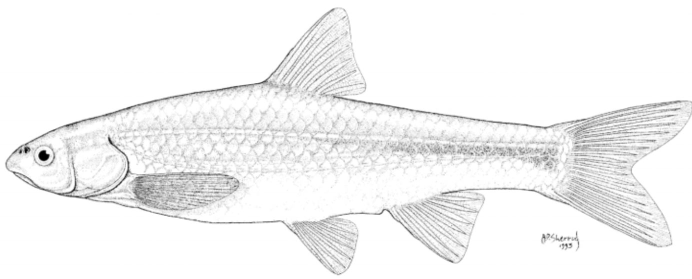
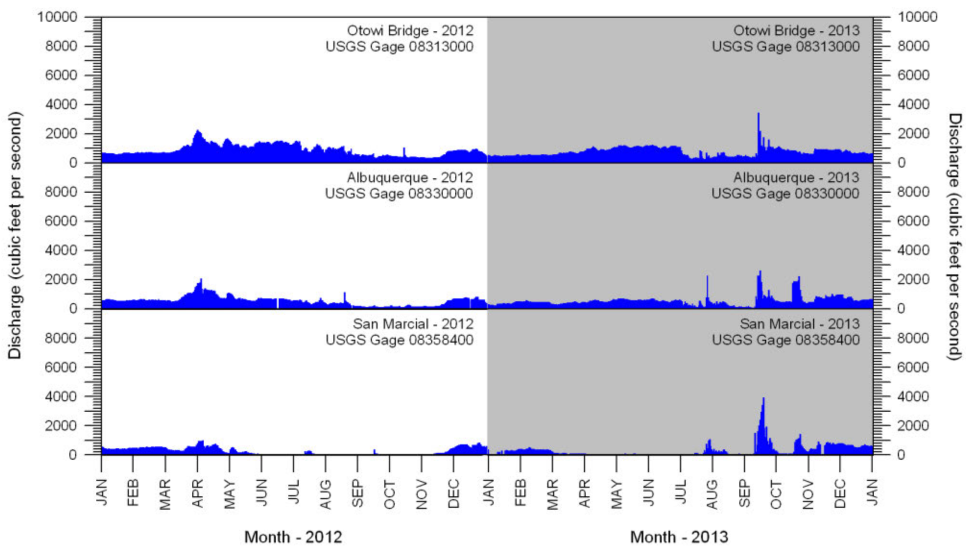
Rio Grande Silvery Minnow Population Monitoring Program Results from May to December 2013

A Middle Rio Grande Endangered Species Collaborative Program Funded Research Project





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EXECUTIVE SUMMARY

The abundance of Rio Grande Silvery Minnow has fluctuated widely over the past two decades (1993–2013). Mixture model density estimates ($E(x)$) for this imperiled species, using October sampling-site density data (i.e., fish per 100 m^2), were highest in 1995 (36.04) and 2005 (44.84) and lowest in 2002 (0.08) and 2012 (0.00). While these extremes indicated general periods of elevated or reduced abundance over time, there were exceptions to these trends where densities quickly declined and rebounded within a few years (e.g., 2005–2007). Most recently, the estimated densities of Rio Grande Silvery Minnow were significantly lower ($P < 0.05$) in 2010–2013 as compared with 2007–2009. Population monitoring efforts in 2013 yielded very few Rio Grande Silvery Minnow ($E(x) = 0.03$) from only three of the 20 sampling sites.

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 the period of study (1993–2013). The top model (δ[Year] μ[ABQ>2,000+random]) received 39% of the AIC_C weight (w_i) and had a scaled r^2 value of 0.63 ($P < 0.001$). The top four models, which accounted for most of the cumulative w_i (ca. 76%), were related to the interaction among μ and hydraulic variables representing elevated spring flows in the Angostura Reach. Although models relating 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. 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 period of study.

Modeled estimates of Rio Grande Silvery Minnow densities ($E(x)$) had reasonably narrow 95% confidence intervals when calculated using either the sampling-site density data (1993–2013) or the mesohabitat-specific density data (2002–2013). Encouragingly, the population trends generated from the mesohabitat-specific or sampling-site density data appear to be quite consistent even though they were measured on two widely different spatial scales. Further, an analysis of sampling variation across days (based on repeated sampling during November 2005–2013) revealed that sampling occasion was an insignificant effect and far less informative in explaining changes in the occurrence or density of Rio Grande Silvery Minnow over time as compared with year. Thus, it appears that the current sampling protocols are resulting in a reasonable level of sampling precision, especially when considering the substantial changes in both the distribution and abundance of Rio Grande Silvery Minnow across years.

Estimates of the probability of extinction for all age-classes were significantly higher ($P < 0.05$) in 2011 and 2012 as compared with 2005–2009. Similarly, there was recent but steady decline in site occupancy probability for all age-classes combined, from 0.91 in 2010 to 0.09 in 2013 with a significant decline ($P < 0.05$) from 2010–2011 to 2013. However, the probability of colonization was 0.15 for all age-classes combined since there were several colonization events in 2013 as compared with 2012 (hence the population was not extinct since there was a non-zero estimate of occupancy probability and colonization probability). Estimates of site occupancy indicated a precipitous decline (> 90%) in the number of sampling sites occupied by Rio Grande Silvery Minnow from 2005–2013.

The native ichthyofauna of the study area, in 2013, consisted of nine species (Red Shiner, Rio Grande Chub, Rio Grande Silvery Minnow, Fathead Minnow, Flathead Chub, Longnose Dace, River Carpsucker, Smallmouth Buffalo, and Bluegill). Red Shiner was the most abundant native species collected (n = 25,919), followed by Fathead Minnow (n = 3,948), River Carpsucker (n = 1,648), Flathead Chub (n = 1,228), and Longnose Dace (n = 1,155). Rio Grande Silvery Minnow (n = 354) was collected throughout the year but was most abundant in December (n = 278) following November stocking efforts. Rio Grande Chub and Bluegill were the least abundant native fishes (n = 1 for each species). The most abundant introduced species were Western Mosquitofish (n = 6,594), Channel Catfish (n = 1,070), Common Carp (n = 903), and White Sucker (n = 887).

While the rank abundance of Rio Grande Silvery Minnow during October increased notably from 2006 (4^{th}) to 2007–2009 (2^{nd}), it dropped again in 2010 (5^{th}). In 2012–2013, Rio Grande Silvery Minnow rank abundance decreased (10^{th}) as compared with 2011 (4^{th}). The coefficient of concordance (W = 0.71) for the ten focal species indicated high overall agreement among ranks over time (2004–2013; X^2=

63.8; $P < 0.001$) despite large changes in ranks for some taxa (e.g., Rio Grande Silvery Minnow and Fathead Minnow).

Density of all fish species generally increased during spring or summer. However, Rio Grande Silvery Minnow abundance steadily declined from May to October, indicating negligible spawning or recruitment in 2013. In contrast, other focal species typically reached their highest densities from June to September, following spawning. An accounting of species-specific temporal abundance revealed similar trends and documented the seasonal occurrence of certain taxa (e.g., Smallmouth Buffalo and Yellow Bullhead).

In addition to temporal variation in the relative abundance of fish species within the community, there were also longitudinal changes in the densities of species among reaches. Flathead Chub, Longnose Dace, River Carpsucker, White Sucker, and Channel Catfish were most common in the Angostura Reach. The most common species in the Isleta Reach included Red Shiner, Fathead Minnow, and Western Mosquitofish. Common Carp and Rio Grande Silvery Minnow were most common in the San Acacia Reach.

Multiple dramatic increases and decreases in the abundance of Rio Grande Silvery Minnow over the past two decades (e.g., increases in excess of 10,000% or decreases in excess of 99% over a few years) 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 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 the successful recruitment of Rio Grande Silvery Minnow by prolonging the persistence of warm and productive nursery habitats required by larval fishes to complete their early life history. However, the extensive river channelization, habitat degradation, abandonment of the floodplain, and associated reductions in water turbidity downstream of Cochiti Dam are limiting the amount of appropriate habitat available for the successful retention and early recruitment of Rio Grande Silvery Minnow, especially in the Cochiti and Angostura reaches.

The extremely low densities of Rio Grande Silvery Minnow in 2012 and 2013 appear to indicate that current management efforts (e.g., stocking, salvage, habitat restoration, flow manipulation etc.) are not sufficiently buffering the population against substantial declines. Several drought years in sequence (e.g., similar to what occurred during 2002–2003) have provided the natural experiment necessary to glean insight into just how much current management efforts are buffering against potentially catastrophic population declines during periods of extended low flows. While ongoing management efforts appear to be providing invaluable protection against extinction, it appears that additional efforts (e.g., providing adequate annual spring and summer flows for successful autumnal recruitment) will be required to yield self-sustaining populations of Rio Grande Silvery Minnow in the Middle Rio Grande over time. Additionally, securing the long-term persistence of Rio Grande Silvery Minnow in the wild will likely depend on attaining self-sustaining populations at multiple locations within its current and 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.

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 and Platania, 2013a). 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 May to December 2013 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, 1995) 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 2012 and 2013, 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 relatively low in 2012 and 2013. During May and June 2013, flows were particularly low in the San Acacia Reach. Peak flows in 2013 occurred during July and September. Flow conditions in 2012 and 2013 included periods of very low discharge from July through October, which were interrupted by elevated flows from summer rains. As compared with the generalized historical spring runoff (based on mean daily discharge values from 1973 [Cochiti Dam operational] to 2013), the timing of this event was early in 2012 and typical (though very low) in 2013, the flow magnitude was low in both 2012 and 2013, and the duration was highly truncated in both years.

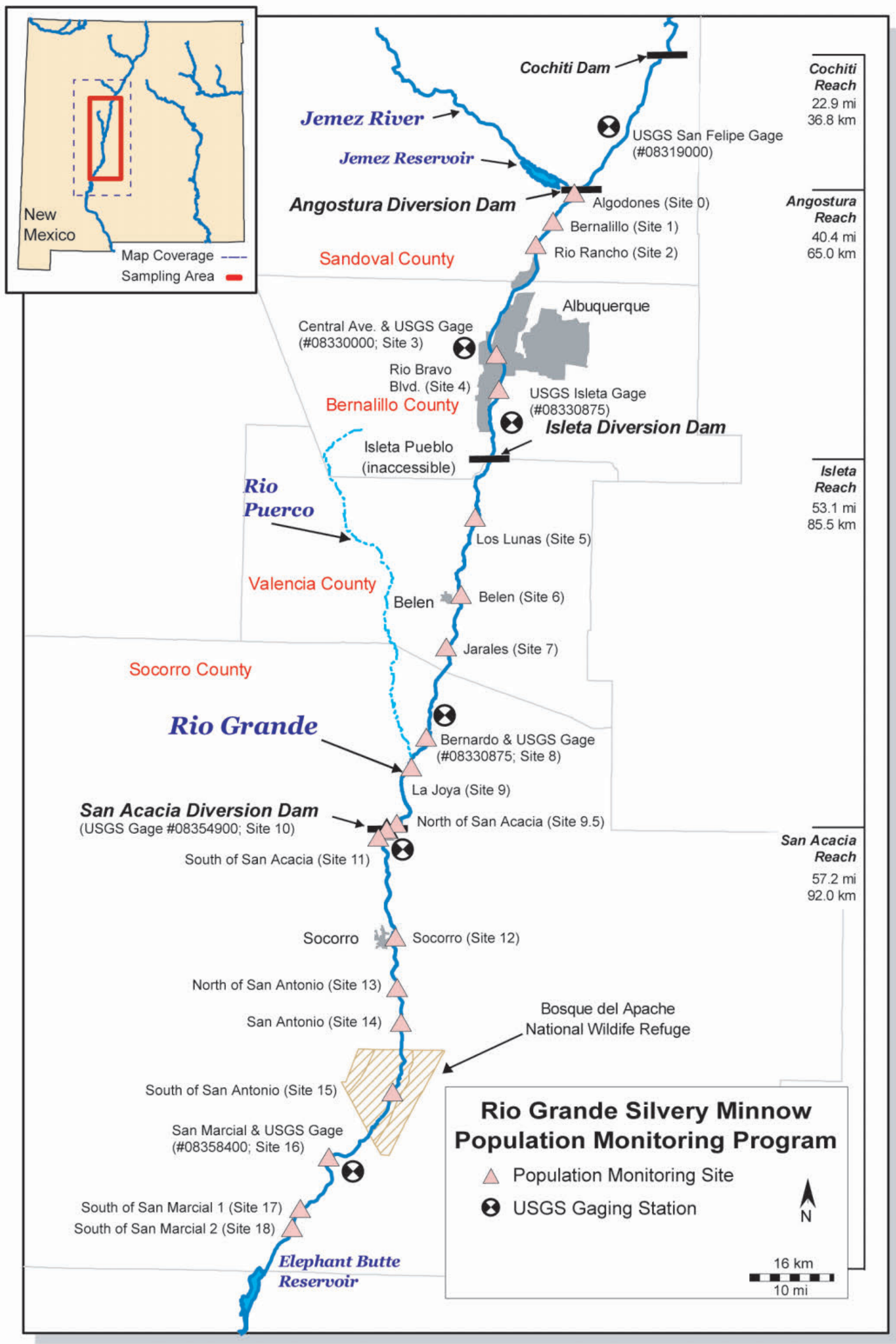

Figure 1. Map of the study area and sampling sites (numbered) for the May to December 2013 Rio Grande Silvery Minnow population monitoring program. Sampling site information and detailed maps are provided in Appendix A.

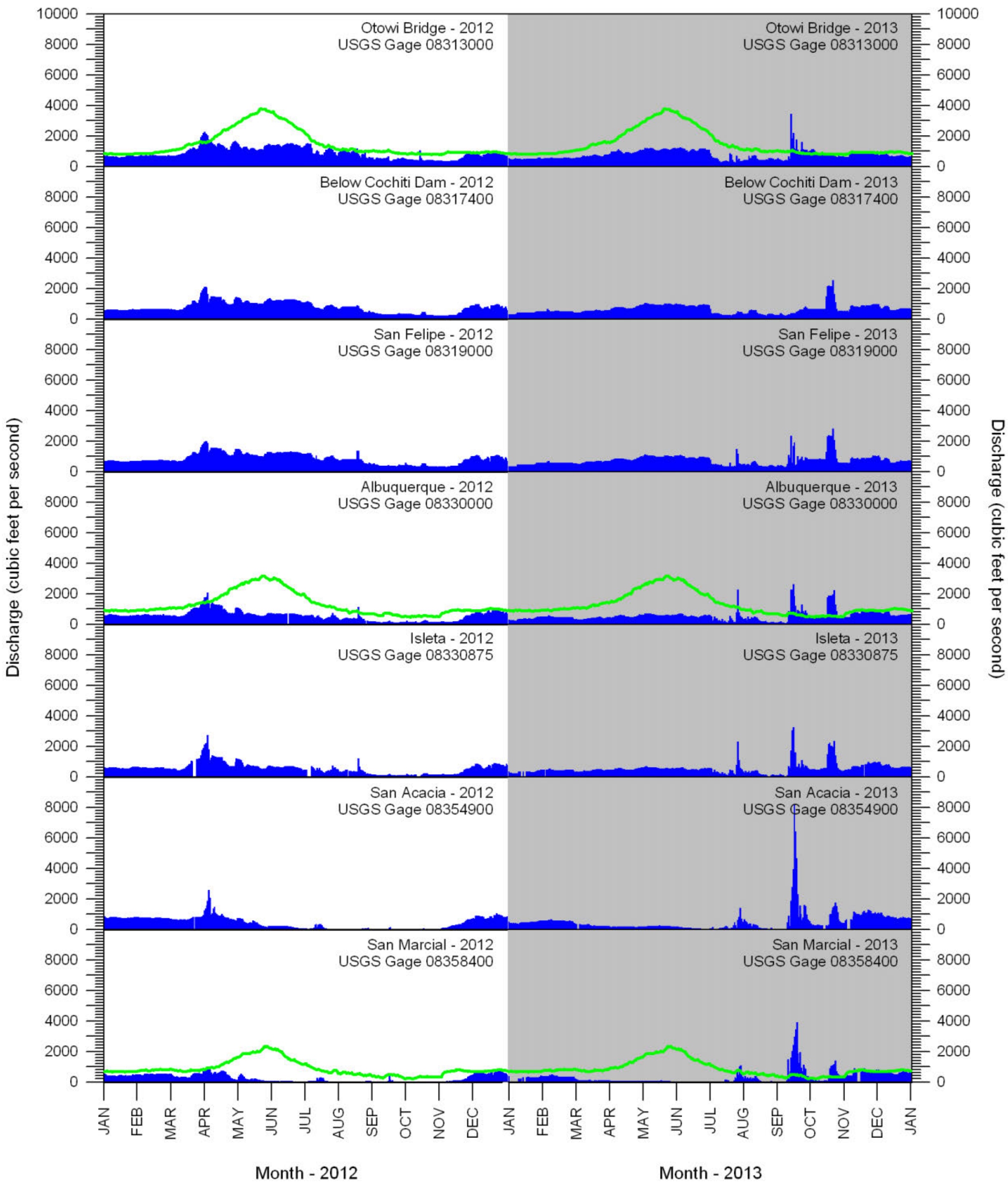

Figure 2. Discharge in the Rio Grande from January 2012 through December 2013 as recorded at seven U.S. Geological Survey (USGS) gaging stations. Solid green lines are historical mean daily discharge values (from 1973 [Cochiti Dam operational] through 2013) from the upper, middle, and lower portions 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 allowed for determination of general spatial and temporal changes in population structure and species abundance. Sampling was conducted monthly from May to October 2013 and also in December 2013. Additional repeated sampling was conducted during November (2013) 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 (May to October) to 20 (December) discrete mesohabitats (< 15 m long). Runs and shoreline pools were sampled four times at each site (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 May 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 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 2013-only 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 (1993–2013) were analyzed using PROC NLMIXED (SAS, 2013), 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 (δ = probability of occurrence, μ = mean of the lognormal density distribution, σ = standard deviation of the lognormal density distribution, and $E(x)$ = estimated density).

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 (1993–2013) 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], 3,000 [ABQ>3,000], and 4,000 [ABQ>4,000] cubic feet per second, cfs) represented the typical range of spring runoff conditions (May–June). 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) 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.

Table 1. Scientific and common names and species codes of fish collected in the Middle Rio Grande from 1993 to 2013.

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 2013 (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.

Random effects models 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.

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. A scaled r^2 value was calculated based on methods outlined in Nagelkerke (1991). Differences between the null model and the alternative models were assessed using a log-likelihood ratio goodness-of-fit test (Zar, 2010).

Rio Grande Silvery Minnow detailed density data during October (i.e., using mesohabitat-specific sampling data from each of the sites), have been available since 2002. Thus, the sampling unit for this analysis was mesohabitat type (e.g., all backwaters at a site) whereas the sampling unit for the long-term analysis (1993–2013) was site. Rio Grande Silvery Minnow mesohabitat-specific density data from October (2002–2013) were analyzed using PROC NLMIXED (SAS, 2013), using the same methods outlined previously, to generate parameter estimates and assess differences among models. A simplified list of mesohabitats (i.e., combining main and side channel samples, coding debris piles as pools, and coding riffles as runs) was used for the purpose of statistical analysis. General linear models were used to incorporate covariates to model δ, μ, and σ. Covariates considered to model detailed density data during October were year (Year) and mesohabitat (Mesohabitat). Additionally, both additive and multiplicative effects were considered for single combinations of the year covariate (i.e., Year+Mesohabitat and Year*Mesohabitat).

Sampling variation was evaluated using sampling-site density data from repeated sampling efforts at each of the 20 sites during November (2005–2013). For the repeated sampling effort, sites were sampled once per day for four days (i.e., 80 site samples per year), using regular population monitoring sampling protocols. Fish samples were taken at the same or similar locations on subsequent days. Sampling-site density data from repeated sampling were analyzed using PROC NLMIXED (SAS, 2013), using the same methods outlined previously, to generate parameter estimates and assess differences among models. General linear models were used to incorporate covariates to model δ, μ, and σ. Covariates considered to model detailed density data during November were year (Year) and sampling occasion (Occasion; the 1st, 2nd, 3rd, or 4th day of sampling). Additionally, both additive and multiplicative effects were considered for single combinations of the year covariate (i.e., Year+Occasion and Year*Occasion).

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 May to December 2013 abundance of Rio Grande Silvery Minnow at reach-specific sampling sites varied within and among seasons. Density of this species also varied noticeably within and among sampling reaches (Figures 3 and 4; Table 2). Large numbers of Rio Grande Silvery Minnow (n = 278) were collected in the San Acacia Reach during December 2013 (although most were recently stocked individuals). The density of age-0 Rio Grande Silvery Minnow did not increase following spring spawning and the abundance of this species dropped rapidly from July to October 2013. Post-spawning densities (June–October) of age-0 individuals were exceptionally low in all three sampling reaches.

Densities of Rio Grande Silvery Minnow from May to December 2013 were generally highest in the Isleta and San Acacia reaches. The San Acacia Reach yielded the most individuals (n = 256) (Figure 5), followed by the Angostura Reach (n = 66), and the Isleta Reach (n = 32). Age-0 individuals composed a modest proportion of the monthly totals from June through October (Figure 6).

Population trends (1993–2013)

Rio Grande Silvery Minnow estimated densities ($E(x)$), using October sampling-site density data (1993–2013), were generated from the year model (δ[Year] µ[Year]). Estimated densities were highest in 1995 (36.04) and 2005 (44.84) and lowest in 2002 (0.08) and 2012 (0.00). The estimated densities of Rio Grande Silvery Minnow were significantly lower ($P < 0.05$) in 2010–2013 as compared with 2007–2009 (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 2013 yielded very few Rio Grande Silvery Minnow ($E(x) = 0.03$). 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 (1993–2013). Estimates of δ increased with maximum discharge, number of days with discharge exceeding a threshold value, 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 (Figure 9) 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 (1993–2013; Table 3). The top model (δ[Year] µ[ABQ>2,000+random]) received 39% of the AIC_C weight (w_i) and had a scaled r^2 value of 0.63 ($P < 0.001$). The top four models, which accounted for most of the cumulative w_i (ca. 76%), 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 lower cumulative values of w_i. Although models relating to the interactions among δ and hydraulic variables received lower values of w_i, the two top models both 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 period of study.

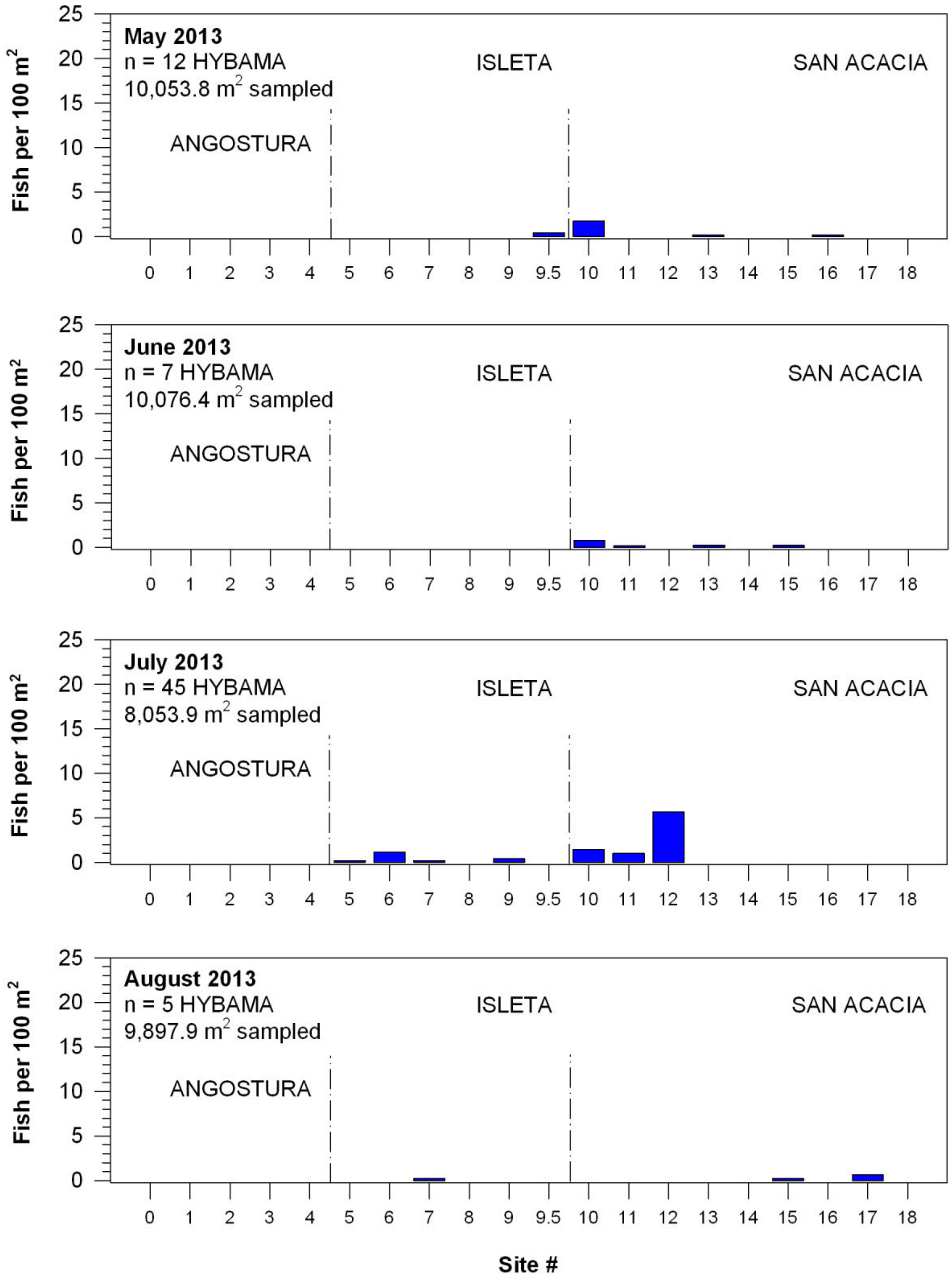

Figure 3. Rio Grande Silvery Minnow densities from May to August 2013 for each sampling site in the Middle Rio Grande.

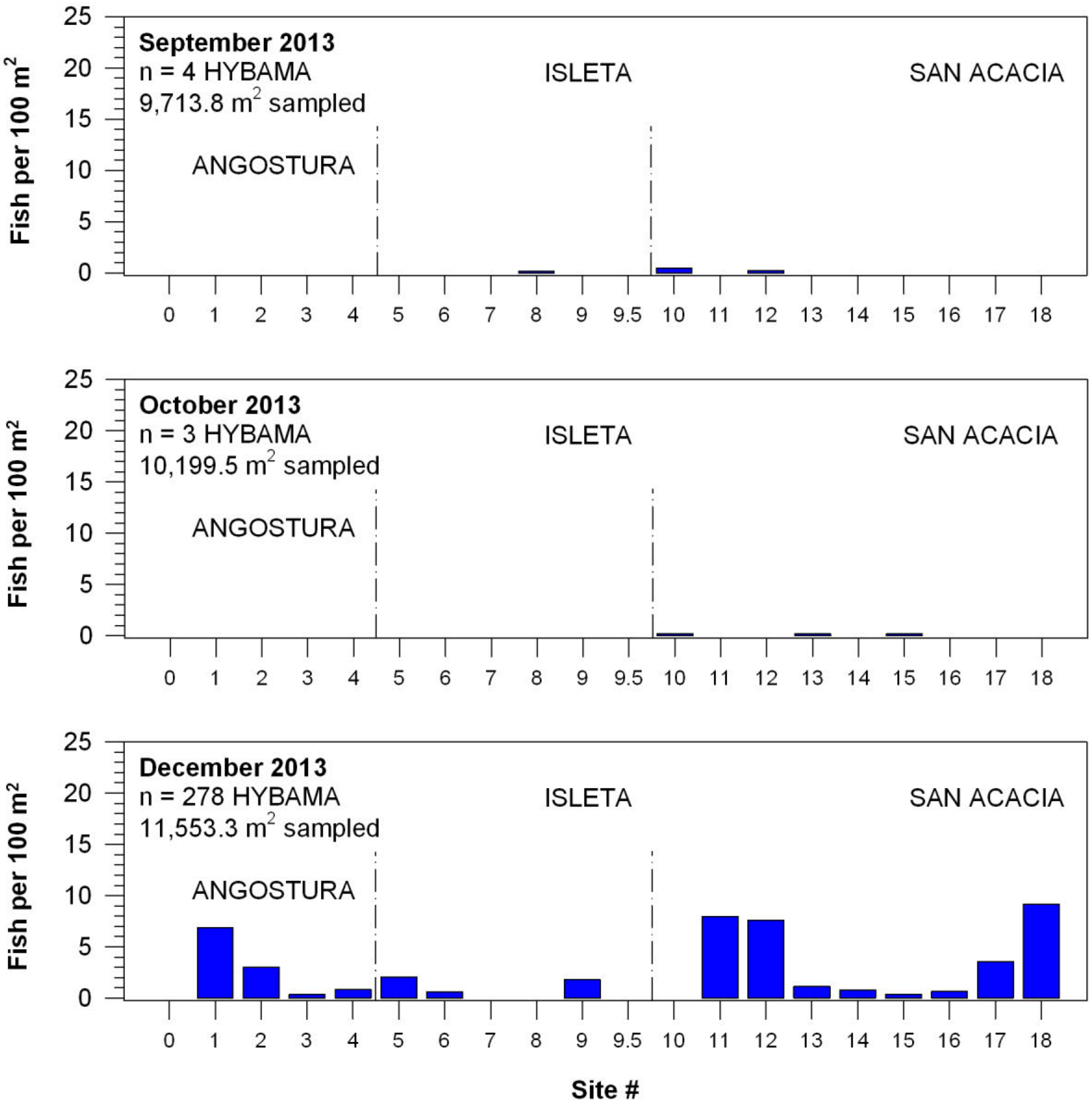

Figure 4. Rio Grande Silvery Minnow densities from September to December 2013 for each sampling site in the Middle Rio Grande.

Table 2. Summary of the monthly catch of Rio Grande Silvery Minnow, by site and reach, from May to December 2013. All marked individuals at a site are shown in parentheses (subset of the total).

REACH	SITE #	SITE NAME	MAY	JUN	JUL	AUG	SEP	OCT	DEC	TOTAL
Angostura	0	Angostura Dam	-	-	-	-	-	-	-	0
Angostura	1	Bernalillo	-	-	-	-	-	-	42(42)	42
Angostura	2	Rio Rancho	-	-	-	-	-	-	17(17)	17
Angostura	3	Central Ave.	-	-	-	-	-	-	2(2)	2
Angostura	4	Rio Bravo Blvd.	-	-	-	-	-	-	5(5)	5
Angostura Totals			0	0	0	0	0	0	66	66
Isleta	5	Los Lunas	-	-	1(1)	-	-	-	11(11)	12
Isleta	6	Belen	-	-	1(0)	-	-	-	3(3)	4
Isleta	7	Jarales	-	-	1(1)	1(0)	-	-	-	2
Isleta	8	Bernardo	-	-	-	-	1(0)	-	-	1
Isleta	9	La Joya	-	-	2(2)	-	-	-	9(9)	11
Isleta	9.5	North of San Acacia	2(2)	-	-	-	-	-	-	2
Isleta Totals			2	0	5	1	1	0	23	32
San Acacia	10	San Acacia Dam	8(8)	4(4)	7(6)	-	2(0)	1(0)	-	22
San Acacia	11	South of San Acacia	-	1(1)	5(5)	-	-	-	51(51)	57
San Acacia	12	Socorro	-	-	28(28)	-	1(0)	-	46(41)	75
San Acacia	13	North of San Antonio	1(1)	1(0)	-	-	-	1(0)	7(7)	10
San Acacia	14	San Antonio	-	-	-	-	-	-	5(5)	5
San Acacia	15	South of San Antonio	-	1(0)	-	1(1)	-	1(0)	2(2)	5
San Acacia	16	San Marcial	1(1)	-	-	-	-	-	4(4)	5
San Acacia	17	South of San Marcial 1	-	-	-	3(0)	-	-	20(19)	23
San Acacia	18	South of San Marcial 2	-	-	-	-	-	-	54(54)	54
San Acacia Totals			10	7	40	4	3	3	189	256
MONTHLY TOTALS			**12**	**7**	**45**	**5**	**4**	**3**	**278**	**354**

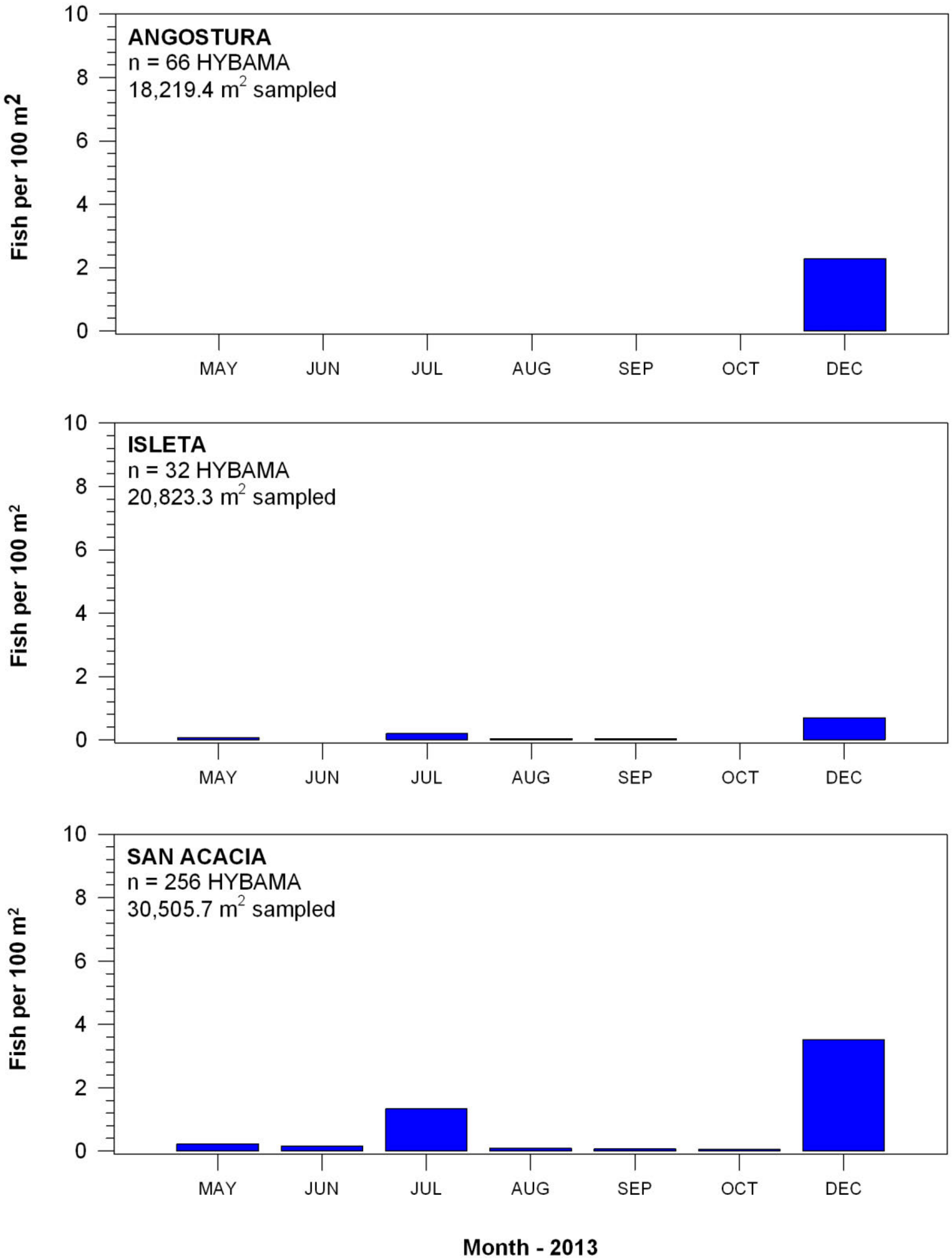

Figure 5. Rio Grande Silvery Minnow densities from May to December 2013 for each sampling site in the Middle Rio Grande.

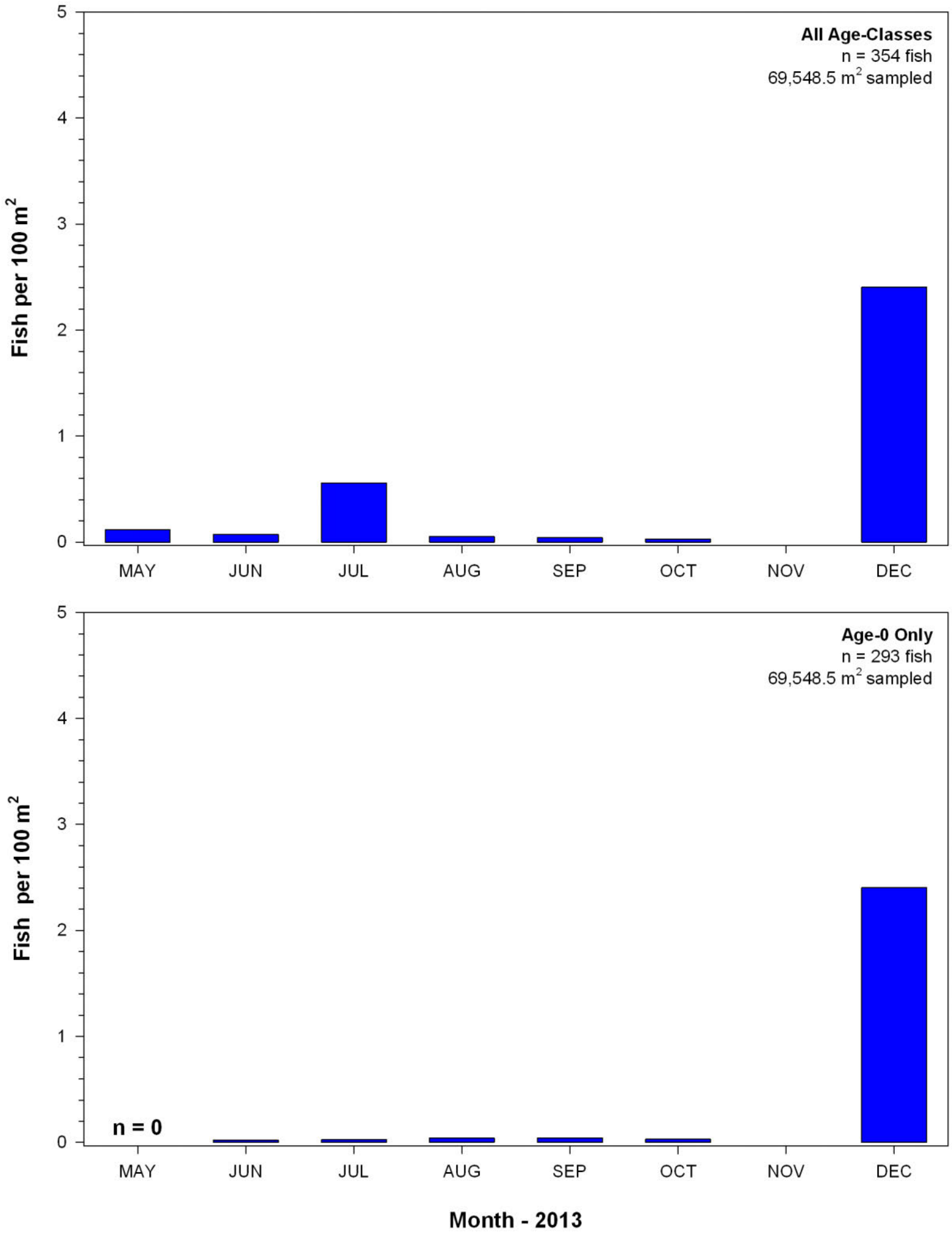

Figure 6. Inter-month fluctuations in densities of Rio Grande Silvery Minnow from May to December 2013 (A = all age-classes; B = age-0 only).

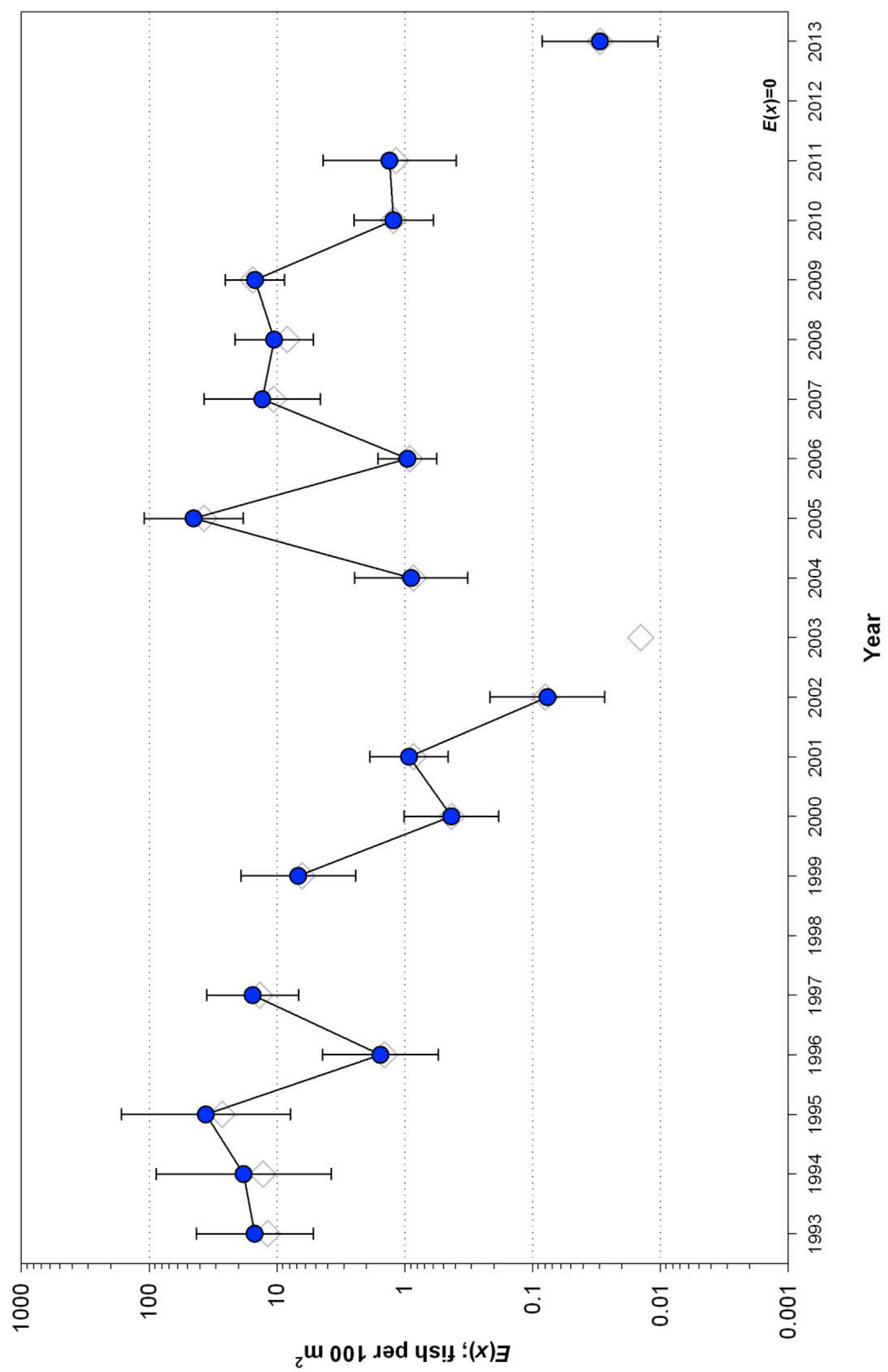

Figure 7. Rio Grande Silvery Minnow mixture-model (δ[Year] μ[Year]) estimates of density ($E(x)$), using October sampling-site density data (1993–2013). Solid circles indicate modeled estimates and bars represent 95% confidence intervals. Dotted horizontal lines represent orders of magnitude. Gray diamonds indicate simple estimates of mean densities using the method of moments.

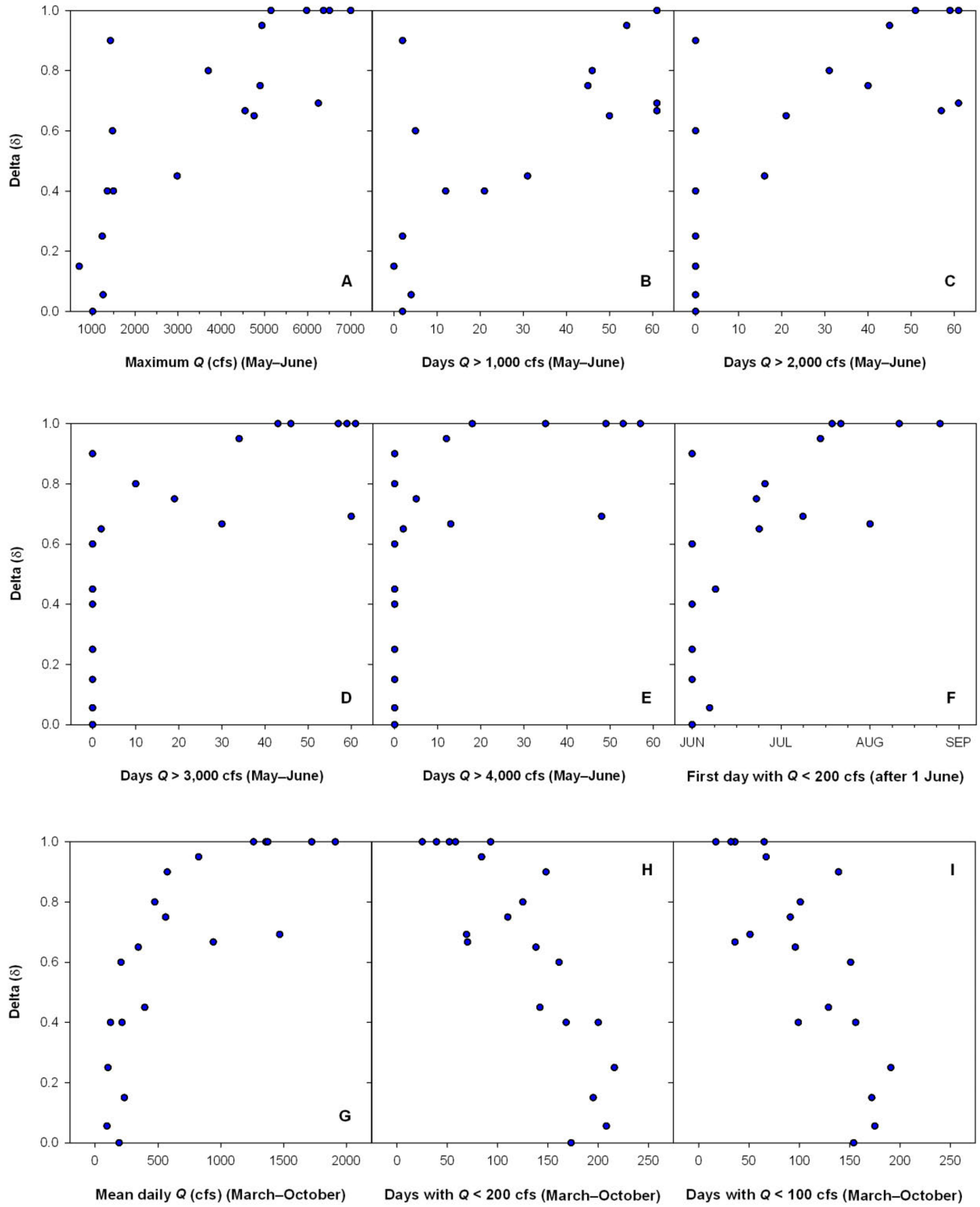

Figure 8. Bivariate relationships among Rio Grande Silvery Minnow estimates of the probability of occurrence (δ), using October sampling-site density data (1993–2013), and hydraulic variables for USGS Gage #08330000 (Figures A–E) and USGS Gage #08358400 (Figures F–I).

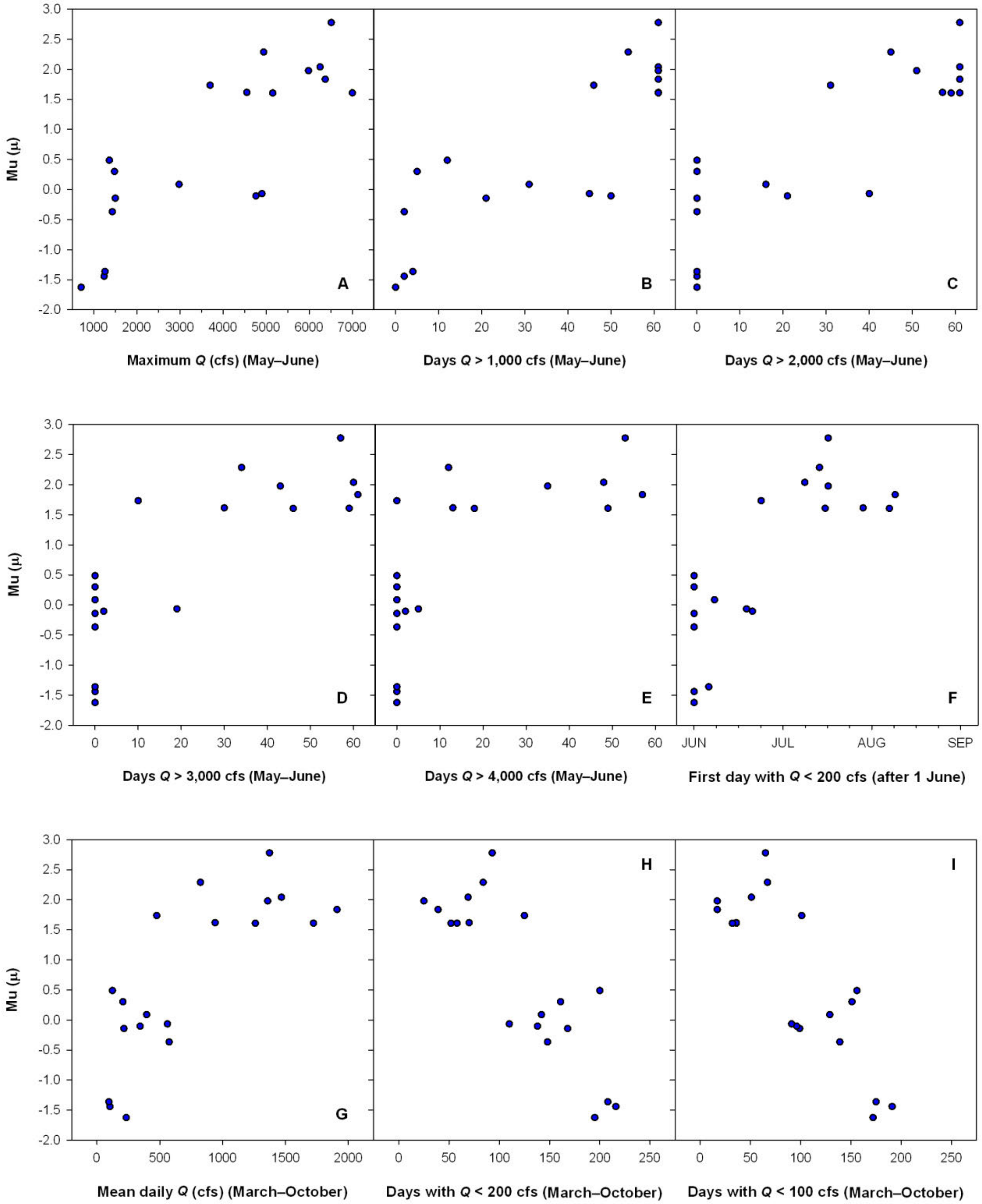

Figure 9. Bivariate relationships among Rio Grande Silvery Minnow estimates of the mean of the lognormal distribution (µ), using October sampling-site density data (1993–2013), and hydraulic variables for USGS Gage #08330000 (Figures A–E) and USGS Gage #08358400 (Figures F–I).

Table 3. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using October sampling-site density data (1993–2013) and different hydraulic variables (allowing for random effects). 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>2,000+random)	625.69	25	681.87	0.3932
δ(Year) µ(ABQ>3,000+random)	627.40	25	683.58	0.1677
δ(Year) µ(ABQ>1,000+random)	627.81	25	683.99	0.1367
δ(Year) µ(ABQmax+random)	629.51	25	685.69	0.0582
δ(Year) µ(SAN<100+random)	629.77	25	685.95	0.0512
δ(Year) µ(SAN<200+random)	630.30	25	686.48	0.0393
δ(Year) µ(SAN1st day<200+random)	630.37	25	686.55	0.0380
δ(Year) µ(SANmean+random)	630.48	25	686.66	0.0359
δ(SANmean+random) µ(ABQ>2,000+random)	669.92	9	688.43	0.0149
δ(SAN<200+random) µ(ABQ>2,000+random)	670.27	9	688.78	0.0124

[1] = Model variables included sampling year during October (1993–2013) and various 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

Mesohabitats sampled in the Middle Rio Grande were classified during field sampling and given unique codes to identify their hydraulic features (Table 4). The percent frequency of mesohabitats sampled was similar among reaches during 2013, although there were a few exceptions (Figure 10). For example, backwaters were more commonly sampled in the Isleta Reach while side channel shoreline runs were more commonly sampled in the Angostura Reach. The actual mesohabitats occupied by Rio Grande Silvery Minnow were diverse and included all of the mesohabitat types sampled, with the exception of riffles and side channel pools. Mesohabitats most frequently used by Rio Grande Silvery Minnow (relative to those sampled) included main and side channel shoreline runs. In the Isleta Reach, there was a pronounced use of backwaters relative to what was sampled. However, the relatively low numbers of samples with Rio Grande Silvery Minnow preclude more definitive insights to their mesohabitat associations in 2013

General linear models of Rio Grande Silvery Minnow mixture-model estimates, using October mesohabitat-specific density data (2002–2013), revealed that variation in δ and μ was reliably predicted by differences among years and mesohabitats (Table 5). The top model (δ[Year+Mesohabitat] μ[Year+Mesohabitat]: AIC_C = 1,410.25) 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 mesohabitat (δ[Year*Mesohabitat] μ[Year*Mesohabitat]: AIC_C = 1,534.28) was far more informative in explaining changes in model parameter values over time as compared with the simple year model (δ[Year] μ[Year]: AIC_C = 1,600.55). A likelihood ratio test indicated that the mesohabitat effect was significant ($P < 0.001$).

Rio Grande Silvery Minnow mesohabitat-specific density data during October (2002–2013) were also used to generate density estimates ($E(x)$) for different mesohabitats. Population trends in the five mesohabitats (BW, PO, SHPO, SHRU, and RU) were quite similar over the period of study (Figure 11). Also, simple estimates of mean densities, using the method of moments, were very similar to estimated densities for different mesohabitats over time. The highest estimated densities ($E(x)$) were observed in 2005 for all mesohabitats but showed a steady decline over time; mesohabitat-specific densities were significantly lower ($P < 0.05$) in 2010–2013 as compared with 2007–2009 in nearly all cases. However, densities in low velocity mesohabitats (BW, PO, and SHPO) were generally more variable and resulted in fewer significant differences among years as compared to higher velocity mesohabitats (RU and SHRU). Also, densities for some mesohabitat/year combinations (e.g., BW in 2003) could not be estimated when there was only a single non-zero density value recorded, which precluded mixture-model estimation of σ. The simple mesohabitat model (δ[Mesohabitat] μ[Mesohabitat]) revealed that overall estimated densities in BW (48.10) and SHPO (13.80) were significantly higher (P < 0.05) than in SHRU (3.20) and RU (1.20).

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 (2005–2013), revealed that variation in δ and μ was reliably predicted by differences among years but not by sampling occasion (Table 6). The top model (δ[Year] μ[Year]: AIC_C = 1,295.66) received nearly 95% of the AIC_C weight while the next most informative model (δ[Year] μ[Year+Occasion]: AIC_C = 1,302.22) received considerably less weight (ca. 4%). A comparison of AIC_C values revealed that sampling occasion (δ[Year*Occasion] μ[Year*Occasion]: AIC_C = 1,387.15) was far less informative in explaining changes in model parameter values over time as compared with the simple year model (δ[Year] μ[Year]: AIC_C = 1,295.66). A likelihood ratio test indicated that the sampling occasion effect was not significant ($P = 0.75$).

Table 4. Codes used for mesohabitat type classification in the Middle Rio Grande.

Mesohabitat Types	
Primary	
MC	Main channel- the section of the river which carries the majority of the flow; there can be only one main channel.
SC	Secondary channel- all channels not designated as the main channel; there can be zero or several secondary channels at a site.
BW	Backwater- a body of water, connected to the main channel, with no appreciable flow; often created by a drop in flow which partially isolates a former channel.
DE	Debris piles- any habitat that has associated organic cover (e.g., grasses, woody vegetation etc.).
RI	Riffle- a shallow and high velocity habitat where the water surface is irregular and broken by waves; generally indicates gravel-cobble substrata.
Secondary	
SH	Shoreline- usually a shallower, lower velocity area that is adjacent to shore. This designation precedes other secondary mesohabitat types (e.g., MCSHRU= main channel shoreline run or SCSHPO= side channel shoreline pool).
PO	Pool- the portion of the river with very little velocity compared to the rest of the river channel (e.g., downstream of islands, instream sand dunes, debris piles, or shoreline peninsulas).
RU	Run- a reach of relatively fast velocity water with laminar flow and a non-turbulent surface.

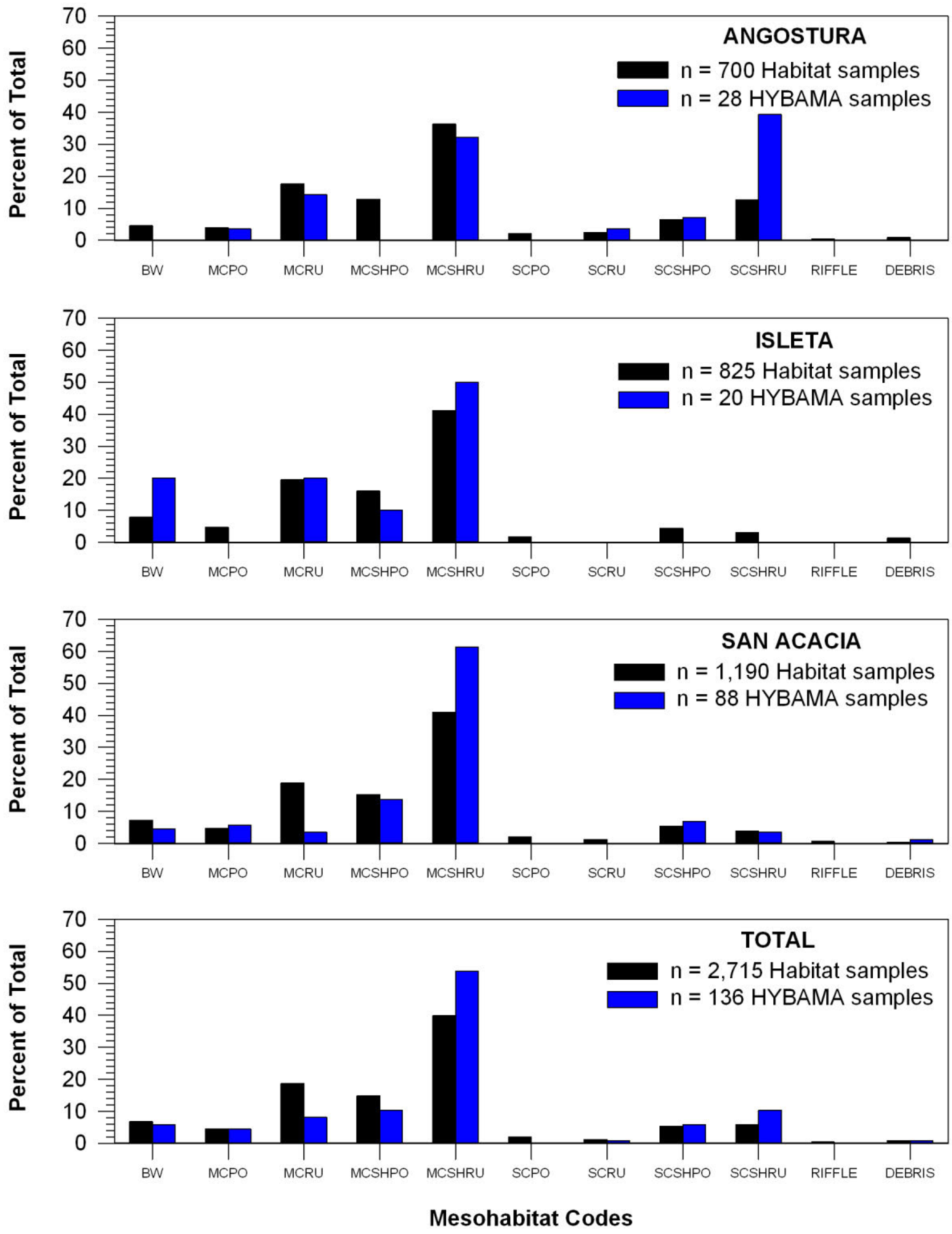

Figure 10. Percent total of mesohabitats (see Table 4 for codes) sampled and those occupied by Rio Grande Silvery Minnow in the Middle Rio Grande as part of population monitoring from May to December 2013 for each river reach and the annual total.

Table 5. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using October mesohabitat-specific density data (2002–2013). 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)	1,302.77	51	1,410.25	0.9982
δ(Year) µ(Year+Mesohabitat)	1,326.41	46	1,422.85	0.0018
δ(Year*Mesohabitat) µ(Year*Mesohabitat)	1,158.79	180	1,534.28	<0.0001
δ(Year+Mesohabitat) µ(Mesohabitat)	1,483.75	27	1,539.27	<0.0001
δ(Year) µ(Mesohabitat)	1,505.97	22	1,550.98	<0.0001
δ(Year) µ(Year)	1,527.93	36	1,600.55	<0.0001
δ(Year) µ(.)	1,664.16	14	1,692.58	<0.0001
δ(Mesohabitat) µ(Year+Mesohabitat)	1,855.68	39	1,936.86	<0.0001
δ(Mesohabitat) µ(Mesohabitat)	2,026.84	15	2,056.95	<0.0001
δ(.) µ(Mesohabitat)	2,040.01	11	2,062.27	<0.0001

[1] = Model variables included year (2002–2013) and mesohabitat (backwater, pool, run, shoreline pool, and shoreline run)
[2] = -2[log-likelihood] of the model
[3] = Number of parameters in the model

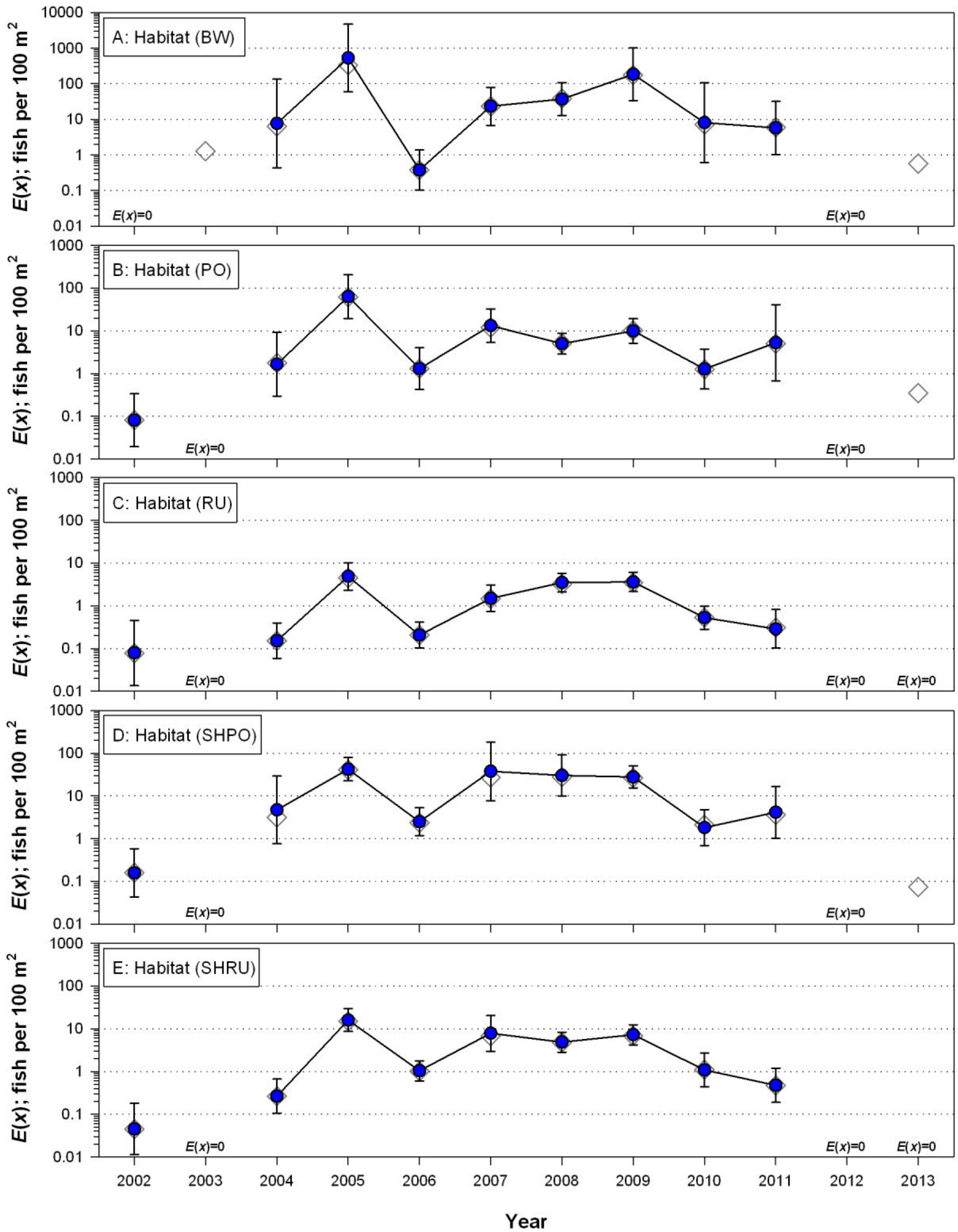

Figure 11. Rio Grande Silvery Minnow mixture-model (δ[Year*Mesohabitat] μ[Year*Mesohabitat]) estimates of density ($E(x)$) by mesohabitat, using October mesohabitat-specific density data (2002–2013). Solid circles indicate modeled estimates and bars represent 95% confidence intervals. Dotted horizontal lines represent orders of magnitude. Gray diamonds indicate simple estimates of mean densities using the method of moments.

Table 6. General linear models of Rio Grande Silvery Minnow mixture-model estimates, using sampling-site density data during repeated sampling in November (2005–2013). 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)	1,241.55	27	1,295.66	0.9485
δ(Year) µ(Year+Occasion)	1,228.53	35	1,302.22	0.0357
δ(Year+Occasion) µ(Year)	1,239.15	31	1,304.03	0.0144
δ(Year+Occasion) µ(Year+Occasion)	1,226.13	39	1,308.72	0.0014
δ(Year*Occasion) µ(Year*Occasion)	1,169.47	108	1,387.15	<0.0001
δ(Year) µ(.)	1,522.54	11	1,546.98	<0.0001
δ(Year+Occasion) µ(Occasion)	1,512.76	21	1,556.09	<0.0001
δ(Year) µ(Occasion)	1,515.16	17	1,558.49	<0.0001
δ(.) µ(Year)	1,646.72	19	1,685.81	<0.0001
δ(Occasion) µ(Year)	1,645.59	22	1,691.04	<0.0001

1 = Model variables included year (2005–2013) 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

Fish Community

Population status

The ichthyofaunal community in the Middle Rio Grande between Angostura Diversion Dam and Elephant Butte Reservoir was numerically dominated by cyprinids (Table 7; Appendix D). The native ichthyofauna consisted of nine species (Red Shiner, Rio Grande Chub, Rio Grande Silvery Minnow, Fathead Minnow, Flathead Chub, Longnose Dace, River Carpsucker, Smallmouth Buffalo, and Bluegill). Red Shiner was the most abundant native species collected (n = 25,919), followed by Fathead Minnow (n = 3,948), River Carpsucker (n = 1,648), Flathead Chub (n = 1,228), and Longnose Dace (n = 1,155). Rio Grande Silvery Minnow (n = 354) was collected throughout the year but was most abundant in December (n = 278) following November stocking efforts. Rio Grande Chub and Bluegill were the least abundant native fishes (n = 1 for each species). The most abundant introduced species were Western Mosquitofish (n = 6,594), Channel Catfish (n = 1,070), Common Carp (n = 903), and White Sucker (n = 887). The six remaining nonnative fish species were present at much lower numbers (n < 100 for each taxon).

Rio Grande Silvery Minnow composed a higher fraction of the total ichthyofaunal community from 2007–2009 than from 2010–2013. While this percentage had dropped precipitously from 1995 to 2000 and remained low through 2004, it improved dramatically in 2005 (Figure 12). There were, however, notable declines from 2005 to 2006 and from 2009 to 2010.

The magnitude of change in the relative abundance of Rio Grande Silvery Minnow during October was particularly evident when compared to other focal species over the past decade (Table 8). For example, Rio Grande Silvery Minnow had increased from being the 5th most common focal species in 2004 to being the most common focal species in 2005. While the rank abundance of Rio Grande Silvery Minnow increased notably from 2006 (4th) to 2007–2009 (2nd), it dropped again in 2010 (5th). In 2012–2013, Rio Grande Silvery Minnow rank abundance was low (10th) as compared with 2011 (4th). The coefficient of concordance (W = 0.71) for the ten focal species indicated high overall agreement among ranks over time (2004–2013; X^2= 63.8; P < 0.001) despite large changes in ranks for some taxa (e.g., Rio Grande Silvery Minnow and Fathead Minnow).

There were notable seasonal changes in the relative abundance of the 10 focal fish species from May to December 2013 (Figures 13 and 14). Density of all fish species generally increased during spring or summer. However, Rio Grande Silvery Minnow abundance steadily declined from May to October, indicating negligible spawning or recruitment in 2013. In contrast, other focal species typically reached their highest densities from June to September, following spawning. An accounting of species-specific temporal abundance revealed similar trends and documented the seasonal occurrence of certain taxa (e.g., Smallmouth Buffalo and Yellow Bullhead; Table 9).

In addition to temporal variation in the relative abundance of fish species within the community, there were also longitudinal changes in the densities of species among reaches (Figure 15). Flathead Chub, Longnose Dace, River Carpsucker, White Sucker, and Channel Catfish were most common in the Angostura Reach. The most common species in the Isleta Reach included Red Shiner, Fathead Minnow, and Western Mosquitofish. Common Carp and Rio Grande Silvery Minnow were most common in the San Acacia Reach.

Table 7. Summary of the May to December 2013 Rio Grande Silvery Minnow population monitoring program 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	-	-	-	-
Clupeidae	Threadfin Shad	I	-	-	-	-
Cyprinidae	Central Stoneroller	I	-	-	-	-
Cyprinidae	Goldfish	I	-	-	-	-
Cyprinidae	Red Shiner	N	25,919	58.68	132	94.29
Cyprinidae	Common Carp	I	903	2.04	59	42.14
Cyprinidae	Rio Grande Chub	N	1	0.00	1	0.71
Cyprinidae	Rio Grande Silvery Minnow	N	354	0.80	39	27.86
Cyprinidae	Golden Shiner	I	-	-	-	-
Cyprinidae	Fathead Minnow	N	3,948	8.94	94	67.14
Cyprinidae	Bullhead Minnow	I	85	0.19	14	10.00
Cyprinidae	Flathead Chub	N	1,228	2.78	69	49.29
Cyprinidae	Longnose Dace	N	1,155	2.61	26	18.57
Catostomidae	River Carpsucker	N	1,648	3.73	61	43.57
Catostomidae	White Sucker	I	887	2.01	41	29.29
Catostomidae	Smallmouth Buffalo	N	330	0.75	14	10.00
Ictaluridae	Black Bullhead	I	2	0.00	2	1.43
Ictaluridae	Yellow Bullhead	I	35	0.08	19	13.57
Ictaluridae	Blue Catfish	N	-	-	-	-
Ictaluridae	Channel Catfish	I	1,070	2.42	81	57.86
Ictaluridae	Flathead Catfish	N	-	-	-	-
Salmonidae	Rainbow Trout	I	-	-	-	-
Salmonidae	Brown Trout	I	-	-	-	-
Poeciliidae	Western Mosquitofish	I	6,594	14.93	91	65.00
Moronidae	White Bass	I	1	0.00	1	0.71
Moronidae	Striped Bass	I	-	-	-	-
Centrarchidae	Green Sunfish	I	-	-	-	-
Centrarchidae	Bluegill	N	1	0.00	1	0.71
Centrarchidae	Longear Sunfish	I	-	-	-	-
Centrarchidae	Smallmouth Bass	I	-	-	-	-
Centrarchidae	Largemouth Bass	I	5	0.01	4	2.86
Centrarchidae	White Crappie	I	6	0.01	5	3.57
Centrarchidae	Black Crappie	I	-	-	-	-
Percidae	Yellow Perch	I	-	-	-	-
Percidae	Bigscale Logperch	I	-	-	-	-
Percidae	Walleye	I	-	-	-	-

[1] N = native; I = introduced
[2] Frequency and % frequency of occurrence are based on 140 site samples (i.e., 20 samples per month) during 2013.

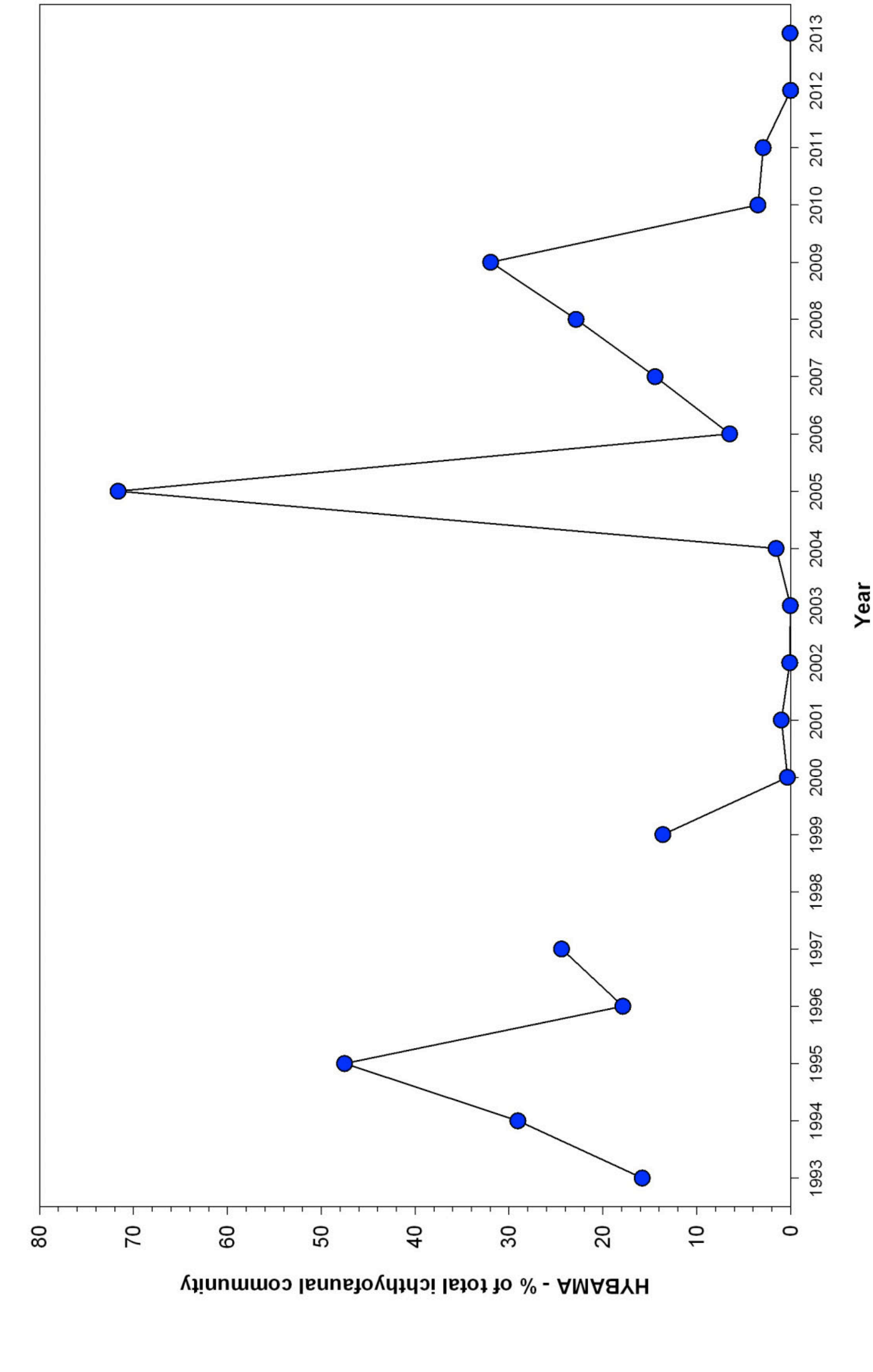

Figure 12. Relative abundance of Rio Grande Silvery Minnow as a percentage of the total ichthyofaunal community during October, at all sampling sites, by sampling year (1993–2013).

Table 8. Summary of rank abundance for focal species collected in the Rio Grande during October over the past decade (2004–2013).

FAMILY Common Name	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CYPRINIDAE										
Red Shiner	1	3	1	1	1	1	1	1	1	1
Common Carp	9	7	10	10	7	10	9	10	6	9
Rio Grande Silvery Minnow	5	1	4	2	2	2	5	4	10	10
Fathead Minnow	3	4	6	7	5	6	6	7	5	4
Flathead Chub	4	5	2	4	4	5	2	3	3	6
Longnose Dace	8	8	7	8	8	9	7	8	8	3
CATOSTOMIDAE										
River Carpsucker	7	9	8	6	9	7	8	5	7	8
White Sucker	10	9	8	9	10	8	10	9	9	7
ICTALURIDAE										
Channel Catfish	6	6	5	5	6	4	4	6	4	5
POECILIIDAE										
Western Mosquitofish	2	2	3	3	3	3	3	2	2	2

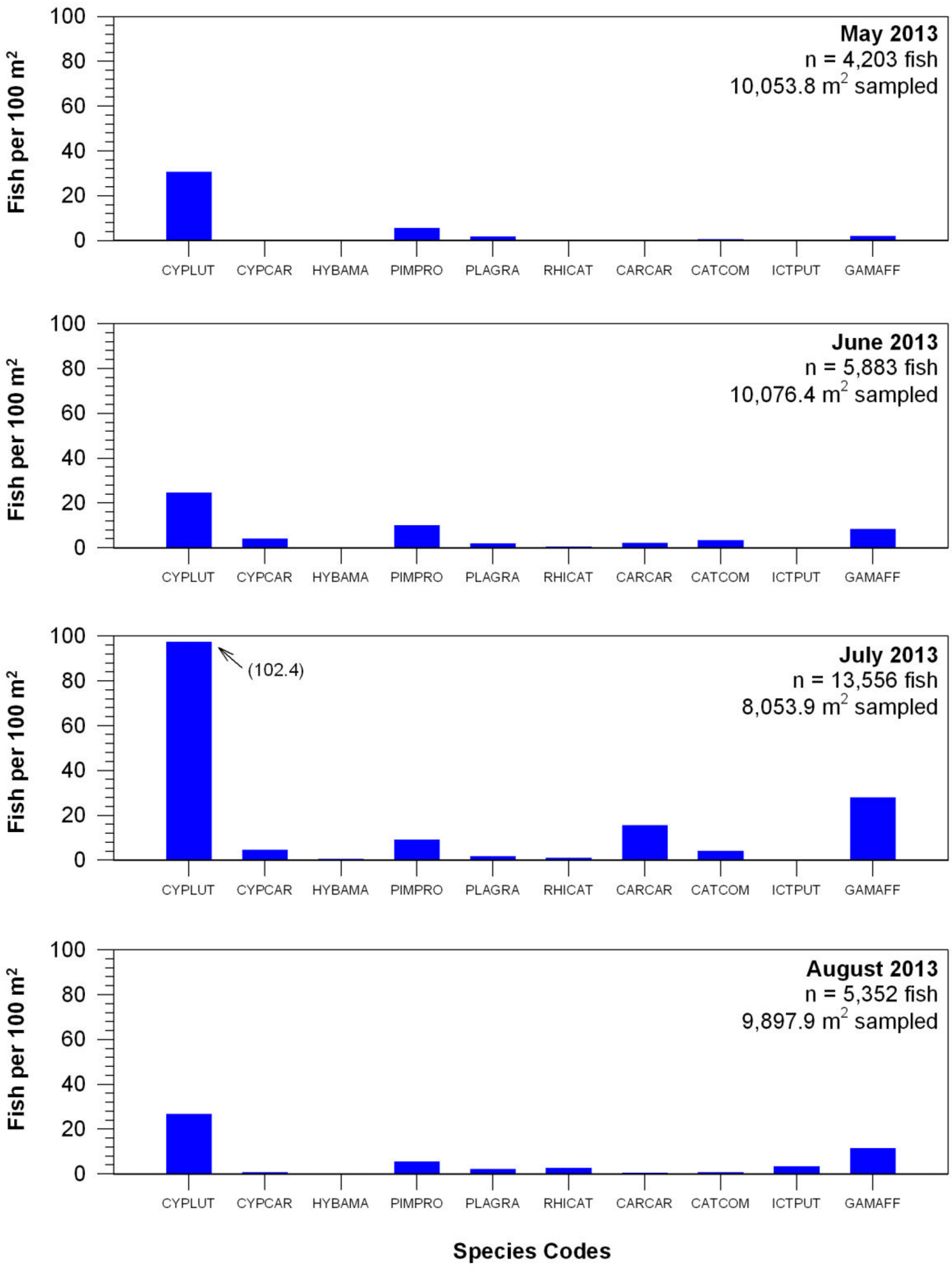

Figure 13. Fish densities from May to August 2013 for each focal species (see Table 1 for species codes) in the Middle Rio Grande.

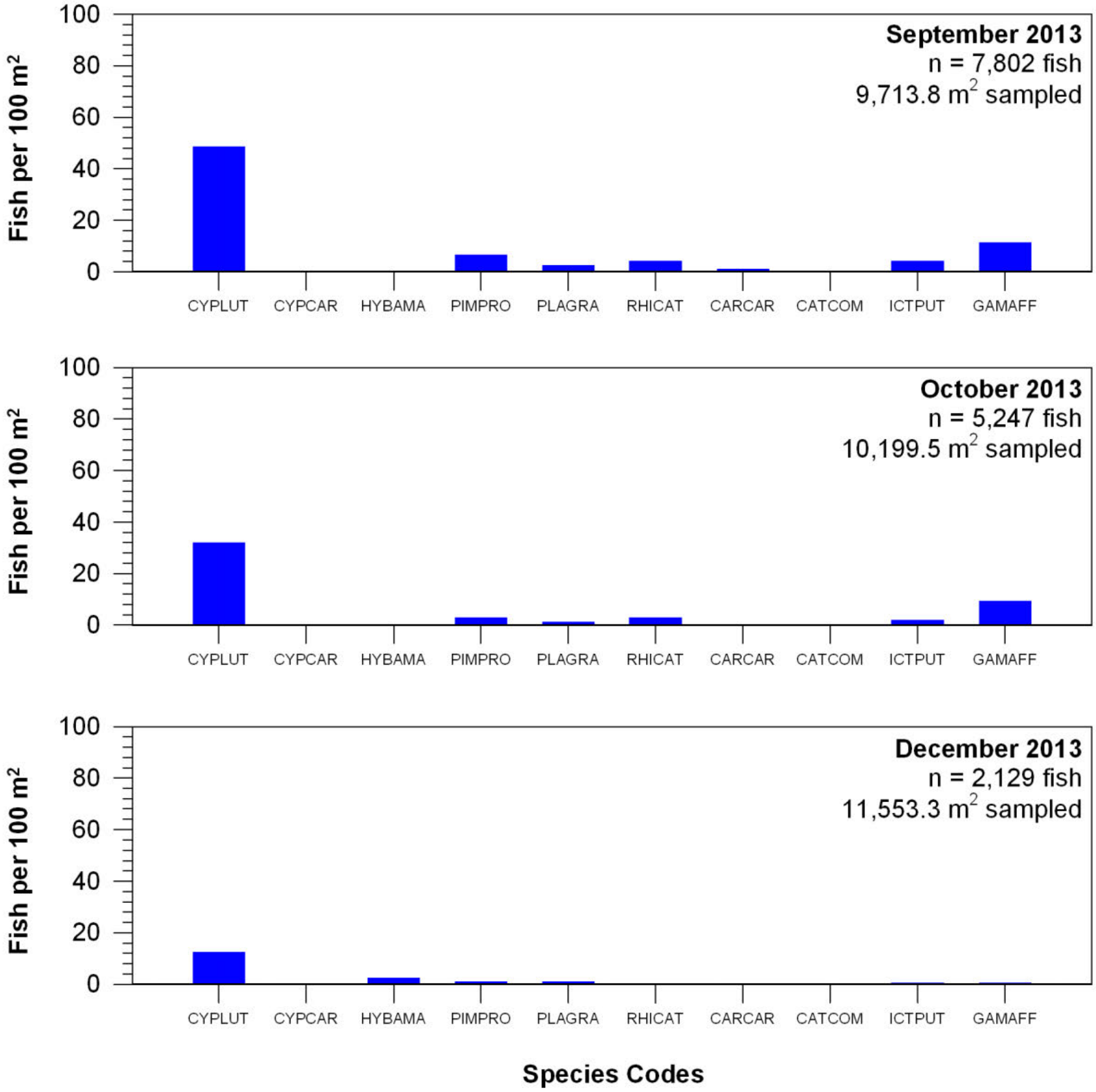

Figure 14. Fish densities from September to December 2013 for each focal species (see Table 1 for species codes) in the Middle Rio Grande.

Table 9. Summary of the May to December 2013 Rio Grande Silvery Minnow population monitoring program fish samples.

FAMILY	SPECIES COMMON NAME	MAY	JUN	JUL	AUG	SEP	OCT	DEC	TOTAL
Clupeidae	Gizzard Shad	-	-	-	-	-	-	-	0
Clupeidae	Threadfin Shad	-	-	-	-	-	-	-	0
Cyprinidae	Central Stoneroller	-	-	-	-	-	-	-	0
Cyprinidae	Goldfish	-	-	-	-	-	-	-	0
Cyprinidae	Red Shiner	3,098	2,483	8,249	2,639	4,740	3,265	1,445	25,919
Cyprinidae	Common Carp	13	408	377	61	36	6	2	903
Cyprinidae	Rio Grande Chub	-	-	-	-	-	1	-	1
Cyprinidae	Rio Grande Silvery Minnow	12	7	45	5	4	3	278	354
Cyprinidae	Golden Shiner	-	-	-	-	-	-	-	0
Cyprinidae	Fathead Minnow	563	1,017	742	554	648	307	117	3,948
Cyprinidae	Bullhead Minnow	-	2	28	28	5	9	13	85
Cyprinidae	Flathead Chub	176	204	137	209	261	127	114	1,228
Cyprinidae	Longnose Dace	41	55	71	252	411	317	8	1,155
Catostomidae	River Carpsucker	7	216	1,243	47	118	7	10	1,648
Catostomidae	White Sucker	75	344	335	70	37	25	1	887
Catostomidae	Smallmouth Buffalo	-	278	52	-	-	-	-	330
Ictaluridae	Black Bullhead	-	-	-	-	2	-	-	2
Ictaluridae	Yellow Bullhead	-	-	1	21	11	2	-	35
Ictaluridae	Blue Catfish	-	-	-	-	-	-	-	0
Ictaluridae	Channel Catfish	19	10	12	324	417	218	70	1,070
Ictaluridae	Flathead Catfish	-	-	-	-	-	-	-	0
Salmonidae	Rainbow Trout	-	-	-	-	-	-	-	0
Salmonidae	Brown Trout	-	-	-	-	-	-	-	0
Poeciliidae	Western Mosquitofish	198	857	2,260	1,142	1,112	959	66	6,594
Moronidae	White Bass	-	-	-	-	-	-	1	1
Moronidae	Striped Bass	-	-	-	-	-	-	-	0
Centrarchidae	Green Sunfish	-	-	-	-	-	-	-	0
Centrarchidae	Bluegill	1	-	-	-	-	-	-	1
Centrarchidae	Longear Sunfish	-	-	-	-	-	-	-	0
Centrarchidae	Smallmouth Bass	-	-	-	-	-	-	-	0
Centrarchidae	Largemouth Bass	-	2	3	-	-	-	-	5
Centrarchidae	White Crappie	-	-	1	-	-	1	4	6
Centrarchidae	Black Crappie	-	-	-	-	-	-	-	0
Percidae	Yellow Perch	-	-	-	-	-	-	-	0
Percidae	Bigscale Logperch	-	-	-	-	-	-	-	0
Percidae	Walleye	-	-	-	-	-	-	-	0
MONTHLY TOTALS		**4,203**	**5,883**	**13,556**	**5,352**	**7,802**	**5,247**	**2,129**	**44,172**

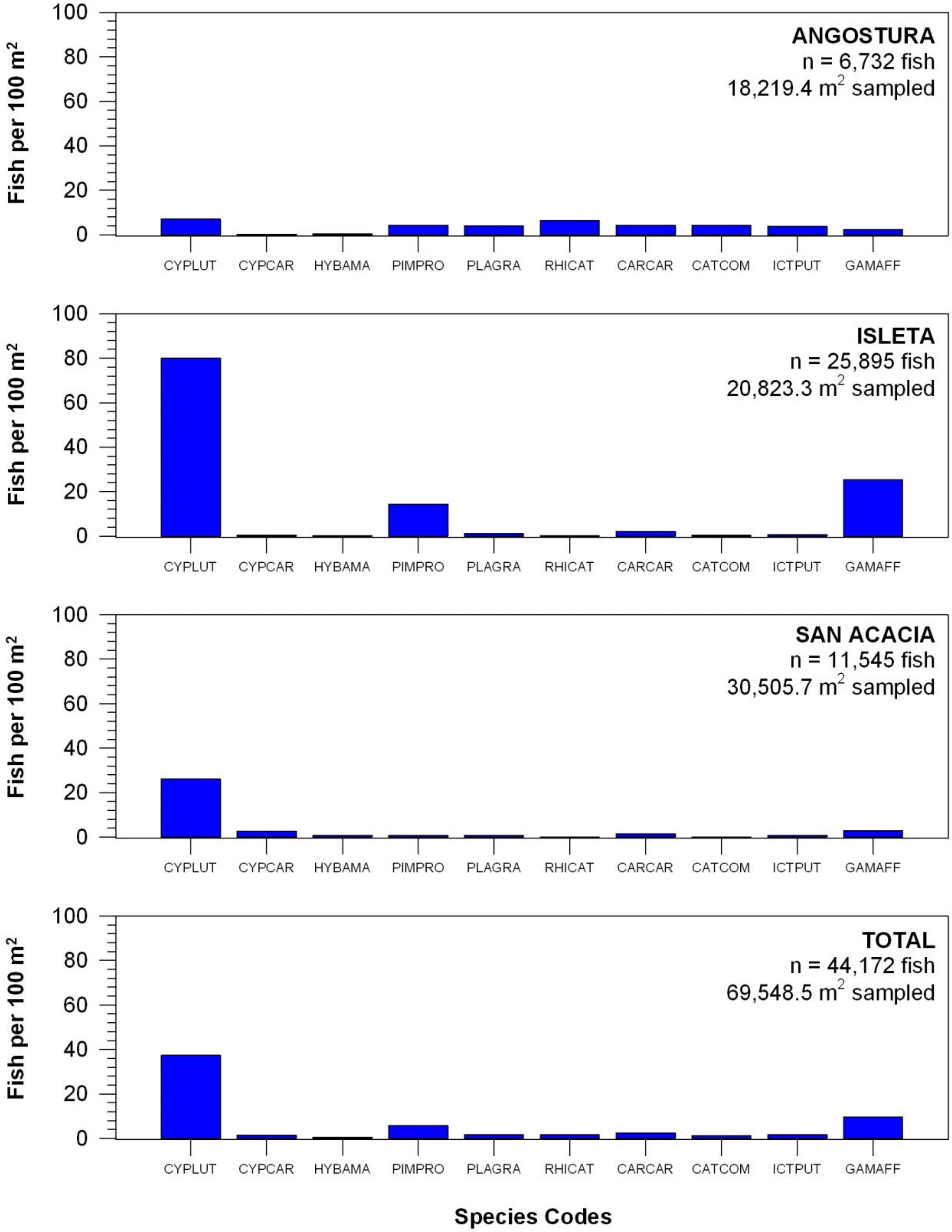

Figure 15. Fish densities by river reach for each focal species (see Table 1 for species codes) in the Middle Rio Grande from May to December 2013.

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 programs 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). 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 programs (Johnson, 2008; Al-Chokhachy et al., 2009).

Statistical analyses revealed a close relationship between the 2008–2011 overall population trends for Rio Grande Silvery Minnow obtained from Population Monitoring Program and Population Estimation Program studies (Dudley et al., 2012). Despite similarities in population trends obtained from the population monitoring and 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 monthly 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 provides a statistically robust annual estimate of the Rio Grande Silvery Minnow population and is necessary for accurately evaluating inter-annual changes in population size.

While both the Population Monitoring Program and Population Estimation Program studies yielded Rio Grande Silvery Minnow density estimates, only those density estimates derived from the Population Estimate Program data should be used to generate population estimates. Mesohabitat-specific density estimates calculated from population monitoring data were likely substantial underestimates of true density since mesohabitats were not enclosed or depleted during sampling. In contrast, sampling-site density estimates, using data combined across all mesohabitats, were likely substantial overestimates of true density since mesohabitats were not sampled in proportion to their availability (e.g., high-density mesohabitats, such as backwaters, were sampled twice when present even though they were quite rare). While density estimates generated from the population monitoring data should not be used to derive population size estimates, they do appear to be quite reflective of Rio Grande Silvery Minnow population trends over time.

The mixture models used to estimate Rio Grande Silvery Minnow densities in this study employed two separate statistical components, an approach which 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 simple models, without covariates or random effects, all 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 and Platania, 2013a), 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 an extremely general approach that avoids assumptions normally required for traditional analyses. One relevant assumption required for our analyses is that sampling intensities (i.e., 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 unreasonable to suggest that observed downward trends in density are strictly from reduced sampling intensity, as sampling methods have not varied over time and were developed to ensure that comparable mesohabitats (depths and velocities) were sampled across years and in different 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.

The Population Monitoring Program has documented remarkable changes in the estimated densities of Rio Grande Silvery Minnow among 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 reasonably high. Significant differences in estimated densities (both increases and decreases) were frequently detected between sequential years. Further, an analysis of sampling variation across days (based on repeated sampling during November 2005–2013) revealed that sampling occasion was an insignificant effect and far less informative in explaining changes in the occurrence or density of Rio Grande Silvery Minnow over time as compared with year. Thus, it appears that the current sampling protocols are resulting in a reasonable level of sampling precision, especially when considering the substantial changes in both the distribution and abundance of Rio Grande Silvery Minnow among years.

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 among years, established sampling protocols for this study ensure that similar mesohabitats (depths and velocities) are 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. However, this was a cursory study of mesohabitat associations and is no substitute for the more rigorous approach used to quantify Rio Grande Silvery Minnow mesohabitat use (including seasonal and ontogenetic shifts) in the past (e.g., Dudley and Platania, 1997).

The types of mesohabitats occupied by Rio Grande Silvery Minnow in 2013 were comparable to those occupied in past years (e.g., Dudley and Platania, 1997, 2013a). The distribution of sampled mesohabitats among reaches and the mesohabitats occupied by Rio Grande Silvery Minnow among reaches were relatively consistent. Population trends in the five different mesohabitats (BW, PO, SHPO, SHRU, and RU) were quite similar over the period of study, despite notable differences in the estimated densities of Rio Grande Silvery Minnow among mesohabitats. Estimated 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).

Rio Grande Silvery Minnow estimated densities, using mesohabitat-specific density data, resulted in population trends that were very similar to those generated using sampling-site density data. Modeled estimates of Rio Grande Silvery Minnow densities ($E(x)$) had reasonably narrow 95% confidence intervals when calculated using either the sampling-site density data (1993–2013) or the mesohabitat-specific density data (2002–2013). Encouragingly, the estimated densities and resulting population trends generated from the mesohabitat-specific or sampling-site density data appear to be 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 the sampling-site data have been collected over a much longer period of time (1993–2013).

There were notable changes in the relative and rank abundance of Middle Rio Grande fish species over the past decade (2004–2013). The species that changed most in rank abundance over time included Rio Grande Silvery Minnow and Fathead Minnow. Despite these occasionally large changes in the abundance of individual species, the combined densities of Middle Rio Grande fishes remained relatively constant 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 some of 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 over time. However, additional study will be required to determine those environmental factors that most influence the spatial and temporal patterns of abundance for other fish species and how those changes might affect ichthyofaunal community dynamics over time.

The annual reproductive effort of Rio Grande Silvery Minnow normally occurs during spring and is initiated, in part, by large-scale increases in stream discharge associated with high-mountain snowmelt. Rio Grande Silvery Minnow release large numbers of eggs (up to several thousand per female) into the water column during spawning and these eggs are passively dispersed with the current. Increased discharge as a result of spring runoff, combined with increasing water temperatures, were likely the historical sources of this reproductive stimulus (Platania and Altenbach, 1998). During years of sufficient snowpack, flow in the Middle Rio Grande peaked in late spring and sometimes resulted in several months of sustained flooded habitats. However, dam operations now moderate the magnitude and duration of spring discharge. Water that is stored in reservoirs or seasonally diverted from the river for agricultural/municipal purposes, along with the associated evapotranspiration from those activities, substantially reduces the total volume of water that would have normally flowed through the Rio Grande. These issues are further compounded in drought years when a large portion of the available water is diverted from the Rio Grande in early spring, reducing the sustained and elevated flows that appear to facilitate early recruitment success of Rio Grande Silvery Minnow.

Runoff began in April of 2013 and there was only a small secondary peak in May for a few weeks. The lack of elevated and extended flows during 2013 likely resulted in less favorable conditions for the growth and survivorship of newly hatched Rio Grande Silvery Minnow larvae. In contrast, it is possible that recruitment success was increased in previous years with high spring flows (e.g., 2008) because of the extended inundation of shoreline pools and backwaters where larval fish were most likely to persist (see Dudley and Platania, 2013b).

Comparison of Rio Grande Silvery Minnow mixture-model estimates during October (1993–2013) 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. General linear models 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 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 (for review see Welcomme, 1979). It is quite likely that similar processes are important for the successful survival and recruitment of the Middle Rio Grande ichthyofaunal community, including early life stages of Rio Grande Silvery Minnow (Pease et al., 2006; Turner et al., 2010, Hoagstrom and Turner, 2013).

Population Monitoring Program sampling efforts during October indicated that the highest densities of Rio Grande Silvery Minnow were generally in the San Acacia Reach. The exceptions to this pattern generally 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. 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). However, a cessation of augmentation efforts in the Angostura Reach from 2008–2012 may have contributed to the reemergence of the San Acacia Reach as the reach supporting the highest October densities of Rio Grande Silvery Minnow since 2008. Recent stocking efforts in November 2013 in the Angostura Reach could shift the population structure among reaches, but this question remains to be answered in 2014.

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, perhaps as a result of the implementation of the current propagation management plan (Alò and Turner, 2005; Osborne et al., 2012). However, the near absence of any Rio Grande Silvery Minnow in samples taken in recent years (i.e., October of 2012–2013) creates considerable uncertainty about the future conservation status of this species.

The extremely low densities of Rio Grande Silvery Minnow in 2012 and 2013 appear to indicate that current management efforts (e.g., stocking, salvage, habitat restoration, flow manipulation etc.) are not sufficiently buffering the population against substantial declines. Several drought years in sequence (e.g., similar to what occurred during 2002–2003) have provided the natural experiment necessary to glean insight into just how much current management efforts are buffering against potentially catastrophic population declines during periods of extended low flows. While ongoing management efforts appear to be providing invaluable protection against extinction, it appears that additional efforts (e.g., providing adequate spring and summer flows for successful autumnal recruitment) will be required to yield self-sustaining populations of Rio Grande Silvery Minnow in the Middle Rio Grande over time. Additionally, securing the long-term persistence of Rio Grande Silvery Minnow in the wild will likely depend on attaining self-sustaining populations at multiple locations within its current and 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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APPENDIX A (Sampling Sites)

Middle Rio Grande Fish Sampling Sites

Table A-1. Sampling sites for May to December 2013 population monitoring of Rio Grande Silvery Minnow.

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

Table A-1. Sampling sites for May to December 2013 population monitoring of Rio Grande Silvery Minnow (continued).

Site #	Site Locality
SAN ACACIA REACH SITES (continued)	
SITE #	
11	New Mexico, Socorro County, Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia.
12	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.
13	New Mexico, Socorro County, Rio Grande, ca. 4.0 miles upstream of US Highway 380 bridge crossing, San Antonio.
14	New Mexico, Socorro County, Rio Grande, upstream of US Highway 380 bridge crossing, San Antonio.
15	New Mexico, Socorro County, Rio Grande, directly east of Bosque del Apache National Wildlife Refuge headquarters, San Antonio.
16	New Mexico, Socorro County, Rio Grande, downstream of the San Marcial railroad crossing, San Marcial.
17	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.
18	New Mexico, Socorro County, Rio Grande, ca. 10.0 miles downstream of the San Marcial Railroad Bridge crossing, San Marcial.

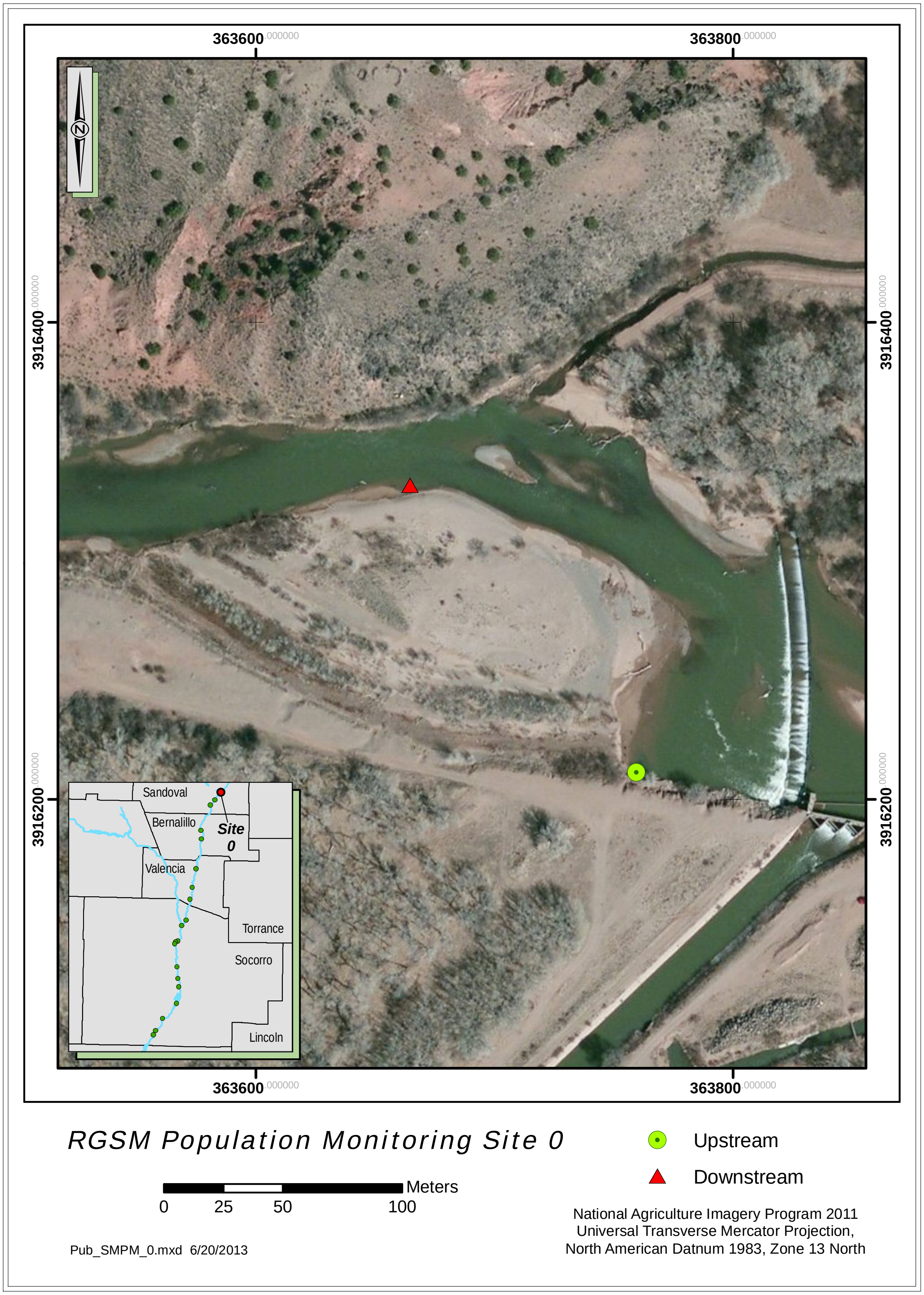

Figure A-1. Map of population monitoring Site 0 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

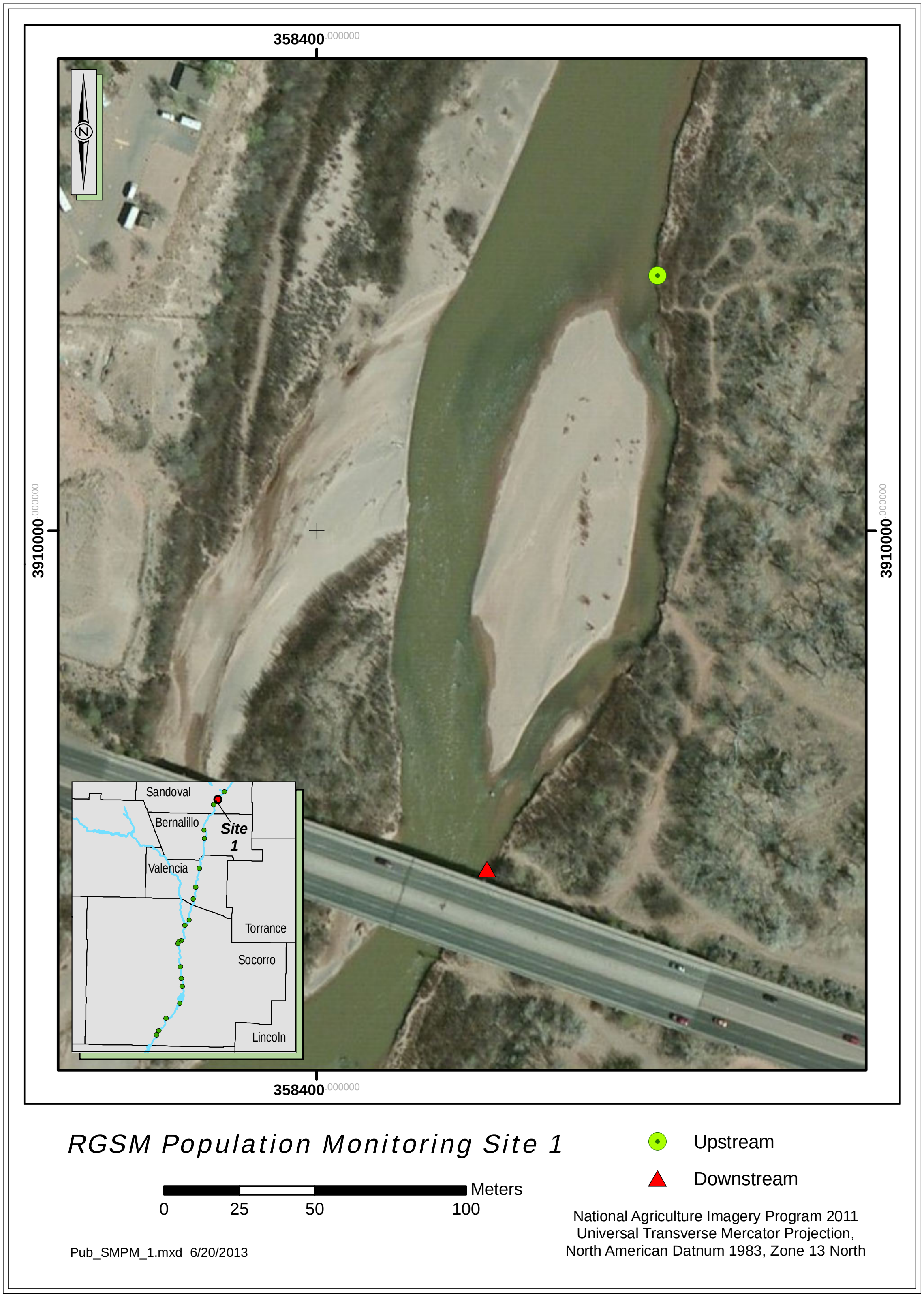

Figure A-2. Map of population monitoring Site 1 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

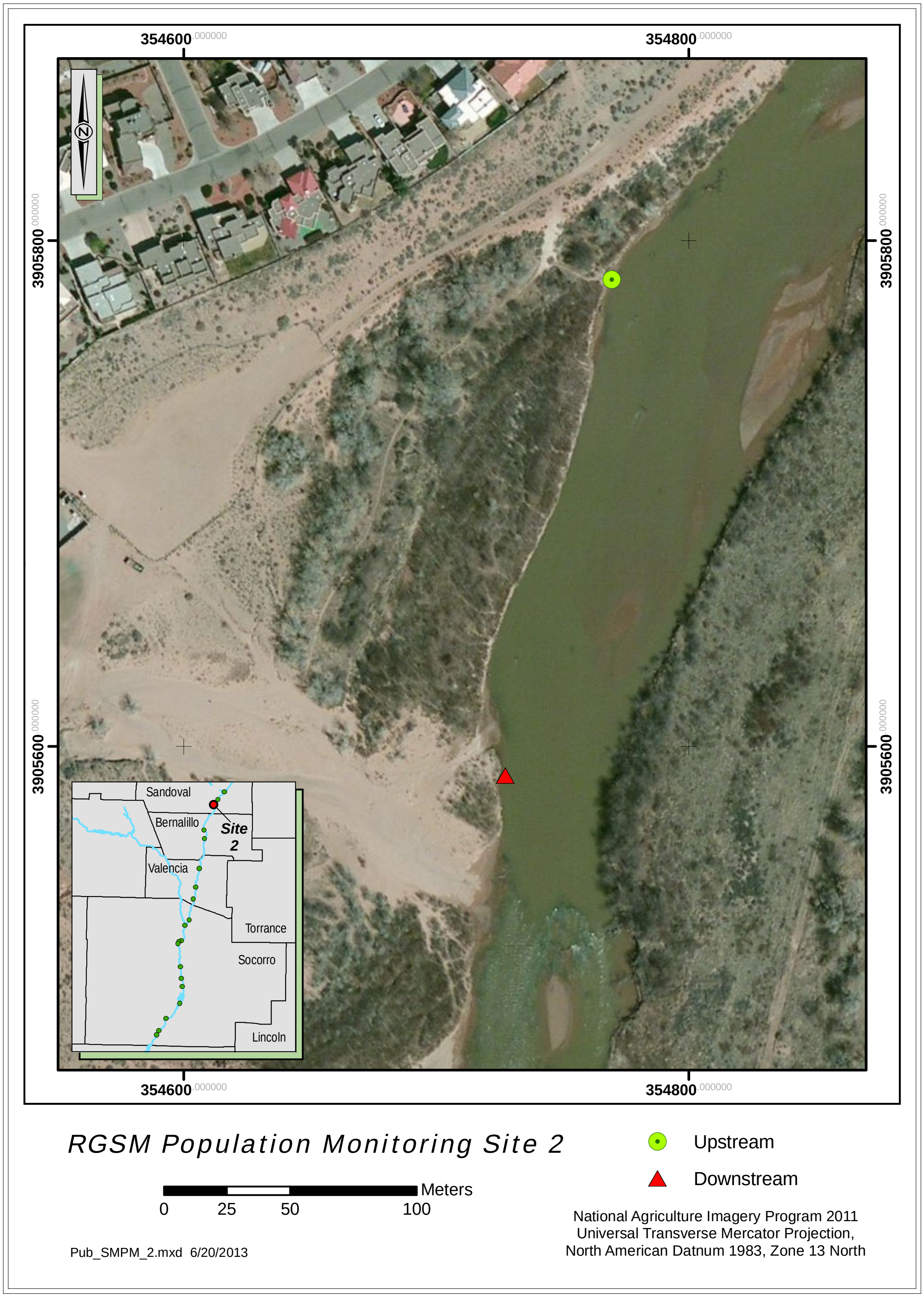

Figure A-3. Map of population monitoring Site 2 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

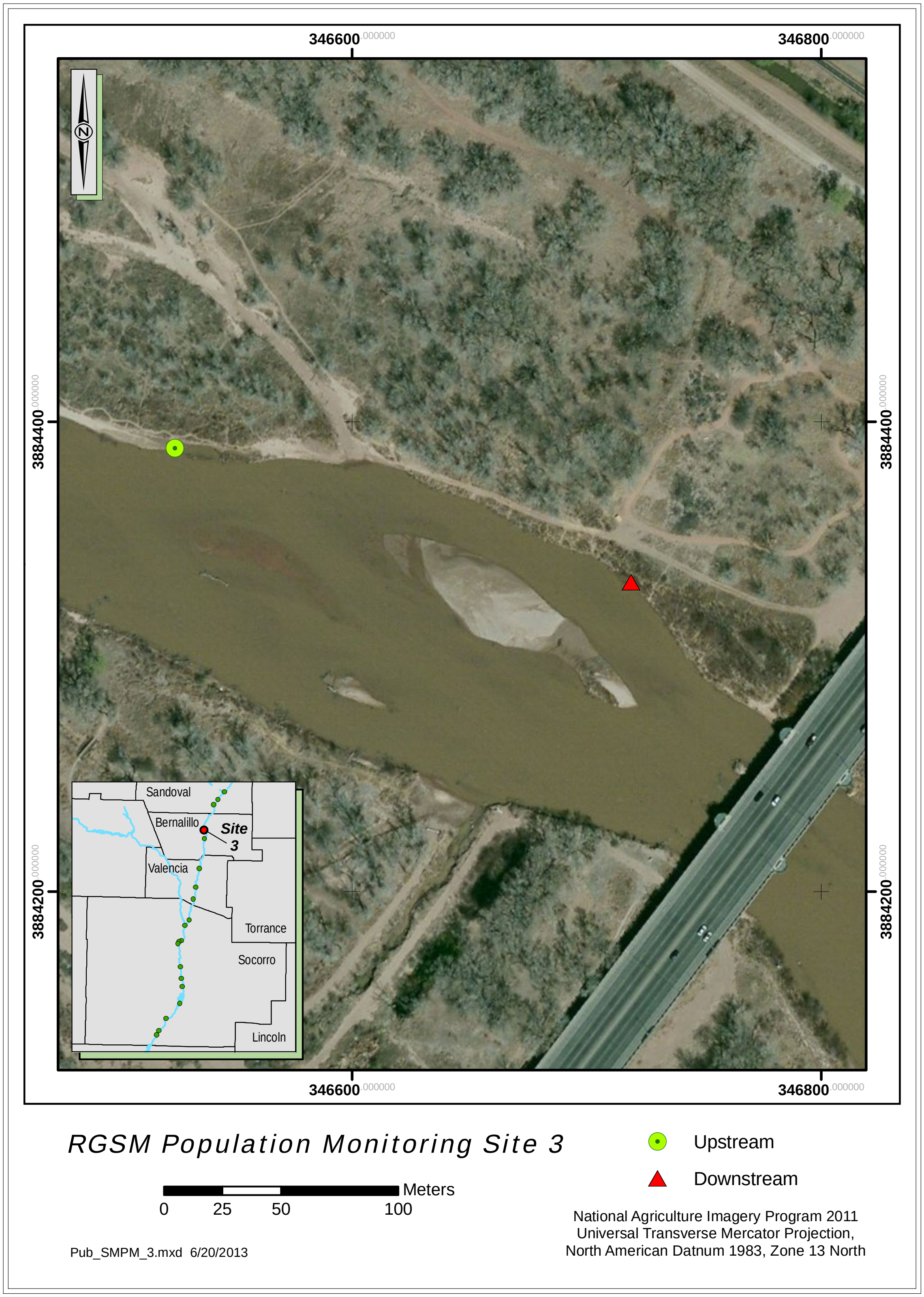

Figure A-4. Map of population monitoring Site 3 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

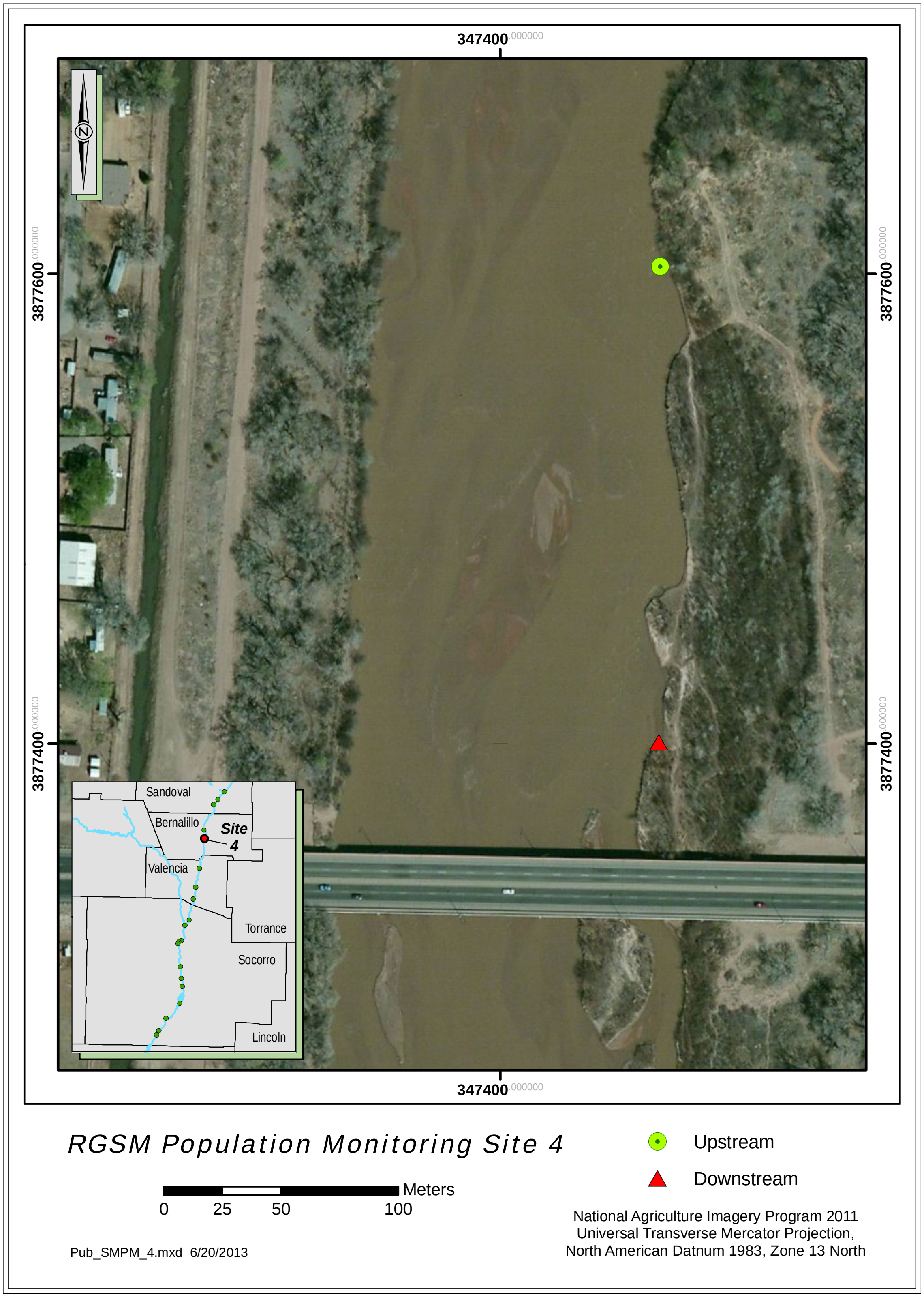

Figure A-5. Map of population monitoring Site 4 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

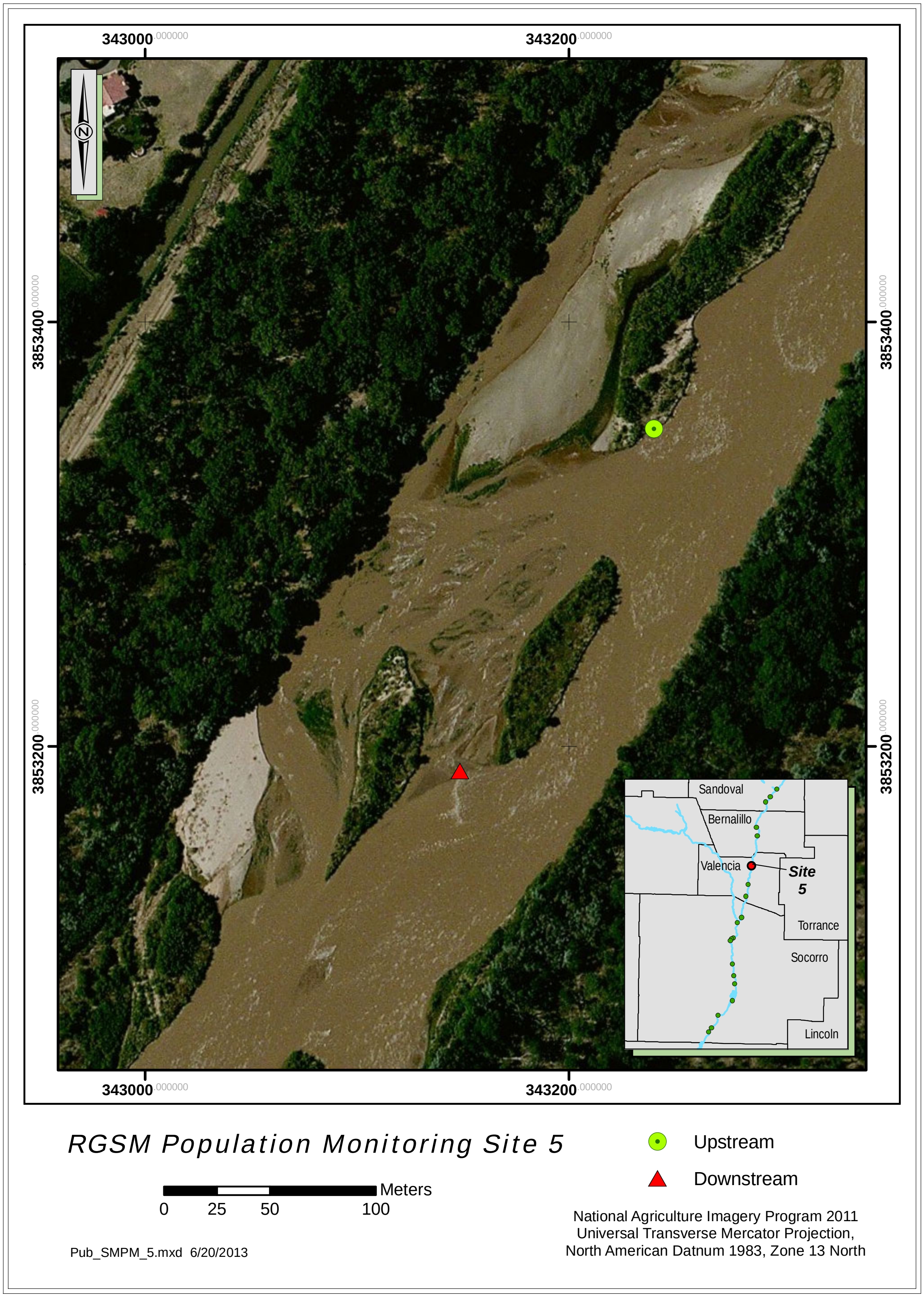

Figure A-6. Map of population monitoring Site 5 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

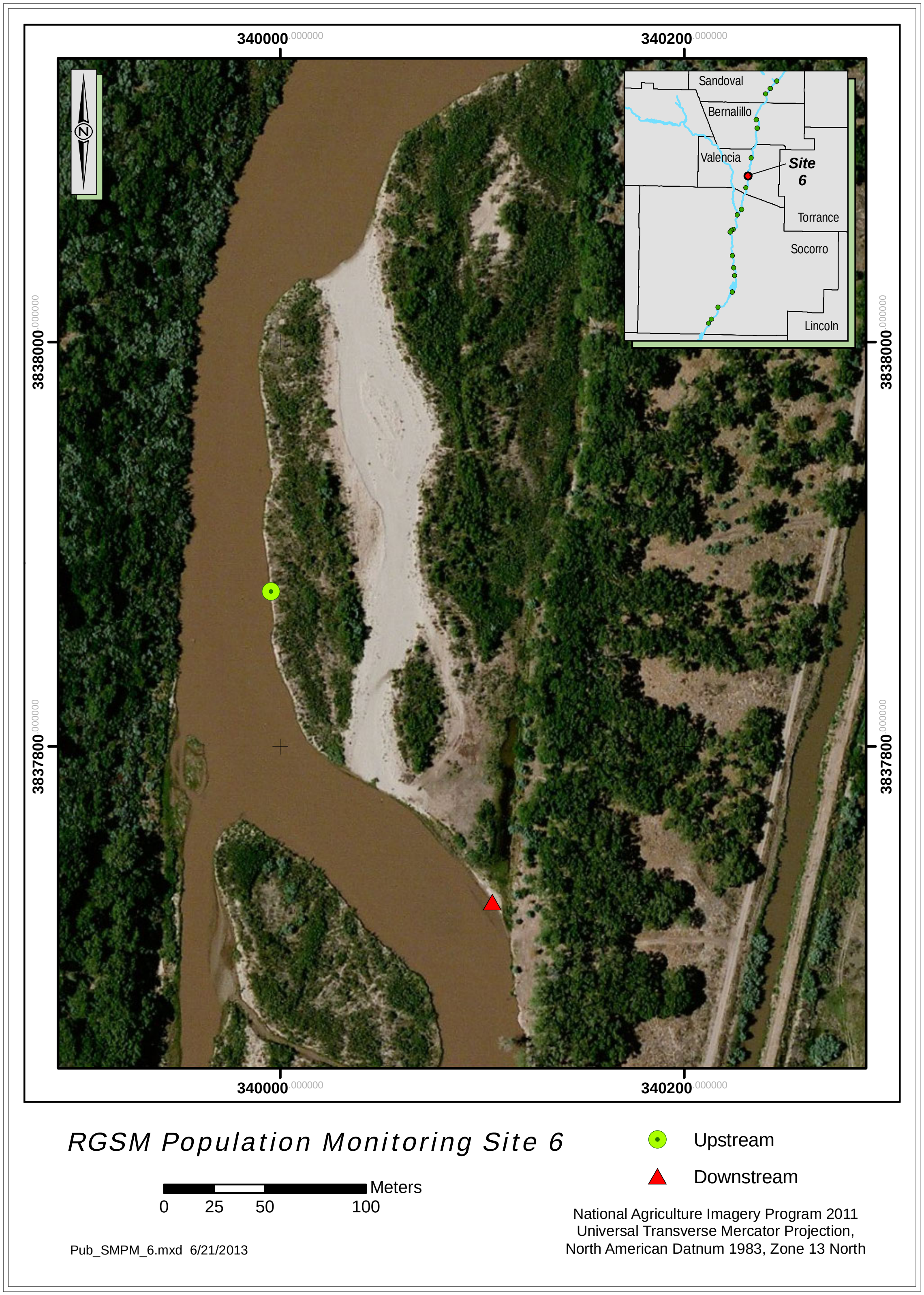

Figure A-7. Map of population monitoring Site 6 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

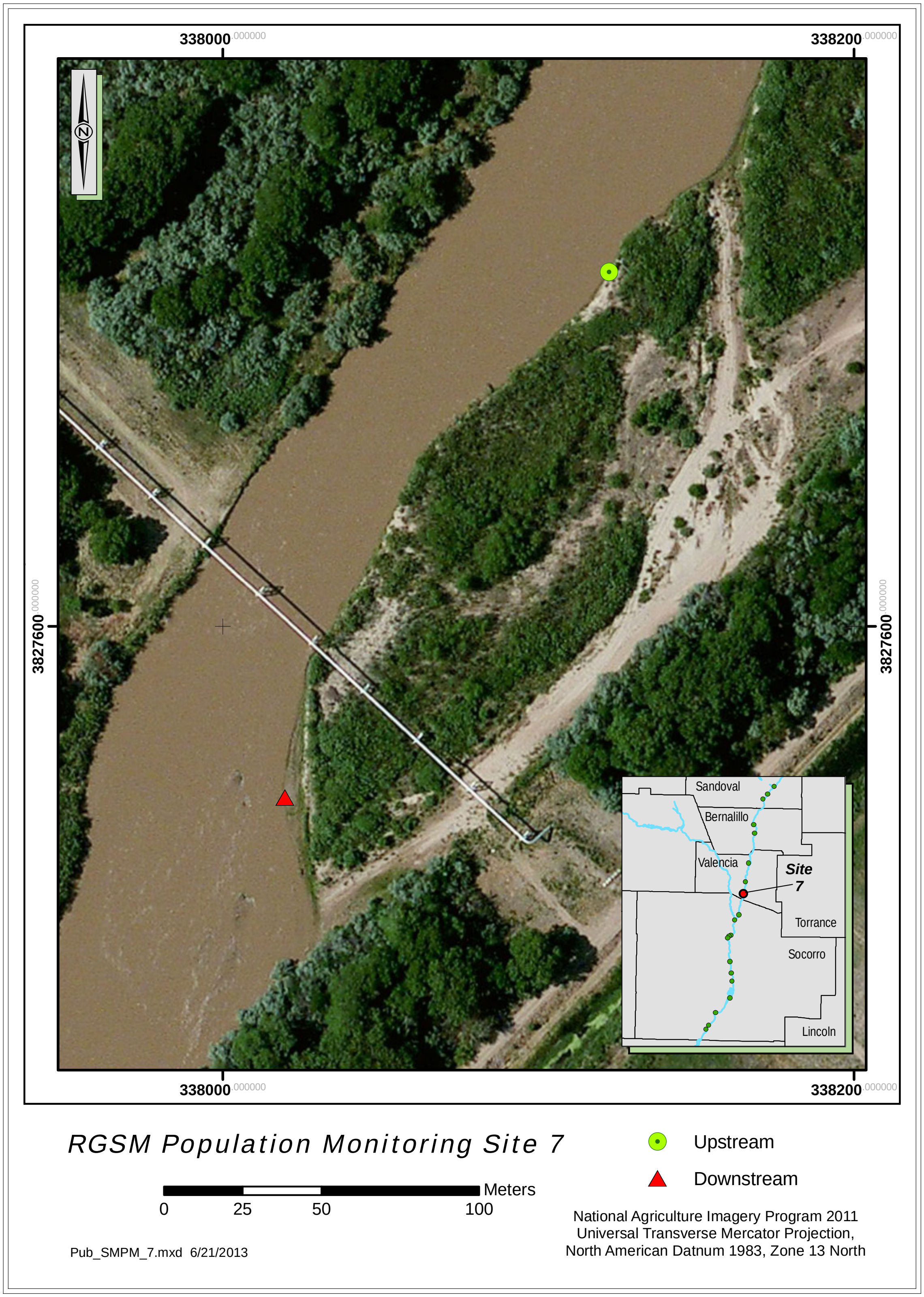

Figure A-8. Map of population monitoring Site 7 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

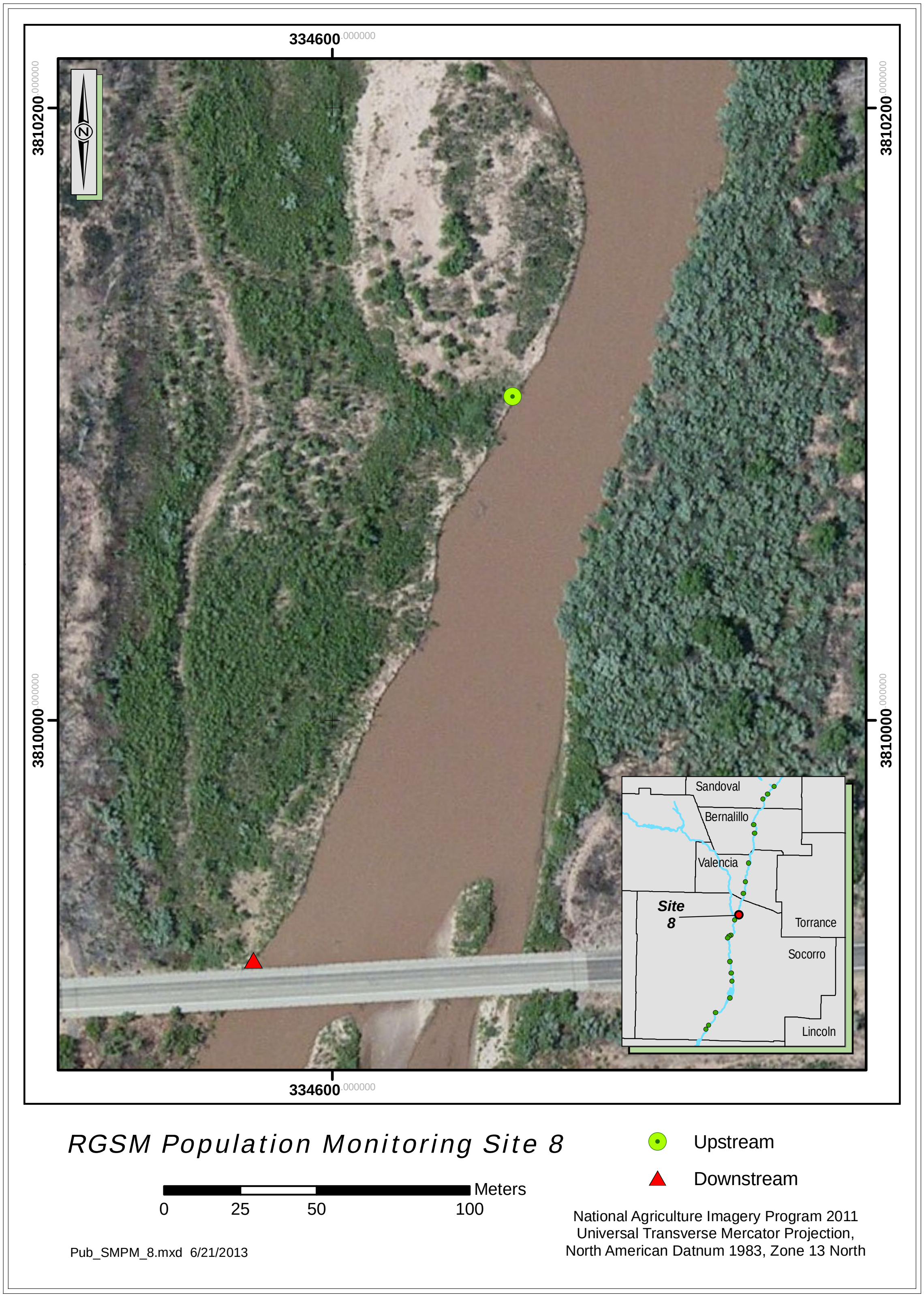

Figure A-9. Map of population monitoring Site 8 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

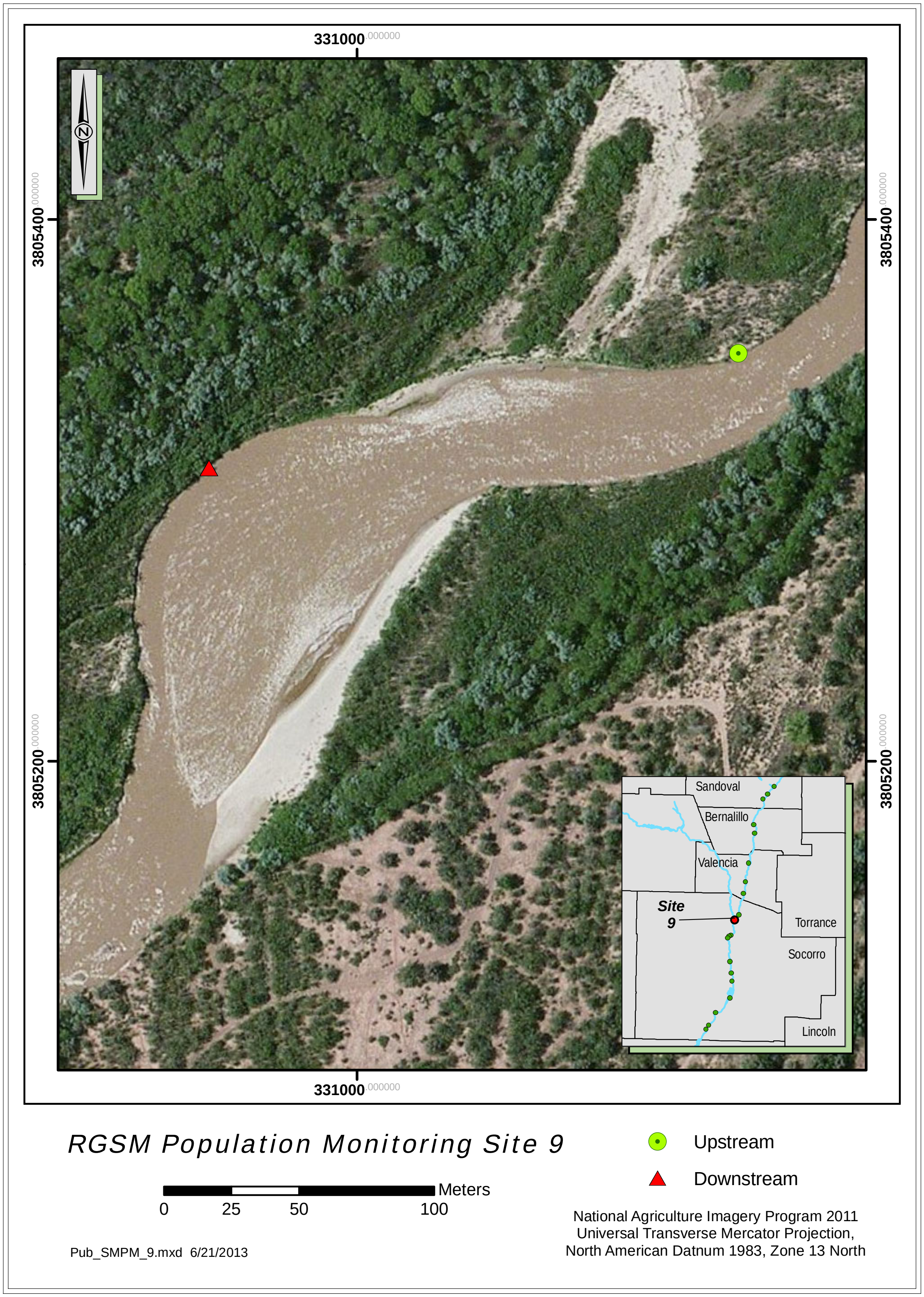

Figure A-10. Map of population monitoring Site 9 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

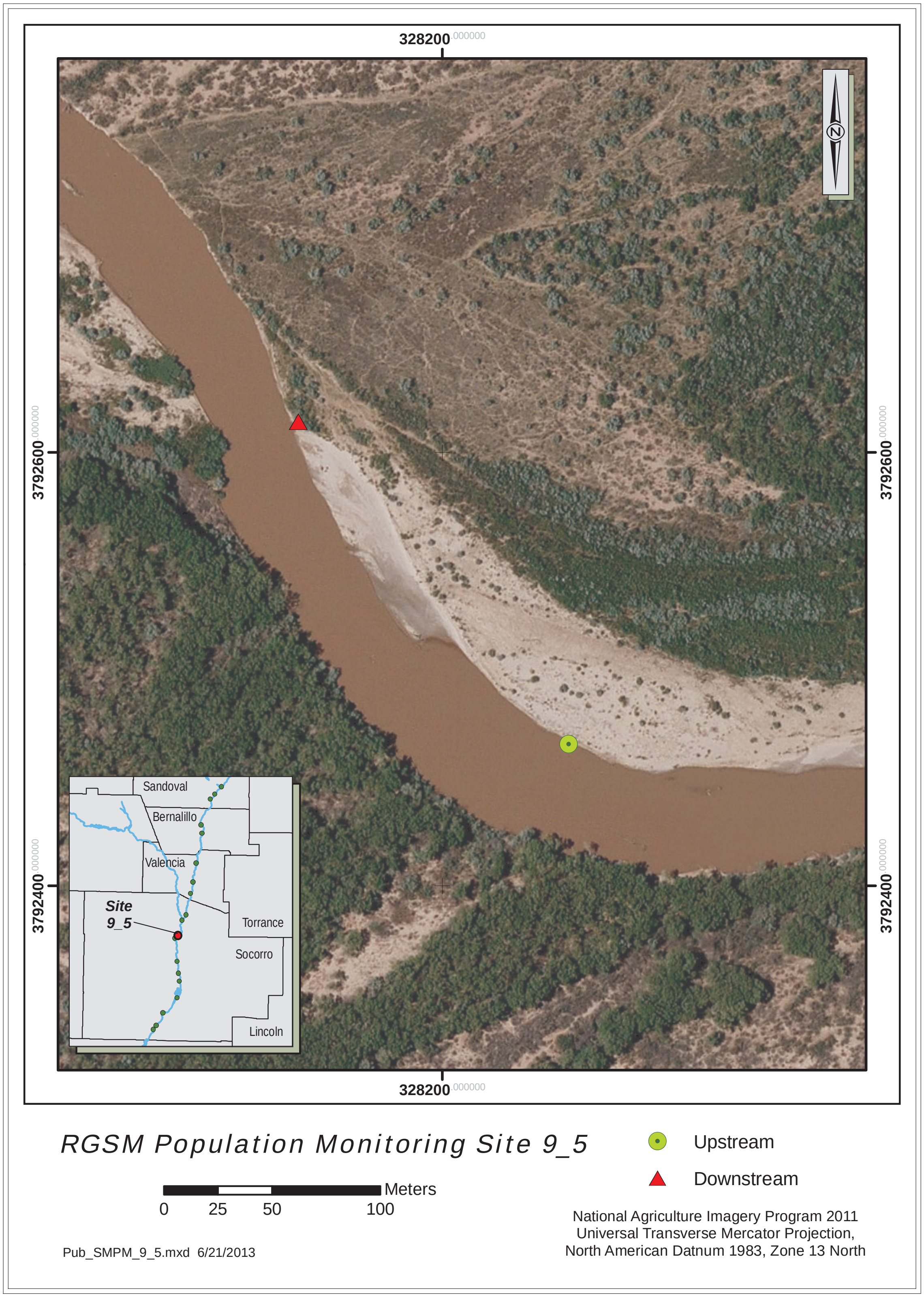

Figure A-11. Map of population monitoring Site 9.5 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

Figure A-12. Map of population monitoring Site 10 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

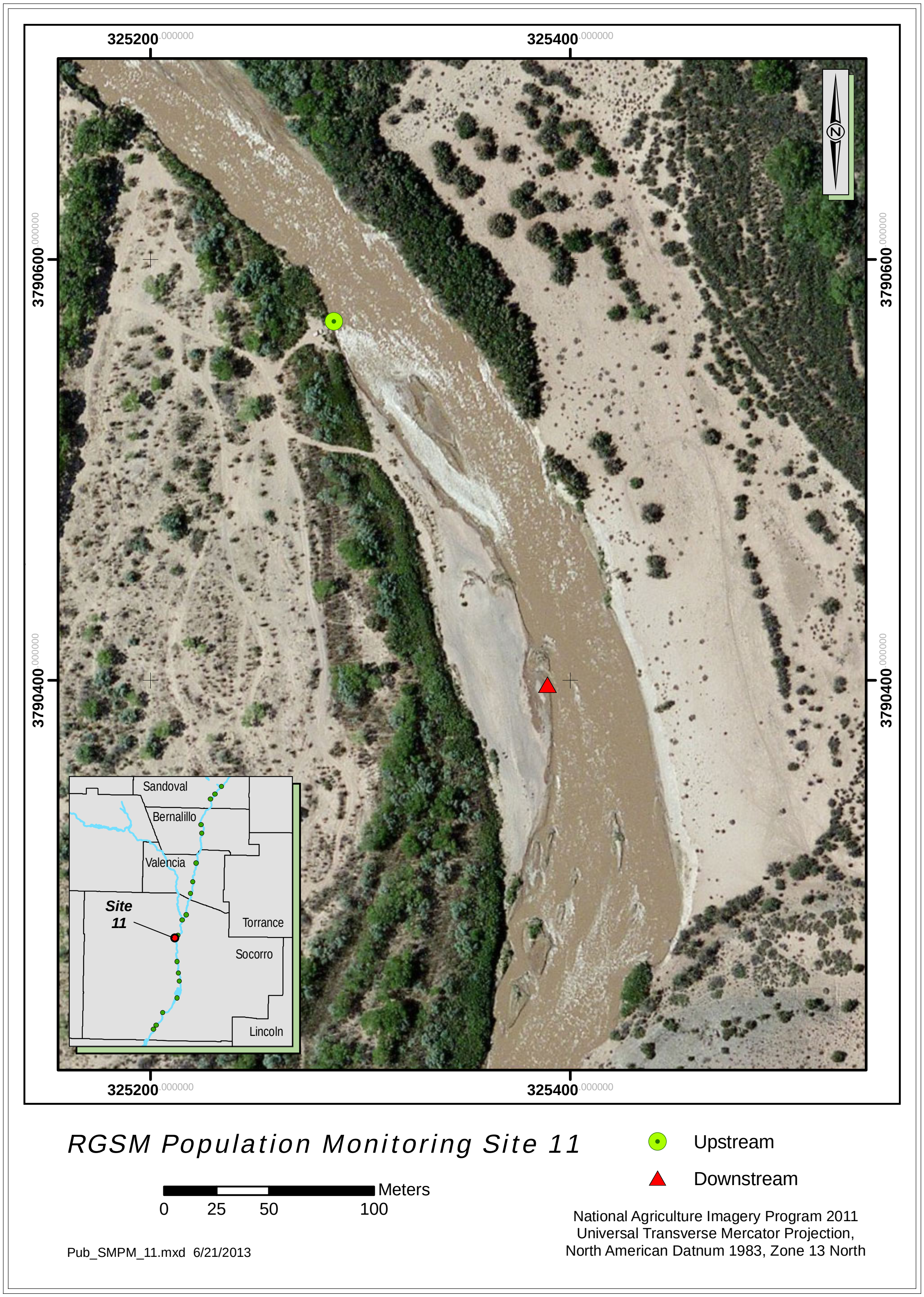

Figure A-13. Map of population monitoring Site 11 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

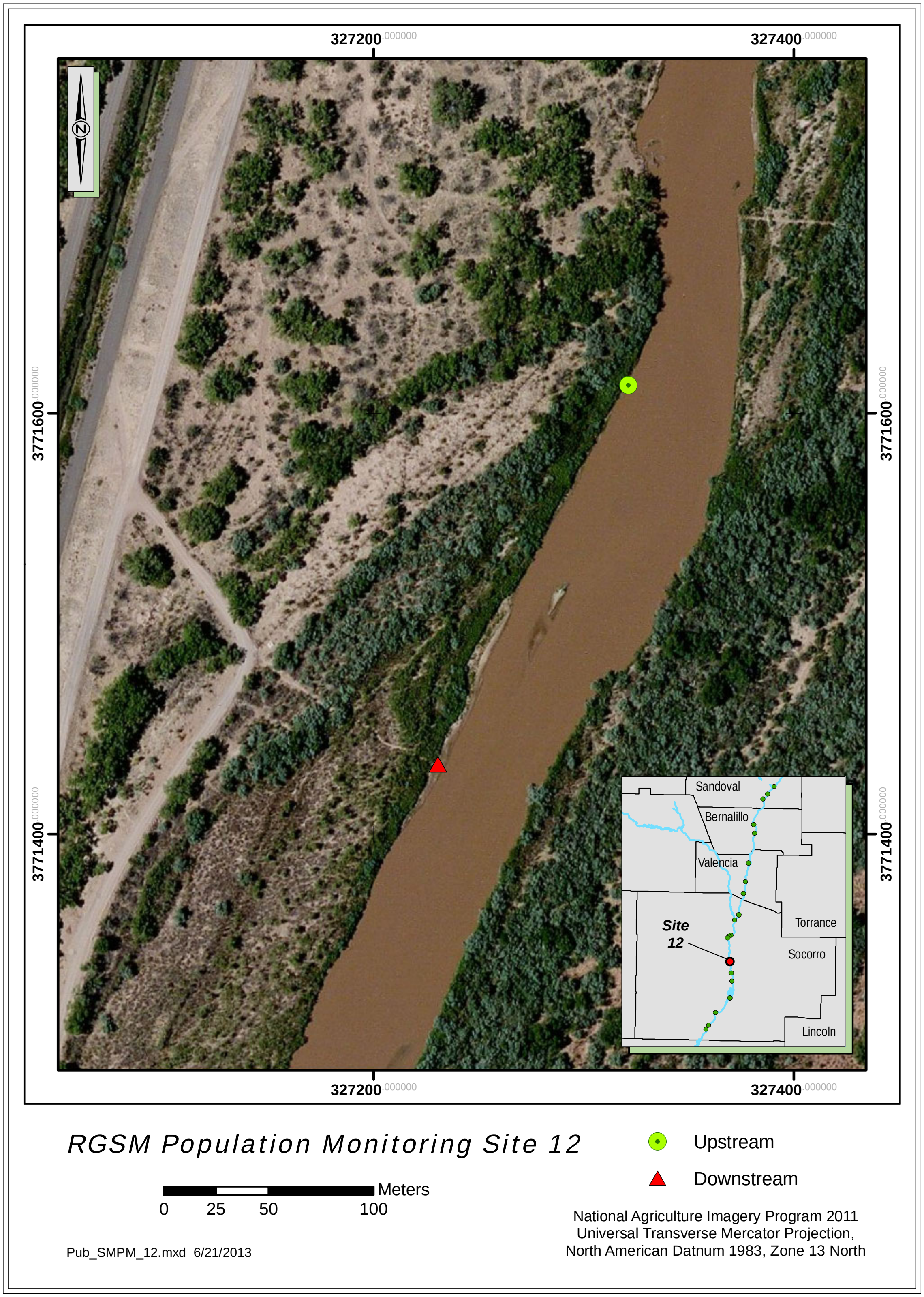

Figure A-14. Map of population monitoring Site 12 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

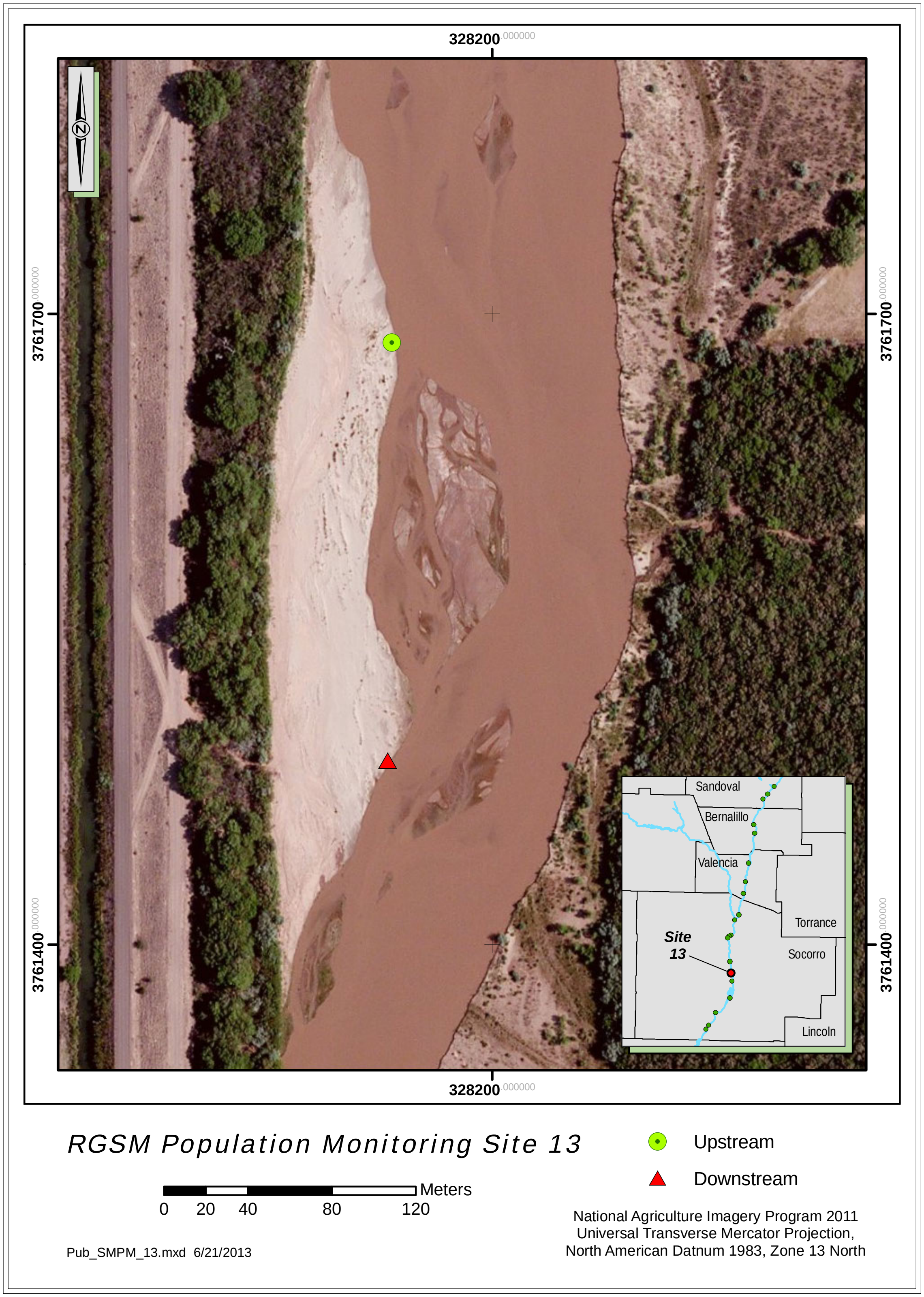

Figure A-15. Map of population monitoring Site 13 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

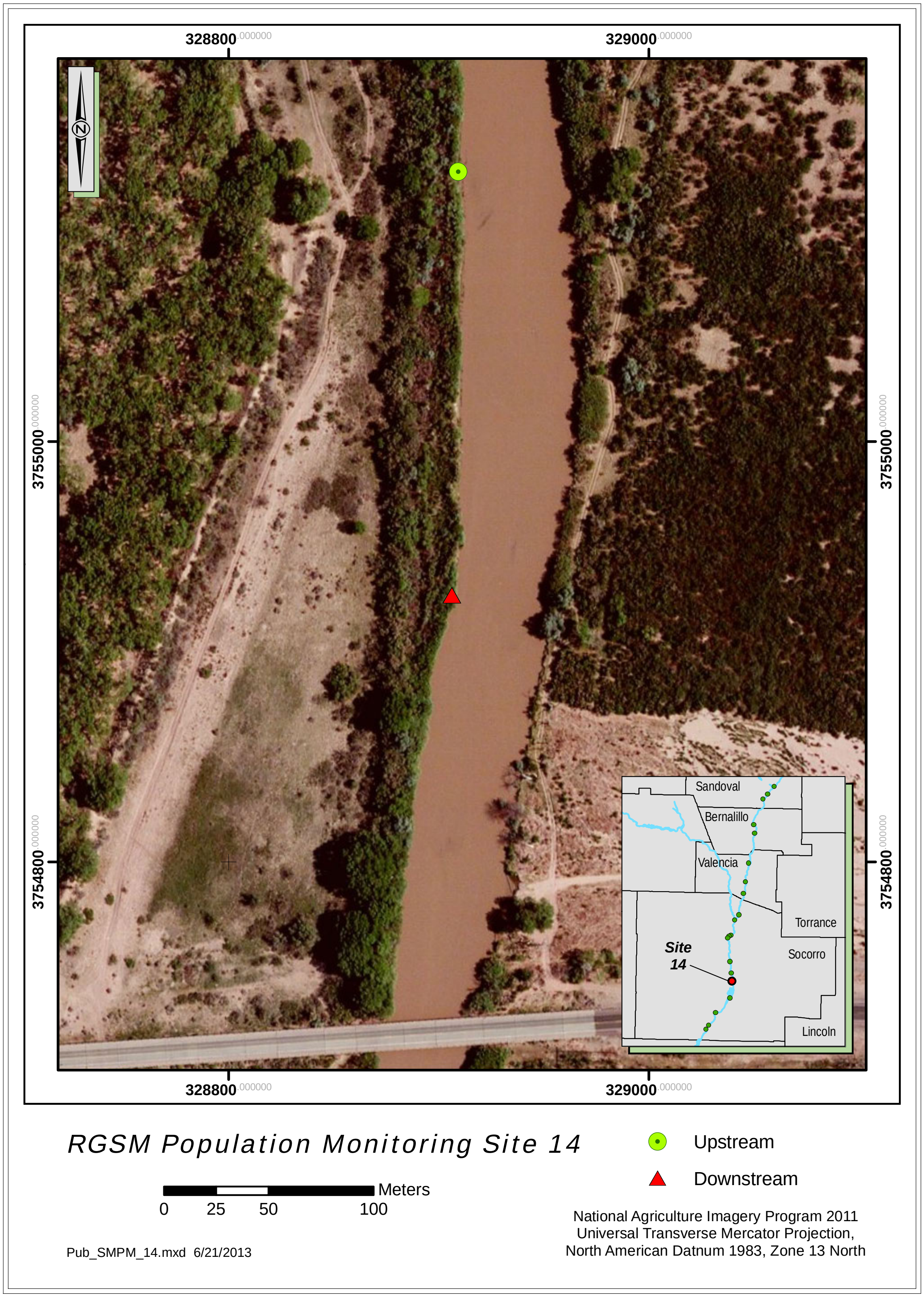

Figure A-16. Map of population monitoring Site 14 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

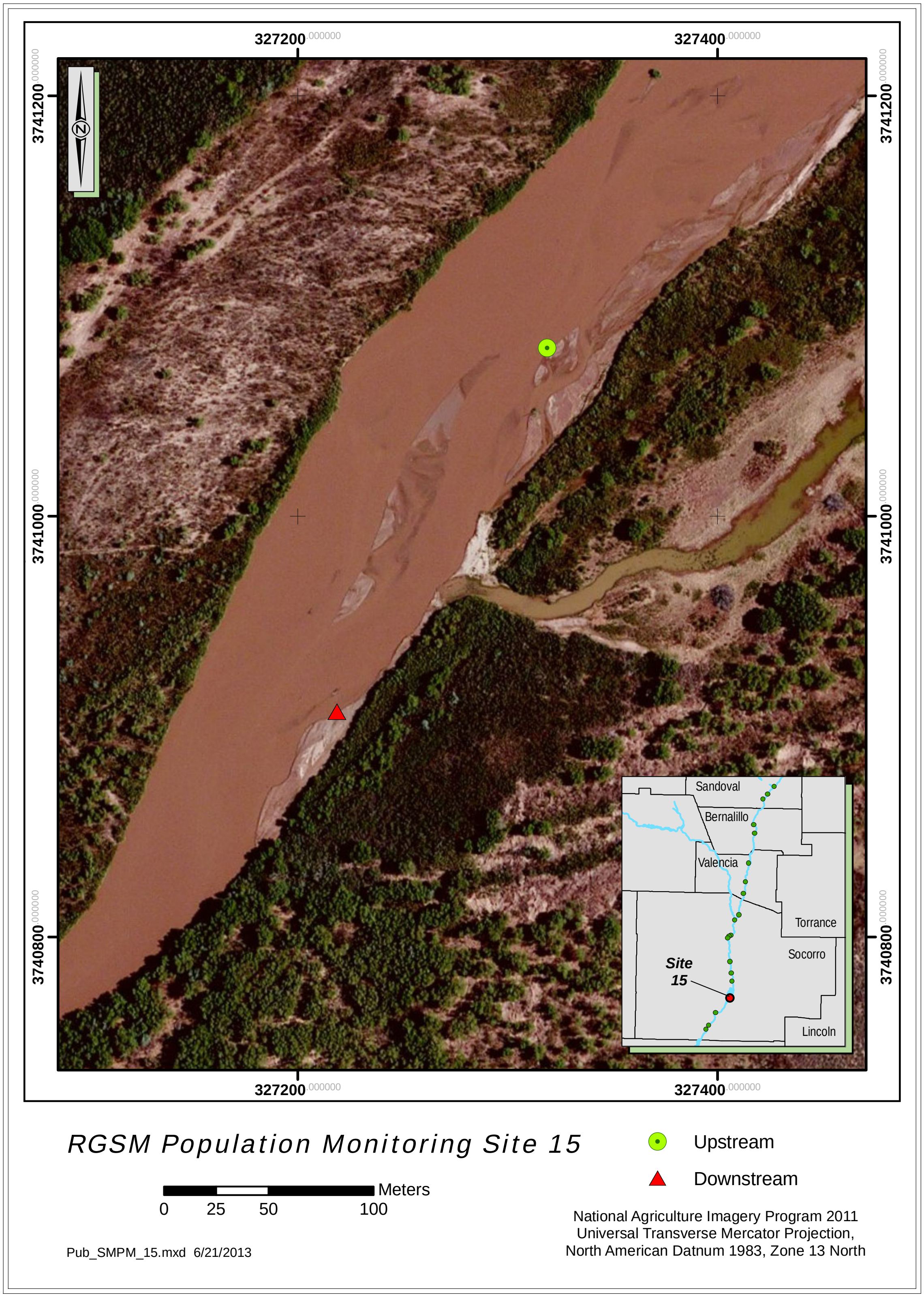

Figure A-17. Map of population monitoring Site 15 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

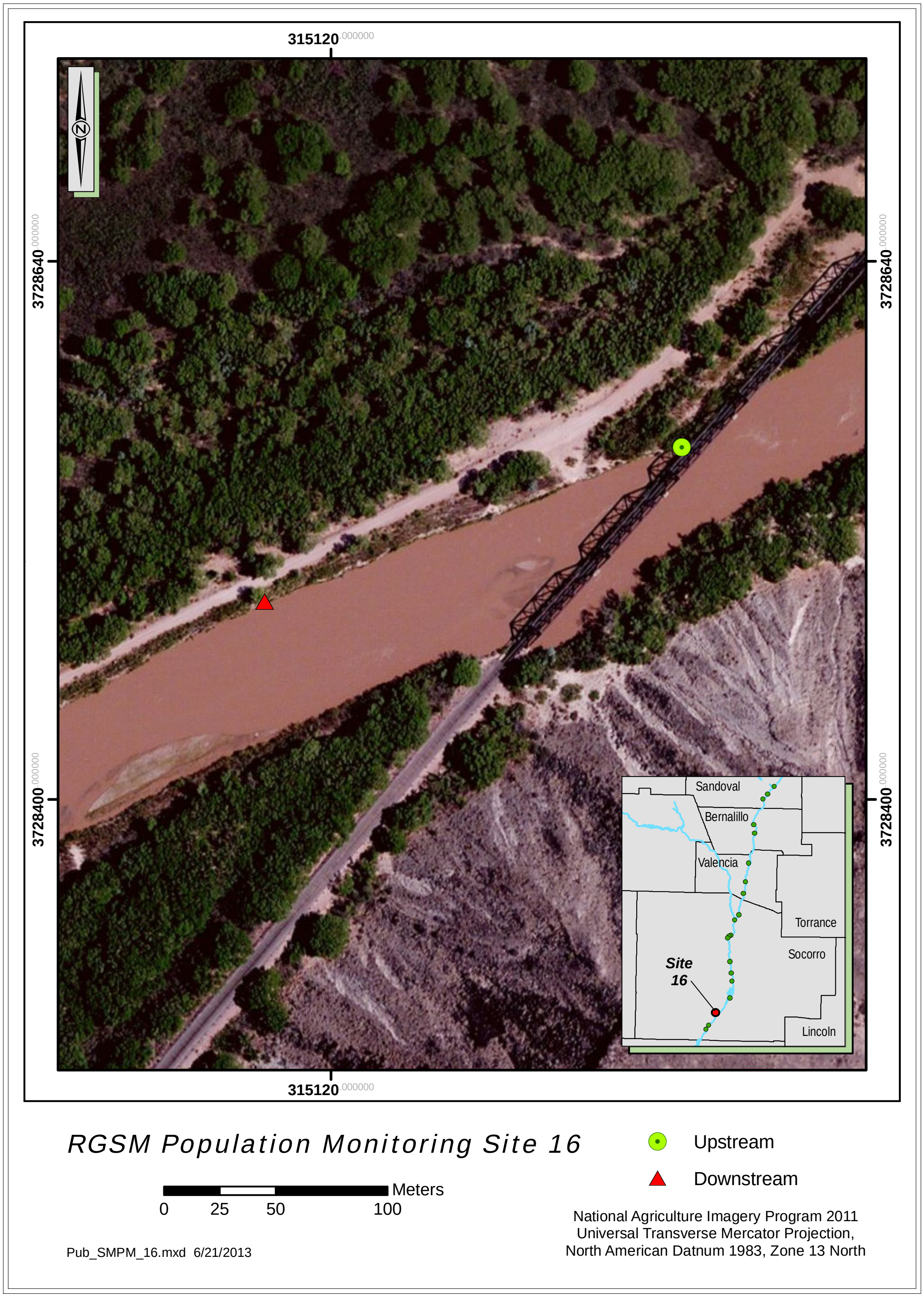

Figure A-18. Map of population monitoring Site 16 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

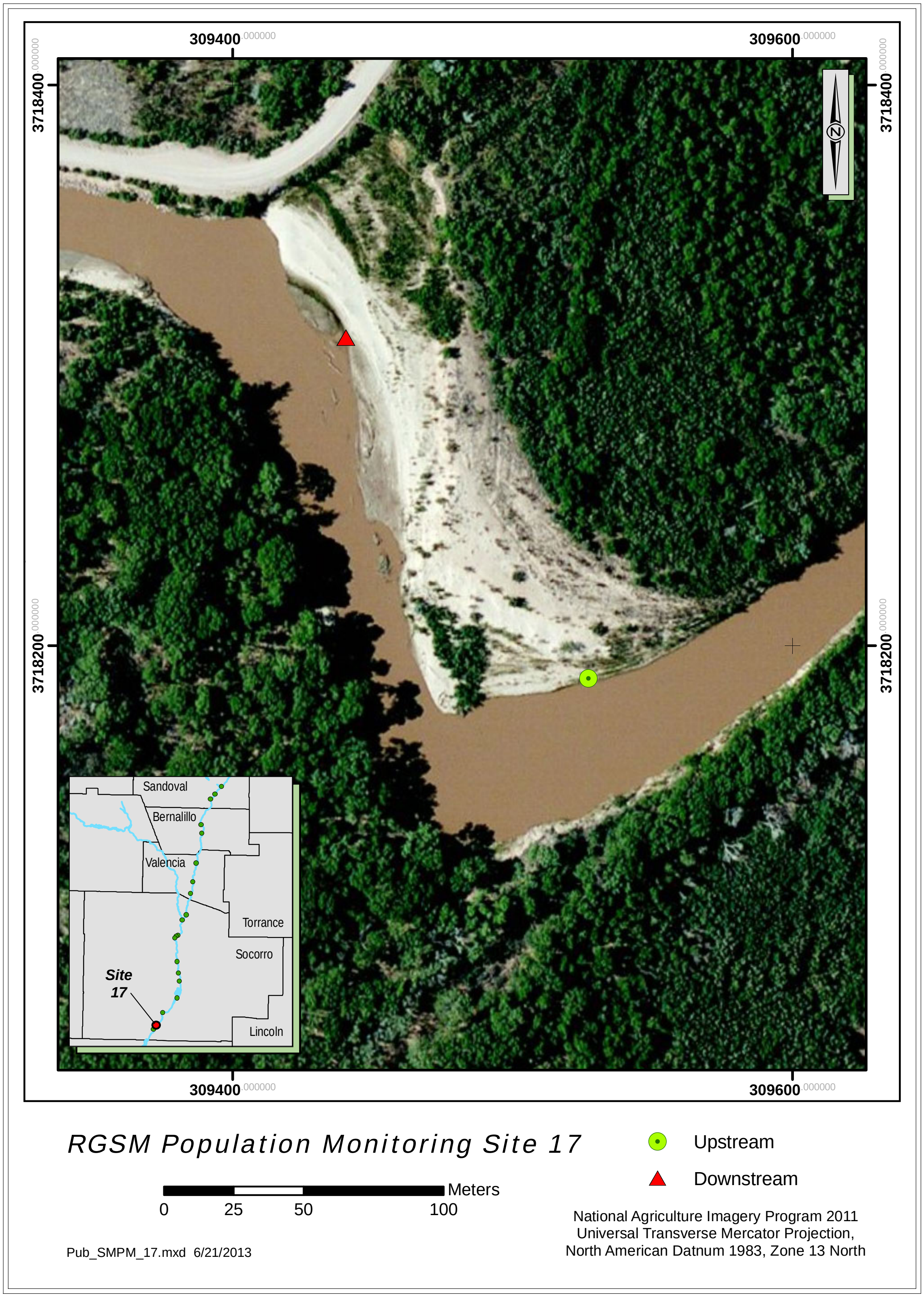

Figure A-19. Map of population monitoring Site 17 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

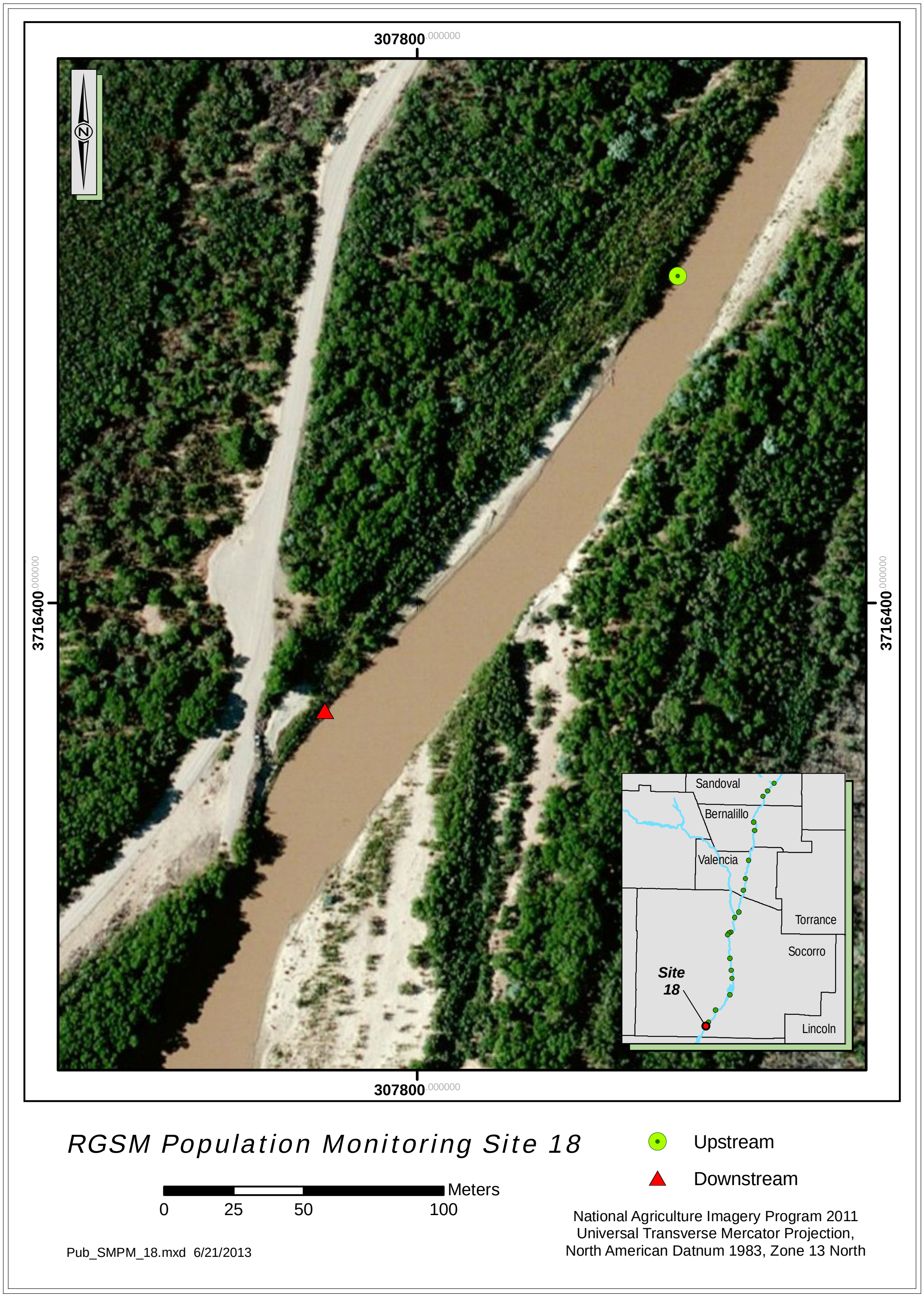

Figure A-20. Map of population monitoring Site 18 in the Middle Rio Grande, including typical upstream and downstream extent of sampling.

APPENDIX B (Rio Grande Silvery Minnow 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 among 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). Failure to detect a species during sampling does not 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 an organism by calculating the probability based on the detection history (i.e., previous information on presence-absence can be used to predict likelihood of non-detection vs. absence). An estimate of historical patterns of site occupancy can be used to complement data collected during the long-term Population Monitoring Program (1993–2013) for the Middle Rio Grande ichthyofaunal community. In contrast to population monitoring that documents trends over multiple time intervals (i.e., monthly or annual) for the entire ichthyofaunal community, this study has supplemented the Population Monitoring Program by providing annual estimates of Rio Grande Silvery Minnow site occupancy rates since 2005.

METHODS

Repeated sampling data from population monitoring efforts (multi-day sampling efforts during November [2005–2013]) 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 established for regular population monitoring efforts. 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 of Rio Grande Silvery Minnow enabled assessment of the likelihood of detecting the presence or absence of Rio Grande Silvery Minnow 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} meant that individuals were collected at a particular site 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 detection estimate (MacKenzie et al., 2006). A higher degree of consistency among 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 among days. Also, fish were nearly always collected at the same sampling sites over multiple days of sampling during past years (Dudley and Platania, 2013). 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 within a specific site was independent of species detection at other sites. The encounter history data from the 20 sampling sites over time allowed for a robust-design model of occupancy (MacKenzie et al. 2003) to estimate the probability of occupancy each year (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, age-2; each age-class was a separate attribute group [*g*]), with covariates of year (*y* = 2005–2013), and a discharge covariate (*d*) for approximate flow during sampling (from the nearest USGS gauging station). Models were considered that allowed detection probabilities to vary by site and reach. Likewise, 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. In addition to the basic parameter estimates ordered by the age-class variable, estimates of the probability of occupancy, by group and year, were also 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) for single sample locality surveys.

RESULTS

A multi-year statistical model based on patterns of occupancy was developed using long-term (2005–2013) sampling-site data (Table B-1 and Figure B-1). The minimum AIC_C model had constant occupancy (psi, ψ), extinction (epsilon, ε) varying by year (*y*), constant colonization (gamma, γ), and detection probability (*p*) varying by year and discharge (*d*). The group variable (*g*) was the age-class category (age-0, age-1, age-2, and all age-classes combined) and was included in all models. Estimates of the probability of extinction for all age-classes were significantly higher ($P < 0.05$) in 2011 and 2012 as compared with 2005–2009. Similarly, there was recent but steady decline in site occupancy probability for all age-classes combined, from 0.91 in 2010 to 0.09 in 2013 with a significant decline ($P < 0.05$) from 2010–2011 to 2013. The probability of colonization was 0.15 for all age-classes combined since there were several colonization events in 2013 as compared with 2012 (hence the population was not extinct since there was a non-zero estimate of occupancy probability and colonization probability). Estimates of the probability of colonization were highest for age-0 individuals (0.28) and lowest for age-1 individuals (0.06). Estimates of site occupancy probability varied among years and age-classes but were most variable for group/year combinations with fewer data (e.g., age-2 in 2012). Rio Grande Silvery Minnow detection probability estimates across years (for all sampling sites combined) were generally lowest during years when this species was rare (e.g., 2013) and highest when this species was more common (e.g., 2010; Table B-2).

Table B-1. Rio Grande Silvery Minnow site occupancy analysis among years for all sampling sites combined in the Middle Rio Grande based on repeated site sampling efforts in November (2005–2013). Model parameters: ψ = probability of occupancy, ε = probability of extinction, γ = probability of colonization, *p* = detection probability, *y* = year, *d* = discharge, and *g* = age-class.

RGSM Site Occupancy Models

Models	**AIC_C**	**Delta AIC_C**	**AIC_C Weights**	**Model Likelihood**	**Number of Parameters**	**Deviance**
A: {ψ(*g*) ε(*g+y*) γ(*g*) *p*(*g*y+d*)}	1746.32	0.00	0.99	1.00	56	1624.69
B: {ψ(*g*) ε(*g+y*) γ(*g+y*) *p*(*g*y+d*)}	1755.45	9.13	0.01	0.01	63	1617.16
C: {ψ(*g*) ε(*g+y*) γ(*g*) *p*(*g*y*)}	1758.10	11.78	0.00	0.00	55	1638.82
D: {ψ(*g*) ε(*g+y*) γ(*g+y*) *p*(*g*y*)}	1767.12	20.79	0.00	0.00	62	1631.22
E: {ψ(*g*) ε(*g*) γ(*g+y*) *p*(*g*y*)}	1776.57	30.25	0.00	0.00	55	1657.29

Parameter Estimates from Minimum AIC_C Model (A)

Parameter	**Estimate**	**SE**	**LCI**	**UCI**
ψ All Fish (2005)	1.00	0.00	0.91	1.00
ψ Age-0 (2005)	1.00	0.00	0.91	1.00
ψ Age-1 (2005)	0.94	0.08	0.72	1.00
ψ Age-2 (2005)	0.41	0.28	0.02	0.94
ε All Fish (2012)	1.00	0.00	1.00	1.00
ε Age-0 (2012)	1.00	0.00	1.00	1.00
ε Age-1 (2012)	1.00	0.00	0.85	1.00
ε Age-2 (2012)	1.00	0.00	1.00	1.00
γ All Fish (All Years)	0.15	0.09	0.04	0.39
γ Age-0 (All Years)	0.28	0.15	0.08	0.64
γ Age-1 (All Years)	0.06	0.05	0.00	0.21
γ Age-2 (All Years)	0.19	0.08	0.00	0.38

Derived estimates of ψ by Year (last four years) from Minimum AIC_C Model (A)

Group	**Year**	**Estimate**	**SE**	**LCI**	**UCI**
All Fish	2010	0.91	0.04	0.79	0.97
All Fish	2011	0.73	0.09	0.52	0.86
All Fish	2012	0.40	0.11	0.21	0.62
All Fish	2013	0.09	0.05	0.03	0.24
Age-0	2010	0.89	0.05	0.74	0.96
Age-0	2011	0.66	0.10	0.46	0.82
Age-0	2012	0.36	0.13	0.16	0.63
Age-0	2013	0.18	0.09	0.06	0.40
Age-1	2010	0.65	0.09	0.46	0.80
Age-1	2011	0.32	0.09	0.17	0.52
Age-1	2012	0.10	0.05	0.03	0.27
Age-1	2013	0.05	0.05	0.01	0.25
Age-2	2010	0.74	0.09	0.52	0.88
Age-2	2011	0.63	0.14	0.34	0.85
Age-2	2012	0.38	0.14	0.17	0.66
Age-2	2013	0.12	0.05	0.05	0.26

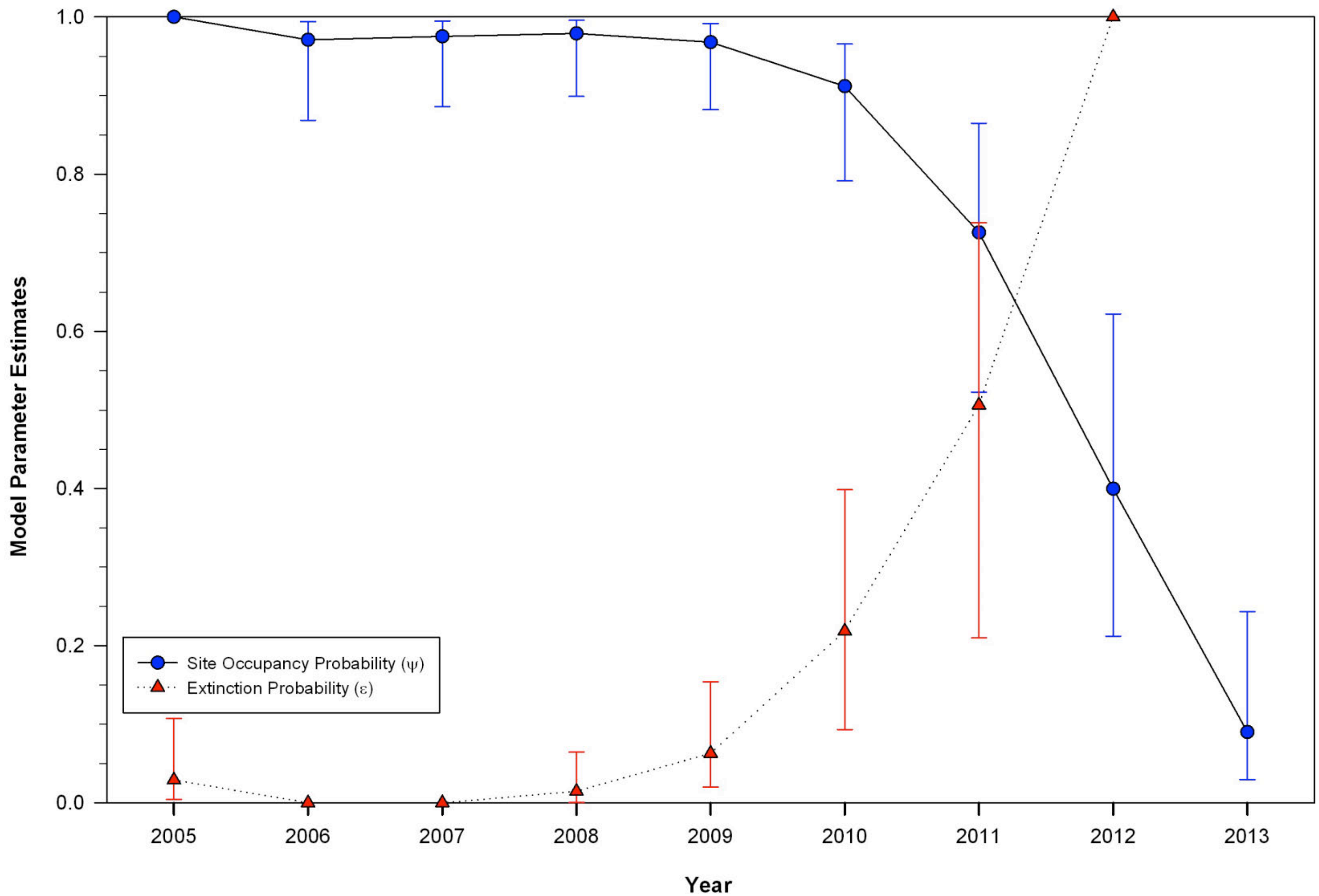

Figure B-1. Site occupancy model estimates (site occupancy (ψ) and extinction probabilities (ε)) for Rio Grande Silvery Minnow (all age-classes combined) based on repeated site sampling efforts from 2005 to 2013. Symbols indicate means and capped-bars represent 95% confidence intervals.

Table B-2. Rio Grande Silvery Minnow detection probability estimates among years (last four years) for all sampling sites combined in the Middle Rio Grande based on repeated site sampling efforts in November (2010–2013).

Detection Probability Estimates (last four years) from Minimum AIC$_c$ Model (A)

Group*	Estimate	SE	LCI	UCI
p 2010 All Day 1	0.8608	0.0409	0.7407	0.9177
p 2010 All Day 2	0.8637	0.0402	0.7399	0.9174
p 2010 All Day 3	0.8631	0.0404	0.7291	0.9137
p 2010 All Day 4	0.8587	0.0414	0.7293	0.9138
p 2010 Age-0 Day 1	0.8891	0.0399	0.7688	0.9439
p 2010 Age-0 Day 2	0.8915	0.0391	0.7680	0.9437
p 2010 Age-0 Day 3	0.8910	0.0393	0.7581	0.9411
p 2010 Age-0 Day 4	0.8873	0.0404	0.7583	0.9411
p 2010 Age-1 Day 1	0.7121	0.0596	0.5502	0.7960
p 2010 Age-1 Day 2	0.7172	0.0590	0.5491	0.7954
p 2010 Age-1 Day 3	0.7161	0.0591	0.5352	0.7876
p 2010 Age-1 Day 4	0.7086	0.0600	0.5355	0.7878
p 2010 Age-2 Day 1	0.3991	0.0666	0.2481	0.4988
p 2010 Age-2 Day 2	0.4050	0.0670	0.2472	0.4978
p 2010 Age-2 Day 3	0.4038	0.0669	0.2371	0.4861
p 2010 Age-2 Day 4	0.3950	0.0664	0.2373	0.4863
p 2011 All Day 1	0.7598	0.0539	0.5344	0.7951
p 2011 All Day 2	0.7432	0.0562	0.5344	0.7951
p 2011 All Day 3	0.7453	0.0559	0.5854	0.8207
p 2011 All Day 4	0.7511	0.0551	0.5827	0.8193
p 2011 Age-0 Day 1	0.7779	0.0536	0.5542	0.8163
p 2011 Age-0 Day 2	0.7622	0.0561	0.5542	0.8163
p 2011 Age-0 Day 3	0.7641	0.0558	0.6044	0.8400
p 2011 Age-0 Day 4	0.7697	0.0549	0.6017	0.8387
p 2011 Age-1 Day 1	0.6425	0.1329	0.2565	0.7875
p 2011 Age-1 Day 2	0.6219	0.1356	0.2565	0.7875
p 2011 Age-1 Day 3	0.6244	0.1353	0.2934	0.8158
p 2011 Age-1 Day 4	0.6316	0.1344	0.2913	0.8143
p 2011 Age-2 Day 1	0.1453	0.0645	0.0383	0.2740
p 2011 Age-2 Day 2	0.1346	0.0603	0.0383	0.2740
p 2011 Age-2 Day 3	0.1359	0.0608	0.0462	0.3125
p 2011 Age-2 Day 4	0.1396	0.0622	0.0457	0.3102
p 2012 All Day 1	0.4440	0.1285	0.1764	0.6308
p 2012 All Day 2	0.4419	0.1284	0.1761	0.6304
p 2012 All Day 3	0.4385	0.1282	0.1766	0.6311
p 2012 All Day 4	0.4348	0.1279	0.1726	0.6252
p 2012 Age-0 Day 1	0.0679	0.0552	0.0083	0.2679
p 2012 Age-0 Day 2	0.0674	0.0548	0.0083	0.2675
p 2012 Age-0 Day 3	0.0665	0.0542	0.0083	0.2681
p 2012 Age-0 Day 4	0.0656	0.0535	0.0081	0.2630
p 2012 Age-1 Day 1	0.4932	0.1919	0.1357	0.7836
p 2012 Age-1 Day 2	0.4911	0.1919	0.1355	0.7833
p 2012 Age-1 Day 3	0.4877	0.1918	0.1358	0.7838
p 2012 Age-1 Day 4	0.4839	0.1917	0.1326	0.7794
p 2012 Age-2 Day 1	0.2977	0.1147	0.0955	0.4850
p 2012 Age-2 Day 2	0.2960	0.1143	0.0954	0.4845
p 2012 Age-2 Day 3	0.2931	0.1136	0.0956	0.4852
p 2012 Age-2 Day 4	0.2900	0.1128	0.0934	0.4788
p 2013 All Day 1	0.3026	0.1818	0.0545	0.6369
p 2013 All Day 2	0.3036	0.1821	0.0544	0.6362
p 2013 All Day 3	0.3073	0.1833	0.0572	0.6479
p 2013 All Day 4	0.3124	0.1850	0.0569	0.6468
p 2013 Age-0 Day 1	0.2280	0.1742	0.0352	0.6019
p 2013 Age-0 Day 2	0.2288	0.1746	0.0351	0.6012
p 2013 Age-0 Day 3	0.2319	0.1763	0.0370	0.6134
p 2013 Age-0 Day 4	0.2361	0.1785	0.0368	0.6122
p 2013 Age-1 Day 1	0.0000	0.0000	0.0000	0.0000
p 2013 Age-1 Day 2	0.0000	0.0000	0.0000	0.0000
p 2013 Age-1 Day 3	0.0000	0.0000	0.0000	0.0000
p 2013 Age-1 Day 4	0.0000	0.0000	0.0000	0.0000
p 2013 Age-2 Day 1	0.0000	0.0000	0.0000	0.0000
p 2013 Age-2 Day 2	0.0000	0.0000	0.0000	0.0000
p 2013 Age-2 Day 3	0.0000	0.0000	0.0000	0.0000
p 2013 Age-2 Day 4	0.0000	0.0000	0.0000	0.0000

*Where *p* = detection probability and day is the sampling occasion sequence for a particular year.

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 (2005–2013). There are numerous benefits in being able to document the estimated site occupancy rate of species over time. Estimates of the probability of detection provide insight to patterns of site occupancy of Rio Grande Silvery Minnow both within and among sampling sites. Site occupancy models can subsequently be developed over time to incorporate changes in the probability of detection and the presence-absence patterns of a species at a particular site.

Site occupancy analyses, based on repeated sampling-site data (2005–2013), revealed that the most parsimonious model had constant occupancy and colonization, extinction varying by year, and detection probabilities varying by year and discharge (during November). One reason that detection probabilities varied with discharge could be that flows during November were unusually low in 2012, which was also a year with relatively low detection probabilities. However, it would be premature to draw inferences from this limited dataset since discharge during November sampling was similar across years with only a few exceptions (e.g., 2006 and 2012). 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 among the repeated sampling efforts. Parameter estimates from the model suggest that site occupancy was highest for age-0 fish but lower for age-1 and age-2 fish. However, the low number of all age-classes in 2013 individuals added notable variation to the estimates for these age-classes. Estimates of site occupancy indicated a precipitous decline (> 90%) in the number of sampling sites occupied by Rio Grande Silvery Minnow from 2005–2013.

Parameter estimates from the model could, however, change dramatically if there are sequential years of either persistently high or low flows, possibly leading to notable differences in Rio Grande Silvery Minnow population dynamics over time. Thus, the site occupancy, extinction, and colonization probabilities should be viewed only as an historical analysis of past data as opposed to a prediction of future trends. The site occupancy results can be used in combination with population monitoring results to provide a more complete understanding of the conservation status of Rio Grande Silvery Minnow. Specifically, the probability of extinction is a valuable metric by which to gauge the vulnerability of the population to decreasing numbers of individuals. A high probability of extinction combined with low estimated densities, as was observed in 2012, indicates multiple serious threats to the persistence of the species. It is well known that simply having large numbers of a particular species in an area doesn't ensure its long-term survival. 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 consistently ensure the presence of individuals over a broad geographical range. Changing environmental conditions can have rapid and severe impacts to Rio Grande Silvery Minnow. 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 year. Additionally, river drying during drought years has regularly resulted in the apparent 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. For these reasons, it is imperative that populations of Rio Grande Silvery Minnow are established at multiple locations within its current and historical range to help ensure its long-term persistence in the wild.

Multi-year statistical models suggest that site occupancy, extinction, and colonization probabilities will continue to have relatively large confidence intervals during years with few Rio Grande Silvery Minnow. The current number of sampling sites for the site occupancy analysis was chosen during 2005 when Rio Grande Silvery Minnow was abundant and present at all sites. While this sampling protocol was adequate during periods of relatively high abundance and presence at nearly all sites, the ability to precisely estimate site occupancy rates was compromised during periods of relatively low abundance and presence at only a fraction of the sampling sites, which also corresponded to lower detection probabilities. This uncertainty was compounded during drought years (e.g., 2012–2013) when individuals were only occasionally present at extremely low densities. Additional sampling sites would provide more precise estimates of site occupancy, extinction, and colonization probabilities, particularly during years with low estimated densities and an uncertain distribution of Rio Grande Silvery Minnow.

The success of this project will be evaluated annually, but insight into the efficacy of estimating site occupancy rates of Rio Grande Silvery Minnow will require a multi-year commitment. Data from future year's efforts will provide additional information that will supplement recent site occupancy analyses and furnish valuable information necessary to gauge recovery of Rio Grande Silvery Minnow in the Middle Rio Grande. Ultimately, those data will be used to evaluate progress towards meeting Rio Grande Silvery Minnow recovery goals, following both planned management actions and stochastic environmental events.

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APPENDIX C (Water Quality Summary)

Table C-1. Water quality* summary statistics [Mean (Standard Error)], by sampling site and reach, during the May to December 2013 population monitoring of Rio Grande Silvery Minnow.

REACH Sampling Site and Name	Sec.	Temp.	Sal.	D.O.	Con. T.	Con.S.	pH
ANGOSTURA REACH							
0 Angostura Dam	22.3 (5)	17.1 (1.3)	0.2 (0.1)	7.9 (0.4)	375.5 (77.7)	448.9 (109.7)	9 (0.1)
1 Bernalillo	18.6 (5.1)	17.1 (2.5)	0.2 (0)	8.2 (0.6)	346.5 (55)	401.6 (48.4)	8.9 (0.1)
2 Rio Rancho	14.1 (4.2)	17.6 (2.7)	0.2 (0)	8 (0.6)	375.8 (62)	413.7 (59.3)	8.9 (0.1)
3 Central Ave.	10.7 (3)	16.7 (2.2)	0.2 (0)	7.7 (0.6)	349.4 (44.1)	412 (42.1)	9 (0.1)
4 Rio Bravo Blvd.	9.4 (2.5)	15.4 (2.2)	0.2 (0)	8 (0.7)	348.3 (53.4)	421.5 (52.1)	9.2 (0.2)
ISLETA REACH							
5 Los Lunas	9.4 (3.2)	24.6 (3.5)	0.2 (0)	6.8 (0.5)	412.4 (80.7)	421.4 (72)	9 (0.2)
6 Belen	11.7 (3.1)	24.4 (3.7)	0.2 (0)	7.3 (0.5)	458.7 (42.2)	478.4 (17.5)	9.1 (0.2)
7 Jarales	12 (3.1)	24.9 (2.6)	0.3 (0)	8 (0.5)	556.5 (53.5)	553 (29.7)	9.2 (0.1)
8 Bernardo	9.1 (3.4)	22.3 (1.6)	0.2 (0)	7.4 (0.2)	478 (37.1)	503.1 (30.9)	9.2 (0)
9 La Joya	16 (7.1)	17.2 (2.1)	0.3 (0)	7.8 (0.3)	539.4 (69.9)	623 (60.3)	9.2 (0.2)
9.5 North of San Acacia	8.1 (2.8)	20.8 (3.1)	0.3 (0)	7.9 (0.8)	645.9 (116.7)	676.7 (89)	8.9 (0.2)
SAN ACACIA REACH							
10 San Acacia Dam	10.4 (2.6)	19.8 (2.1)	0.4 (0)	7.7 (0.5)	691.6 (82.5)	774.4 (70.6)	9 (0.2)
11 South of San Acacia	9.7 (2.7)	20.1 (3)	0.4 (0)	7.8 (0.6)	709.7 (112.9)	763.1 (84.6)	9 (0.2)
12 Socorro	10.9 (3.9)	18.6 (2.7)	0.4 (0.1)	8.1 (0.6)	759 (150.5)	830.4 (134.3)	8.9 (0.2)
13 North of San Antonio	5.8 (2)	16 (2.7)	0.4 (0.1)	8.7 (0.8)	728.2 (189.3)	850.6 (188.9)	9 (0.2)
14 San Antonio	5.2 (2)	20.6 (3.2)	0.3 (0)	8.5 (0.6)	574.7 (74.9)	617.5 (48.9)	9 (0.2)
15 South of San Antonio	3.7 (1.4)	19.4 (3.9)	0.3 (0)	8.2 (0.7)	573.7 (100.7)	618 (67.9)	8.8 (0.3)
16 San Marcial	9.7 (2.8)	20.5 (3.2)	0.4 (0.1)	8.2 (0.8)	800.5 (157.3)	852.5 (113.3)	8.9 (0.1)
17 South of San Marcial 1	10.6 (3.9)	19.3 (2.9)	0.4 (0)	8.1 (0.7)	785.7 (116.9)	846.1 (83.9)	8.9 (0.2)
18 South of San Marcial 2	12.1 (4.8)	17.9 (2.9)	0.5 (0)	8.1 (0.8)	824.2 (113.6)	929.5 (92.8)	8.9 (0.3)

*Water quality codes:
Sec. = Secchi depth (cm)
Temp. = Water Temperature (^{o}C)
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 (Ichthyofaunal Composition of Samples)

Ichthyofaunal Composition of the May to December 2013
Rio Grande Silvery Minnow Population Monitoring Samples

Monthly reports are available at:
http://www.middleriogrande.com/Default.aspx?tabid=273

Annual reports are available at:
http://www.asirllc.com/rgsm/

Rio Grande Silvery Minnow Population Monitoring
May 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, directly below Angostura Diversion Dam, Algodones. Site Number: 0
09 May 2013 **RKD13-058** River Mile: 209.7
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
R.K. Dudley, J.L. Hester Effort: 515.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1
76	*Pimephales promelas*	1
76	*Rhinichthys cataractae*	22
81	*Catostomus commersonii*	3

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo. Site Number: 1
09 May 2013 **RKD13-059** River Mile: 203.8
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Hester Effort: 538.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	25
76	*Platygobio gracilis*	67
76	*Rhinichthys cataractae*	6
81	*Catostomus commersonii*	5

Rio Grande Silvery Minnow Population Monitoring
May 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
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: 2
River Mile: 200.0
09 May 2013 **RKD13-060**
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Hester Effort: 515.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	21
76	*Pimephales promelas*	4
76	*Platygobio gracilis*	52
76	*Rhinichthys cataractae*	13
81	*Catostomus commersonii*	22

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque. Site Number: 3
09 May 2013 **RKD13-057** River Mile: 183.4
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Hester Effort: 531.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	41
76	*Cyprinus carpio*	7
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	27
81	*Catostomus commersonii*	4
93	*Ictalurus punctatus*	1

Rio Grande Silvery Minnow Population Monitoring
May 2013

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque. Site Number: 4
River Mile: 178.3
09 May 2013 **RKD13-056**
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
R.K. Dudley, W.H. Brandenburg, J.L. Hester Effort: 499.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	4
76	*Cyprinus carpio*	2
76	*Pimephales promelas*	38
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	29
93	*Ictalurus punctatus*	3

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas. Site Number: 5
08 May 2013 **RKD13-055** River Mile: 161.4
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 520.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	262
76	*Pimephales promelas*	7
81	*Catostomus commersonii*	3
93	*Ictalurus punctatus*	1

Rio Grande Silvery Minnow Population Monitoring
May 2013

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen. Site Number: 6
08 May 2013 **RKD13-054** River Mile: 151.5
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 491.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	339
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	478
81	*Carpiodes carpio*	3
81	*Catostomus commersonii*	3
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	52

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales. Site Number: 7
08 May 2013 **RKD13-053** River Mile: 143.2
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 475.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	593
76	*Pimephales promelas*	5
81	*Carpiodes carpio*	2
81	*Catostomus commersonii*	1
212	*Gambusia affinis*	16

Rio Grande Silvery Minnow Population Monitoring
May 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 60 bridge crossing, Bernardo. Site Number: 8
08 May 2013 **RKD13-052** River Mile: 130.6
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 493.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	769
76	*Pimephales promelas*	23
81	*Carpiodes carpio*	1
212	*Gambusia affinis*	85

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo. Site Number: 9
08 May 2013 **RKD13-051** River Mile: 127.0
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 508.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	521
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	16

Rio Grande Silvery Minnow Population Monitoring
May 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia — Site Number: 9.5
03 May 2013 — **RKD13-050** — River Mile: 116.8
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
M.A. Farrington, W.H. Brandenburg, K.R. Naegele — Effort: 480.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	29
76	*Hybognathus amarus**	2
76	*Platygobio gracilis*	12
81	*Catostomus commersonii*	4
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	17

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly below San Acacia Diversion Dam, San Acacia. — Site Number: 10
03 May 2013 — **RKD13-049** — River Mile: 116.2
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
M.A. Farrington, W.H. Brandenburg, K.R. Naegele — Effort: 461.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	199
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	8
76	*Pimephales promelas*	2
76	*Platygobio gracilis*	6
81	*Catostomus commersonii*	1
212	*Gambusia affinis*	6
294	*Lepomis macrochirus*	1

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

age-0:
age-1: 6
age-2: 2

Rio Grande Silvery Minnow Population Monitoring
May 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia. Site Number: 11
03 May 2013 **RKD13-048** River Mile: 114.6
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
M.A. Farrington, W.H. Brandenburg, K.R. Naegele Effort: 496.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	74
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	9
93	*Ictalurus punctatus*	7

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Site Number: 12
Socorro Wastewater Treatment Plant, Socorro. River Mile: 99.5
03 May 2013 **RKD13-047**
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
M.A. Farrington, W.H. Brandenburg, K.R. Naegele Effort: 505.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	84
212	*Gambusia affinis*	5

Rio Grande Silvery Minnow Population Monitoring
May 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing. Site Number: 13
03 May 2013 **RKD13-046** River Mile: 91.7
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
M.A. Farrington, W.H. Brandenburg, K.R. Naegele Effort: 511.6 sq. m

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

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 380 bridge crossing, San Antonio. Site Number: 14
02 May 2013 **RKD13-045** River Mile: 87.1
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
R.K. Dudley, M.A. Farrington, K.R. Naegele Effort: 496.2 sq. m

FAMILY		N
	No Fish Collected	

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters. Site Number: 15
02 May 2013 **RKD13-044** River Mile: 79.1
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
R.K. Dudley, M.A. Farrington, K.R. Naegele Effort: 465.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	14

Rio Grande Silvery Minnow Population Monitoring
May 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at San Marcial Railroad Bridge, San Marcial. Site Number: 16
02 May 2013 **RKD13-043** River Mile: 68.6
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
R.K. Dudley, M.A. Farrington, K.R. Naegele Effort: 534.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	36
76	*Hybognathus amarus**	1

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing Site Number: 17
02 May 2013 **RKD13-042** River Mile: 60.5
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
R.K. Dudley, M.A. Farrington, K.R. Naegele Effort: 506.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	53
76	*Cyprinus carpio*	1
212	*Gambusia affinis*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing Site Number: 18
02 May 2013 **RKD13-041** River Mile: 58.8
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
R.K. Dudley, M.A. Farrington, K.R. Naegele Effort: 506.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	32
76	*Cyprinus carpio*	1

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, directly below Angostura Diversion Dam, Algodones. Site Number: 0
05 June 2013 **RKD13-078** River Mile: 209.7
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 493.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	5
76	*Platygobio gracilis*	1
76	*Rhinichthys cataractae*	17
81	*Catostomus commersonii*	20

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo. Site Number: 1
05 June 2013 **RKD13-079** River Mile: 203.8
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 534.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	26
76	*Platygobio gracilis*	37
76	*Rhinichthys cataractae*	28
81	*Catostomus commersonii*	145

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
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: 2
River Mile: 200.0
05 June 2013 **RKD13-080**
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Hester, J.M. Barkstedt
Effort: 498.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	32
76	*Pimephales promelas*	5
76	*Platygobio gracilis*	4
76	*Rhinichthys cataractae*	9
81	*Catostomus commersonii*	75

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.
Site Number: 3
05 June 2013 **RKD13-077**
River Mile: 183.4
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Hester, J.M. Barkstedt
Effort: 552.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	9
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	13
81	*Carpiodes carpio*	11
81	*Catostomus commersonii*	48

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque. Site Number: 4
River Mile: 178.3
05 June 2013 **RKD13-076**
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 538.6 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	4
76	*Cyprinus carpio*	4
76	*Pimephales promelas*	21
93	*Ictalurus punctatus*	2

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas. Site Number: 5
04 June 2013 **RKD13-075** River Mile: 161.4
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
M.A. Farrington, J.L. Hester, K.R. Naegele Effort: 534.8 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	125
76	*Cyprinus carpio*	3
76	*Pimephales promelas*	51
81	*Catostomus commersonii*	2
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	8

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen. Site Number: 6
04 June 2013 **RKD13-074** River Mile: 151.5
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
M.A. Farrington, J.L. Hester, K.R. Naegele Effort: 515.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	243
76	*Cyprinus carpio*	3
76	*Pimephales promelas*	562
81	*Carpiodes carpio*	15
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	560

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales. Site Number: 7
04 June 2013 **RKD13-073** River Mile: 143.2
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
M.A. Farrington, J.L. Hester, K.R. Naegele Effort: 472.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	318
76	*Cyprinus carpio*	2
76	*Pimephales promelas*	93
81	*Carpiodes carpio*	5
81	*Catostomus commersonii*	19
212	*Gambusia affinis*	72
294	*Micropterus salmoides*	1

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 60 bridge crossing, Bernardo. Site Number: 8
04 June 2013 **RKD13-072** River Mile: 130.6
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
M.A. Farrington, J.L. Hester, K.R. Naegele Effort: 496.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	548
76	*Pimephales promelas*	142
81	*Catostomus commersonii*	4
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	43

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo. Site Number: 9
04 June 2013 **RKD13-071** River Mile: 127.0
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
M.A. Farrington, J.L. Hester, K.R. Naegele Effort: 473.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	324
76	*Cyprinus carpio*	2
76	*Pimephales promelas*	4
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	50

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia — Site Number: 9.5
03 June 2013 — **RKD13-070** — River Mile: 116.8
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
R.K. Dudley, W.H. Brandenburg, J.M. Barkstedt — Effort: 530.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	94
76	*Cyprinus carpio*	9
76	*Pimephales promelas*	89
76	*Platygobio gracilis*	97
81	*Carpiodes carpio*	96
81	*Catostomus commersonii*	30
212	*Gambusia affinis*	20

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly below San Acacia Diversion Dam, San Acacia. — Site Number: 10
03 June 2013 — **RKD13-069** — River Mile: 116.2
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
R.K. Dudley, W.H. Brandenburg, J.M. Barkstedt — Effort: 516.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	155
76	*Cyprinus carpio*	3
76	*Hybognathus amarus**	4
76	*Pimephales promelas*	35
76	*Platygobio gracilis*	6
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	6
81	*Ictiobus bubalus*	1
212	*Gambusia affinis*	54
294	*Micropterus salmoides*	1

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

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

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia. Site Number: 11
03 June 2013 **RKD13-068** River Mile: 114.6
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
R.K. Dudley, W.H. Brandenburg, J.M. Barkstedt Effort: 512.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	74
76	*Cyprinus carpio*	3
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	7
76	*Platygobio gracilis*	43
81	*Carpiodes carpio*	32
81	*Ictiobus bubalus*	2

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Site Number: 12
Socorro Wastewater Treatment Plant, Socorro. River Mile: 99.5
03 June 2013 **RKD13-067**
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
R.K. Dudley, W.H. Brandenburg, J.M. Barkstedt Effort: 510.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	17
76	*Cyprinus carpio*	39
76	*Pimephales promelas*	4
81	*Carpiodes carpio*	5
81	*Catostomus commersonii*	1
81	*Ictiobus bubalus*	9
212	*Gambusia affinis*	5

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing. Site Number: 13
03 June 2013 **RKD13-066** River Mile: 91.7
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
R.K. Dudley, W.H. Brandenburg, J.M. Barkstedt Effort: 495.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	8
76	*Cyprinus carpio*	123
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	12
81	*Ictiobus bubalus*	2
212	*Gambusia affinis*	2

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 380 bridge crossing, San Antonio. Site Number: 14
03 June 2013 **RKD13-065** River Mile: 87.1
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
M.A. Farrington, J.L. Hester, K.R. Naegele Effort: 455.8 sq. m

FAMILY		N
76	*Cyprinus carpio*	29
81	*Carpiodes carpio*	20
81	*Ictiobus bubalus*	48

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters. Site Number: 15
03 June 2013 **RKD13-064** River Mile: 79.1
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
M.A. Farrington, J.L. Hester, K.R. Naegele Effort: 458.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	9
76	*Cyprinus carpio*	102
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	2
81	*Carpiodes carpio*	14
81	*Ictiobus bubalus*	92
212	*Gambusia affinis*	1

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at San Marcial Railroad Bridge, San Marcial. Site Number: 16
03 June 2013 **RKD13-063** River Mile: 68.6
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
M.A. Farrington, J.L. Hester, K.R. Naegele Effort: 523.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	90
76	*Cyprinus carpio*	10
81	*Ictiobus bubalus*	72
212	*Gambusia affinis*	1

Rio Grande Silvery Minnow Population Monitoring
June 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing — Site Number: 17
03 June 2013 — **RKD13-062** — River Mile: 60.5
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
M.A. Farrington, J.L. Hester, K.R. Naegele — Effort: 483.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	128
76	*Cyprinus carpio*	21
81	*Ictiobus bubalus*	22
212	*Gambusia affinis*	26

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing — Site Number: 18
03 June 2013 — **RKD13-061** — River Mile: 58.8
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
M.A. Farrington, J.L. Hester, K.R. Naegele — Effort: 482.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	274
76	*Cyprinus carpio*	55
76	*Pimephales vigilax*	2
81	*Ictiobus bubalus*	30
212	*Gambusia affinis*	15

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, directly below Angostura Diversion Dam, Algodones. Site Number: 0
02 July 2013 **RKD13-098** River Mile: 209.7
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
M.A.Farrington, J.L.Hester, K.R.Naegele Effort: 545.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	11
76	*Platygobio gracilis*	1
76	*Rhinichthys cataractae*	47
81	*Catostomus commersonii*	45
212	*Gambusia affinis*	2

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo. Site Number: 1
02 July 2013 **RKD13-099** River Mile: 203.8
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
M.A.Farrington, J.L.Hester, K.R.Naegele Effort: 496.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	30
76	*Pimephales promelas*	52
76	*Platygobio gracilis*	19
76	*Rhinichthys cataractae*	23
81	*Catostomus commersonii*	124
212	*Gambusia affinis*	3
294	*Pomoxis annularis*	1

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing, at Rio Rancho
Site Number: 2
Wastewater Treatment Plant, Rio Rancho. River Mile: 200.0
02 July 2013 **RKD13-100**
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
M.A.Farrington, J.L.Hester, K.R.Naegele Effort: 499.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	28
76	*Pimephales promelas*	108
76	*Platygobio gracilis*	7
81	*Carpiodes carpio*	17
81	*Catostomus commersonii*	117

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque. Site Number: 3
02 July 2013 **RKD13-097** River Mile: 183.4
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
M.A.Farrington, J.L.Hester, K.R.Naegele Effort: 486.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	187
76	*Cyprinus carpio*	2
76	*Pimephales promelas*	15
76	*Platygobio gracilis*	9
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	738
81	*Catostomus commersonii*	14
294	*Micropterus salmoides*	1

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque. Site Number: 4
River Mile: 178.3
02 July 2013 **RKD13-096**
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
M.A.Farrington, J.L.Hester, K.R.Naegele Effort: 506.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	15
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	12
81	*Carpiodes carpio*	11
81	*Catostomus commersonii*	1
93	*Ameiurus natalis*	1

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas. Site Number: 5
03 July 2013 **RKD13-095** River Mile: 161.4
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
W.H.Brandenburg, J.L.Hester, J.M.Barkstedt Effort: 506.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	453
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	49
81	*Carpiodes carpio*	36
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	45

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

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

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen. Site Number: 6
03 July 2013 **RKD13-094** River Mile: 151.5
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
W.H.Brandenburg, J.L.Hester, J.M.Barkstedt Effort: 90.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1261
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	89
81	*Carpiodes carpio*	17
212	*Gambusia affinis*	34

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

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

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales. Site Number: 7
03 July 2013 **RKD13-093** River Mile: 143.2
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
W.H.Brandenburg, J.L.Hester, J.M.Barkstedt Effort: 517.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	677
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	116
81	*Carpiodes carpio*	15
212	*Gambusia affinis*	137

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

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

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 60 bridge crossing, Bernardo. — Site Number: 8
03 July 2013 — **RKD13-092** — River Mile: 130.6
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
W.H.Brandenburg, J.L.Hester, J.M.Barkstedt — Effort: 491.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1478
76	*Cyprinus carpio*	9
76	*Pimephales promelas*	64
76	*Platygobio gracilis*	19
81	*Carpiodes carpio*	18
212	*Gambusia affinis*	882

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo. — Site Number: 9
03 July 2013 — **RKD13-091** — River Mile: 127.0
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
W.H.Brandenburg, J.L.Hester, J.M.Barkstedt — Effort: 475.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	579
76	*Cyprinus carpio*	12
76	*Hybognathus amarus**	2
76	*Pimephales promelas*	118
81	*Carpiodes carpio*	55
81	*Catostomus commersonii*	15
93	*Ictalurus punctatus*	8
212	*Gambusia affinis*	570
294	*Micropterus salmoides*	2

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

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

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia — Site Number: 9.5
01 July 2013 — **RKD13-090** — River Mile: 116.8
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
R.K.Dudley, J.L.Hester, K.R.Naegele — Effort: 440.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	242
76	*Cyprinus carpio*	5
76	*Pimephales promelas*	56
76	*Platygobio gracilis*	38
81	*Carpiodes carpio*	18
212	*Gambusia affinis*	108

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly below San Acacia Diversion Dam, San Acacia. — Site Number: 10
01 July 2013 — **RKD13-089** — River Mile: 116.2
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
R.K.Dudley, J.L.Hester, K.R.Naegele — Effort: 479.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	173
76	*Cyprinus carpio*	86
76	*Hybognathus amarus**	7
76	*Pimephales promelas*	24
76	*Platygobio gracilis*	16
81	*Carpiodes carpio*	5
81	*Catostomus commersonii*	18
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	266

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

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

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia. Site Number: 11
01 July 2013 **RKD13-088** River Mile: 114.6
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
R.K.Dudley, J.L.Hester, K.R.Naegele Effort: 507.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	217
76	*Cyprinus carpio*	43
76	*Hybognathus amarus**	5
76	*Pimephales promelas*	31
76	*Platygobio gracilis*	26
81	*Carpiodes carpio*	155
81	*Ictiobus bubalus*	1
212	*Gambusia affinis*	34

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

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

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
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: 12
River Mile: 99.5
01 July 2013 **RKD13-087**
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
R.K.Dudley, J.L.Hester, K.R.Naegele
Effort: 495.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	661
76	*Cyprinus carpio*	113
76	*Hybognathus amarus**	28
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	152
81	*Catostomus commersonii*	1
81	*Ictiobus bubalus*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	52

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

age-0:
age-1: 28
age-2:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing.
Site Number: 13
01 July 2013 **RKD13-086**
River Mile: 91.7
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
R.K.Dudley, J.L.Hester, K.R.Naegele
Effort: sq. m

FAMILY		N
	Site Not Sampled (Site Dry)	

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 380 bridge crossing, San Antonio. Site Number: 14
01 July 2013 **RKD13-085** River Mile: 87.1
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
M.A.Farrington, W.H.Brandenburg, J.M.Barkstedt Effort: sq. m

FAMILY		N
	Site Not Sampled (Site Dry)	

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters. Site Number: 15
01 July 2013 **RKD13-084** River Mile: 79.1
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
M.A.Farrington, W.H.Brandenburg, J.M.Barkstedt Effort: sq. m

FAMILY		N
	Site Not Sampled (Site Dry)	

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at San Marcial Railroad Bridge, San Marcial. Site Number: 16
01 July 2013 **RKD13-083** River Mile: 68.6
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
M.A.Farrington, W.H.Brandenburg, J.M.Barkstedt Effort: 533.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	394
76	*Cyprinus carpio*	48
81	*Carpiodes carpio*	4
81	*Ictiobus bubalus*	13
212	*Gambusia affinis*	17

Rio Grande Silvery Minnow Population Monitoring
July 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing — Site Number: 17
01 July 2013 **RKD13-082** — River Mile: 60.5
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
M.A.Farrington, W.H.Brandenburg, J.M.Barkstedt — Effort: 484.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	501
76	*Cyprinus carpio*	37
76	*Pimephales promelas*	6
76	*Pimephales vigilax*	14
81	*Carpiodes carpio*	2
81	*Ictiobus bubalus*	20
212	*Gambusia affinis*	42

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing — Site Number: 18
01 July 2013 **RKD13-081** — River Mile: 58.8
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
M.A.Farrington, W.H.Brandenburg, J.M.Barkstedt — Effort: 498.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1342
76	*Cyprinus carpio*	21
76	*Pimephales promelas*	2
76	*Pimephales vigilax*	14
81	*Ictiobus bubalus*	17
212	*Gambusia affinis*	68

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, directly below Angostura Diversion Dam, Algodones. Site Number: 0
08 August 2013 **RKD13-118** River Mile: 209.7
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
W.H. Brandenburg, M.A. Farrington, J.M. Barkstedt Effort: 498.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	64
76	*Pimephales promelas*	35
76	*Platygobio gracilis*	12
76	*Rhinichthys cataractae*	205
81	*Catostomus commersonii*	29
93	*Ictalurus punctatus*	13
212	*Gambusia affinis*	3

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo. Site Number: 1
08 August 2013 **RKD13-119** River Mile: 203.8
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
W.H. Brandenburg, M.A. Farrington, J.M. Barkstedt Effort: 487.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	11
76	*Pimephales promelas*	21
76	*Platygobio gracilis*	89
76	*Rhinichthys cataractae*	43
81	*Catostomus commersonii*	7
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	24

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, ca. 4.0 miles downstream of US HWY 550 (formerly NM State HWY 44) bridge crossing, at Rio Rancho
Site Number: 2
Wastewater Treatment Plant, Rio Rancho. River Mile: 200.0
08 August 2013 **RKD13-120**
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
W.H. Brandenburg, M.A. Farrington, J.M. Barkstedt Effort: 502.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	20
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	33
76	*Platygobio gracilis*	11
76	*Rhinichthys cataractae*	3
81	*Catostomus commersonii*	30
93	*Ameiurus natalis*	4
93	*Ictalurus punctatus*	8
212	*Gambusia affinis*	23

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque. Site Number: 3
08 August 2013 **RKD13-117** River Mile: 183.4
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
W.H. Brandenburg, M.A. Farrington, J.M. Barkstedt Effort: 511.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	47
76	*Pimephales promelas*	33
76	*Platygobio gracilis*	8
76	*Rhinichthys cataractae*	1
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	2
93	*Ameiurus natalis*	6
93	*Ictalurus punctatus*	130
212	*Gambusia affinis*	15

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque. Site Number: 4
River Mile: 178.3
08 August 2013 **RKD13-116**
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
W.H. Brandenburg, M.A. Farrington, J.M. Barkstedt Effort: 489.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	15
76	*Pimephales promelas*	20
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	3
93	*Ameiurus natalis*	6
93	*Ictalurus punctatus*	47
212	*Gambusia affinis*	7

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas. Site Number: 5
07 August 2013 **RKD13-115** River Mile: 161.4
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 462.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	196
76	*Pimephales promelas*	31
76	*Platygobio gracilis*	3
81	*Carpiodes carpio*	2
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	14
212	*Gambusia affinis*	42

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen. Site Number: 6
07 August 2013 **RKD13-114** River Mile: 151.5
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 460.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	211
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	111
81	*Carpiodes carpio*	8
212	*Gambusia affinis*	250

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales. Site Number: 7
07 August 2013 **RKD13-113** River Mile: 143.2
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 501.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	410
76	*Cyprinus carpio*	8
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	164
81	*Carpiodes carpio*	2
81	*Catostomus commersonii*	2
93	*Ictalurus punctatus*	10
212	*Gambusia affinis*	164

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

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

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 60 bridge crossing, Bernardo. Site Number: 8
07 August 2013 **RKD13-112** River Mile: 130.6
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 489.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	339
76	*Cyprinus carpio*	2
76	*Pimephales promelas*	27
81	*Carpiodes carpio*	7
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	329

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo. Site Number: 9
07 August 2013 **RKD13-111** River Mile: 127.0
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 476.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	309
76	*Pimephales promelas*	57
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	141

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia | Site Number: 9.5
05 August 2013 **RKD13-110** | River Mile: 116.8
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
R.K. Dudley, J.L. Hester, J.M. Barkstedt | Effort: 546.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Platygobio gracilis*	39
81	*Carpiodes carpio*	1
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	8

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly below San Acacia Diversion Dam, San Acacia. | Site Number: 10
05 August 2013 **RKD13-109** | River Mile: 116.2
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
R.K. Dudley, J.L. Hester, J.M. Barkstedt | Effort: 455.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	5
76	*Cyprinus carpio*	2
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	18
93	*Ictalurus punctatus*	9

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia. Site Number: 11
05 August 2013 **RKD13-108** River Mile: 114.6
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 543.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	30
76	*Cyprinus carpio*	2
76	*Pimephales promelas*	5
76	*Platygobio gracilis*	26
81	*Carpiodes carpio*	1
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	20

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Site Number: 12
Socorro Wastewater Treatment Plant, Socorro. River Mile: 99.5
05 August 2013 **RKD13-107**
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 492.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	27
76	*Cyprinus carpio*	2
76	*Pimephales promelas*	5
76	*Pimephales vigilax*	1
81	*Carpiodes carpio*	12
93	*Ictalurus punctatus*	11
212	*Gambusia affinis*	1

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing. Site Number: 13
05 August 2013 **RKD13-106** River Mile: 91.7
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 513.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1
76	*Cyprinus carpio*	7
76	*Pimephales promelas*	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	12
212	*Gambusia affinis*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 380 bridge crossing, San Antonio. Site Number: 14
06 August 2013 **RKD13-105** River Mile: 87.1
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt Effort: 491.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	45
76	*Cyprinus carpio*	1
93	*Ictalurus punctatus*	8
212	*Gambusia affinis*	9

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters. Site Number: 15
06 August 2013 **RKD13-104** River Mile: 79.1
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt Effort: 491.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	39
76	*Cyprinus carpio*	8
76	*Hybognathus amarus**	1
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	6

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at San Marcial Railroad Bridge, San Marcial. Site Number: 16
06 August 2013 **RKD13-103** River Mile: 68.6
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt Effort: 485.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	262
76	*Cyprinus carpio*	3
76	*Pimephales promelas*	1
93	*Ictalurus punctatus*	6
212	*Gambusia affinis*	5

Rio Grande Silvery Minnow Population Monitoring
August 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing — Site Number: 17
06 August 2013 — **RKD13-102** — River Mile: 60.5
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt — Effort: 484.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	387
76	*Cyprinus carpio*	12
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	2
76	*Pimephales vigilax*	18
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	6
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	16
212	*Gambusia affinis*	66

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing — Site Number: 18
06 August 2013 — **RKD13-101** — River Mile: 58.8
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt — Effort: 515.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	218
76	*Cyprinus carpio*	12
76	*Pimephales promelas*	5
76	*Pimephales vigilax*	9
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	9
212	*Gambusia affinis*	48

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, directly below Angostura Diversion Dam, Algodones. Site Number: 0
12 September 2013 **RKD13-138** River Mile: 209.7
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 483.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	100
76	*Pimephales promelas*	72
76	*Platygobio gracilis*	22
76	*Rhinichthys cataractae*	212
81	*Catostomus commersonii*	9
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	64
212	*Gambusia affinis*	2

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo. Site Number: 1
12 September 2013 **RKD13-139** River Mile: 203.8
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 535.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	30
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	31
76	*Platygobio gracilis*	147
76	*Rhinichthys cataractae*	190
81	*Catostomus commersonii*	6
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	9
212	*Gambusia affinis*	87

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
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: 2
River Mile: 200.0
12 September 2013 **RKD13-140**
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Hester, J.M. Barkstedt
Effort: 504.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	87
76	*Pimephales promelas*	28
76	*Platygobio gracilis*	22
76	*Rhinichthys cataractae*	5
81	*Catostomus commersonii*	19
93	*Ictalurus punctatus*	118
212	*Gambusia affinis*	36

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque. Site Number: 3
12 September 2013 **RKD13-137** River Mile: 183.4
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Hester, J.M. Barkstedt
Effort: 504.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	61
76	*Cyprinus carpio*	11
76	*Pimephales promelas*	38
76	*Platygobio gracilis*	25
76	*Rhinichthys cataractae*	4
81	*Carpiodes carpio*	1
81	*Catostomus commersonii*	3
93	*Ameiurus natalis*	2
93	*Ictalurus punctatus*	47
212	*Gambusia affinis*	16

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque. Site Number: 4
River Mile: 178.3
12 September 2013 **RKD13-136**
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 480.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	146
76	*Cyprinus carpio*	10
76	*Pimephales promelas*	60
76	*Platygobio gracilis*	4
81	*Carpiodes carpio*	2
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	50
212	*Gambusia affinis*	17

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas. Site Number: 5
11 September 2013 **RKD13-135** River Mile: 161.4
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt Effort: 468.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	353
76	*Pimephales promelas*	18
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	10
212	*Gambusia affinis*	94

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen. Site Number: 6
11 September 2013 **RKD13-134** River Mile: 151.5
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt Effort: 469.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	758
76	*Pimephales promelas*	243
81	*Carpiodes carpio*	92
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	18
212	*Gambusia affinis*	107

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales. Site Number: 7
11 September 2013 **RKD13-133** River Mile: 143.2
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt Effort: 494.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	826
76	*Cyprinus carpio*	4
76	*Pimephales promelas*	27
81	*Carpiodes carpio*	4
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	20
212	*Gambusia affinis*	247

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 60 bridge crossing, Bernardo. Site Number: 8
11 September 2013 **RKD13-132** River Mile: 130.6
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt Effort: 502.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	991
76	*Cyprinus carpio*	1
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	58
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
93	*Ameiurus melas*	1
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	257

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo. Site Number: 9
11 September 2013 **RKD13-131** River Mile: 127.0
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
W.H. Brandenburg, J.L. Hester, J.M. Barkstedt Effort: 484.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	321
76	*Pimephales promelas*	38
81	*Carpiodes carpio*	1
93	*Ameiurus melas*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	59

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia — Site Number: 9.5
09 September 2013 — **RKD13-130** — River Mile: 116.8
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
R.K. Dudley, J.L. Hester, J.M. Barkstedt — Effort: 547.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	99
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	8
93	*Ameiurus natalis*	2
212	*Gambusia affinis*	36

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly below San Acacia Diversion Dam, San Acacia. — Site Number: 10
09 September 2013 — **RKD13-129** — River Mile: 116.2
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
R.K. Dudley, J.L. Hester, J.M. Barkstedt — Effort: 433.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	92
76	*Hybognathus amarus**	2
76	*Pimephales promelas*	26
76	*Platygobio gracilis*	21
93	*Ictalurus punctatus*	30
212	*Gambusia affinis*	2

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

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

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia. Site Number: 11
09 September 2013 **RKD13-128** River Mile: 114.6
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 532.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	27
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	10
93	*Ictalurus punctatus*	13
212	*Gambusia affinis*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
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: 12
River Mile: 99.5
09 September 2013 **RKD13-127**
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 485.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	58
76	*Cyprinus carpio*	6
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	6
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	14
93	*Ameiurus natalis*	1
93	*Ictalurus punctatus*	12
212	*Gambusia affinis*	3

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

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

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing. Site Number: 13
09 September 2013 **RKD13-126** River Mile: 91.7
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
R.K. Dudley, J.L. Hester, J.M. Barkstedt Effort: 480.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	36
76	*Cyprinus carpio*	2
93	*Ictalurus punctatus*	16
212	*Gambusia affinis*	4

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 380 bridge crossing, San Antonio. Site Number: 14
10 September 2013 **RKD13-125** River Mile: 87.1
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
M.A. Farrington, J.L. Hester, J.M. Barkstedt Effort: 238.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	2
81	*Carpiodes carpio*	2

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters. Site Number: 15
10 September 2013 **RKD13-124** River Mile: 79.1
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
M.A. Farrington, J.L. Hester, J.M. Barkstedt Effort: 525.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at San Marcial Railroad Bridge, San Marcial. Site Number: 16
10 September 2013 **RKD13-123** River Mile: 68.6
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
M.A. Farrington, J.L. Hester, J.M. Barkstedt Effort: 482.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	186
76	*Pimephales vigilax*	3
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	9

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing Site Number: 17
10 September 2013 **RKD13-122** River Mile: 60.5
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
M.A. Farrington, J.L. Hester, J.M. Barkstedt Effort: 522.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	389
76	*Pimephales promelas*	1
76	*Pimephales vigilax*	1
93	*Ictalurus punctatus*	6
212	*Gambusia affinis*	70

Rio Grande Silvery Minnow Population Monitoring
September 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing — Site Number: 18
10 September 2013 **RKD13-121** — River Mile: 58.8
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
M.A. Farrington, J.L. Hester, J.M. Barkstedt — Effort: 536.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	177
76	*Pimephales vigilax*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	65

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, directly below Angostura Diversion Dam, Algodones. Site Number: 0
10 October 2013 **RKD13-158** River Mile: 209.7
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 501.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	101
76	*Gila pandora*	1
76	*Pimephales promelas*	39
76	*Platygobio gracilis*	6
76	*Rhinichthys cataractae*	242
81	*Catostomus commersonii*	8
93	*Ictalurus punctatus*	18

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo. Site Number: 1
10 October 2013 **RKD13-159** River Mile: 203.8
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 556.2 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1
76	*Pimephales promelas*	6
76	*Platygobio gracilis*	26
76	*Rhinichthys cataractae*	42
81	*Catostomus commersonii*	7
93	*Ictalurus punctatus*	13
212	*Gambusia affinis*	1

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
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: 2
River Mile: 200.0
10 October 2013 **RKD13-160**
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
R.K. Dudley, J.L. Hester, R.E. Grey
Effort: 501.4 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	81
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	41
76	*Platygobio gracilis*	32
76	*Rhinichthys cataractae*	29
81	*Catostomus commersonii*	2
93	*Ictalurus punctatus*	55
212	*Gambusia affinis*	40

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque.
Site Number: 3
10 October 2013 **RKD13-157**
River Mile: 183.4
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Hester, R.E. Grey
Effort: 535.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	30
76	*Pimephales promelas*	9
76	*Platygobio gracilis*	15
76	*Rhinichthys cataractae*	1
93	*Ameiurus natalis*	2
93	*Ictalurus punctatus*	64
212	*Gambusia affinis*	27

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque. Site Number: 4
River Mile: 178.3
10 October 2013 **RKD13-156**
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 485.7 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	40
76	*Cyprinus carpio*	2
76	*Pimephales promelas*	20
76	*Platygobio gracilis*	3
81	*Catostomus commersonii*	8
93	*Ictalurus punctatus*	33
212	*Gambusia affinis*	114

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas. Site Number: 5
09 October 2013 **RKD13-155** River Mile: 161.4
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
R.K. Dudley, J.M. Barkstedt, R.E. Grey Effort: 499.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	199
76	*Pimephales promelas*	16
76	*Platygobio gracilis*	1
76	*Rhinichthys cataractae*	1
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	14

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen. Site Number: 6
09 October 2013 **RKD13-154** River Mile: 151.5
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
R.K. Dudley, J.M. Barkstedt, R.E. Grey Effort: 496.6 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	259
76	*Pimephales promelas*	55
76	*Rhinichthys cataractae*	1
93	*Ictalurus punctatus*	2
212	*Gambusia affinis*	227

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales. Site Number: 7
09 October 2013 **RKD13-153** River Mile: 143.2
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
R. K. Dudley, J.M. Barkstedt, R.E. Grey Effort: 495.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	841
76	*Cyprinus carpio*	1
76	*Pimephales promelas*	91
81	*Carpiodes carpio*	3
93	*Ictalurus punctatus*	4
212	*Gambusia affinis*	191

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 60 bridge crossing, Bernardo. Site Number: 8
08 October 2013 **RKD13-152** River Mile: 130.6
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 512.9 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	424
76	*Pimephales promelas*	8
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	292
294	*Pomoxis annularis*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo. Site Number: 9
09 October 2013 **RKD13-151** River Mile: 127.0
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
R.K. Dudley, J.M. Barkstedt, R.E. Grey Effort: 545.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	464
76	*Pimephales promelas*	16
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	1
212	*Gambusia affinis*	36

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia — Site Number: 9.5
21 October 2013 **RKD13-150** River Mile: 116.8
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
R.K. Dudley, J.L. Hester, R.E. Grey — Effort: 558.2 sq. m

FAMILY		**N**
76	*Platygobio gracilis*	19

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly below San Acacia Diversion Dam, San Acacia. — Site Number: 10
08 October 2013 **RKD13-149** River Mile: 116.2
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
R.K. Dudley, J.L. Hester, R.E. Grey — Effort: 472.0 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	11
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	7
76	*Rhinichthys cataractae*	1
212	*Gambusia affinis*	3

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

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

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia. Site Number: 11
08 October 2013 **RKD13-148** River Mile: 114.6
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 492.7 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	18
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	12
93	*Ictalurus punctatus*	18
212	*Gambusia affinis*	6

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Site Number: 12
Socorro Wastewater Treatment Plant, Socorro. River Mile: 99.5
08 October 2013 **RKD13-147**
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 545.2 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	92
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	2

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing. Site Number: 13
08 October 2013 **RKD13-146** River Mile: 91.7
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 536.2 sq. m

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

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 380 bridge crossing, San Antonio. Site Number: 14
07 October 2013 **RKD13-145** River Mile: 87.1
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
R.K. Dudley, J.L. Hester, J.M. Barkstedt, R.E. Grey Effort: 501.1 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	37
76	*Platygobio gracilis*	1
93	*Ictalurus punctatus*	1

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters. Site Number: 15
21 October 2013 **RKD13-144** River Mile: 79.1
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 518.1 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	8
76	*Hybognathus amarus**	1
76	*Pimephales promelas*	2
81	*Carpiodes carpio*	1
212	*Gambusia affinis*	3

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at San Marcial Railroad Bridge, San Marcial. Site Number: 16
07 October 2013 **RKD13-143** River Mile: 68.6
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
R.K. Dudley, J.L. Hester, J.M. Barkstedt, R.E. Grey Effort: 448.1 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	198
76	*Cyprinus carpio*	1
76	*Platygobio gracilis*	1
212	*Gambusia affinis*	1

Rio Grande Silvery Minnow Population Monitoring
October 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing — Site Number: 17
07 October 2013 — **RKD13-142** — River Mile: 60.5
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
R.K. Dudley, J.L. Hester, J.M. Barkstedt, R.E. Grey — Effort: 492.0 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	240
76	*Pimephales vigilax*	4
76	*Platygobio gracilis*	1
212	*Gambusia affinis*	4

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing — Site Number: 18
07 October 2013 — **RKD13-141** — River Mile: 58.8
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
R.K. Dudley, J.L. Hester, J.M. Barkstedt, R.E. Grey — Effort: 507.0 sq. m

FAMILY		**N**
76	*Cyprinella lutrensis*	183
76	*Cyprinus carpio*	1
76	*Pimephales vigilax*	5
93	*Ictalurus punctatus*	2

Rio Grande Silvery Minnow Population Monitoring
December 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, directly below Angostura Diversion Dam, Algodones. Site Number: 0
05 December 2013 **RKD13-258** River Mile: 209.7
UTM Easting: 363811 UTM Northing: 3916006 Zone: 13 Quad: San Felipe Pueblo
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt Effort: 561.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	1
76	*Platygobio gracilis*	1
76	*Rhinichthys cataractae*	8
93	*Ictalurus punctatus*	1

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
Rio Grande, at US HWY 550 (formerly NM State HWY 44) bridge crossing, Bernalillo. Site Number: 1
05 December 2013 **RKD13-259** River Mile: 203.8
UTM Easting: 358543 UTM Northing: 3909722 Zone: 13 Quad: Bernalillo
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt Effort: 610.5 sq. m

FAMILY		N
76	*Hybognathus amarus**	42
76	*Platygobio gracilis*	12
93	*Ictalurus punctatus*	1

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

age-0: 42
age-1:
age-2:

Rio Grande Silvery Minnow Population Monitoring
December 2013

NEW MEXICO: SANDOVAL Co., RIO GRANDE Drainage
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: 2
River Mile: 200.0
05 December 2013 **RKD13-260**
UTM Easting: 354772 UTM Northing: 3905355 Zone: 13 Quad: Bernalillo
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt Effort: 558.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	3
76	*Hybognathus amarus**	17
76	*Pimephales promelas*	3
76	*Platygobio gracilis*	40
81	*Catostomus commersonii*	1
283	*Morone chrysops*	1
294	*Pomoxis annularis*	1

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

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

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Central Avenue bridge crossing (US HWY 66), Albuquerque. Site Number: 3
05 December 2013 **RKD13-257** River Mile: 183.4
UTM Easting: 346840 UTM Northing: 3884094 Zone: 13 Quad: Albuquerque West
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt Effort: 568.8 sq. m

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

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

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

Rio Grande Silvery Minnow Population Monitoring
December 2013

NEW MEXICO: BERNALILLO Co., RIO GRANDE Drainage
Rio Grande, at Rio Bravo Blvd. Bridge crossing (NM State HWY 500) crossing, Albuquerque. Site Number: 4
River Mile: 178.3
05 December 2013 **RKD13-256**
UTM Easting: 347554 UTM Northing: 3877163 Zone: 13 Quad: Albuquerque West
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt Effort: 594.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	6
76	*Hybognathus amarus**	5
76	*Pimephales promelas*	6
76	*Platygobio gracilis*	6
93	*Ictalurus punctatus*	4
294	*Pomoxis annularis*	1

Hybognathus amarus **by age class:**

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

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, at Los Lunas Bridge crossing (NM State HWY 49), Los Lunas. Site Number: 5
05 December 2013 **RKD13-255** River Mile: 161.4
UTM Easting: 342898 UTM Northing: 3852531 Zone: 13 Quad: Los Lunas
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 542.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	76
76	*Hybognathus amarus**	11
76	*Pimephales promelas*	5
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	5
212	*Gambusia affinis*	4

Hybognathus amarus **by age class:**

age-0: 11
age-1:
age-2:

Rio Grande Silvery Minnow Population Monitoring
December 2013

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 1.0 miles upstream of NM State HWY 309/6 bridge crossing, Belen. Site Number: 6
05 December 2013 **RKD13-254** River Mile: 151.5
UTM Easting: 339972 UTM Northing: 3837061 Zone: 13 Quad: Tome
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 509.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	105
76	*Hybognathus amarus**	3
76	*Pimephales promelas*	28
212	*Gambusia affinis*	8
294	*Pomoxis annularis*	2

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

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

NEW MEXICO: VALENCIA Co., RIO GRANDE Drainage
Rio Grande, ca. 2.2 miles upstream of NM State HWY 346 bridge crossing, Jarales. Site Number: 7
05 December 2013 **RKD13-253** River Mile: 143.2
UTM Easting: 338136 UTM Northing: 3827329 Zone: 13 Quad: Veguita
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 550.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	238
76	*Pimephales promelas*	30
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	3
212	*Gambusia affinis*	3

Rio Grande Silvery Minnow Population Monitoring
December 2013

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 60 bridge crossing, Bernardo. Site Number: 8
05 December 2013 **RKD13-252** River Mile: 130.6
UTM Easting: 334604 UTM Northing: 3809726 Zone: 13 Quad: Abeytas
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 586.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	153
76	*Pimephales promelas*	5
212	*Gambusia affinis*	8

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 3.5 miles downstream of the US HWY 60 bridge crossing, Bernardo. Site Number: 9
05 December 2013 **RKD13-251** River Mile: 127.0
UTM Easting: 331094 UTM Northing: 3805229 Zone: 13 Quad: Abeytas
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 502.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	229
76	*Hybognathus amarus**	9
76	*Pimephales promelas*	14
76	*Platygobio gracilis*	1
81	*Carpiodes carpio*	1
212	*Gambusia affinis*	42

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

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

Rio Grande Silvery Minnow Population Monitoring
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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 0.6 miles upstream of San Acacia Diversion Dam, San Acacia — Site Number: 9.5
04 December 2013 — **RKD13-250** — River Mile: 116.8
UTM Easting: 327902 UTM Northing: 3792603 Zone: 13 Quad: La Joya
R.K. Dudley, J.L. Hester, R.E. Grey — Effort: 606.8 sq. m

FAMILY		N
76	*Platygobio gracilis*	4
212	*Gambusia affinis*	1

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly below San Acacia Diversion Dam, San Acacia. — Site Number: 10
04 December 2013 — **RKD13-249** — River Mile: 116.2
UTM Easting: 326162 UTM Northing: 3791977 Zone: 13 Quad: San Acacia
R.K. Dudley, J.L. Hester, R.E. Grey — Effort: 561.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	41
76	*Pimephales promelas*	20
76	*Platygobio gracilis*	7
93	*Ictalurus punctatus*	23

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 1.5 miles downstream of San Acacia Diversion Dam, San Acacia. Site Number: 11
04 December 2013 **RKD13-248** River Mile: 114.6
UTM Easting: 325263 UTM Northing: 3790442 Zone: 13 Quad: Lemitar
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 639.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	15
76	*Hybognathus amarus**	51
76	*Pimephales promelas*	1
76	*Platygobio gracilis*	23
93	*Ictalurus punctatus*	5

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, east of Socorro, 0.5 miles upstream of Socorro Low Flow Conveyance Channel bridge and east just upstream of Site Number: 12
Socorro Wastewater Treatment Plant, Socorro. River Mile: 99.5
04 December 2013 **RKD13-247**
UTM Easting: 327097 UTM Northing: 3771043 Zone: 13 Quad: Loma de las Canas
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 607.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	123
76	*Hybognathus amarus**	46
76	*Pimephales promelas*	4
76	*Pimephales vigilax*	2
76	*Platygobio gracilis*	2
81	*Carpiodes carpio*	3
93	*Ictalurus punctatus*	2

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

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

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 4.0 miles upstream of U.S. 380 bridge crossing. Site Number: 13
04 December 2013 **RKD13-246** River Mile: 91.7
UTM Easting: 328140 UTM Northing: 3761283 Zone: 13 Quad: San Antonio
R.K. Dudley, J.L. Hester, R.E. Grey Effort: 622.3 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	18
76	*Cyprinus carpio*	2
76	*Hybognathus amarus**	7

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

age-0: 7
age-1:
age-2:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at US HWY 380 bridge crossing, San Antonio. Site Number: 14
04 December 2013 **RKD13-245** River Mile: 87.1
UTM Easting: 328914 UTM Northing: 3754471 Zone: 13 Quad: San Antonio
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt Effort: 625.5 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	47
76	*Hybognathus amarus**	5
76	*Platygobio gracilis*	16
81	*Carpiodes carpio*	2
93	*Ictalurus punctatus*	4

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

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

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, directly east of Bosque del Apache National Wildlife Refuge Headquarters. Site Number: 15
04 December 2013 **RKD13-244** River Mile: 79.1
UTM Easting: 327055 UTM Northing: 3740839 Zone: 13 Quad: San Antonio SE
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt Effort: 556.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	4
76	*Hybognathus amarus**	2
81	*Carpiodes carpio*	1
93	*Ictalurus punctatus*	1

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

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

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, at San Marcial Railroad Bridge, San Marcial. Site Number: 16
04 December 2013 **RKD13-243** River Mile: 68.6
UTM Easting: 315284 UTM Northing: 3728347 Zone: 13 Quad: San Marcial
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt Effort: 602.0 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	155
76	*Hybognathus amarus**	4
76	*Pimephales promelas*	1
93	*Ictalurus punctatus*	2

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

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

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NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 8 miles downstream of the San Marcial railroad bridge crossing — Site Number: 17
04 December 2013 — **RKD13-242** — River Mile: 60.5
UTM Easting: 309487 UTM Northing: 3718178 Zone: 13 Quad: Paraje Well
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt — Effort: 558.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	51
76	*Hybognathus amarus**	20
76	*Pimephales vigilax*	3
93	*Ictalurus punctatus*	8

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

age-0: 20
age-1:
age-2:

NEW MEXICO: SOCORRO Co., RIO GRANDE Drainage
Rio Grande, ca. 10 mi downstream of the San Marcial railroad bridge crossing — Site Number: 18
04 December 2013 — **RKD13-241** — River Mile: 58.8
UTM Easting: 307846 UTM Northing: 3716150 Zone: 13 Quad: Paraje Well
M.A. Farrington, W.H. Brandenburg, J.M. Barkstedt — Effort: 589.8 sq. m

FAMILY		N
76	*Cyprinella lutrensis*	171
76	*Hybognathus amarus**	54
76	*Pimephales vigilax*	8
93	*Ictalurus punctatus*	9

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

age-0: 54
age-1:
age-2: