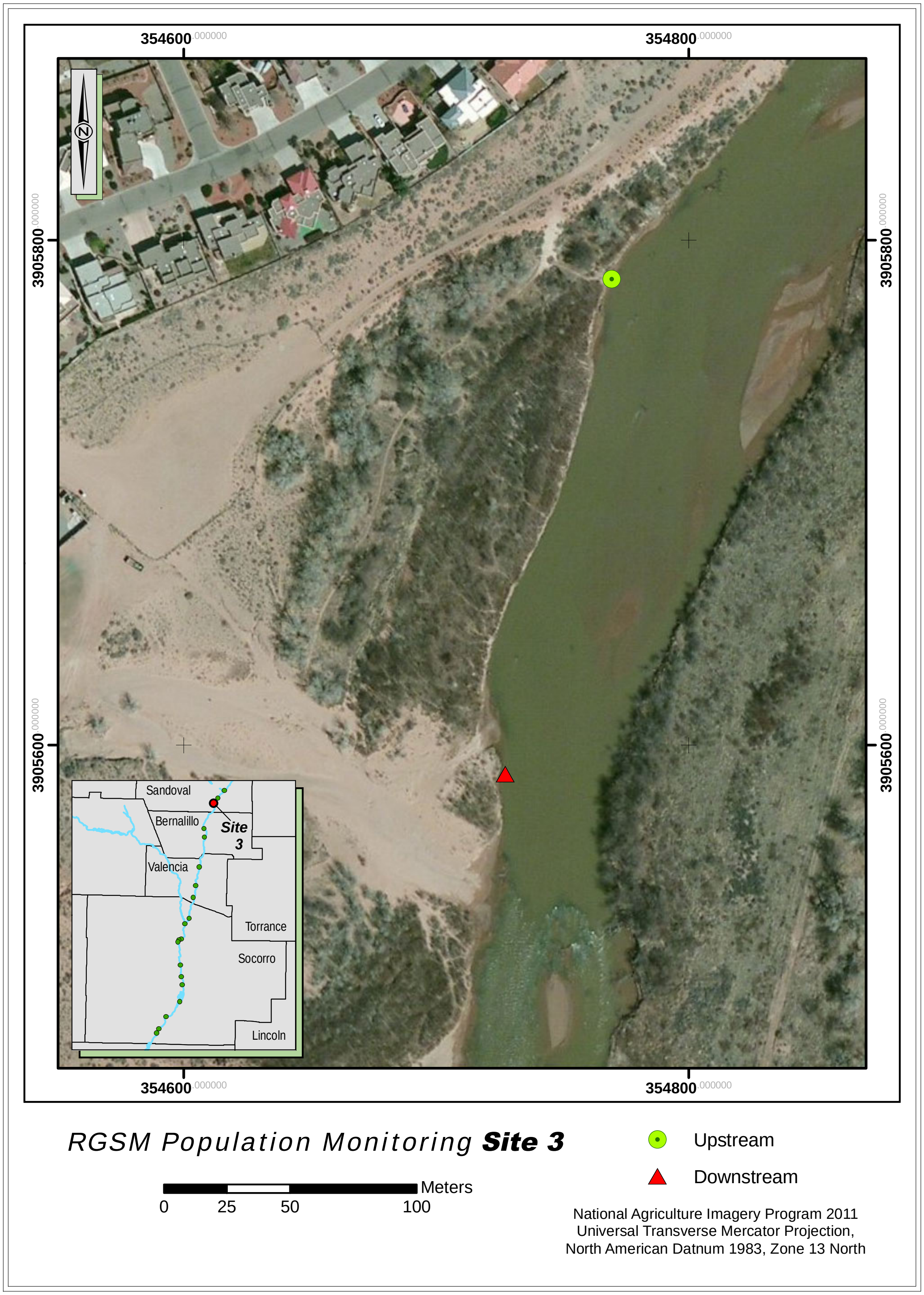

Figure A - 3. Map of population monitoring Site 3 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

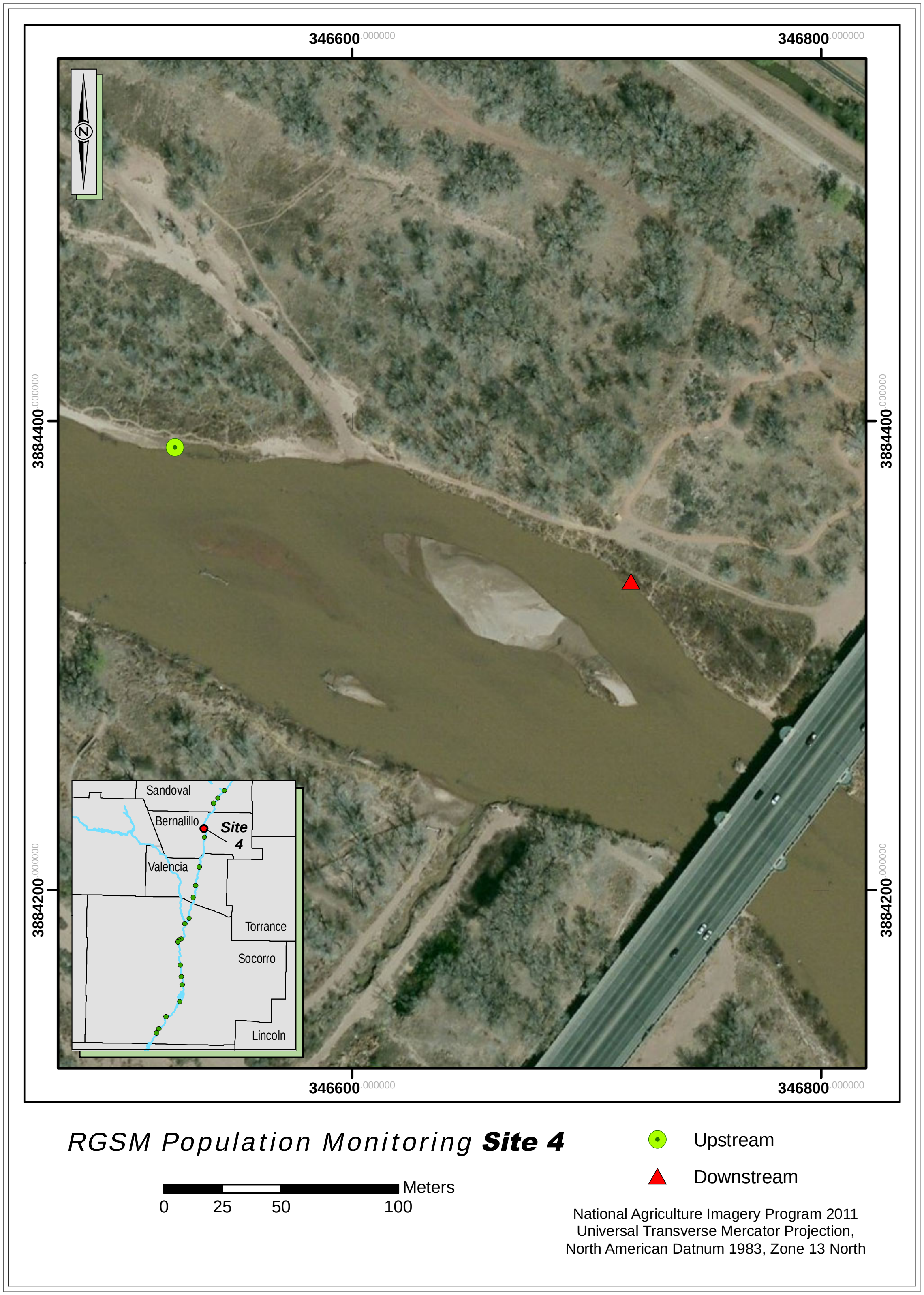

Figure A - 4. Map of population monitoring Site 4 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

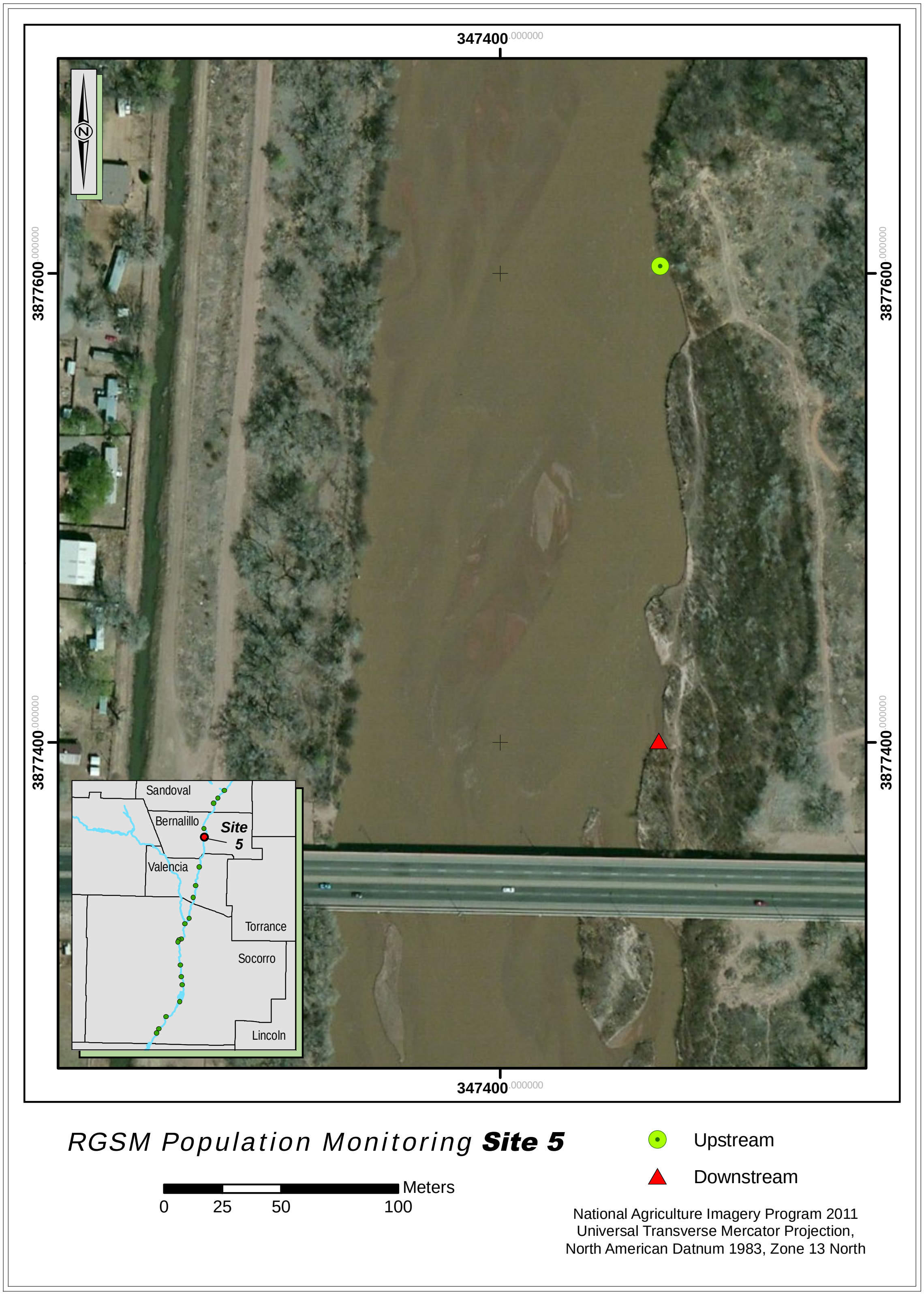

Figure A - 5. Map of population monitoring Site 5 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

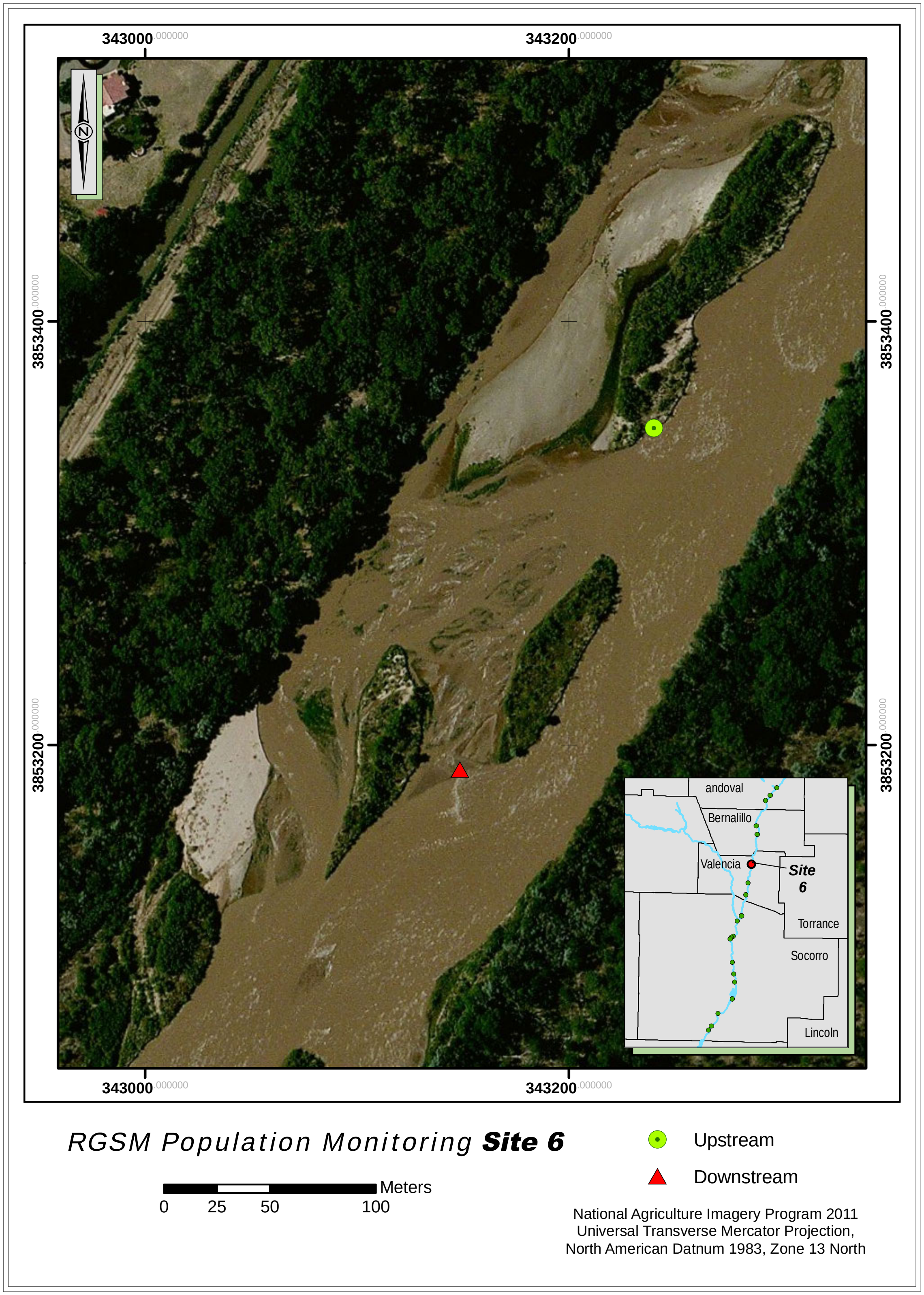

Figure A - 6. Map of population monitoring Site 6 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

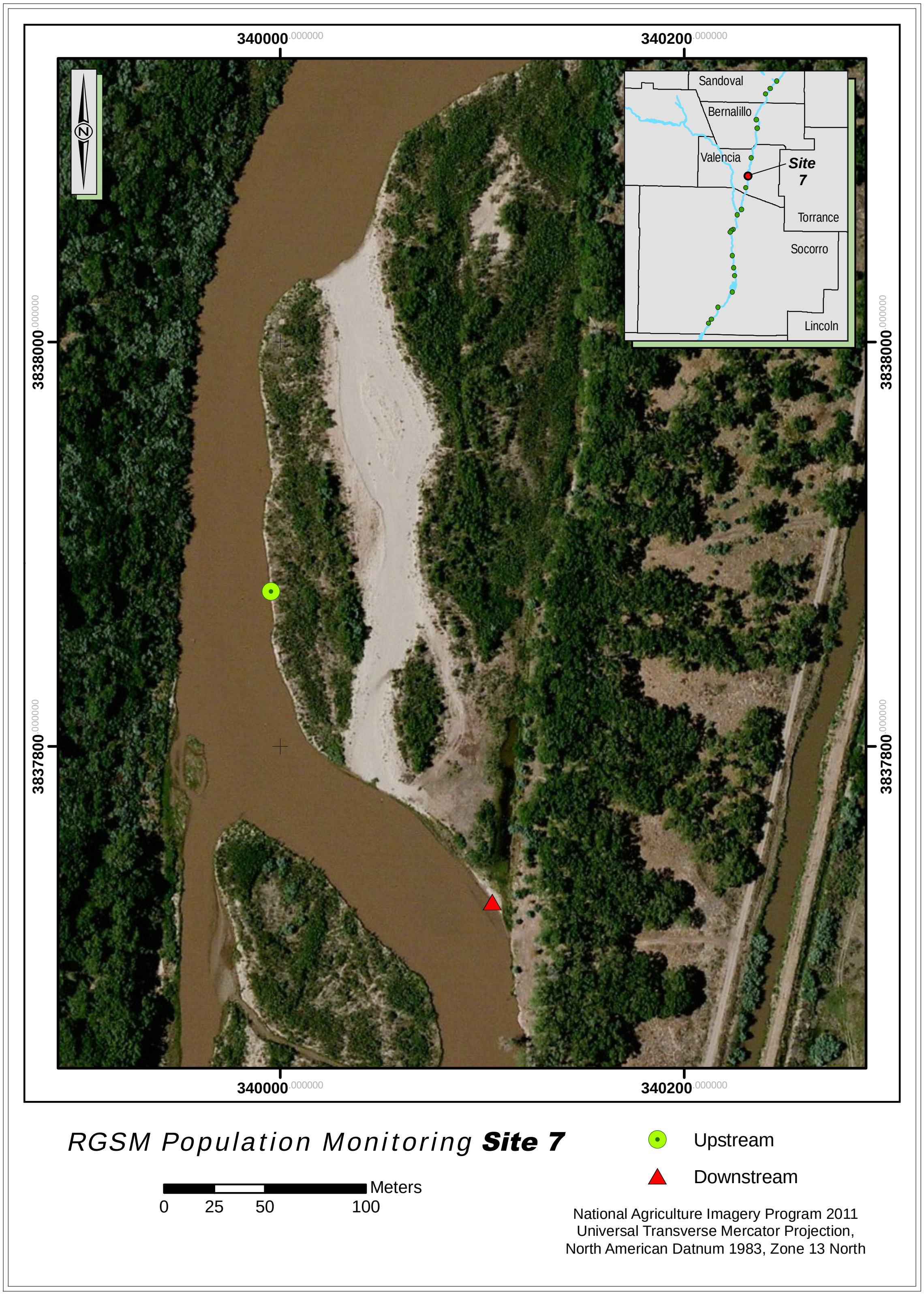

Figure A - 7. Map of population monitoring Site 7 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

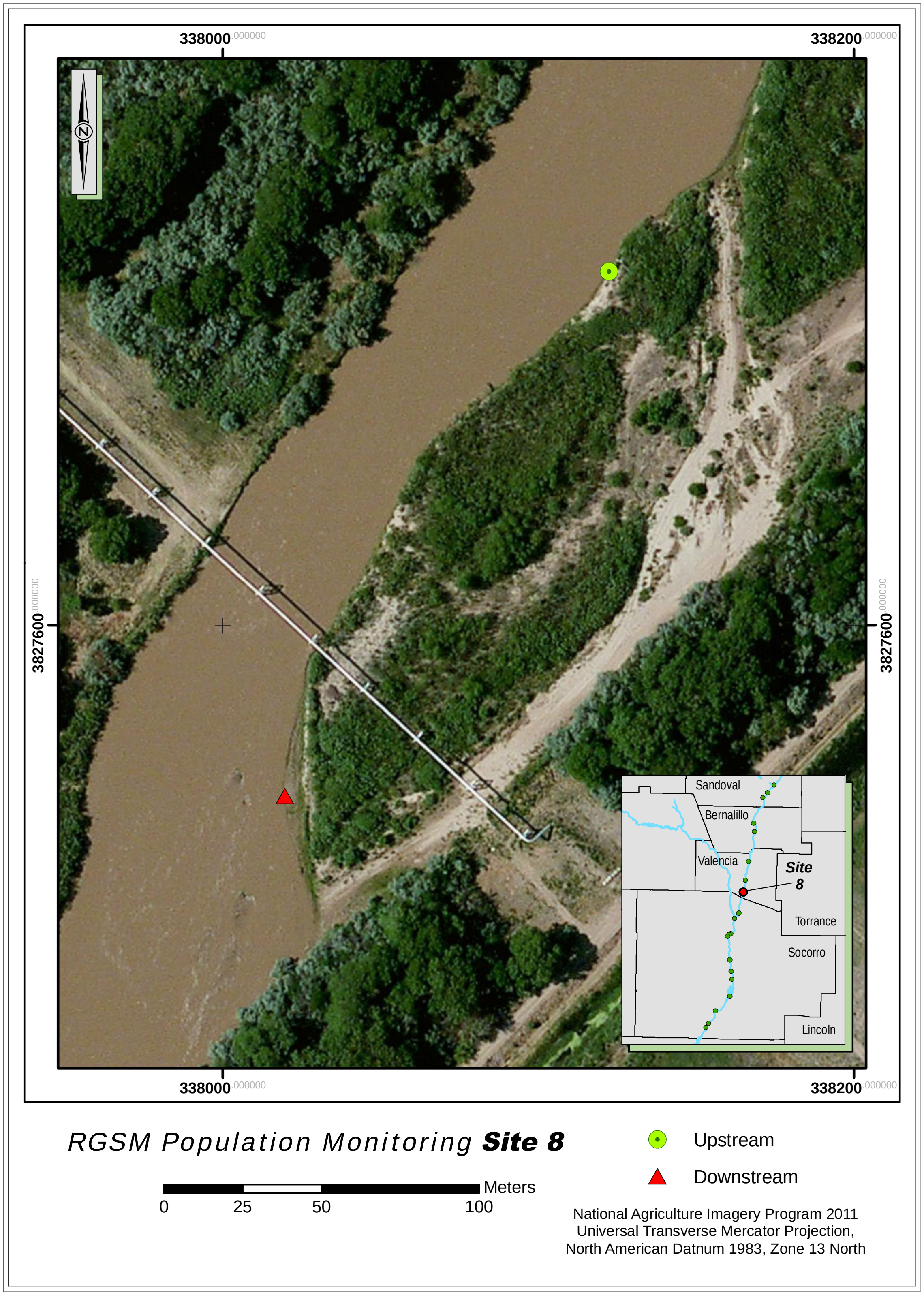

Figure A - 8. Map of population monitoring Site 8 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

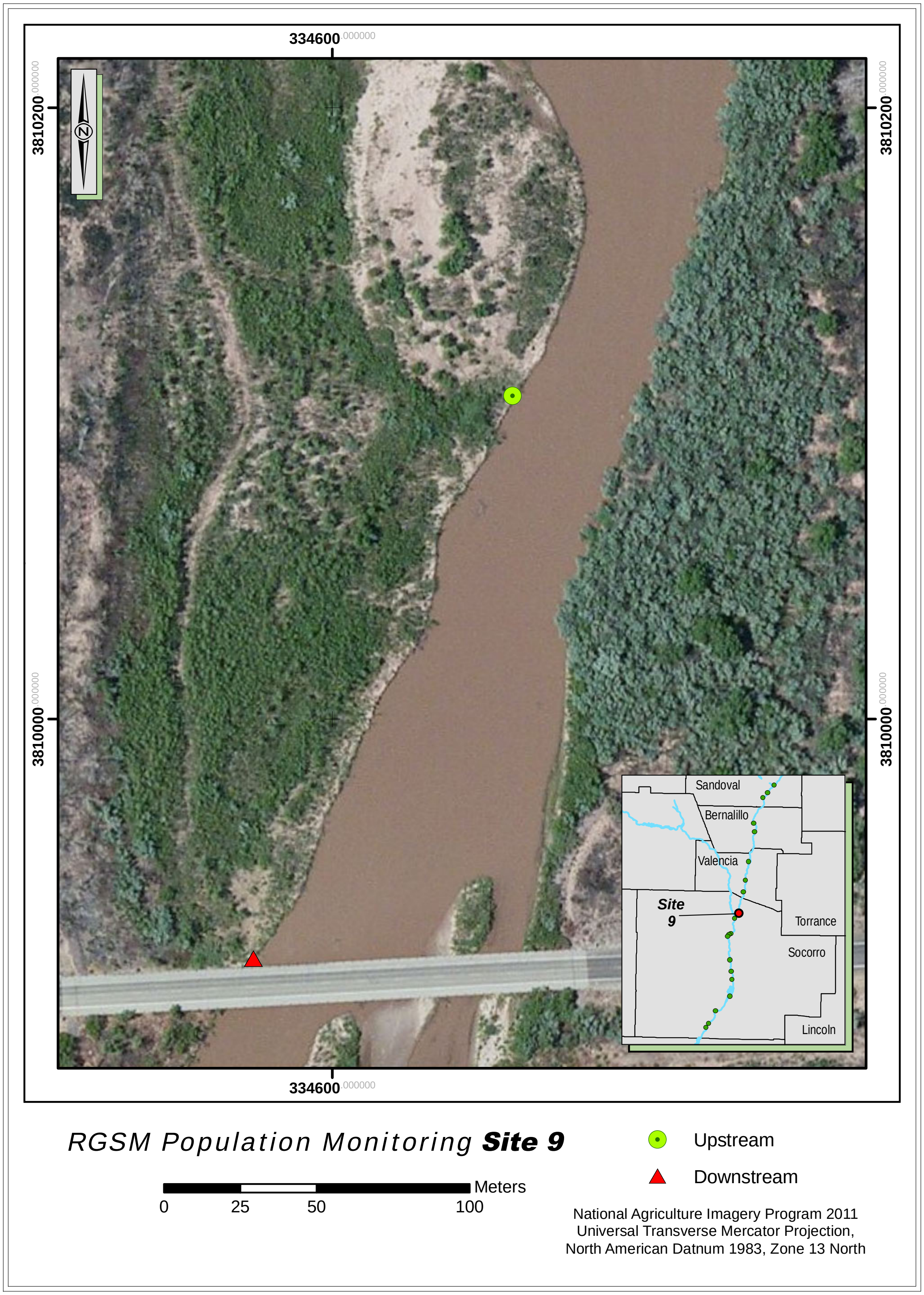

Figure A - 9. Map of population monitoring Site 9 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

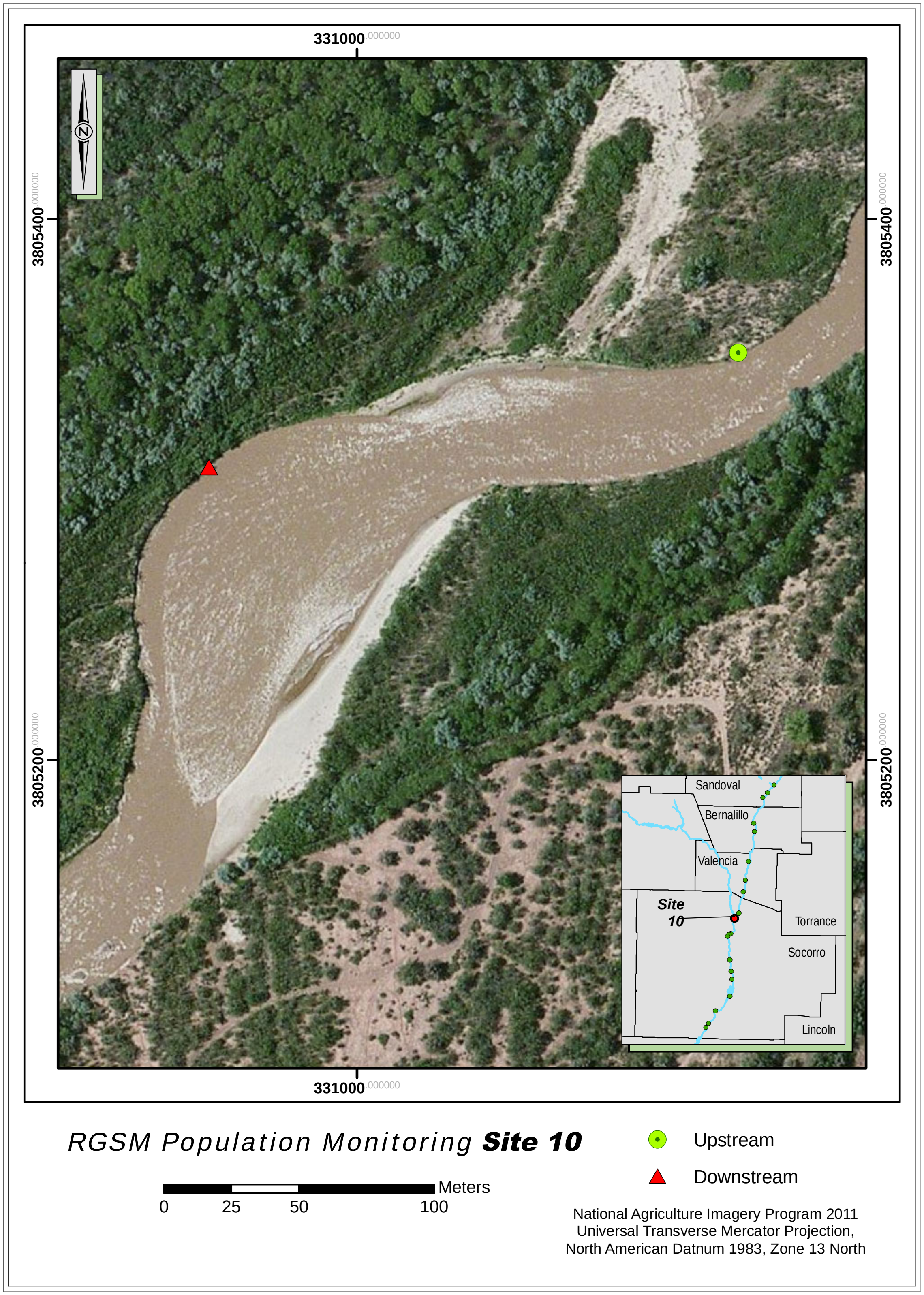

Figure A - 10. Map of population monitoring Site 10 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

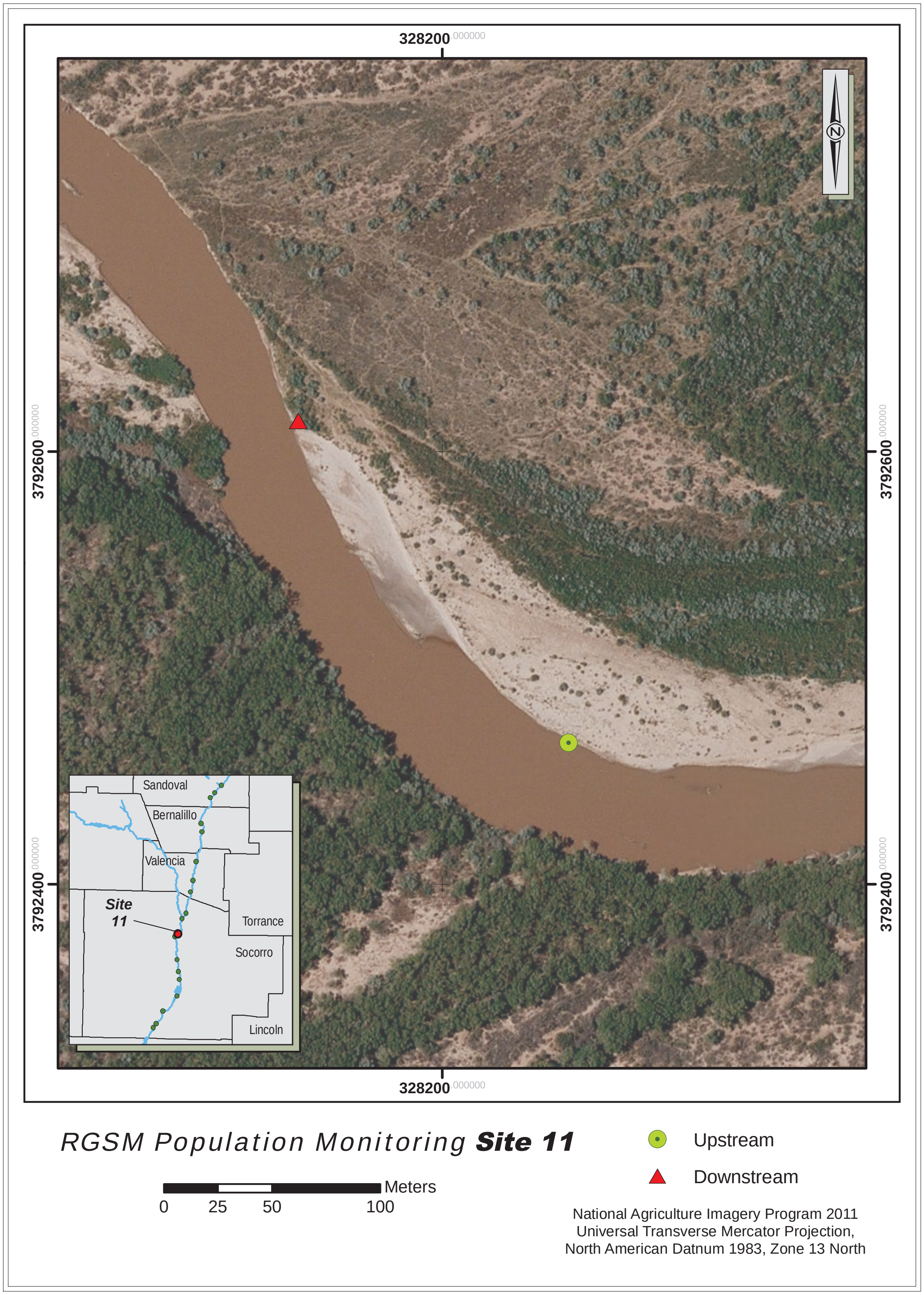

Figure A - 11. Map of population monitoring Site 11 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

Figure A - 12. Map of population monitoring Site 12 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

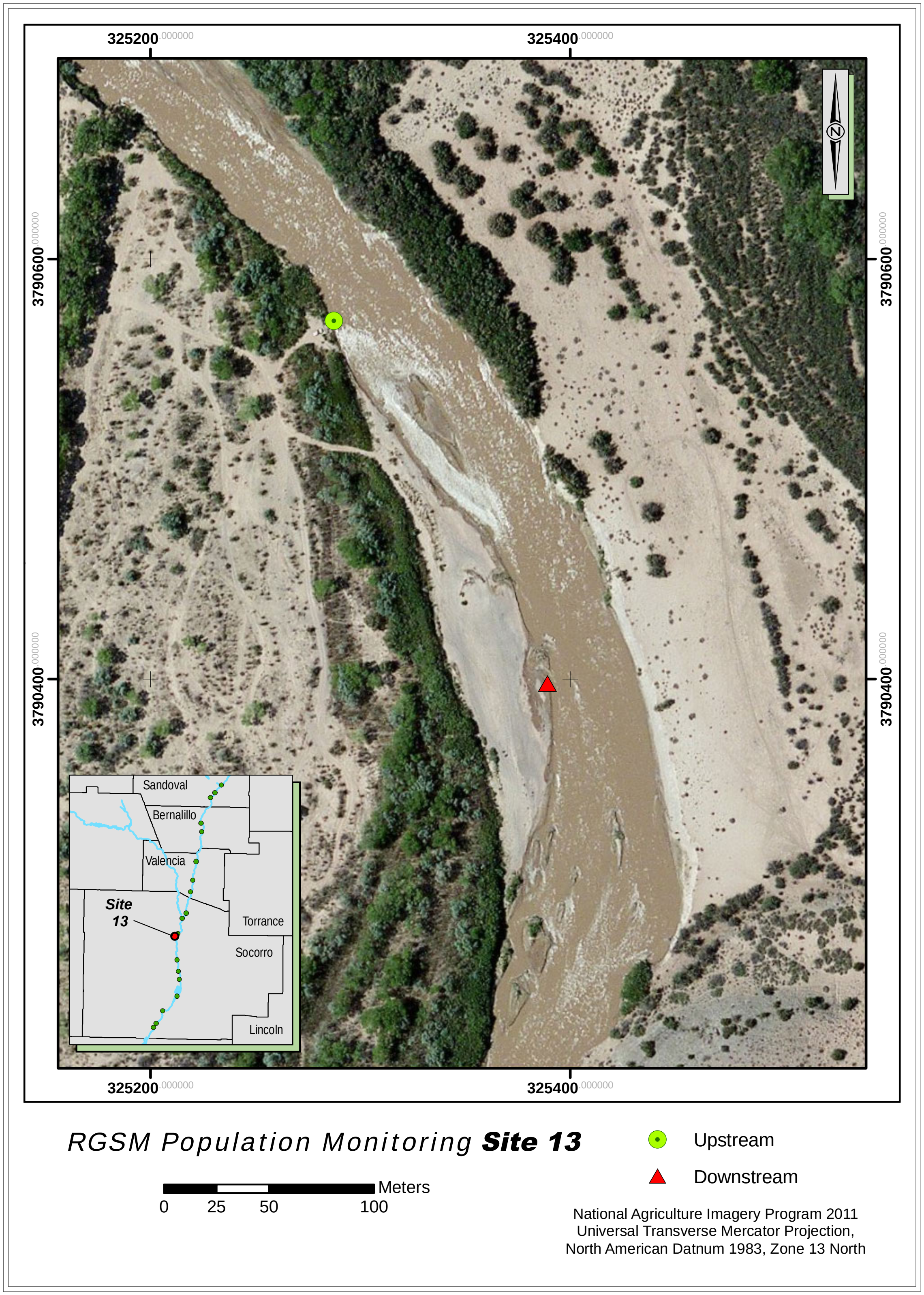

Figure A - 13. Map of population monitoring Site 13 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

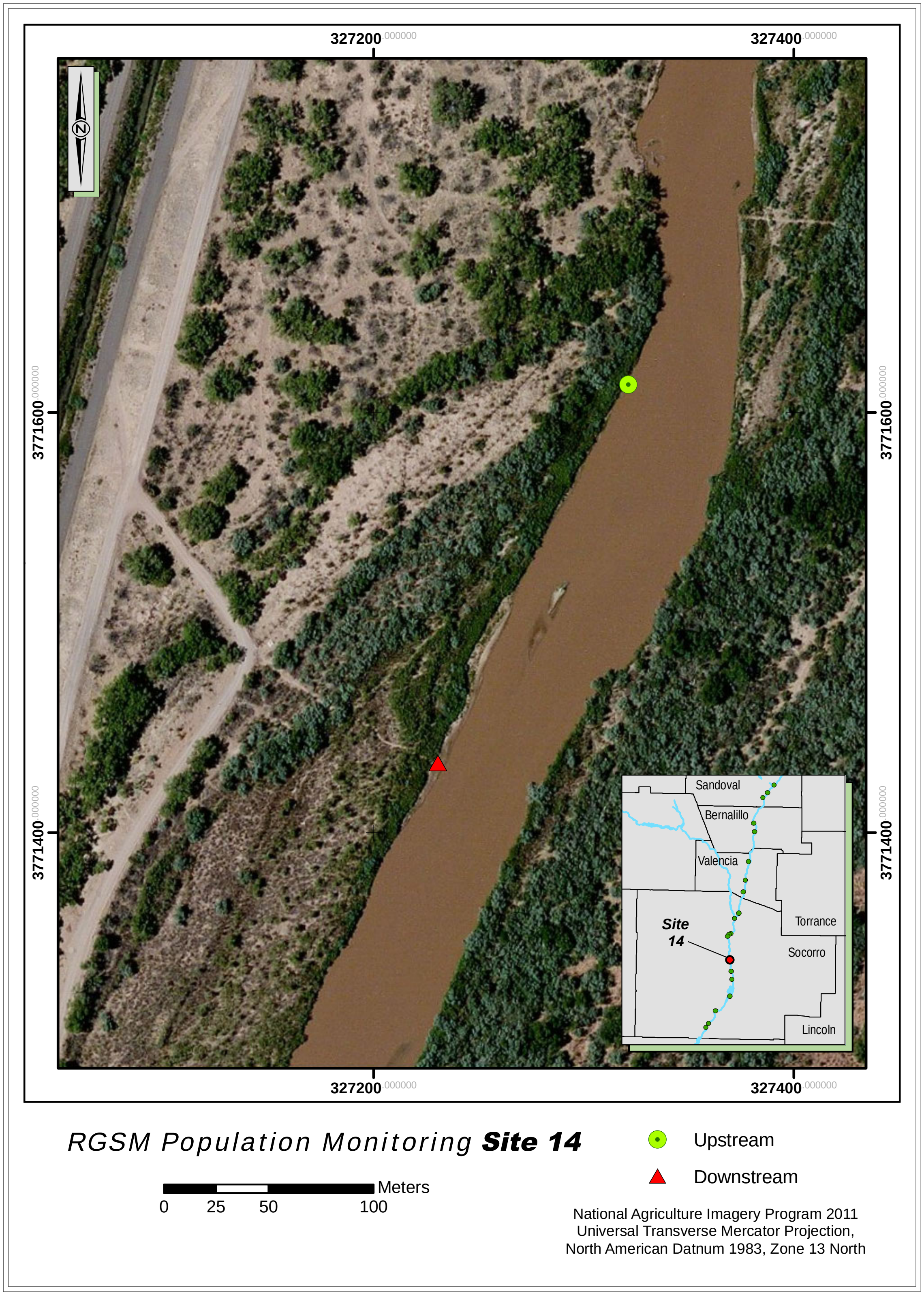

Figure A - 14. Map of population monitoring Site 14 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

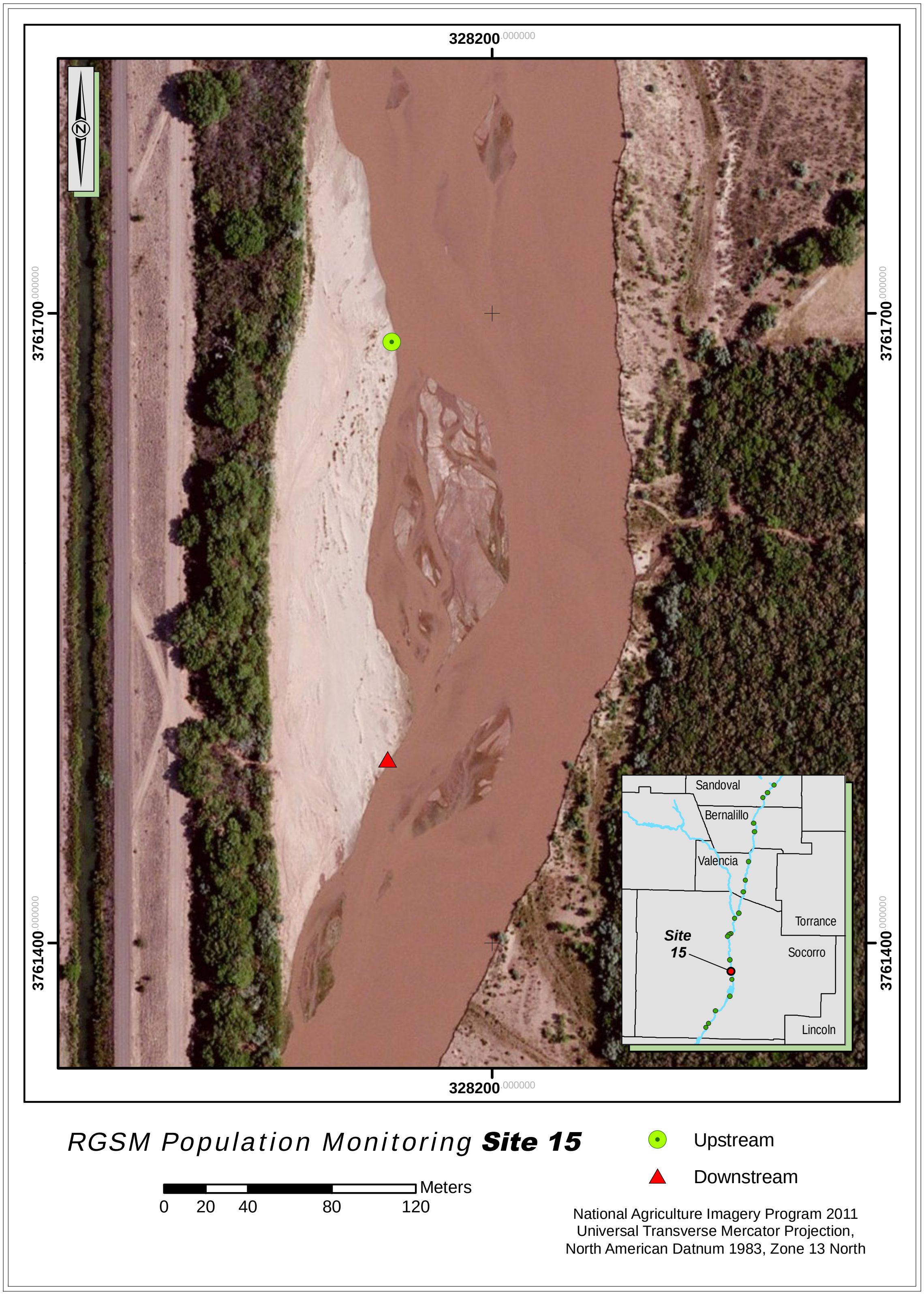

Figure A - 15. Map of population monitoring Site 15 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

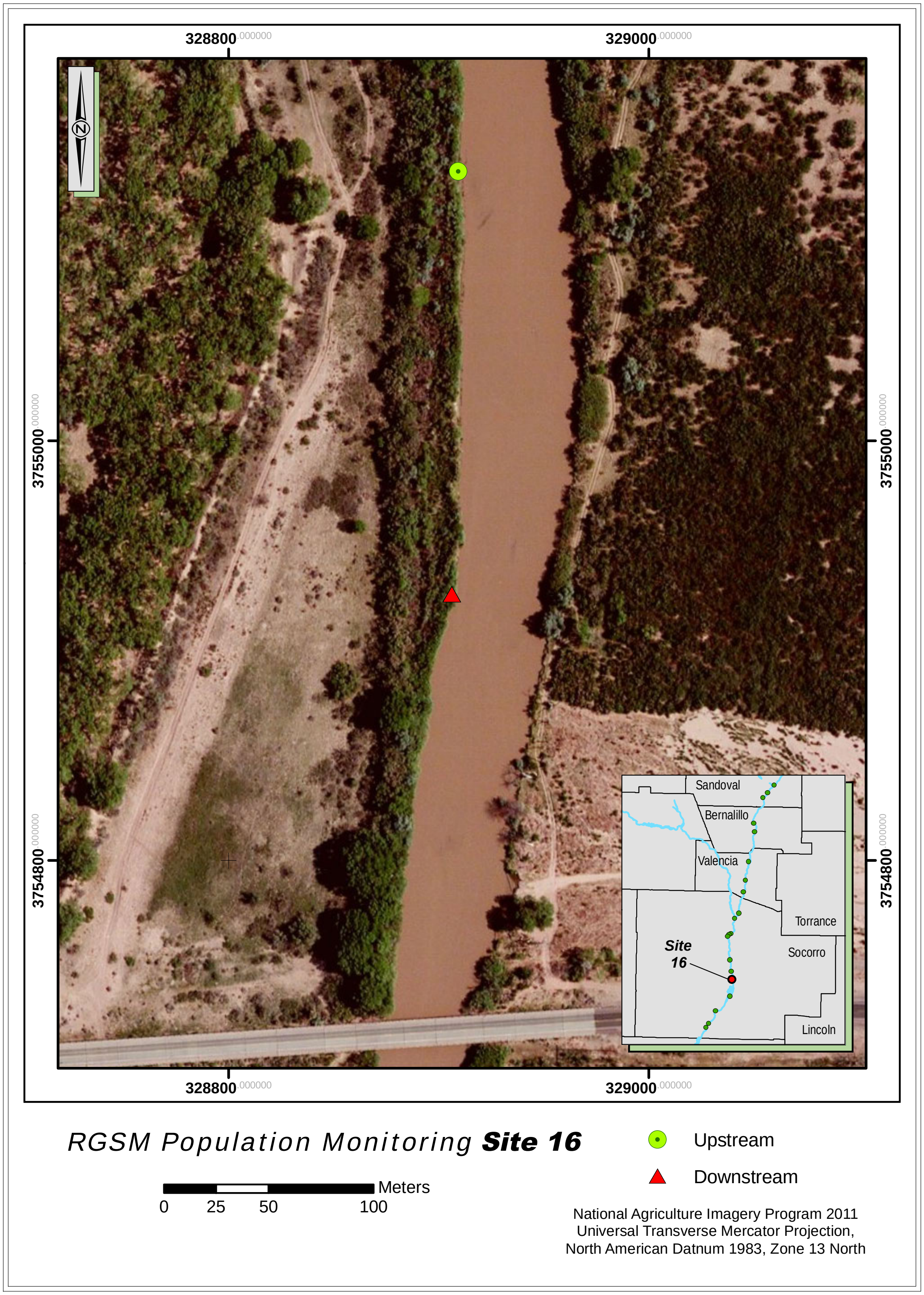

Figure A - 16. Map of population monitoring Site 16 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

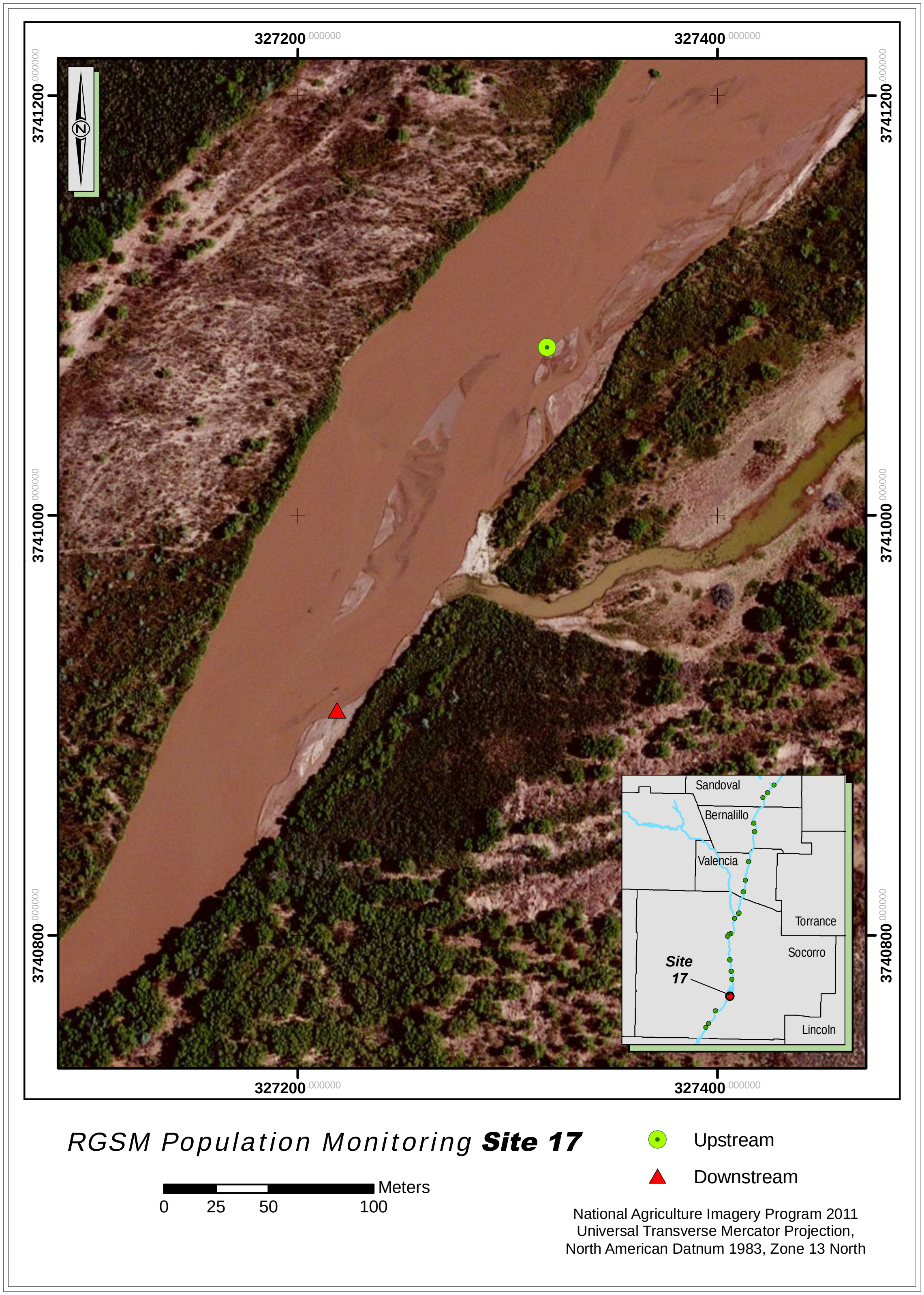

Figure A - 17. Map of population monitoring Site 17 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

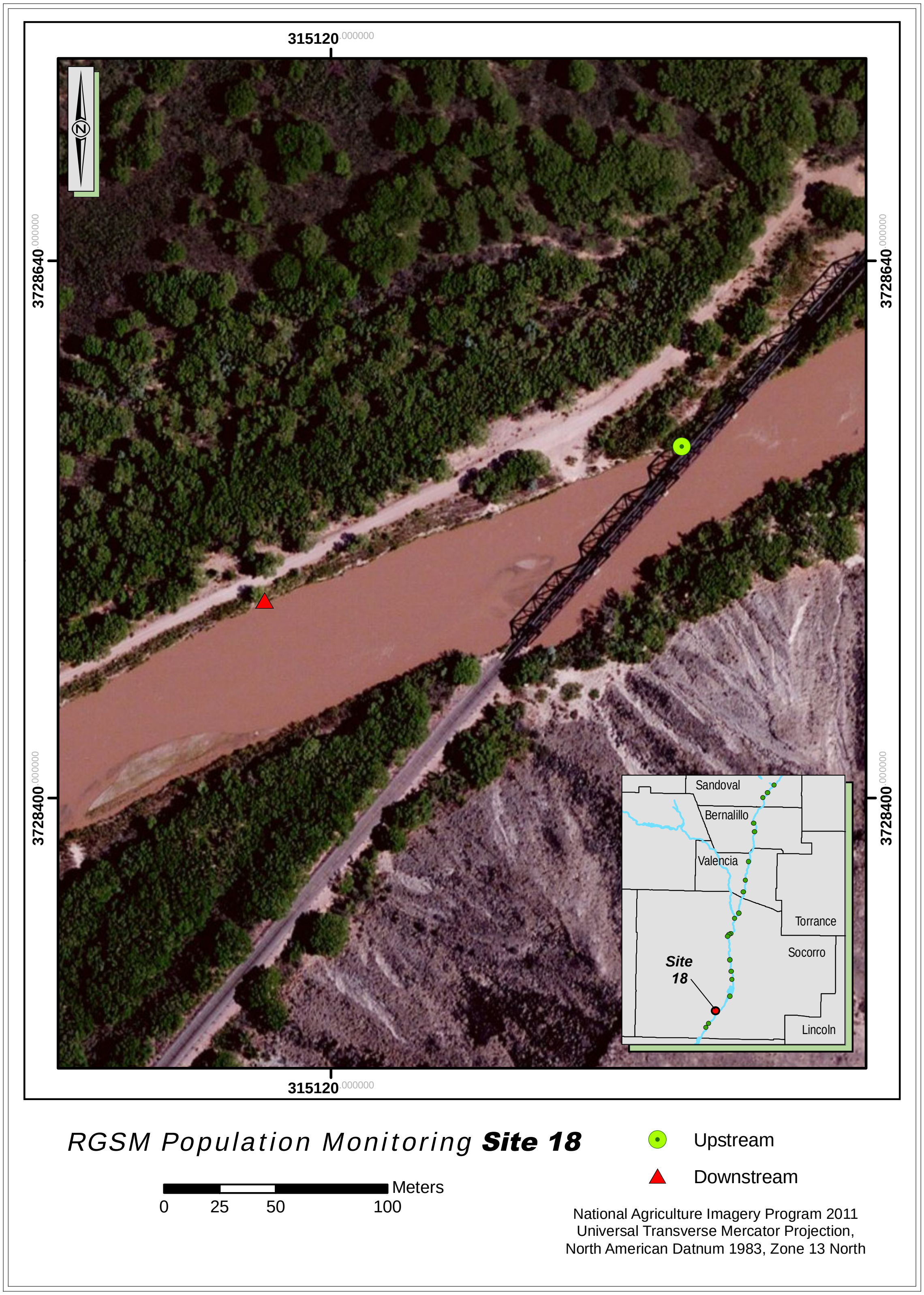

Figure A - 18. Map of population monitoring Site 18 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

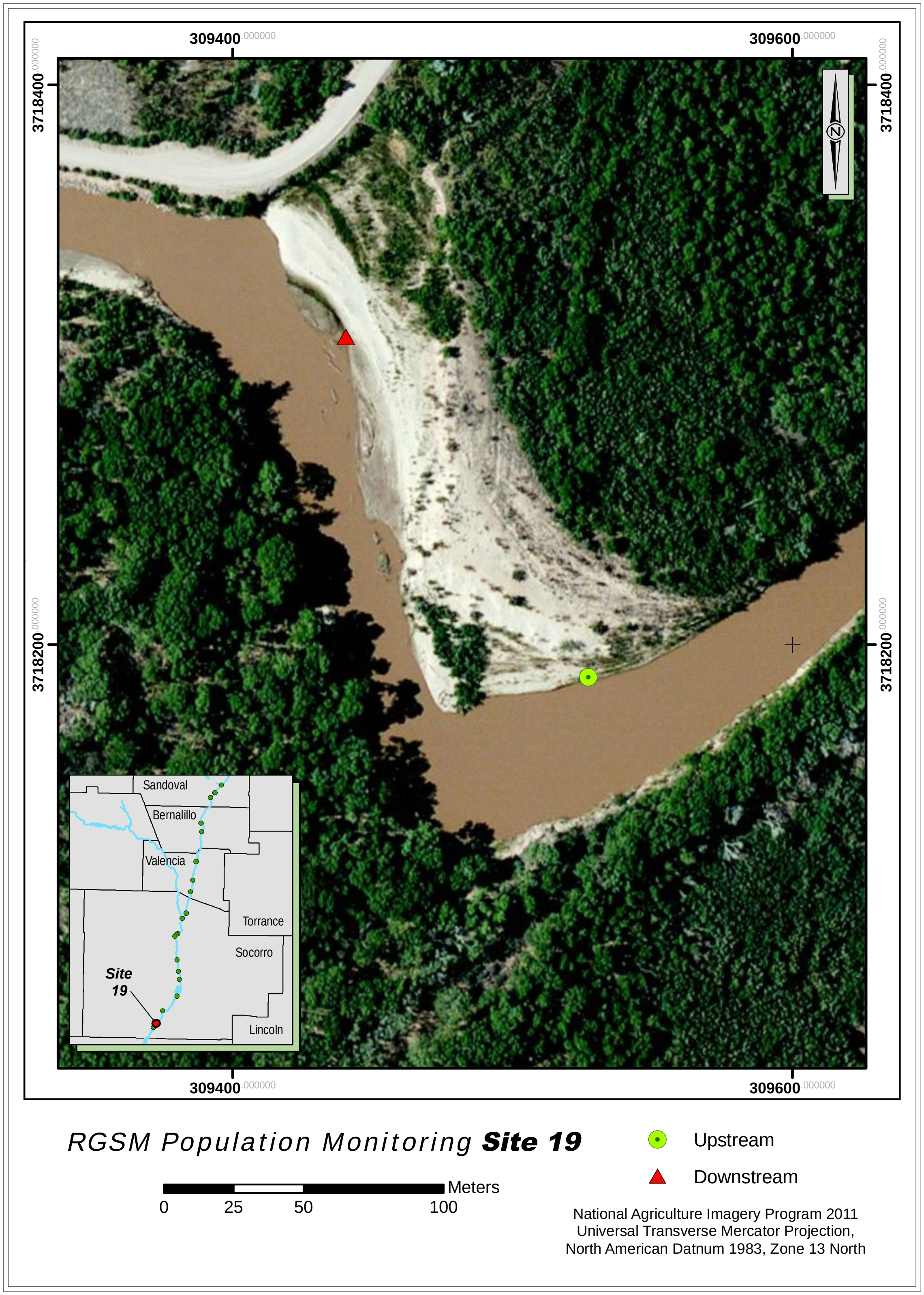

Figure A - 19. Map of population monitoring Site 19 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

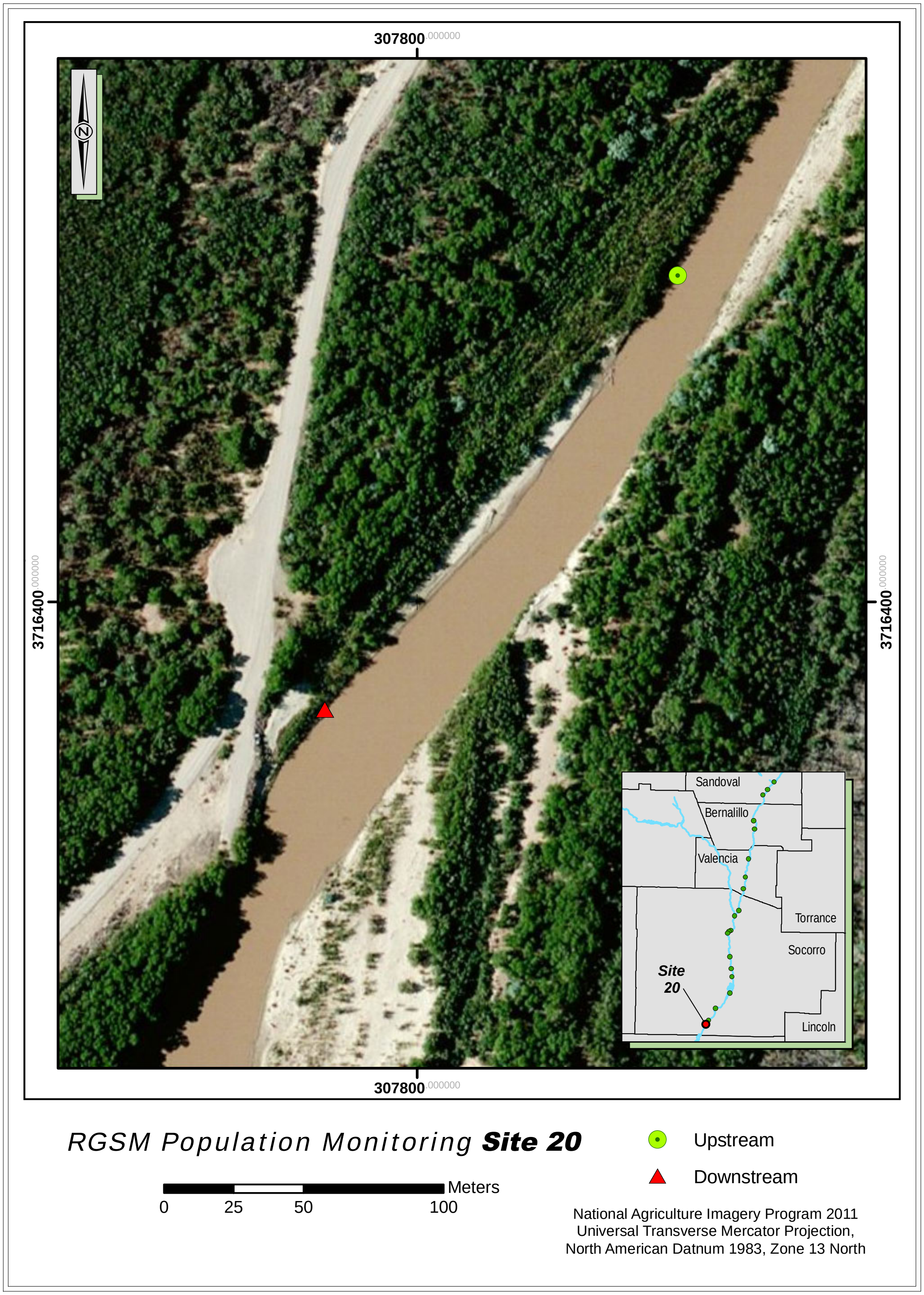

Figure A - 20. Map of population monitoring Site 20 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

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 provides 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. 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 detection, occupancy, extinction, and colonization. Long-term trend assessments are also now possible because of the continuous and consistent monitoring of Rio Grande Silvery Minnow over the entire study period (2005–2015).

Estimates of historical patterns of site occupancy can also be used to complement data collected during the long-term population monitoring study (1993–2015). 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 has provided targeted annual estimates of Rio Grande Silvery Minnow site occupancy rates since 2005. The objective of this study is to evaluate changes in the probability of occupancy, extinction, and colonization for different age-classes (age-0 and age1+) of Rio Grande Silvery Minnow over the period of study.

METHODS

Repeated sampling data from population monitoring efforts (multi-day sampling efforts during November [2005–2015]) 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 their 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 was interpreted as indicating 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 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 (all fish, age-0, age-1+) 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 detection, occupancy, colonization, and extinction probabilities were generated. Associated measures of sampling variance (SE = standard error) and profile likelihood confidence intervals (LCI = 95% lower confidence bound, UCI = 95% upper confidence bound) were generated for all parameter estimates, following methods of MacKenzie et al. (2006).

RESULTS

Multi-year statistical models based on patterns of occupancy were developed for different age-classes using long-term (2005–2015) sampling-site data (Table B-1). The minimum AIC_c model for all age-classes combined had constant occupancy (psi, ψ), constant extinction (epsilon, ε), constant colonization (gamma, γ), and detection probability (p) varying by year. For age-0 fish only, the minimum AIC_c model also had constant occupancy (psi, ψ), constant extinction (epsilon, ε), constant colonization (gamma, γ), and detection probability (p) varying by year. For age-1+ fish only, the minimum AIC_c model had constant occupancy (psi, ψ), but with extinction (epsilon, ε), colonization (gamma, γ), and detection probability (p) all varying by year. Models that included sampling occasion (ψ(Null) ε(Year) γ(Year) p(Year*Occasion)) received essentially no weight for any of the age-class analyses, indicating that the day of sampling was not particularly informative in explaining variation in p over time.

All Age-Classes Combined

For all age-classes combined, estimates of site occupancy probability (ψ) showed a progressive decline over the past decade but with a slight improvement from 2014 to 2015 (Figure B-1). The values of ψ declined from 1.00 in 2005 to 0.85 in 2015. Detection probability estimates were generally lowest during years when this species was extremely rare (e.g., 2012–2014) and highest when this species was more ubiquitous (e.g., 2007–2009). The elevated detection probabilities in 2014 (p = 0.46) and 2015 (p = 0.81) reflect the recent increase in occurrence throughout the study area from 2013 to 2015. Also, there was increased uncertainty in both the site occupancy probabilities and detection probabilities during years when individuals were absent at many sites over multiple sampling days (e.g., 2012–2014).

Estimates of the probability of extinction were notably elevated from 2011–2014 as compared with 2005–2011 (Figure B-2). The most recent estimate of extinction probability (2014–2015) indicated a marked improvement as compared with estimates based on data collected during the past several years. However, so few sites were occupied in 2013–2014 that there were not many sites left where the species status could change from present to absent in 2015. The estimated colonization probability was essentially zero from 2005 to 2011, but there was an initial increase in the estimated colonization probability from 2011–2013 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 from 2013 to 2014 as Rio Grande Silvery Minnow was detected at many formerly unoccupied sites. This trend continued into 2015 when the estimated colonization probability reached its highest level since sampling began in 2005.

Age-0 Fish Only

For age-0 fish only, estimates of site occupancy probability (ψ) showed a progressive decline since 2009 but with some improvement since 2013 (Figure B-3). The values of ψ declined from 1.00 in 2005 to 0.85 in 2015. Detection probability estimates were generally lowest during years when this age-class was extremely rare (e.g., 2012–2014) and highest when this age-class was more ubiquitous (e.g., 2007–2009). The elevated detection probability in 2015 (p = 0.76) reflects the recent increase in occurrence throughout the study area from 2014 to 2015. Also, there was increased uncertainty in both the site occupancy probabilities and detection probabilities during years when individuals were absent at many sites over multiple sampling days (e.g., 2012–2014).

Estimates of the probability of extinction were elevated from 2012–2014 as compared with 2005–2012 (Figure B-4). The most recent estimate of extinction probability (2014–2015) indicated a marked improvement as compared with estimates based on data collected during the past several years. 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 2012–2014 because of the rarity of age-0 fish during that period. Since 2005, the estimated colonization probability periodically spiked following extinction events at individual sites but reached one of its highest levels from 2014–2015 as age-0 individuals were detected at many previously unoccupied sites.

Table B - 1. Rio Grande Silvery Minnow site occupancy analyses, for different age-classes, among years for all sampling sites combined in the Middle Rio Grande based on repeated site sampling efforts in November (2005–2015). The models are ranked by Akaike's information criterion (AIC_c) and include the AIC_c weight (w_i).

Models for all age-classes combined[1]	**logLike**[2]	**K**[3]	**AIC_c**	**w_i**
ψ(Null) ε(Null) γ(Null) *p*(Year)	532.06	14	562.11	0.9967
ψ(Null) ε(Year) γ(Null) *p*(Year)	522.33	23	573.96	0.0027
ψ(Null) ε(Null) γ(Year) *p*(Year)	526.06	23	577.69	0.0004
ψ(Null) ε(Year) γ(Year) *p*(Year)	503.56	32	578.85	0.0002
ψ(Null) ε(Year) γ(Year) *p*(Year*Occasion)	464.25	65	649.97	<0.0001
ψ(Null) ε(Null) γ(Null) *p*(Null)	746.04	4	754.22	<0.0001

Models for all age-0 fish only[1]	**logLike**[2]	**K**[3]	**AIC_c**	**w_i**
ψ(Null) ε(Null) γ(Null) *p*(Year)	488.59	14	518.64	0.6852
ψ(Null) ε(Null) γ(Year) *p*(Year)	468.57	23	520.20	0.3143
ψ(Null) ε(Year) γ(Year) *p*(Year)	457.77	32	533.06	0.0005
ψ(Null) ε(Year) γ(Null) *p*(Year)	494.24	23	545.88	<0.0001
ψ(Null) ε(Null) γ(Null) *p*(Null)	738.25	4	746.44	<0.0001
ψ(Null) ε(Year) γ(Year) *p*(Year*Occasion)	738.04	65	923.75	<0.0001

Models for all age-1+ fish only[1]	**logLike**[2]	**K**[3]	**AIC_c**	**w_i**
ψ(Null) ε(Year) γ(Year) *p*(Year)	740.83	32	816.13	>0.9999
ψ(Null) ε(Year) γ(Year) *p*(Year*Occasion)	702.61	65	888.32	<0.0001
ψ(Null) ε(Null) γ(Null) *p*(Null)	909.46	4	917.64	<0.0001
ψ(Null) ε(Null) γ(Null) *p*(Year)	2,150.11	14	2,180.16	<0.0001
ψ(Null) ε(Null) γ(Year) *p*(Year)	2,192.56	23	2,244.20	<0.0001
ψ(Null) ε(Year) γ(Null) *p*(Year)	2,875.56	23	2,927.19	<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 (2005–2015) and sampling occasion (i.e., the 1st, 2nd, 3rd, or 4th day of sampling).
[2] = -2[log-likelihood] of the model
[3] = Number of parameters in the model

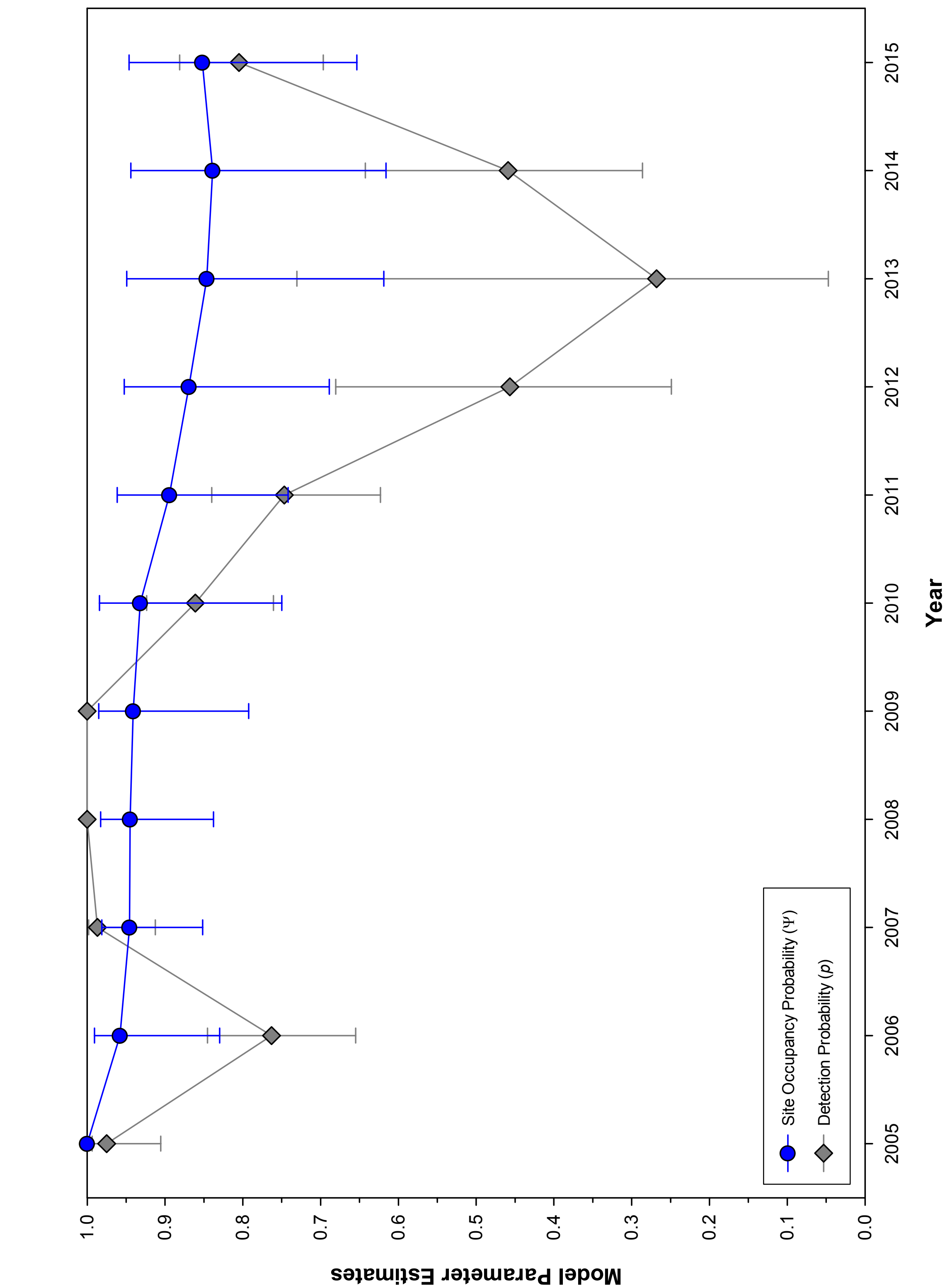

Figure B - 1. Site occupancy model estimates (site occupancy probability and detection probability) for Rio Grande Silvery Minnow (all age-classes combined) based on repeated site sampling efforts (2005–2015). Solid circles indicate means and capped-bars represent 95% confidence intervals.

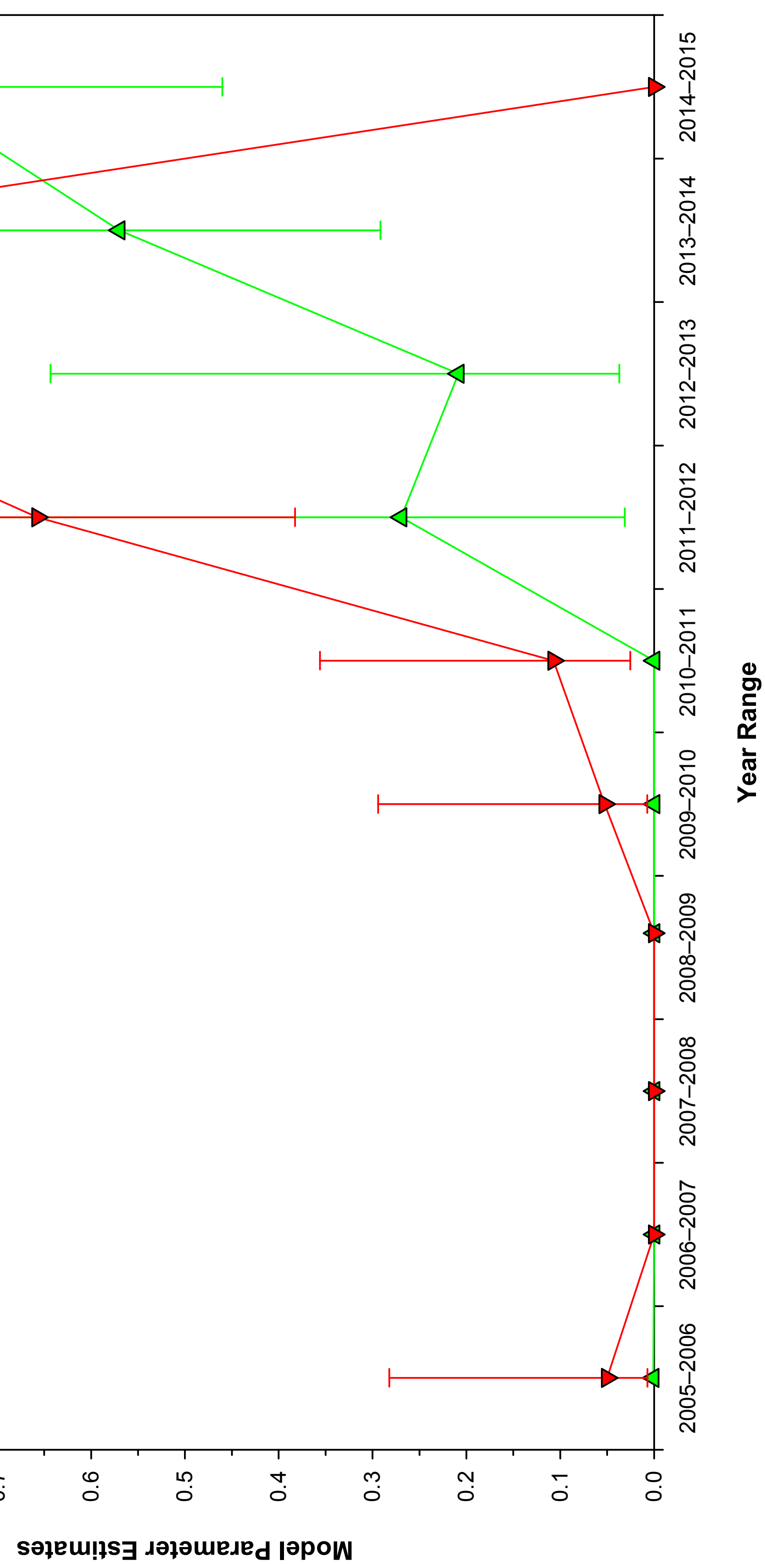

Figure B - 2. Site occupancy model estimates (extinction probability and colonization probability) for Rio Grande Silvery Minnow (all age-classes combined) based on repeated site sampling efforts (2005–2015). Symbols indicate means and capped-bars represent 95% confidence intervals.

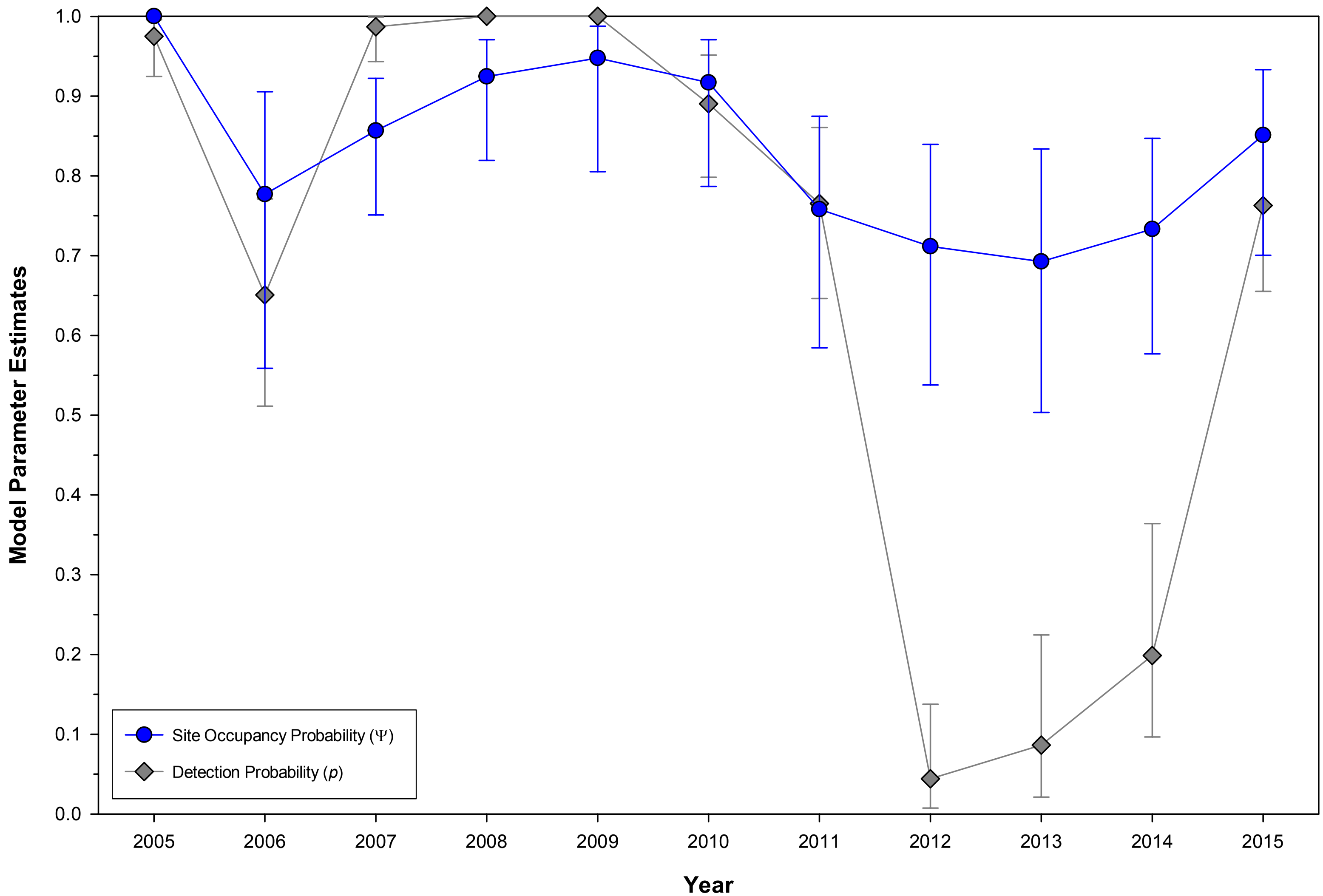

Figure B - 3. Site occupancy model estimates (site occupancy probability and detection probability) for Rio Grande Silvery Minnow (age-0 fish only) based on repeated site sampling efforts (2005–2015). Solid circles indicate means and capped-bars represent 95% confidence intervals.

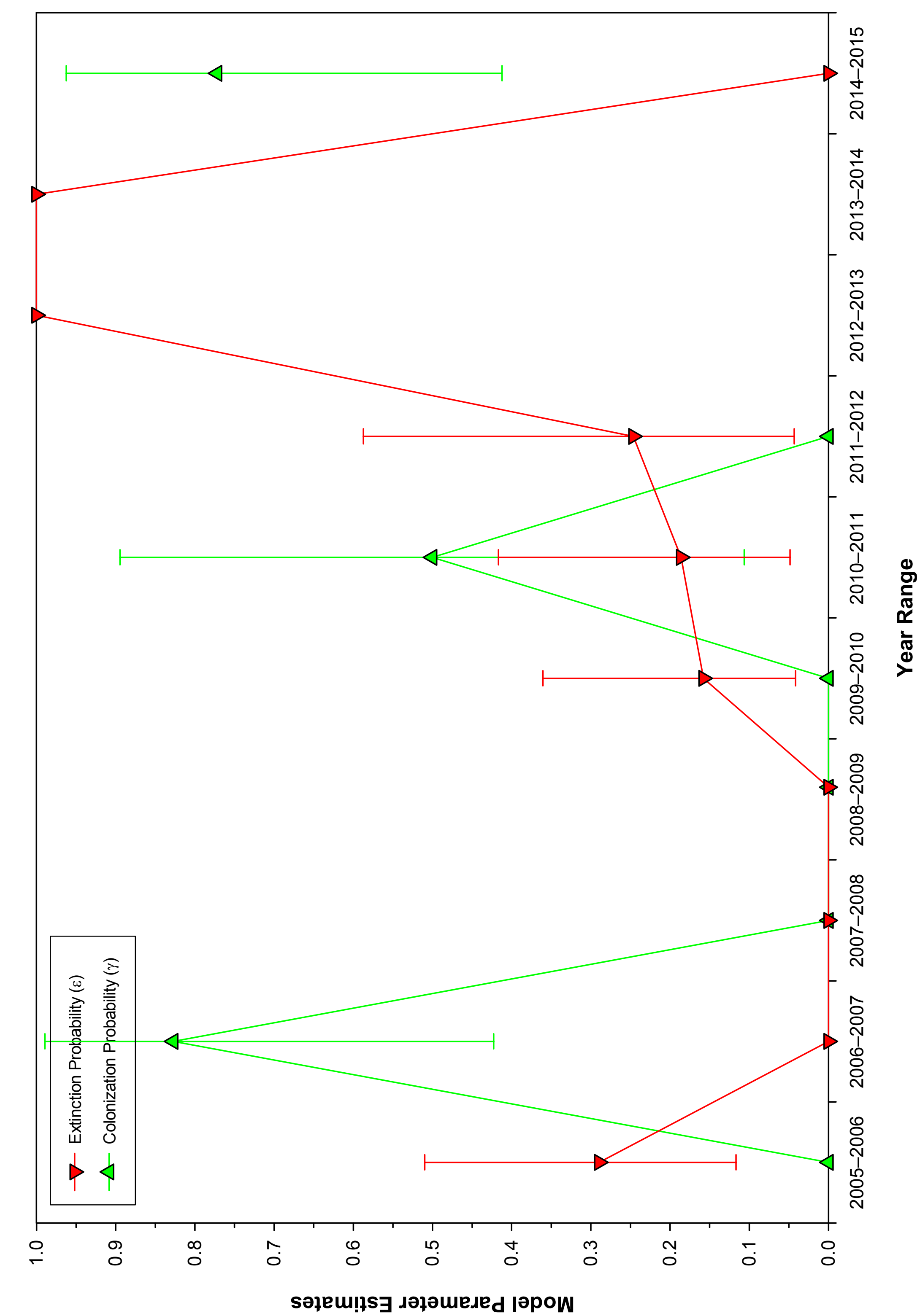

Figure B - 4. Site occupancy model estimates (extinction probability and colonization probability) for Rio Grande Silvery Minnow (age-0 fish only) based on repeated site sampling efforts (2005–2015). Symbols indicate means and capped-bars represent 95% confidence intervals.

Age-1+ Fish Only

For age-1+ fish only, estimates of site occupancy probability (ψ) showed a progressive decline since 2009 but with notable improvement since 2013 (Figure B-5). The values of ψ declined from 0.85 in 2009 to 0.60 in 2015. Detection probability estimates were generally lowest during years when this age-class was extremely rare or absent (e.g., 2007 and 2013, respectively) and highest when this age-class was more common (e.g., 2009–2010). The elevated detection probability in 2015 (p = 0.66) reflects the recent increase in occurrence throughout the study area from 2014 to 2015. Also, there was increased uncertainty in both the site occupancy probabilities and detection probabilities during years when individuals were absent at many sites over multiple sampling days (e.g., 2011–2014).

Estimates of the probability of extinction were elevated from 2010–2013 as compared with 2008–2010 (Figure B-6). The most recent estimate of extinction probability (2014–2015) indicated a marked improvement as compared with estimates based on data collected during the past several years. 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. Since 2005, the estimated colonization probability periodically spiked following extinction events at individual sites and reached an elevated level from 2014–2015 as age-1+ individuals were detected at several previously unoccupied sites.

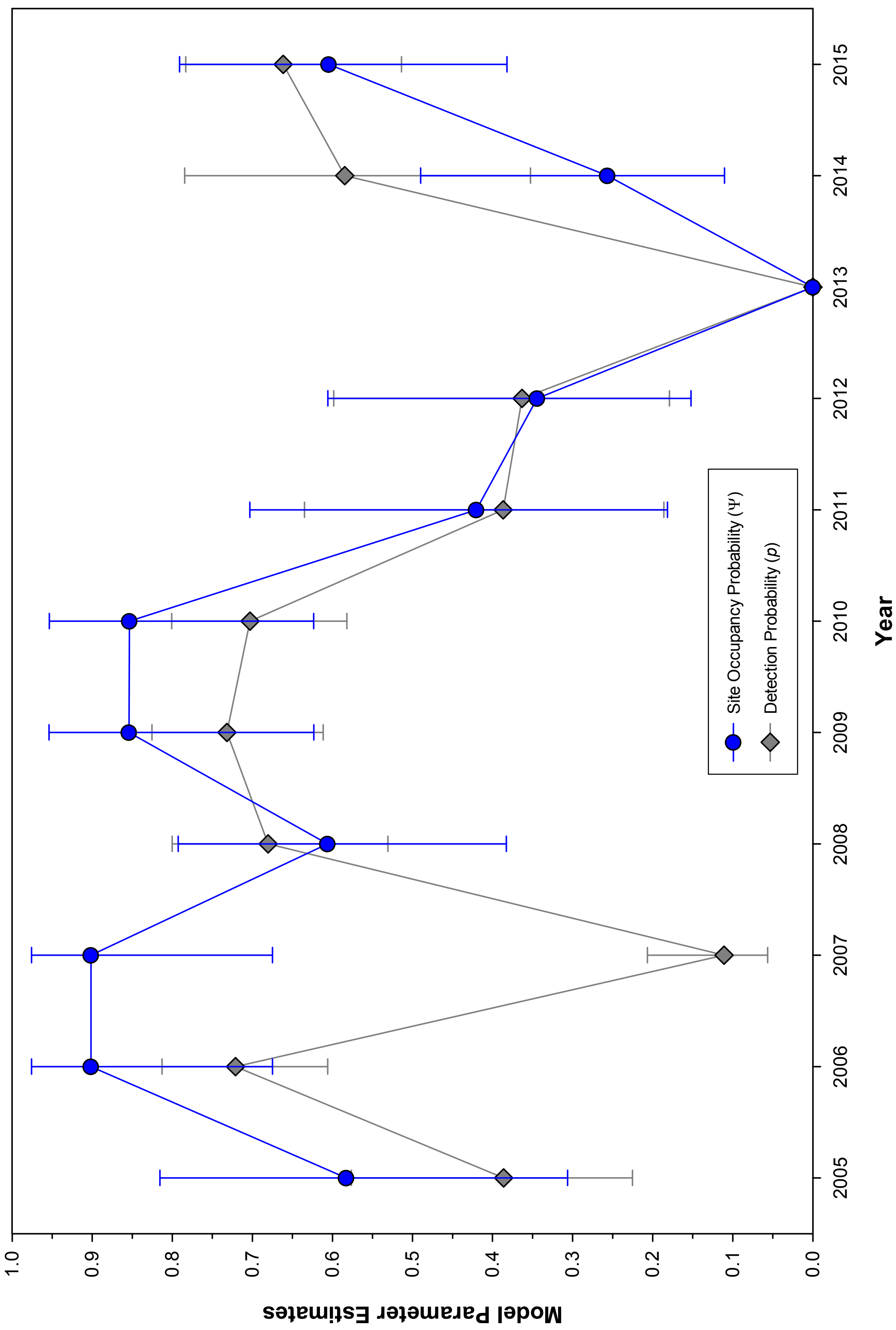

Figure B - 5. Site occupancy model estimates (site occupancy probability and detection probability) for Rio Grande Silvery Minnow (age-1+ fish only) based on repeated site sampling efforts (2005–2015). Solid circles indicate means and capped-bars represent 95% confidence intervals.

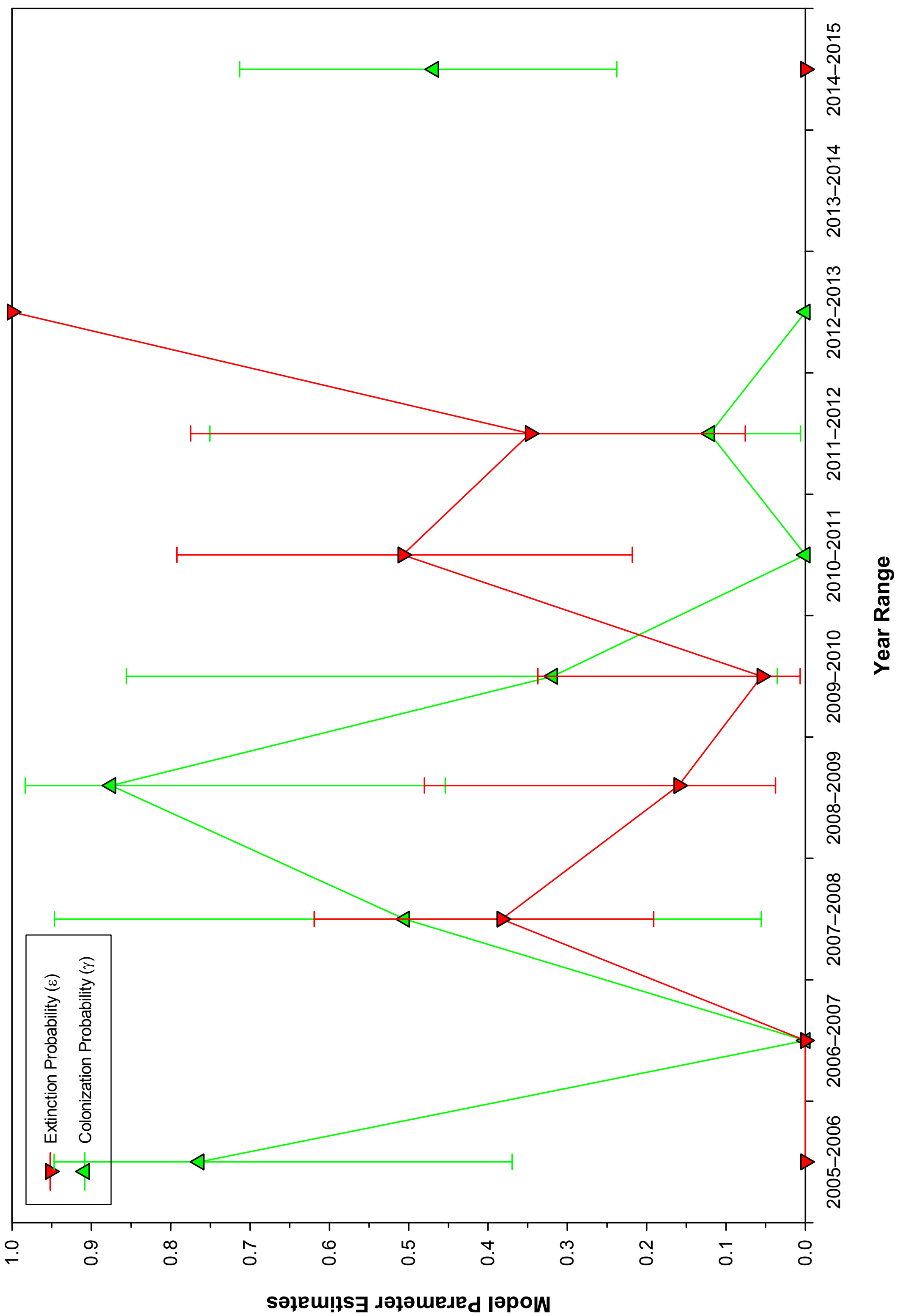

Figure B - 6. Site occupancy model estimates (extinction probability and colonization probability) for Rio Grande Silvery Minnow (age-1+ fish only) based on repeated site sampling efforts (2005–2015). Symbols indicate means and capped-bars represent 95% confidence intervals.

DISCUSSION

Probability of detection values were used to estimate the proportion of sampling sites occupied by Rio Grande Silvery Minnow during repeated sampling efforts in November (2005–2015). There are numerous benefits in documenting 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. Site occupancy models were developed, based on equations provided in MacKenzie et al. (2002, 2003), to incorporate long-term changes in the probability of detection and the presence-absence patterns of Rio Grande Silvery Minnow. Detection probability estimates for this species have provided insight to patterns of site occupancy both within and among sampling sites in the Middle Rio Grande over the past decade.

Multi-year statistical models suggest that site occupancy, extinction, and colonization probabilities will continue to have larger confidence intervals during years when Rio Grande Silvery Minnow is less common. For this study, the number and size of sampling sites were chosen during 2005 when this species was abundant and present at all sites. While the sampling design for this study matched that of the long-term population monitoring study, sites were sampled four times during the site occupancy study and once during the population monitoring study. While the site occupancy sampling protocols were adequate during periods of modest abundance and occurrence, the ability to precisely estimate site occupancy rates was compromised during periods of very low abundance and occurrence. These periods of rarity also consistently corresponded to lower detection probabilities. This uncertainty was compounded during drought years (e.g., 2006 and 2012–2014) when age-0 individuals were only occasionally present at very low densities. A similar pattern was observed for age-1 fish, although detection probabilities declined most sharply in the year following the onset of drought conditions (e.g., 2007 and 2013), presumably as a result of poor recruitment of age-0 fish in the prior year. Site occupancy estimates were higher than expected, based on the raw data, for the years of the study when this species was uncommonly rare and the associated detection probabilities were quite low. Thus, site occupancy estimates should be interpreted cautiously for select years of the study.

Site occupancy analyses for all age-classes combined, based on repeated sampling-site data (2005–2015), revealed that the most parsimonious model had detection probabilities varying by year but that estimates of the probability of occupancy, extinction, and colonization remained constant over time. While the same model also received the most weight for age-0 fish, a model that included extinction and colonization varying by year was most parsimonious for age-1+ fish. However, the results for age-1+ fish should be interpreted cautiously because of the relatively low numbers of age-1+ individuals that were collected over the period of study. 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. Also, the estimates did not change appreciably among the models, as demonstrated by the year-specific estimates of p across the repeated sampling occasions. Parameter estimates from the age-0 fish model suggest that site occupancy was highest during the early years of the study, except for 2006, and that it has declined steadily over the past decade. The trend for age-1+ fish was more erratic but suggested a strong decline from 2010 to 2013. However, recent estimates of site occupancy for all age-classes indicated an increase in the number of sites occupied from 2014 to 2015, which corresponded to similar results obtained during the population monitoring study.

Extinction probabilities reached their highest levels and colonization probabilities reached their lowest levels during a 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 reduced summer flows that characterized that period. An interesting pattern emerged from 2005 to 2006 when age-0 fish became less common following low spring and summer flows (i.e., poor recruitment), but where age-1+ fish recolonized many sites following favorable flows for age-0 fish during 2005 (i.e., good recruitment). The persistence of age-1+ fish during 2006 was important as these older fish appeared to buffer the overall population from precipitous decline and likely led to a relatively quick recovery during 2007. This was in contrast to the multiple years of recruitment failure that characterized recent years (2012–2014) where both age-classes became uncommon or absent throughout the study area. While the balance of extinction and colonization probabilities from 2014–2015 was still not as favorable as it was during the early years of this study (2005–2010), the conservation status of Rio Grande Silvery Minnow (overall and individual age-classes) showed signs of improvement from 2013 to 2015.

Parameter estimates from the model could, however, change dramatically if there are sequential years of either persistently high or low flows, possibly leading to marked differences in Rio Grande Silvery Minnow population dynamics over time. Thus, the site occupancy, extinction, and colonization probabilities should be viewed as an historical analysis of past data as opposed to a prediction of future trends. The site occupancy results can also be used in combination with population monitoring results to provide a more complete 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 to decreasing numbers of individuals. A high probability of extinction combined with low estimated densities, as was observed from 2012 to 2014, indicates serious and imminent threats to the persistence of Rio Grande Silvery Minnow in the wild. These years coincided with periods of reduced spring runoff and persistent drought throughout the Middle Rio Grande (Dudley et al., 2015).

While an examination of all results (i.e., detection, occupancy, extinction, and colonization probabilities) facilitates a more comprehensive interpretation of changes in the conservation status of Rio Grande Silvery Minnow over time, an increase in sampling effort (e.g., more sites, larger sites, or more samples per site) would likely provide more accurate and precise estimates. Indeed, the strength of inference will ultimately be strongly dependent on these fundamental aspects of the overall study design (MacKenzie et al., 2006). Despite the inherent challenges of monitoring rare species, the current Rio Grande Silvery Minnow site occupancy study has proven invaluable in providing useful 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 on extensively modifying the existing study designs, has improved our overall strength of inference across a wide range of environmental conditions 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. This is particularly true for short-lived species such as Rio Grande Silvery Minnow. The dramatic population fluctuations of this species, within short time periods, underscore the need to ensure the presence of individuals over a broad geographical range. Changing environmental conditions can have rapid and severe impacts to Rio Grande Silvery Minnow populations. For example, poor spring runoff conditions might inhibit spawning and limit recruitment to such a degree that estimated densities could decline 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 means that, following periods of low recruitment, the total population is not well buffered by surviving age-classes. Thus, the establishment of Rio Grande Silvery Minnow at multiple locations within its current and historical range should 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 site occupancy, colonization, and extinction probabilities of Rio Grande Silvery Minnow will require a long-term commitment to consistent 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 Rio Grande Silvery Minnow in the Middle Rio Grande. Ultimately, those data can be used to evaluate progress towards meeting Rio Grande Silvery Minnow recovery goals, following both planned management actions and stochastic environmental events.

LITERATURE CITED

Akaike, H. 1973. Information theory as an extension of the maximum likelihood principle. *In*: B. N. Petrov and F. Csaki (eds.). Second International Symposium on Information Theory. Akademiai, Budapest.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. 2nd Edition. Springer-Verlag, New York, New York, USA. 488 pp.

Dudley, R. K., S. P. Platania, and G. C. White. 2015. Rio Grande Silvery Minnow population monitoring program results from February to December 2014. Report to the Middle Rio Grande Endangered Species Collaborative Program and the U.S. Bureau of Reclamation, Albuquerque, New Mexico. 185 pp.

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.

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, Burlington, MA. 324 pp.

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:120–138.

APPENDIX C (Water Quality Summary)

Table C - 1. Water quality* summary statistics [Mean (Standard Error)], by sampling site and reach, during the February to December 2015 population monitoring of Rio Grande Silvery Minnow.

REACH Sampling Site and Name	Sec.	Temp.	Sal.	D.O.	Con. T.	Con.S.	pH
ANGOSTURA REACH							
1 Angostura Dam	29.6 (3.4)	16 (2.2)	0.2 (0.1)	8.1 (0.6)	149.3 (10.7)	240.6 (15.1)	8.1 (0.1)
2 Bernalillo	21.4 (3.6)	17.5 (2.6)	0.1 (0)	8.3 (0.6)	217.1 (29.7)	277.2 (10.8)	8.2 (0.1)
3 Rio Rancho	21.8 (4.4)	17.7 (2.6)	0.1 (0)	8.1 (0.5)	171 (18.6)	260.8 (13.4)	8.1 (0.1)
4 Central Ave.	12.2 (2.1)	16 (2.2)	0.1 (0)	8 (0.4)	159.5 (15.3)	271.8 (14.9)	8.2 (0.1)
5 Rio Bravo Blvd.	8.9 (1.3)	14.8 (2.2)	0.1 (0)	8.3 (0.6)	180.4 (33.1)	284.7 (13.4)	8.2 (0.1)
ISLETA REACH							
6 Los Lunas	9.9 (1.4)	20.2 (2.8)	0.2 (0)	7.5 (0.5)	255.3 (65.7)	374.1 (22.3)	8.3 (0.1)
7 Belen	12.9 (3.1)	20.5 (2.9)	0.2 (0)	7.3 (0.5)	254.1 (53.9)	391.2 (33.6)	8.3 (0.1)
8 Jarales	15.1 (4.8)	18.6 (2.7)	0.2 (0)	7.4 (0.5)	191.1 (26.6)	380 (25.3)	8.3 (0.1)
9 Bernardo	12.1 (4.2)	17.3 (2.4)	0.2 (0)	7.2 (0.5)	223.2 (14.4)	386.2 (21.5)	8.3 (0.1)
10 La Joya	10.4 (2.4)	16.5 (2.3)	0.2 (0)	7.2 (0.5)	263.7 (63.4)	417.9 (28.3)	8.3 (0.1)
11 North of San Acacia	7.4 (1.6)	20.5 (2.8)	0.2 (0)	7 (0.5)	200.8 (19.8)	462.3 (48.3)	8.2 (0.1)
SAN ACACIA REACH							
12 San Acacia Dam	6.9 (1.4)	19.9 (2.3)	0.3 (0)	6.9 (0.4)	617 (NA)	561.8 (54.8)	8.2 (0.1)
13 South of San Acacia	6.9 (1.4)	19 (2.5)	0.2 (0)	7.3 (0.5)	221.8 (16.3)	473.7 (49.5)	8.2 (0.1)
14 Socorro	6.6 (1.6)	18.6 (2.4)	0.3 (0)	7.7 (0.6)	231.8 (1.9)	512.6 (43)	8.2 (0.2)
15 North of San Antonio	5.2 (0.8)	17.7 (2.5)	0.2 (0)	7.3 (0.5)	214.3 (14.3)	476.8 (47.2)	8.2 (0.1)
16 San Antonio	3.6 (0.9)	21 (2.8)	0.3 (0)	6.7 (0.6)	336.3 (84.8)	540.8 (63.8)	8.3 (0.1)
17 South of San Antonio	4.4 (1.4)	21.1 (2.5)	0.3 (0)	7 (0.5)	329.1 (91.9)	536.1 (63.5)	8.3 (0.1)
18 San Marcial	5.1 (2.1)	19.5 (2.6)	0.3 (0)	7.3 (0.6)	327.9 (93.1)	530.2 (59.6)	8.2 (0.1)
19 South of San Marcial 1	5.1 (2)	19 (2.6)	0.3 (0)	6.9 (0.6)	316 (73.3)	550.2 (55.6)	8.2 (0.1)
20 South of San Marcial 2	5.2 (2.4)	17.8 (2.5)	0.3 (0)	7 (0.6)	220.2 (12.6)	536.8 (66.5)	8.2 (0.1)

*Water quality codes:
Sec. = Secchi depth (cm)
Temp. = Water Temperature (^oC)
Sal. = Salinity (ppt)
D.O. = Dissolved Oxygen (mg/l)
Con. T. = True Conductivity (ms)
Con. S. = Specific Conductance (ms)
pH = pH (dimensionless measure of the acidity or basicity of a solution)

APPENDIX D (Site-Specific Ichthyofaunal Composition)

Site-specific ichthyofaunal composition during the 2015
Rio Grande Silvery Minnow population monitoring study

Monthly and annual reports are available at:
http://mrgescp.dbstephens.com

Rio Grande Silvery Minnow Population Monitoring
February 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-018**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 05 February 2015
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 566.3 sq. m

FAMILY		N
76	*Platygobio gracilis*	4
76	*Rhinichthys cataractae*	1

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-019**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 05 February 2015
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 583.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	9
76	*Hybognathus amarus**	8
76	*Platygobio gracilis*	8

***Hybognathus amarus* by age class:**

age-0:
age-1: 5
age-2+: 3

Rio Grande Silvery Minnow Population Monitoring
February 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-020**
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 05 February 2015
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 533.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	43
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	52
76	*Platygobio gracilis*	49
76	*Rhinichthys cataractae*	3
81	*Catostomus commersonii*	1
212	*Gambusia affinis*	5

*** *Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
February 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-017**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 04 February 2015
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 618.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	36
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	2
81	*Catostomus commersonii*	5
93	*Ictalurus punctatus*	1

*** *Hybognathus amarus* by age class:**
age-0:
age-1: 2
age-2+:

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-016**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 04 February 2015
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 577.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	4
76	*Hybognathus amarus**	10
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	1
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	1

*** *Hybognathus amarus* by age class:**
age-0:
age-1: 9
age-2+: 1

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NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-015**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 03 February 2015
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 550.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	225
76	*Hybognathus amarus**	6
76	*Pimephales promelas*	5
76	*Platygobio gracilis*	8
81	*Carpiodes carpio*	4

***Hybognathus amarus* by age class:**

age-0:
age-1: 1
age-2+: 5

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-014**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 03 February 2015
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 555.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	169
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	7
76	*Platygobio gracilis*	1
212	*Gambusia affinis*	1

***Hybognathus amarus* by age class:**

age-0:
age-1: 3
age-2+:

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NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-013**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 03 February 2015
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 593.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	234
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	12
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	1

***Hybognathus amarus* by age class:**
age-0:
age-1: 1
age-2+: 2

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-012**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 03 February 2015
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 601.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	70
76	*Hybognathus amarus**	4
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	7
283	*Morone chrysops*	1

***Hybognathus amarus* by age class:**
age-0:
age-1: 2
age-2+: 2

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-011**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 03 February 2015
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 612.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	119
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	45
212	*Gambusia affinis*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-010**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 02 February 2015
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
R.K. Dudley, M.A. Farrington, J.L. Kennedy Effort: 648.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	10
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	20
76	*Platygobio gracilis*	35
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	6

***Hybognathus amarus* by age class:**
age-0:
age-1: 1
age-2+:

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-009**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 02 February 2015
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
R.K. Dudley, M.A. Farrington, J.L. Kennedy Effort: 557.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	8
76	*Hybognathus amarus**	5
76	*Platygobio gracilis*	5
93	*Ictalurus punctatus*	4

**** Hybognathus amarus* by age class:**

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-008**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 02 February 2015
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
R.K. Dudley, M.A. Farrington, J.L. Kennedy Effort: 614.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	21
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	56
93	*Ictalurus punctatus*	4

**** Hybognathus amarus* by age class:**

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

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-007**
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 04 February 2015
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 578.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	105
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	52
76	*Platygobio gracilis*	13

***Hybognathus amarus* by age class:**
age-0:
age-1: 52
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-006**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 02 February 2015
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
R.K. Dudley, M.A. Farrington, J.L. Kennedy Effort: 543.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	42
76	*Hybognathus amarus**	15
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	3

***Hybognathus amarus* by age class:**
age-0:
age-1: 15
age-2+:

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-005**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 04 February 2015
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 579.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	30
76	*Hybognathus amarus**	11
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	1

***Hybognathus amarus* by age class:**
age-0:
age-1: 11
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-004**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 05 February 2015
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 566.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	38
76	*Hybognathus amarus**	1
93	*Ictalurus punctatus*	2

***Hybognathus amarus* by age class:**
age-0:
age-1: 1
age-2+:

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-003**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 05 February 2015
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 549.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	390
76	*Hybognathus amarus**	5
76	*Pimephales vigilax*	1
76	*Platygobio gracilis*	3
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	1

***Hybognathus amarus* by age class:**
age-0:
age-1: 5
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-002**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 05 February 2015
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 594.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	136
76	*Hybognathus amarus**	18
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	4
93	*Ictalurus punctatus*	3

***Hybognathus amarus* by age class:**
age-0:
age-1: 18
age-2+:

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-001**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 05 February 2015
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
W.H. Brandenburg, S.L. Clark Barkalow, J.L. Kennedy Effort: 601.3 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	139
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	23

**** Hybognathus amarus*** **by age class:**

age-0:
age-1: 3
age-2+:

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NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-038**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 07 April 2015
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 502.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	5
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	4
76	*Rhinichthys cataractae*	6
81	*Catostomus commersonii*	3

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-039**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 07 April 2015
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 516.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	4
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	54
76	*Rhinichthys cataractae*	24
81	*Catostomus commersonii*	4

***Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
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NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-040**
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 07 April 2015
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 585.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	14
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	79
76	*Rhinichthys cataractae*	92
81	*Catostomus commersonii*	5
93	*Ictalurus punctatus*	5

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-037**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 07 April 2015
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 525.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	6
76	*Platygobio gracilis*	32
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	2

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NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-036**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 07 April 2015
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 543.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	14
76	*Platygobio gracilis*	3
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	9
93	*Ictalurus punctatus*	3

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-035**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 09 April 2015
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
M.A. Farrington, J.L. Kennedy, T.E. Mitchusson Effort: 466.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	346
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	8
93	*Ictalurus punctatus*	40
212	*Gambusia affinis*	8
294	*Pomoxis annularis*	1

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NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-034**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 09 April 2015
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
M.A. Farrington, J.L. Kennedy, T.E. Mitchusson Effort: 493.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	394
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	6
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	13
212	*Gambusia affinis*	4

***Hybognathus amarus* by age class:**

age-0:
age-1: 3
age-2+:

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-033**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 09 April 2015
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
M.A. Farrington, J.L. Kennedy, T.E. Mitchusson Effort: 484.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	265
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	3
93	*Ictalurus punctatus*	9
212	*Gambusia affinis*	15
294	*Micropterus salmoides*	1

***Hybognathus amarus* by age class:**

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

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-032**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 09 April 2015
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
M.A. Farrington, J.L. Kennedy, T.E. Mitchusson Effort: 528.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	317
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	28
212	*Gambusia affinis*	2

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-031**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 09 April 2015
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
M.A. Farrington, J.L. Kennedy, T.E. Mitchusson Effort: 525.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	292
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	9
212	*Gambusia affinis*	24
283	*Morone chrysops*	2

***Hybognathus amarus* by age class:**

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

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-030**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 08 April 2015
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
M.A. Farrington, J.L. Kennedy, T.E. Mitchusson Effort: 532.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	25
76	*Platygobio gracilis*	7
93	*Ictalurus punctatus*	50
212	*Gambusia affinis*	4

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-029**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 08 April 2015
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
M.A. Farrington, J.L. Kennedy, T.E. Mitchusson Effort: 536.9 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	5
76	*Cyprinella lutrensis*	35
76	*Platygobio gracilis*	6
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	8
294	*Pomoxis annularis*	1

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-028**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 08 April 2015
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
M.A. Farrington, J.L. Kennedy, T.E. Mitchusson Effort: 534.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	24
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	12
93	*Ictalurus punctatus*	28

***Hybognathus amarus* by age class:**
age-0:
age-1: 2
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-027**
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 16 April 2015
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
R.K. Dudley, M.A. Farrington, J.L. Kennedy Effort: 474.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	113
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	2

***Hybognathus amarus* by age class:**
age-0:
age-1: 1
age-2+:

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-026**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 08 April 2015
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
M.A. Farrington, J.L. Kennedy, T.E. Mitchusson Effort: 495.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	70
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	8
93	*Ictalurus punctatus*	2

***Hybognathus amarus* by age class:**
age-0:
age-1: 1
age-2+: 1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-025**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 06 April 2015
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 545.7 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	1
76	*Cyprinella lutrensis*	67
76	*Hybognathus amarus**	2
93	*Ictalurus punctatus*	2

***Hybognathus amarus* by age class:**
age-0:
age-1: 2
age-2+:

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-024**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 06 April 2015
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 449.2 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	1
76	*Cyprinella lutrensis*	17
76	*Hybognathus amarus**	2

**** Hybognathus amarus* by age class:**
age-0:
age-1: 2
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-023**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 06 April 2015
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 488.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	188
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	1

**** Hybognathus amarus* by age class:**
age-0:
age-1: 2
age-2+:

Rio Grande Silvery Minnow Population Monitoring
April 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-022**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 06 April 2015
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 545.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	255
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	8

***Hybognathus amarus* by age class:**
age-0:
age-1: 2
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-021**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 06 April 2015
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
J.L. Kennedy, S.L. Clark Barkalow, T.E. Mitchusson Effort: 488.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	89
76	*Pimephales vigilax*	1
93	*Ictalurus punctatus*	15

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-058**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 07 May 2015
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
M.A. Farrington, W.H. Brandenburg, E.I. Gilbert Effort: 543.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	26
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	6
76	*Rhinichthys cataractae*	121
81	*Catostomus commersonii*	3

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-059**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 07 May 2015
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
M.A. Farrington, W.H. Brandenburg, E.I. Gilbert Effort: 570.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	6
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	73
76	*Rhinichthys cataractae*	62
81	*Catostomus commersonii*	6
93	*Ictalurus punctatus*	4

***Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-060**
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 07 May 2015
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
M.A. Farrington, W.H. Brandenburg, E.I. Gilbert Effort: 487.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	19
76	*Pimephales promelas*	9
76	*Platygobio gracilis*	40
76	*Rhinichthys cataractae*	50
81	*Catostomus commersonii*	20
93	*Ictalurus punctatus*	1
294	*Lepomis macrochirus*	1

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-057**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 07 May 2015
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
M.A. Farrington, W.H. Brandenburg, E.I. Gilbert Effort: 475.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	10
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	7
76	*Platygobio gracilis*	24
81	*Catostomus commersonii*	17
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	13

**** Hybognathus amarus*** **by age class:**
age-0:
age-1: 3
age-2+:

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-056**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.
Site Number: 5 River Mile: 178.3 07 May 2015
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
M.A. Farrington, W.H. Brandenburg, E.I. Gilbert Effort: 573.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	23
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	4
76	*Platygobio gracilis*	4
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	2

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-055**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 14 May 2015
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
R.K. Dudley, M.A. Farrington, S.L. Clark Barkalow Effort: 509.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	177
76	*Pimephales promelas*	2
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	6
93	*Ictalurus punctatus*	18
212	*Gambusia affinis*	2
294	*Pomoxis annularis*	3

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-054**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 14 May 2015
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
R.K. Dudley, M.A. Farrington, S.L. Clark Barkalow Effort: 510.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	224
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	19
212	*Gambusia affinis*	4

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-053**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 14 May 2015
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
R.K. Dudley, M.A. Farrington, S.L. Clark Barkalow Effort: 533.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	315
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	37
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	3

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-052**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 14 May 2015
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
R.K. Dudley, M.A. Farrington, S.L. Clark Barkalow Effort: 586.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	181
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	24
212	*Gambusia affinis*	5

***Hybognathus amarus* by age class:**

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-051**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 14 May 2015
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
R.K. Dudley, M.A. Farrington, S.L. Clark Barkalow Effort: 548.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	139
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	55
212	*Gambusia affinis*	1

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-050**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 07 May 2015
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 558.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	10
76	*Pimephales promelas*	7
76	*Platygobio gracilis*	32
81	*Carpiodes carpio*	4
81	*Catostomus commersonii*	13
93	*Ictalurus punctatus*	18
212	*Gambusia affinis*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-049**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 07 May 2015
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 490.7 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	18
76	*Cyprinella lutrensis*	33
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	17
93	*Ictalurus punctatus*	2

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-048**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 07 May 2015
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 538.9 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	2
76	*Cyprinella lutrensis*	41
76	*Platygobio gracilis*	10
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	8
295	*Sander vitreus*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-047**
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 07 May 2015
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 558.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	187
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	6
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	2

***Hybognathus amarus* by age class:**
age-0:
age-1: 1
age-2+:

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-046**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 07 May 2015
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
R.K. Dudley, J.L. Kennedy, S.L. Clark Barkalow Effort: 488.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	26
76	*Cyprinus carpio*	2
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	1
93	*Ictalurus furcatus*	2
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	1
294	*Pomoxis annularis*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-045**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 08 May 2015
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
R.K. Dudley, S.L. Clark Barkalow, E.I. Gilbert Effort: 561.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	86
76	*Cyprinus carpio*	18
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	7
81	*Carpiodes carpio*	20
93	*Ictalurus punctatus*	2

*** *Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-044**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 08 May 2015
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
R.K. Dudley, S.L. Clark Barkalow, E.I. Gilbert Effort: 482.1 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	1
76	*Cyprinella lutrensis*	86
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	4
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	2
93	*Ictalurus furcatus*	3

**** Hybognathus amarus* by age class:**

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-043**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 08 May 2015
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
R.K. Dudley, S.L. Clark Barkalow, E.I. Gilbert Effort: 560.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	118
76	*Platygobio gracilis*	3
93	*Ictalurus furcatus*	2

Rio Grande Silvery Minnow Population Monitoring
May 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-042**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 08 May 2015
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
R.K. Dudley, S.L Clark Barkalow, E.I. Gilbert Effort: 564.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	986
76	*Pimephales vigilax*	1
76	*Platygobio gracilis*	4
93	*Ictalurus furcatus*	4
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	2

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-041**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 08 May 2015
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
R.K. Dudley, S.L Clark Barkalow, E.I. Gilbert Effort: 561.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	395
76	*Platygobio gracilis*	6
93	*Ictalurus furcatus*	2
93	*Ictalurus punctatus*	5

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-078**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 02 June 2015
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 534.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	7
76	*Gila pandora*	4
76	*Platygobio gracilis*	1
76	*Rhinichthys cataractae*	78
81	*Catostomus commersonii*	33
294	*Pomoxis annularis*	1

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-079**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 02 June 2015
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 559.7 sq. m

FAMILY		N
76	*Platygobio gracilis*	10
76	*Rhinichthys cataractae*	40
81	*Catostomus commersonii*	2
93	*Ictalurus punctatus*	3

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-080**
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 02 June 2015
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 607.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	4
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	28
76	*Rhinichthys cataractae*	33
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	1

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-077**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 02 June 2015
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 594.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	67
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	7
76	*Rhinichthys cataractae*	1
81	*Catostomus commersonii*	2

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-076**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 02 June 2015
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
R.K. Dudley, R.C. Keller, R.A. Reese Effort: 548.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	12
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	2

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-075**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 04 June 2015
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 512.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	124
76	*Cyprinus carpio*	27
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	4
76	*Platygobio gracilis*	5
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	11

***Hybognathus amarus* by age class:**
age-0: 2
age-1: 1
age-2+:

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-074**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 04 June 2015
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 528.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	309
76	*Cyprinus carpio*	9
76	*Hybognathus amarus**	8
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	9
81	*Catostomus commersonii*	3
93	*Ictalurus punctatus*	11
212	*Gambusia affinis*	50

*** *Hybognathus amarus* by age class:**

age-0: 8
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-073**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 04 June 2015
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 542.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	338
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	5
76	*Pimephales promelas*	1
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	4

*** *Hybognathus amarus* by age class:**
age-0: 5
age-1:
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-072**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 04 June 2015
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 523.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	88
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	1
93	*Ictalurus punctatus*	18
212	*Gambusia affinis*	46

*** *Hybognathus amarus* by age class:**
age-0:
age-1: 1
age-2+:

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-071**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 04 June 2015
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 568.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	223
93	*Ictalurus punctatus*	5

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-070**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 03 June 2015
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
J.L. Kennedy, A.L. Barkalow, R. C. Keller Effort: 549.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Cyprinus carpio*	3
76	*Platygobio gracilis*	91
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	15

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-069**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 03 June 2015
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
J.L. Kennedy, A.L. Barkalow, R. C. Keller Effort: 522.3 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	3
76	*Cyprinella lutrensis*	54
76	*Cyprinus carpio*	3
76	*Platygobio gracilis*	24
93	*Ictalurus furcatus*	5
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	8

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-068**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 03 June 2015
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
J.L. Kennedy, A.L. Barkalow, R. C. Keller Effort: 605.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	17
76	*Platygobio gracilis*	16
93	*Ictalurus furcatus*	2
93	*Ictalurus punctatus*	9

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-067**
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 03 June 2015
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
J.L. Kennedy, A.L. Barkalow, R. C. Keller Effort: 555.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	187
76	*Platygobio gracilis*	13
93	*Ictalurus punctatus*	5

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-066**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 03 June 2015
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
J.L. Kennedy, A.L. Barkalow, R. C. Keller Effort: 510.0 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	1
76	*Cyprinella lutrensis*	61
76	*Cyprinus carpio*	4
76	*Hybognathus amarus**	14
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	24
81	*Carpiodes carpio*	8
93	*Ictalurus furcatus*	1
93	*Ictalurus punctatus*	5

***Hybognathus amarus* by age class:**
age-0: 10
age-1: 4
age-2+:

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-065**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 01 June 2015
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
R.K. Dudley, J.L. Kennedy, S.L. Clark-Barkalow Effort: 520.1 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	1
76	*Cyprinella lutrensis*	35
81	*Ictiobus bubalus*	3
93	*Ictalurus furcatus*	2
93	*Ictalurus punctatus*	5

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-064**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.
Site Number: 17 River Mile: 79.1 01 June 2015
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
R.K. Dudley, J.L. Kennedy, S.L. Clark-Barkalow Effort: 463.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	15
76	*Hybognathus amarus**	3
93	*Ictalurus punctatus*	2

***Hybognathus amarus* by age class:**
age-0:
age-1: 3
age-2+:

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-063**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 01 June 2015
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
R.K. Dudley, J.L. Kennedy, S.L. Clark-Barkalow Effort: 535.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	301
76	*Pimephales vigilax*	1
93	*Ictalurus furcatus*	3
93	*Ictalurus punctatus*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-062**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 01 June 2015
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
R.K. Dudley, J.L. Kennedy, S.L. Clark-Barkalow Effort: 522.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	898
76	*Hybognathus amarus**	2
76	*Pimephales vigilax*	1
76	*Platygobio gracilis*	11
81	*Catostomus commersonii*	1
81	*Ictiobus bubalus*	1
93	*Ictalurus furcatus*	4
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	7

**** Hybognathus amarus*** **by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
June 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-061**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 01 June 2015
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
R.K. Dudley, J.L. Kennedy, S.L. Clark-Barkalow Effort: 533.2 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	128
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	1
81	*Ictiobus bubalus*	1
93	*Ictalurus furcatus*	3
93	*Ictalurus punctatus*	1

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-098**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 06 July 2015
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller, L.K. Atchison Effort: 495.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	23
76	*Cyprinus carpio*	14
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	10
76	*Rhinichthys cataractae*	48
212	*Gambusia affinis*	1
295	*Perca flavescens*	1

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-099**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 06 July 2015
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller, L.K. Atchison Effort: 558.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	8
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	12
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	61
76	*Rhinichthys cataractae*	100
81	*Catostomus commersonii*	38
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	3

*** *Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-100**
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 06 July 2015
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller, L.K. Atchison Effort: 585.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	8
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	8
76	*Platygobio gracilis*	30
76	*Rhinichthys cataractae*	4
81	*Catostomus commersonii*	5

***** ***Hybognathus amarus*** **by age class:**

age-0: 8
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-097**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 06 July 2015
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller, L.K. Atchison Effort: 528.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	17
76	*Cyprinus carpio*	20
76	*Hybognathus amarus**	297
76	*Pimephales promelas*	8
76	*Platygobio gracilis*	9
76	*Rhinichthys cataractae*	3
81	*Carpiodes carpio*	17
81	*Catostomus commersonii*	36
212	*Gambusia affinis*	7

*** *Hybognathus amarus* by age class:**

age-0: 297
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-096**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.
Site Number: 5 River Mile: 178.3 06 July 2015
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller, L.K. Atchison Effort: 561.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Cyprinus carpio*	18
76	*Hybognathus amarus**	18
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	4
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	2
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	1

**** Hybognathus amarus*** **by age class:**
age-0: 18
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-095**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 09 July 2015
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 493.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Hybognathus amarus**	3
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	8
212	*Gambusia affinis*	4

***Hybognathus amarus* by age class:**

age-0: 3
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-094**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 09 July 2015
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 550.9 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	1
76	*Cyprinella lutrensis*	138
76	*Cyprinus carpio*	11
76	*Hybognathus amarus**	9
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	18
212	*Gambusia affinis*	3
294	*Pomoxis annularis*	1

***Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-093**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 09 July 2015
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 464.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	29
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	11
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	10
212	*Gambusia affinis*	37

***Hybognathus amarus* by age class:**
age-0: 11
age-1:
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-092**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 09 July 2015
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 515.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	23
76	*Cyprinus carpio*	5
76	*Hybognathus amarus**	6
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	76
212	*Gambusia affinis*	5

***Hybognathus amarus* by age class:**
age-0: 6
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-091**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.
Site Number: 10 River Mile: 127.0 09 July 2015
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 491.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	27
76	*Hybognathus amarus**	48
76	*Platygobio gracilis*	5
81	*Carpiodes carpio*	3
93	*Ameiurus natalis*	5
93	*Ictalurus punctatus*	42
212	*Gambusia affinis*	3

***Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-090**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 08 July 2015
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 501.8 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	7
76	*Cyprinus carpio*	23
76	*Hybognathus amarus**	21
76	*Pimephales vigilax*	1
76	*Platygobio gracilis*	197
93	*Ameiurus natalis*	16
93	*Ictalurus punctatus*	585
212	*Gambusia affinis*	4

*** *Hybognathus amarus* by age class:**

age-0: 21
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-089**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 08 July 2015
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 481.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	51
76	*Cyprinus carpio*	17
76	*Hybognathus amarus**	5
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	110
76	*Rhinichthys cataractae*	2
93	*Ameiurus natalis*	11
93	*Ictalurus furcatus*	5
93	*Ictalurus punctatus*	99
212	*Gambusia affinis*	9

***Hybognathus amarus* by age class:**

age-0: 5
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-088**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 08 July 2015
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 580.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	6
76	*Cyprinus carpio*	2
76	*Platygobio gracilis*	26
93	*Ictalurus furcatus*	5
93	*Ictalurus punctatus*	22
212	*Gambusia affinis*	2

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-087**
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 08 July 2015
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 588.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	18
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	19
81	*Carpiodes carpio*	2
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	28
212	*Gambusia affinis*	1

***Hybognathus amarus* by age class:**

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

Funding: U.S. Bureau of Reclamation

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-086**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 08 July 2015
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 497.6 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	54
76	*Hybognathus amarus**	32
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	32
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	9
93	*Ictalurus punctatus*	74
212	*Gambusia affinis*	5

***Hybognathus amarus* by age class:**

age-0: 32
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-085**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 07 July 2015
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 580.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	23
76	*Cyprinus carpio*	4
76	*Platygobio gracilis*	24
81	*Carpiodes carpio*	1
93	*Ictalurus furcatus*	5
93	*Ictalurus punctatus*	73
93	*Pylodictis olivaris*	1
212	*Gambusia affinis*	8

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-084**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 07 July 2015
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 474.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	46
76	*Cyprinus carpio*	14
76	*Hybognathus amarus**	16
76	*Platygobio gracilis*	50
81	*Carpiodes carpio*	5
93	*Ictalurus punctatus*	29
212	*Gambusia affinis*	2

**** Hybognathus amarus*** **by age class:**

age-0: 16
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-083**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 07 July 2015
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 525.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	422
76	*Cyprinus carpio*	62
76	*Hybognathus amarus**	48
76	*Platygobio gracilis*	9
81	*Carpiodes carpio*	9
93	*Ameiurus melas*	1
93	*Ictalurus furcatus*	4
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	13

***Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
July 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-082**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 07 July 2015
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 503.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	275
76	*Cyprinus carpio*	9
76	*Hybognathus amarus**	3
76	*Pimephales vigilax*	1
76	*Platygobio gracilis*	9
81	*Carpiodes carpio*	2
93	*Ictalurus furcatus*	3
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	11

***Hybognathus amarus* by age class:**
age-0: 3
age-1:
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-081**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 07 July 2015
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 570.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	54
76	*Cyprinus carpio*	7
93	*Ictalurus furcatus*	7
93	*Ictalurus punctatus*	8
212	*Gambusia affinis*	1

Funding: U.S. Bureau of Reclamation
Contract GS-10F-0249X: Order R15PD00171

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-118**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 05 August 2015
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 477.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	22
76	*Pimephales promelas*	8
76	*Platygobio gracilis*	22
76	*Rhinichthys cataractae*	18
81	*Catostomus commersonii*	3
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	24
294	*Lepomis macrochirus*	1
294	*Pomoxis annularis*	1

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-119**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 05 August 2015
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 547.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	84
76	*Rhinichthys cataractae*	39
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	17
212	*Gambusia affinis*	18

*** *Hybognathus amarus* by age class:**

age-0: 3
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-120**
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 05 August 2015
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 580.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	7
76	*Hybognathus amarus**	14
76	*Pimephales promelas*	7
76	*Platygobio gracilis*	26
76	*Rhinichthys cataractae*	4
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	2
93	*Ictalurus punctatus*	9
212	*Gambusia affinis*	22

***Hybognathus amarus* by age class:**

age-0: 14
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-117**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 05 August 2015
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 556.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	9
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	9
76	*Platygobio gracilis*	4
93	*Ameiurus natalis*	2
93	*Ictalurus punctatus*	72
212	*Gambusia affinis*	1

***Hybognathus amarus* by age class:**
age-0: 9
age-1:
age-2+:

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-116**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 05 August 2015
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 555.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Platygobio gracilis*	2
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	19

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-115**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 06 August 2015
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 482.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	33
76	*Hybognathus amarus**	47
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	2
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	23
212	*Gambusia affinis*	2

***Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-114**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 06 August 2015
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 505.3 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	1
76	*Cyprinella lutrensis*	84
76	*Cyprinus carpio*	4
76	*Hybognathus amarus**	51
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	3
93	*Ictalurus punctatus*	30
212	*Gambusia affinis*	57

***Hybognathus amarus* by age class:**

age-0: 51
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-113**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 06 August 2015
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 538.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	88
76	*Cyprinus carpio*	4
76	*Hybognathus amarus**	16
76	*Pimephales promelas*	6
76	*Rhinichthys cataractae*	1
93	*Ameiurus natalis*	2
93	*Ictalurus punctatus*	45
212	*Gambusia affinis*	66

***Hybognathus amarus* by age class:**

age-0: 16
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-112**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 06 August 2015
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 497.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	149
76	*Cyprinus carpio*	5
76	*Hybognathus amarus**	46
76	*Pimephales promelas*	5
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	1
93	*Ameiurus natalis*	4
93	*Ictalurus punctatus*	35
212	*Gambusia affinis*	112

**** Hybognathus amarus* by age class:**

age-0: 46
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-111**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 06 August 2015
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 500.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	175
76	*Hybognathus amarus**	8
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	4
81	*Carpiodes carpio*	2
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	39
212	*Gambusia affinis*	26

***Hybognathus amarus* by age class:**

age-0: 8
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-110**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 03 August 2015
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
M.A. Farrington, J.L. Kennedy, R.C. Keller Effort: 591.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	10
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	4
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	183
93	*Ictalurus punctatus*	142

***Hybognathus amarus* by age class:**
age-0: 4
age-1:
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-109**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 03 August 2015
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
M.A. Farrington, J.L. Kennedy, R.C. Keller Effort: 499.2 sq. m

FAMILY		N
69	*Dorosoma cepedianum*	1
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	25
93	*Ictalurus punctatus*	73

***Hybognathus amarus* by age class:**
age-0: 1
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-108**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 03 August 2015
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
M.A. Farrington, J.L. Kennedy, R.C. Keller Effort: 524.3 sq. m

FAMILY		N
76	*Platygobio gracilis*	11
93	*Ictalurus punctatus*	39

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-107**
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 03 August 2015
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
M.A. Farrington, J.L. Kennedy, R.C. Keller Effort: 537.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	17
76	*Hybognathus amarus**	4
76	*Platygobio gracilis*	53
93	*Ictalurus punctatus*	69

**** Hybognathus amarus*** **by age class:**
age-0: 4
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-106**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 03 August 2015
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
M.A. Farrington, J.L. Kennedy, R.C. Keller Effort: 503.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	10
93	*Ictalurus punctatus*	6

***Hybognathus amarus* by age class:**
age-0: 2
age-1:
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-105**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 04 August 2015
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 544.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	2
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	8
76	*Platygobio gracilis*	34
81	*Ictiobus bubalus*	1
93	*Ameiurus natalis*	4
93	*Ictalurus punctatus*	55

***Hybognathus amarus* by age class:**
age-0: 7
age-1: 1
age-2+:

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-104**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 04 August 2015
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 526.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	79
76	*Hybognathus amarus**	13
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	18
93	*Ictalurus punctatus*	10

*** *Hybognathus amarus* by age class:**

age-0: 13
age-1:
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-103**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 04 August 2015
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 593.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	26
76	*Platygobio gracilis*	3
93	*Ictalurus furcatus*	3
93	*Ictalurus punctatus*	24
93	*Pylodictis olivaris*	2

Funding: U.S. Bureau of Reclamation
Contract GS-10F-0249X: Order R15PD00171

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-102**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 04 August 2015
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 515.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	71
76	*Hybognathus amarus**	4
76	*Platygobio gracilis*	8
93	*Ameiurus natalis*	3
93	*Ictalurus furcatus*	1
93	*Ictalurus punctatus*	21
212	*Gambusia affinis*	2

**** Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
August 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-101**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 04 August 2015
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 511.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	18
76	*Hybognathus amarus**	1
93	*Ameiurus melas*	1
93	*Ictalurus furcatus*	1
93	*Ictalurus punctatus*	21
93	*Pylodictis olivaris*	1

***Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-138**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 09 September 2015
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 492.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	15
76	*Cyprinus carpio*	3
76	*Pimephales promelas*	5
76	*Platygobio gracilis*	20
76	*Rhinichthys cataractae*	36
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	81
294	*Lepomis macrochirus*	1
294	*Pomoxis annularis*	2

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-139**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 09 September 2015
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 483.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	21
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	53
76	*Rhinichthys cataractae*	25
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	66

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-140**
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 2015
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 581.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	20
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	86
76	*Rhinichthys cataractae*	14
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	37

Hybognathus amarus **by age class:**
age-0: 1
age-1:
age-2+:

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-137**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 09 September 2015
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 552.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	11
76	*Platygobio gracilis*	6
76	*Rhinichthys cataractae*	1
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	8

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-136**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 09 September 2015
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Kennedy, R.C. Keller Effort: 529.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	31

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-135**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 10 September 2015
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 489.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	98
76	*Hybognathus amarus**	16
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	23
81	*Carpiodes carpio*	3
93	*Ictalurus punctatus*	8
212	*Gambusia affinis*	14

***Hybognathus amarus* by age class:**

age-0: 16
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-134**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 10 September 2015
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 459.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	66
76	*Hybognathus amarus**	148
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	4
93	*Ictalurus punctatus*	9
212	*Gambusia affinis*	27

***Hybognathus amarus* by age class:**
age-0: 144
age-1: 3
age-2+: 1

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-133**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 10 September 2015
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 533.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	156
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	156

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September 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-132**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 10 September 2015
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 486.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	15
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	2
212	*Gambusia affinis*	39

***Hybognathus amarus* by age class:**

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-131**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 10 September 2015
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 453.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	25
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	1
93	*Ameiurus natalis*	1
212	*Gambusia affinis*	25

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-130**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 11 September 2015
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
W.H. Brandenburg, S.L. Clark Barkalow, R.C. Keller Effort: 511.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	20
76	*Hybognathus amarus**	4
76	*Platygobio gracilis*	28
93	*Ictalurus punctatus*	10
212	*Gambusia affinis*	22

*** *Hybognathus amarus* by age class:**

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-129**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 11 September 2015
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
W.H. Brandenburg, S.L. Clark Barkalow, R.C. Keller Effort: 508.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	12
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	25
76	*Rhinichthys cataractae*	1
93	*Ictalurus punctatus*	18
212	*Gambusia affinis*	3

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-128**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 11 September 2015
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
W.H. Brandenburg, S.L. Clark Barkalow, R.C. Keller Effort: 518.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	2
76	*Platygobio gracilis*	26
93	*Ictalurus punctatus*	24
212	*Gambusia affinis*	18

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-127**
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 11 September 2015
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
W.H. Brandenburg, S.L. Clark Barkalow, R.C. Keller Effort: 534.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	4
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	20
93	*Ictalurus punctatus*	19

**** Hybognathus amarus*** **by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-126**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 11 September 2015
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
W.H. Brandenburg, S.L. Clark Barkalow, R.C. Keller Effort: 504.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	7
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	17
76	*Platygobio gracilis*	59
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	16
212	*Gambusia affinis*	1

**** Hybognathus amarus*** **by age class:**

age-0: 17
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-125**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 08 September 2015
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 584.9 sq. m

FAMILY		N
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	22
93	*Ictalurus punctatus*	12
93	*Pylodictis olivaris*	1
212	*Gambusia affinis*	2

***Hybognathus amarus* by age class:**
age-0: 2
age-1:
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-124**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 08 September 2015
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 535.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	4
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	20
93	*Ictalurus punctatus*	24
93	*Pylodictis olivaris*	2
212	*Gambusia affinis*	1

***Hybognathus amarus* by age class:**
age-0: 2
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-123**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 08 September 2015
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 575.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	2
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	9

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-122**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 08 September 2015
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 581.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	19
76	*Platygobio gracilis*	17
93	*Ictalurus punctatus*	10
93	*Pylodictis olivaris*	1
212	*Gambusia affinis*	3

Rio Grande Silvery Minnow Population Monitoring
September 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-121**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 08 September 2015
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
J.L. Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 539.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	2
93	*Ictalurus punctatus*	11
93	*Pylodictis olivaris*	2
212	*Gambusia affinis*	1

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-158**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 08 October 2015
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
M.A. Farrington, S.L. Clark Baralow, R. C. Keller Effort: 482.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	2
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	19
76	*Rhinichthys cataractae*	27
212	*Gambusia affinis*	257
294	*Lepomis cyanellus*	1
294	*Lepomis macrochirus*	1

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-159**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 08 October 2015
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
M.A. Farrington, S.L. Clark Baralow, R. C. Keller Effort: 488.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	39
76	*Rhinichthys cataractae*	14
212	*Gambusia affinis*	2

Funding: U.S. Bureau of Reclamation
Contract GS-10F-0249X: Order R15PD00171

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-160**
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 08 October 2015
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
M.A. Farrington, S.L. Clark Baralow, R. C. Keller Effort: 494.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	74
76	*Hybognathus amarus**	2
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	20
76	*Rhinichthys cataractae*	24
81	*Carpiodes carpio*	5
212	*Gambusia affinis*	61

***Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-157**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 08 October 2015
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
M.A. Farrington, S.L. Clark Baralow, R. C. Keller Effort: 526.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	19
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	4
76	*Platygobio gracilis*	4
76	*Rhinichthys cataractae*	3
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	19
212	*Gambusia affinis*	10

*** *Hybognathus amarus* by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-156**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.
Site Number: 5 River Mile: 178.3 08 October 2015
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
M.A. Farrington, S.L. Clark Baralow, R. C. Keller Effort: 548.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Hybognathus amarus**	2
76	*Pimephales promelas*	7
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	14
212	*Gambusia affinis*	28

***Hybognathus amarus* by age class:**
age-0: 1
age-1: 1
age-2+:

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-155**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 07 October 2015
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 525.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	70
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	1

***Hybognathus amarus* by age class:**
age-0: 3
age-1:
age-2+:

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-154**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 07 October 2015
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 458.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	83
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	10
212	*Gambusia affinis*	17
294	*Pomoxis annularis*	1

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-153**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 07 October 2015
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 502.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	70
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	6
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	9

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-152**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 07 October 2015
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 487.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	63
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	1
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	129

***Hybognathus amarus* by age class:**
age-0: 1
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-151**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 07 October 2015
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 485.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	98
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	54

Hybognathus amarus **by age class:**

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

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-150**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 06 October 2015
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
J.L Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 545.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	32
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	3
76	*Platygobio gracilis*	15
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	16
212	*Gambusia affinis*	24

*** *Hybognathus amarus* by age class:**
age-0: 3
age-1:
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-149**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 06 October 2015
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
J.L Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 495.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	43
76	*Platygobio gracilis*	39
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	13

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-148**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 06 October 2015
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
J.L Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 530.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	32
76	*Platygobio gracilis*	6
93	*Ictalurus punctatus*	12
212	*Gambusia affinis*	3

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-147**
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 06 October 2015
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
J.L Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 483.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	8
76	*Hybognathus amarus**	3
76	*Platygobio gracilis*	5
93	*Ictalurus punctatus*	12
212	*Gambusia affinis*	1

**** Hybognathus amarus* by age class:**
age-0: 2
age-1: 1
age-2+:

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-146**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 06 October 2015
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
J.L Kennedy, S.L. Clark Barkalow, R.C. Keller Effort: 484.7 sq. m

FAMILY		N
212	*Gambusia affinis*	2

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-145**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 05 October 2015
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 0.0 sq. m

FAMILY		N
	Site Not Sampled (Site Dry)	

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-144**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 05 October 2015
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 499.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	2
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	3

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-143**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 05 October 2015
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 472.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	30
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	3

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-142**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 05 October 2015
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 561.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	24
76	*Platygobio gracilis*	3
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	35

Rio Grande Silvery Minnow Population Monitoring
October 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-141**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 05 October 2015
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 552.1 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	34
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	14
93	*Pylodictis olivaris*	1
212	*Gambusia affinis*	3

Rio Grande Silvery Minnow Population Monitoring
December 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-258**
Rio Grande, directly below Angostura Diversion Dam, Algodones.

Site Number: 1 River Mile: 209.7 04 December 2015
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
J.L. Kennedy, R.C. Keller, S.L. Clark Barkalow Effort: 592.3 sq. m

FAMILY		N
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	2
76	*Rhinichthys cataractae*	1
212	*Gambusia affinis*	1

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-259**
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo.

Site Number: 2 River Mile: 203.8 04 December 2015
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
J.L. Kennedy, R.C. Keller, S.L. Clark Barkalow Effort: 587.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	3
76	*Platygobio gracilis*	2
76	*Rhinichthys cataractae*	2
81	*Catostomus commersonii*	1
212	*Gambusia affinis*	2

***Hybognathus amarus* by age class:**

age-0: 3
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
December 2015

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage **RKD15-260**
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 04 December 2015
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
J.L. Kennedy, R.C. Keller, S.L. Clark Barkalow Effort: 627.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1
76	*Hybognathus amarus**	4
76	*Rhinichthys cataractae*	1
81	*Catostomus commersonii*	1
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	7

*** *Hybognathus amarus* by age class:**
age-0: 4
age-1:
age-2+:

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-257**
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.

Site Number: 4 River Mile: 183.4 04 December 2015
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
J.L. Kennedy, R.C. Keller, S.L. Clark Barkalow Effort: 625.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	2
76	*Platygobio gracilis*	23
93	*Ictalurus punctatus*	7

Rio Grande Silvery Minnow Population Monitoring
December 2015

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage **RKD15-256**
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque.

Site Number: 5 River Mile: 178.3 04 December 2015
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
J.L. Kennedy, R.C. Keller, S.L. Clark Barkalow Effort: 633.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1
76	*Hybognathus amarus**	10
76	*Platygobio gracilis*	3

**** Hybognathus amarus*** **by age class:**
age-0: 6
age-1: 4
age-2+:

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-255**
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas.

Site Number: 6 River Mile: 161.4 03 December 2015
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
J.L. Kennedy, R.C. Keller, E.I. Gilbert Effort: 578.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	5
76	*Hybognathus amarus**	19
76	*Platygobio gracilis*	11
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	2

**** Hybognathus amarus*** **by age class:**
age-0: 10
age-1: 7
age-2+: 2

Rio Grande Silvery Minnow Population Monitoring
December 2015

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-254**
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen.

Site Number: 7 River Mile: 151.5 03 December 2015
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
J.L. Kennedy, R.C. Keller, E.I. Gilbert Effort: 587.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	20
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	9
212	*Gambusia affinis*	1

***Hybognathus amarus* by age class:**
age-0: 1
age-1:
age-2+:

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage **RKD15-253**
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales.

Site Number: 8 River Mile: 143.2 03 December 2015
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
J.L. Kennedy, R.C. Keller, E.I. Gilbert Effort: 555.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	17
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	2
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	3

***Hybognathus amarus* by age class:**
age-0: 1
age-1:
age-2+:

Rio Grande Silvery Minnow Population Monitoring
December 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-252**
Rio Grande, at US HWY 60 bridge crossing, Bernardo.

Site Number: 9 River Mile: 130.6 03 December 2015
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
J.L. Kennedy, R.C. Keller, E.I. Gilbert Effort: 514.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	7
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	6
212	*Gambusia affinis*	4

Hybognathus amarus **by age class:**
age-0:
age-1: 1
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-251**
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo.

Site Number: 10 River Mile: 127.0 03 December 2015
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
J.L. Kennedy, R.C. Keller, E.I. Gilbert Effort: 573.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1
76	*Hybognathus amarus**	1

Hybognathus amarus **by age class:**
age-0:
age-1: 1
age-2+:

Rio Grande Silvery Minnow Population Monitoring
December 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-250**
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia

Site Number: 11 River Mile: 116.8 02 December 2015
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 625.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	4
76	*Hybognathus amarus**	1
76	*Platygobio gracilis*	135
93	*Ictalurus punctatus*	2

***Hybognathus amarus* by age class:**
age-0: 1
age-1:
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-249**
Rio Grande, directly below San Acacia Diversion Dam, San Acacia.

Site Number: 12 River Mile: 116.2 02 December 2015
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 545.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	8
76	*Hybognathus amarus**	46
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	47
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	27

***Hybognathus amarus* by age class:**
age-0: 31
age-1: 8
age-2+: 7

Rio Grande Silvery Minnow Population Monitoring
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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-248**
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.

Site Number: 13 River Mile: 114.6 02 December 2015
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 603.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	91
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	19
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	78
93	*Ictalurus punctatus*	51

**** Hybognathus amarus* by age class:**
age-0: 18
age-1: 1
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-247**
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 02 December 2015
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 595.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Hybognathus amarus**	60
76	*Platygobio gracilis*	20
93	*Ictalurus punctatus*	22
212	*Gambusia affinis*	4

**** Hybognathus amarus* by age class:**
age-0: 58
age-1: 2
age-2+:

Rio Grande Silvery Minnow Population Monitoring
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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-246**
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.

Site Number: 15 River Mile: 91.7 02 December 2015
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
W.H. Brandenburg, J.L. Kennedy, R.C. Keller Effort: 520.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	12
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	4
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	29

*** Hybognathus amarus* by age class:**
age-0: 11
age-1: 1
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-245**
Rio Grande, at US HWY 380 bridge crossing, San Antonio.

Site Number: 16 River Mile: 87.1 01 December 2015
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 649.0 sq. m

FAMILY		N
76	*Platygobio gracilis*	3
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	1

Rio Grande Silvery Minnow Population Monitoring
December 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-244**
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters.

Site Number: 17 River Mile: 79.1 01 December 2015
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 590.5 sq. m

FAMILY		N
76	*Hybognathus amarus**	4
76	*Platygobio gracilis*	5
93	*Ictalurus punctatus*	25

*** *Hybognathus amarus* by age class:**

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-243**
Rio Grande, at San Marcial Railroad Bridge, San Marcial.

Site Number: 18 River Mile: 68.6 01 December 2015
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 601.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	21
76	*Platygobio gracilis*	9
93	*Ictalurus punctatus*	8

Rio Grande Silvery Minnow Population Monitoring
December 2015

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-242**
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing

Site Number: 19 River Mile: 60.5 01 December 2015
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 559.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	7
76	*Hybognathus amarus**	27
76	*Pimephales vigilax*	5
76	*Platygobio gracilis*	7
93	*Ictalurus punctatus*	5

*** *Hybognathus amarus* by age class:**

age-0: 25
age-1: 2
age-2+:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage **RKD15-241**
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing

Site Number: 20 River Mile: 58.8 01 December 2015
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
R.K. Dudley, S.L. Clark Barkalow, R.C. Keller Effort: 533.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	62
76	*Hybognathus amarus**	20
76	*Pimephales vigilax*	11
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	44
212	*Gambusia affinis*	3

*** *Hybognathus amarus* by age class:**

age-0: 19
age-1: 1
age-2+: