ZUNI BLUEHEAD SUCKER MONITORING AND CONSERVATION EFFORTS 2010

Zuni bluehead sucker, Tampico Draw, August 2010 Photo by Stephanie Carman, NMDGF

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SUMMARY

Zuni bluehead sucker *Catostomus discobolus yarrowi* historically occurred in the Zuni River and tributaries, Ríos Nutría and Pescado, Tampico Draw, and Agua Remora (formerly Radosovich Creek). These populations have been irregularly studied by the New Mexico Department of Game and Fish (NMDGF), U.S. Fish and Wildlife Service (USFWS), Zuni Fish and Wildlife Department, and U.S. Forest Service (USFS) since the 1970s, providing presence/absence and life history information. In 2004, NMDGF completed and began implementing the *Zuni Bluehead Sucker Recovery Plan* (Carman 2004), which included annual monitoring. Over the past seven years, with the assistance of USFWS New Mexico Fish and Wildlife Conservation Office, The Nature Conservancy (TNC), Zuni Department of Fish and Wildlife, New Mexico Environment Department (NMED), Silva Family, Albuquerque BioPark (BioPark), and U.S. Forest Service Cibola National Forest, Mount Taylor Ranger District surveys have been completed throughout much of the species historical range and monitoring was implemented in accessible and currently occupied habitats.

In 2010, habitat and fish population monitoring was completed at four sites in the upper Río Nutría drainage; persistence of Zuni bluehead sucker was confirmed in the Agua Remora, Tampico Springs, Tampico Draw, and Río Nutría. At the request of the Pueblo of Zuni, the Río Nutría on the Pueblo of Zuni was not sampled although visual surveys were allowed and confirmed the presence of larval and adult Zuni bluehead sucker. Sites on the Río Nutría on the Pueblo of Zuni and on TNC lands continue to have the best habitat for Zuni bluehead sucker. Water levels in the Río Nutría below the confluence with Tampico Draw were similar to that observed in 2009. Levels are lower than those observed in the early 2000s. However, water levels in the Río Nutría box canyon on the Pueblo of Zuni appear (based on photographic evidence) to be slightly higher than observed in 2008 and 2009 and more closely resemble the level in 2004. Isolated spring habitats in the upper watershed continued to support Zuni bluehead sucker populations. Larval and young-of-year suckers were documented at all sites where adults were present, including the Agua Remora where larvae were seen for the first time in five years in 2009. In previous years several sites were surveyed in historically occupied habitats in the Zuni River and Río Pescado. Zuni bluehead sucker has not been found in these rivers since the mid-1990s. These sites were neither sampled in 2010 nor were visual surveys conducted.

Additional conservation activities for Zuni bluehead sucker in 2010 included Zuni bluehead sucker captive rearing investigations, augmentation of captive population with wild caught fish and habitat restoration. Habitat restoration focused on repair of fencing around the Agua Remora. In 2009, the U.S. Forest Service Cibola National Forest, Mount Taylor Ranger District completed an access agreement with private landowners to provide access to the Agua Remora. In 2010, all NEPA compliance measures were fulfilled and an administrative–use-only road was constructed. This new road guarantees access to the Agua Remora for future monitoring and planned habitat restoration projects. Public information and outreach efforts this year included a presentation to the Albuquerque Wildlife Federation. This same organization provided volunteers who repaired the fencing around the Agua Remora.

AREA OVERVIEW

Long-term monitoring of Zuni bluehead sucker began in 2004. At this time three primary areas of Zuni bluehead sucker occurrence were identified using historical records, previous sampling, discussions with local landowners, and reconnaissance surveys: the upper watershed isolated spring habitats, including Agua Remora and Tampico Springs; the middle watershed canyon-bound habitats, including the upper Río Nutría and Tampico Draw; and the lower watershed mainstem habitats, including the Pescado and Zuni rivers (Figure 1). Zuni bluehead sucker historically occurred throughout these areas, but populations are no longer found or suitable habitat is lacking in the mainstem habitats. A summary of the habitats follows:

Isolated Spring Habitats

Zuni bluehead sucker distribution extends to headwater springs in the Zuni Mountains near the continental divide. These habitats are intermittent and are frequently isolated from downstream reaches and each other; connecting flow to downstream habitats only occurs during high flow events. Currently, the confirmed extant populations occur in perennial habitats in the Agua Remora and Tampico Springs on USFS and private lands. Agua Remora, where sampled, is a series of semi-isolated, permanently-watered pools occupied by Zuni bluehead sucker and green sunfish (*Lepomis cyanellus*). Until 2010 access to this site was dependant on private landowner permission. Access is now available through the USFS easement road constructed in the fall of 2010. Tampico Springs is on private property and is a series of semi-isolated pools occupied only by Zuni bluehead sucker. Access to this site may be irregular as it is dependant on yearly approval. Access to this site has been granted since 2007.

Canyon-Bound Habitats

Canyon-bound reaches of the Río Nutría are owned primarily by TNC and the Pueblo of Zuni, and are the current stronghold of Zuni bluehead sucker. Habitat quality and extent varies in response to precipitation, beaver activity, and upstream land-use. Water is primarily perennial and three sites in this area have been monitored annually since 2004: Tampico Draw, Río Nutría below the confluence with Tampico Draw, and Río Nutría in the box canyon. Since 2006, wetted habitat has been irregularly present in the Río Nutría immediately above the confluence and is sampled when present. In 2008, NMDGF and TNC completed purchase of upper areas of the Río Nutría, where Zuni bluehead sucker occurred regularly in the 1990s. Habitat was seasonally dry in 2009 and 2010. Tampico Draw near its confluence with Río Nutría on TNC land is perennial, but upper reaches are interrupted and Zuni bluehead sucker has not been documented there. Nonnative crayfish *Orconectes virilis* and fathead minnow *Pimephales promelas* are present in the Río Nutría, with abundance of each increasing downstream; speckled dace *Rhinichthys osculus* historically was present, but has been absent in recent years.

Mainstem Habitats

Mainstem habitats in the lower watershed occur solely on Pueblo of Zuni land. The Río Nutría below the box canyon meanders through a willow wetland and a series of impoundments. One site at the uppermost part of this section, just below the mouth of the box canyon near the USGS gage, has been monitored annually with the current exception of 2010. The most recent documentation of Zuni bluehead sucker at this site was in 2005. Crayfish and fathead minnow are common and beaver activity is abundant. Although Zuni bluehead sucker have been reported

downstream of the gage, they are likely dispersants from upstream populations. The USGS gage in this area (USGS 09386900 Río Nutría near Ramah, NM) is currently located within a beaver pond and readings since 2005 have not reflected streamflow accurately.

The Río Pescado, which flows primarily on Pueblo of Zuni land, historically held populations of Zuni bluehead sucker. Since 2004, several sites have been sampled, but neither Zuni bluehead sucker nor suitable habitat was found. Ríos Pescado and Nutría join above BIA Rte 4 to form the Zuni River, which historically had populations of Zuni bluehead sucker. Habitat is now degraded and few areas of perennial flow exist with continual water, most occurring below Black Rock Reservoir. While perennial waters exist in some areas of the Río Pescado and Zuni River, suitable habitat is lacking and nonnative predators such as green sunfish, largemouth bass, rainbow trout, channel catfish and northern pike *Esox lucius* dominate. In 2010, these habitats were not sampled nor were visual surveys conducted.

ANNUAL MONITORING

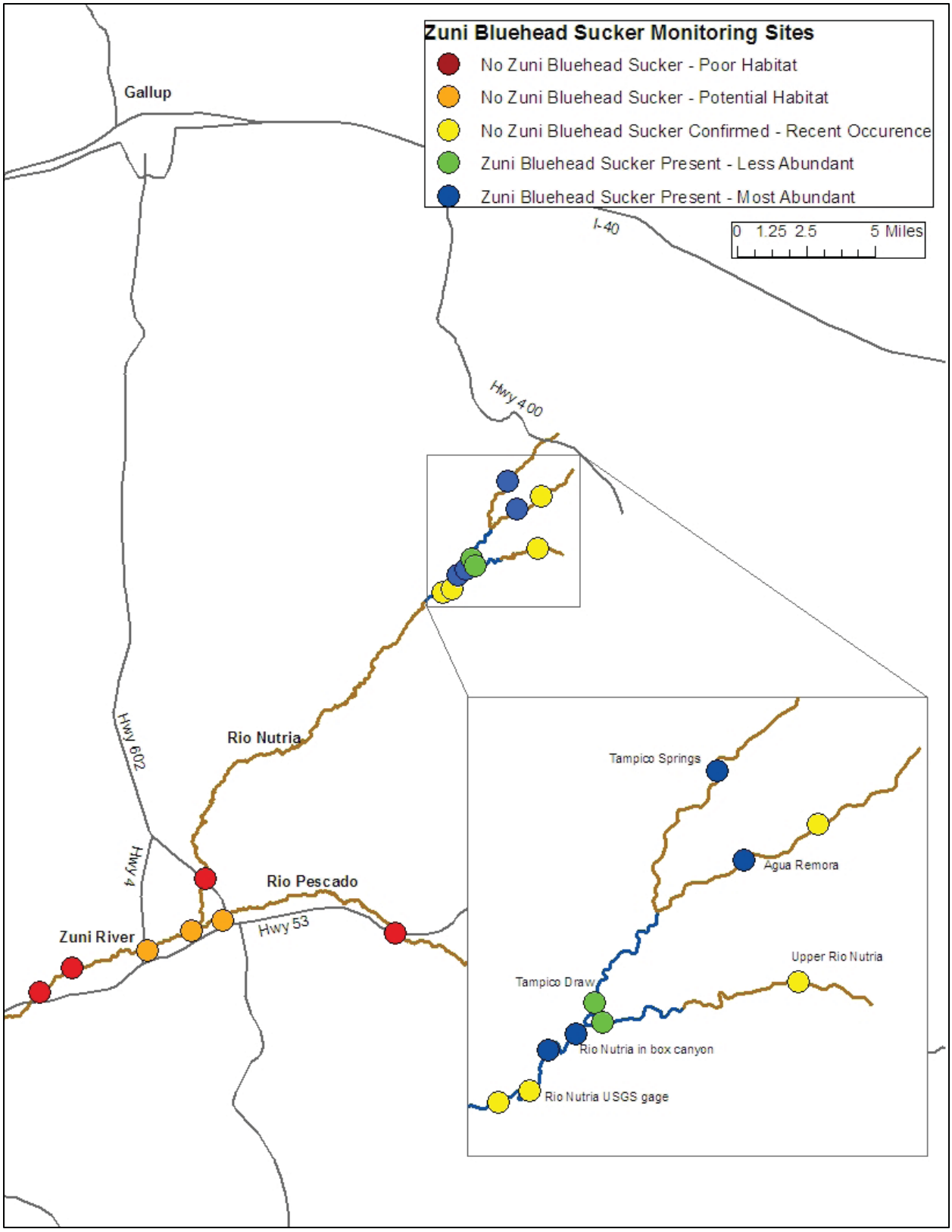
Evaluation Methods

Areas for monitoring Zuni bluehead sucker populations were selected in 2004 using historical records, previous sampling, discussions with local landowners and managers, and reconnaissance surveys. Monitoring sites were identified in three main areas of the watershed; the upper watershed isolated spring habitats, the middle watershed canyon-bound habitats, and the lower watershed mainstem habitats (Figure 1). Monitoring of several sites is irregular, based upon landowner permission and presence of wetted habitat.

Fish collection and habitat evaluation methods follow those commonly used by NMDGF Conservation Services Division for monitoring endangered fish species, including past Zuni bluehead sucker surveys. These fish collection methods have been shown to be most effective and least intrusive for collecting benthic species. Sucker species, which often hide under cover or in deeper areas, are easily and effectively captured with electrofishing gear, which draws them out and up from hiding places. When used properly, potentially harmful effects of electrofishing are significantly reduced and mortality is minimal. Additionally, electrofishing is less disruptive to benthos, which is vital for species that feed and live on the substrate. In the Zuni River watershed, other fish capture methods such as seining are ineffective because of instream obstructions (e.g., boulders and instream debris) and habitat depth (some >1.5 m). Since methods have been similar across time, catch per unit effort data can be compared and used to determine Zuni bluehead population trends.

Fish collection began at the downstream boundary of the site and proceeded upstream until all available mesohabitats (e.g., pool, riffle, and run) were sampled. Sampling effort per mesohabitat (area sampled and elapsed time electrofishing) was recorded. Fish were collected using a battery-powered backpack electrofisher (24 V DC) set to appropriate levels for sucker collection based on local conductivity. Two netters immediately removed stunned fish and placed them in aerated buckets until completion of the pass. Native fish were identified, enumerated, measured (length and mass), sex determined when possible, and released at the approximate point of capture. Non-native fishes were preserved for identification and accession

Figure 1. Zuni bluehead sucker monitoring and survey sites, 2004 through 2010, with inset of upper watershed sites. Blue areas indicate perennial watercourses, brown intermittent or ephemeral.



to University of New Mexico Museum of Southwestern Biology or removed. When needed for genetic assessment, small clips (<2 mm^2) are taken from pelvic fins of Zuni bluehead suckers and preserved in 95% ethanol. In 2010, no fins clips were taken.

To determine movement between upstream and downstream populations, Zuni bluehead suckers over 150 mm total length (TL) were implanted with Passive Integrated Transponder tags (PIT tags) and the number and location recorded in 2005 and 2006. All Zuni bluehead suckers over 150 mm TL were scanned with a PIT tag reader to check for recapture in 2006 and 2007. In 2007, PIT tag implantations ceased because few fish greater than 150 mm TL were captured.

Quantitative habitat evaluation methods were used to determine availability of Zuni bluehead sucker habitat at each site. Water depth and velocity were measured and recorded at randomly selected points within each sampled mesohabitat. Substrata was visually characterized (e.g., sand, cobble, bedrock) at each depth/velocity measurement point. Presence of silt over base substratum was also recorded at each depth/velocity point, as well as information on cover and vegetation. Water quality parameters (water temperature, dissolved oxygen, pH, conductivity, and salinity) were measured at each site. Qualitative site descriptions were recorded, including riparian vegetation descriptions, stream size, and weather observations. Location data, including GPS points, were recorded for all sites. In 2009, seven HOBO® U22 Water Temperature Pro v2 data loggers were deployed throughout the watershed to track the presence and temperature of water (Table 1). Temperature was recorded on the units every 4 hours. During the 2010 annual monitoring efforts, data from these temperature loggers were downloaded and the data loggers redeployed, except for the logger at Tampico Draw above the confluence which was lost. To date, this data logger has not been replaced. Data will continue to be downloaded each time sites are visited. To determine presence of water at sites where data loggers were deployed comparisons of temperature were made between those sites in which it is known water was present and sites in which it was suspected or known that the data logger did not remain submerged in water throughout the year.

Monitoring occurred on 13-15 September 2004, 22-24 August 2005, 28-31 August 2006, 19-21 August 2007, 24-28 August 2008, 17-20 August 2009, and 22-24 August 2010.

Table 1. Distribution of HOBO U22 Water Temperature Pro v2 data loggers in Zuni bluehead sucker habitat. (Data logger 2022735 was not recovered)

HOBO Unit	Site	Date Deployed	Date Downloaded
2022744	Agua Remora, Lower Pool	19-Aug-09	22-Aug-10
2022742	Agua Remora, Middle Pool	19-Aug-09	22-Aug-10
2022741	Agua Remora, Upper Pool	19-Aug-09	22-Aug-10
2022749	Upper Río Nutría, section 2	20-Aug-09	23-Aug-10
2022735	Tampico Draw above Confluence	19-Aug-09	---------
2022729	Río Nutría below Confluence on TNC	19-Aug-09	9-Sept-10
2022728	Río Nutría at USGS gage	18-Aug-09	9-Sept-10

Habitat Monitoring Results

Monitoring for Zuni Bluehead suckers occurred at four sites: Tampico Springs, Agua Remora, Tampico Draw and the Río Nutría below the confluence with Tampico Draw (Figure 1). Monitoring did not occur in the upper Río Nutría nor the Río Nutría above the confluence with Tampico Draw due to a lack of water. Monitoring also did not occur on any waters within the Zuni Pueblo which include all sites from the Río Nutría in box canyon downstream to the Zuni River, the Zuni River and Río Pescado (Figure 1).

The best habitat for Zuni bluehead sucker, defined as clean, hard substrate with flowing water, was found in the canyon-bound reaches on the Río Nutría on TNC land (Table 2). visual observation on the Río Nutría in the box canyon on Pueblo of Zuni indicated this portion of the river remains good habitat for the Zuni bluehead sucker. Sites immediately adjacent to these areas, Tampico Draw above the confluence and Río Nutría at the USGS gage, and in the isolated headwater habitats, had marginal habitat (some flowing water over patchily silted or debris-laden substrate). Degraded (deep water and heavy silt) habitat was visually observed at the USGS gage. Lower mainstem habitats located on Zuni Pueblo land which were determined to be degraded in previous years were not visited in 2010.

The occupied isolated spring habitats (Tampico Springs and Agua Remora) in the upper areas of the watershed were visited in 2010 for annual monitoring. These habitats are quite different from the canyon-bound habitats where Zuni bluehead sucker is found; these are small (about 1-2 m x 10 m), spring-fed semi-connected pools in grassy meadows (Figure 2). Water in these areas is tannic and slow moving and substrate is largely silt overlaying boulder. Habitat conditions at Tampico Springs were similar to those observed in 2009. Water levels were higher in Agua Remora in 2010 than observed in 2009 when the lowest pool was almost dry. Deep silt was still present in the lower two pools as was observed in 2009. The intermittent connection between the lowest two pools is increasing, appearing more like an “elk wallow” or wet meadow. Other ephemeral or interrupted habitats in the area (i.e., upper Agua Remora) were not visited in 2010.

In 2010, a visual observation of the upper Río Nutría, on property purchased by NMDGF in partnership with TNC, was completed. Many wetted pools over bedrock were present (Figure 3). The area appears to be intermittently wetted as it was wet in the spring of 2009, dry in August 2009 and only partially wetted August 2010.

As in previous years, the largest extent of suitable habitat was found in the Río Nutría box canyon, from the confluence with Tampico Draw downstream to the canyon mouth, just above the USGS gage (Figure 4). Water levels at two of the four annual monitoring sites were measured in 2010. Water levels at Tampico Draw above the confluence with Río Nutría were at the lowest levels since monitoring began but were similar to levels measured in 2007 and 2008. Water levels in the Río Nutría, below its confluence with Tampico Draw, were the same as measured in 2009 and higher than levels observed 2007 and 2008. Habitat within Tampico Draw had previously been considered marginal due to pools and dams created by beaver activity. It appears that 2010 spring flows washed out these dams and current habitat within Tampico Draw is more suitable for Zuni bluehead sucker (Figure 5). Water levels were not measured in the Río Nutría box canyon and just above the USGS gage as these sites are located on Zuni Pueblo and permission was not granted to conduct work within their waters.

Water levels were not measured in currently or historically occupied sites on Zuni Pueblo. Pictorial evidence shows that levels in occupied habitat on the Río Nutría in the box canyon appear higher than that observed in 2008 and 2009 (Figure 6).

Water chemistry data collected by NMDGF during 2004-2010 Zuni bluehead sucker monitoring is summarized in Table 3. Water temperatures were relatively high compared to previous years at all sites sampled with the exception of Tampico Springs. Dissolved oxygen was at recorded highs in all habitats sampled except for Tampico Springs even though the water's capacity for dissolved oxygen was lower due to higher water temperatures. Salinity was the same between the two isolated spring habitats. Salinity levels in both the isolated spring habitats and canyon bound habitat of the Río Nutría did not vary greatly from previous years. Conductivity readings were at the low end of the range as compared to previous years. Data on water quality was not taken in mainstem habitats on tribal lands which had previously been warmer than the canyon-bound and isolated spring habitats. In previous years, mainstem habitats had also shown increased salinity as compared to the canyon-bound and isolated spring habitats.

Habitats are currently designated under the New Mexico Water Quality Standards (State of New Mexico Standards for Interstate and Intrastate Surface Waters, 20.6.4 NMAC as amended through February 16, 2006) as follows: Río Nutría (Tampico Draw to headwaters) intermittent (WQS 20.6.4.98); Río Nutría (Zuni Pueblo boundary to Tampico Draw) perennial (WQS 20.6.4.99); Tampico Draw (Río Nutría to headwaters) perennial (WQS 20.6.4.99). In 2004, NMED completed water quality and chemistry analyses in the Zuni River watershed. The report showed one exceedence of New Mexico Water Quality Standards criteria within Zuni bluehead sucker occupied habitat, dissolved oxygen levels were 2.93 mg/L in the Río Nutría above Tampico Draw, below the 6 mg/L standard for coldwater aquatic life. The complete NMED report is available at:
ftp://ftp.nmenv.state.nm.us/www/swqb/MAS/Surveys/ZuniSurveySummary2004.pdf

The Final 2010 Standards from the 2009 Triennial Review of the Water Quality Standards for Interstate and Intrastate Surface Waters, 20.6.4 NMAC designated the Río Nutría as a coolwater system with dissolved oxygen 5.0 mg/L or more, temperature 25°C (77°F) or less, and pH between 6.6 to 9.0 criteria. The proposal is available at:
ftp://ftp.nmenv.state.nm.us/www/swqb/Standards/2010/20.6.4NMAC-Integrated2010-12-15.pdf

Water temperatures among the three pools at Agua Remora were similar to one another. The middle pool tended to show higher temperatures than the upper and lower pool with the exception of the winter months where the lower pool showed the highest temperatures (Figure 7). Temperatures ranged from -3.24 (4-Dec-09) – 17.63 (17-Jul-10) ºC in the upper pool, from -3.15 (4-Dec-09) – 24.03 (6-Jun-10) ºC in the middle pool ranged and from -0.06 (2-Apr-10) – 21.94 (15-Jul-10) ºC in the lower pool.

Table 2. Attributes of habitats sampled in the Zuni River watershed, 2004 through 2010. Dashed lines indicate information was not recorded. Current Class is based on average of cubic feet per second measurements: Minimal ≤0.04 cfs; Moderate > 0.04 cfs. The term "vegetation" is inclusive of submergent, emergent and overhanging vegetation. Shading indicates sites where Zuni bluehead sucker has not been recently verified. An asterisk indicates site was dry. No sites were sampled on Zuni Pueblo in 2010. A visual presence/absence survey was conducted in the Río Nutría box on Zuni Pueblo verifying the presence of Zuni bluehead sucker.

Site	Year	Macro-habitats Sampled	Dominant Mesohabitat Type(s)	Average Depth (m)	Dominant Current Class	Dominate Substrate	Secondary Substrate	Dominant Cover
Tampico Springs	2007	2	Pool	0.64	Minimal	Silt	Cobble	Boulder
	2008	2	Pool	0.47	Minimal	Silt	Sand	Vegetation
	2009	2	Pool	0.24	Minimal	Silt	Cobble	Vegetation
	2010	**2**	**Pool**	**0.25**	**Minimal**	**Silt**	**Gravel**	**Vegetation**
Agua Remora, Forest Service	2005	2	Pool	1.75	Minimal	Cobble	Boulder	Vegetation
	2006	3	Pool	0.62	Minimal	Silt	Boulder	Algae
	2007	3	Pool	0.56	Minimal	Silt	Boulder	Vegetation
	2008	2	Pool	0.28	Minimal	Silt	Boulder	None
	2009	3	Pool	0.28	Minimal	Silt	Boulder	Woody Debris
	2010	**2**	**Pool**	**0.45**	**Minimal**	**Silt**	**Boulder**	**Vegetation**
Tampico Draw above confluence	2004	2	Pool	0.56	Minimal	Bedrock	Silt	
	2005	2	Pool	0.58	Moderate	Gravel	Silt	Boulder
	2006	1	Pool	0.52	Minimal	Bedrock	Silt	Vegetation
	2007	3	Pool	0.21	Minimal	Silt	Bedrock	Vegetation
	2008	2	Pool	0.24	Minimal	Silt	Bedrock	
	2009	2	Pool	0.43	Minimal	Silt	Silt	Gravel
	2010	**2**	**Pool**	**0.20**	**Minimal**	**Bedrock**	**Silt**	**Vegetation**
Río Nutría above confluence	2006	1	Pool	----	Minimal	Cobble	Bedrock	
	2007	1	Pool	0.29	Minimal	Bedrock	Silt	Boulder
	2008	1	Pool	0.42	Minimal	Bedrock	Gravel	Boulder
	2009*							
	2010*							

Table 2. Continued

Site	Year	Macro-habitats Sampled	Dominant Mesohabitat Type(s)	Average Depth (m)	Dominant Current Class	Dominate Substrate	Secondary Substrate	Dominant Cover
Río Nutría below confluence	2004	2	Pool	0.68	Minimal/Moderate	Bedrock	Silt	Filamentous algae
	2005	2	Pool	0.69	Minimal/Moderate	Bedrock	Silt	Boulder
	2006	3	Pool	0.35	Minimal	Bedrock	Boulder	Boulder
	2007	3	Pool	0.23	Minimal	Bedrock	Silt	Boulder
	2008	3	Pool	0.17	Minimal	Bedrock	Silt	Boulder
	2009	2	Pool	0.24	Minimal	Bedrock	Silt	Boulder
	2010	**3**	**Pool**	**0.24**	**Minimal**	**Bedrock**	**Silt**	**Boulder**
Río Nutría in box canyon	2004	4	Pool	0.35	Minimal	Clay	Bedrock	Willow
	2005	3	Pool	1.34	Moderate	Gravel	Boulder	
	2006	3	Pool	0.42	Minimal	Gravel	Silt	Boulder
	2007	3	Pool	0.39	Minimal	Bedrock	Silt	Boulder
	2008	2	Pool	0.60	Minimal	Bedrock	Gravel	Boulder
	2009	2	Pool	0.24	Minimal	Gravel	Boulder	
Río Nutría at USGS gage	2004	2	Pool	0.39	Moderate	Clay	Gravel	Debris
	2005	2	Pool	1.46	Minimal	Gravel	Silt	Vegetation
	2006	2	Pool	0.41	Minimal	Silt	Gravel	Vegetation
	2007	2	Pool	0.52	Minimal	Silt	Gravel	Vegetation
	2008	3	Slow Run	0.53	Minimal	Gravel	Silt	Vegetation
	2009	2	Slow Run	0.59	Minimal	Silt	Gravel	Vegetation
Río Nutría in willow wetland	2004	-----	Slow Run	-----	Minimal	Silt		Willow
Río Pescado at Hwy 53	2004	9	Slow Run	1.00	Minimal	Clay	Silt	Vegetation
	2009	2	Slow Run	0.51	Minimal	Silt	Cobble	
Río Pescado at Hwy 602	2006 2009*	1	Slow Run	----	Minimal	Silt	Silt	Boulder
Zuni River at confluence	2008	1	Pool	1.00	Minimal	Silt	Gravel	
	2009	1	Pool	1.00	Minimal	Silt		

Table 2. Continued

Site	Year	Macro-habitats Sampled	Dominant Mesohabitat Type(s)	Average Depth (m)	Dominant Current Class	Dominate Substrate	Secondary Substrate	Dominant Cover
Zuni River at BIA Route 4	2006	1	Pool	0.50	Minimal	Silt	Boulder	Boulder
	2007	1	Pool	---	Minimal	Silt	Boulder	
	2008	2	Pool	0.33	Minimal	Silt	Boulder	Boulder
	2009*							
Zuni River below Black Rock	2004	2	Wetland Pool	0.34	Minimal/Moderate	Silt	Boulder	Woody
	2007	1	Wetland Pool	---	Minimal	Silt		Vegetation
Zuni R. between Black Rock & Eustace	2006	2	Slow Run	0.63	Minimal	Silt	Concrete	Vegetation
	2008	3	Slow Run	0.06	Minimal	Bedrock	Silt	Vegetation

Figure 2. Sampling isolated spring habitat, Tampico Springs, 2007. Photo: Matthew Silva.

Figure 3. Upper Río Nutría on the TNC Río Nutría Preserve. Left: Middle pool present in May 2009. Right: Dried pools in August 2009. Bottom: Pool present August 2010. Photos by Angela James, USFWS.

Three data loggers were placed throughout the Río Nutría. The data logger in Tampico Draw above the confluence with the Río Nutría appears to have been washed out due to high flows and attempts to find it were not successful. The data logger on the Río Nutría below its confluence with Tampico Draw indicated water temperature ranged from -4.38 (2-Apr-10) – 51.46 (19-Jul-10) ºC. The data logger at the USGS Gage on the Río Nutría showed that water temperatures ranged from -0.03 (8-Mar-10) – 24.07 (6-Jun-10) ºC. The range at this site was similar to those observed in the pools at Agua Remora.

Temperatures at the most northern site, Upper Río Nutría Section 2, were the most extreme ranging from -20.59 (4-Dec-09) – 55.60 (21-Aug-09) ºC. When this data logger was deployed in 2009 there was no water in the pool and thus initial readings were of the ambient air temperature. However, the data logger was found out of the water on the edge of a wetted pool and appeared to have been washed out. While presumably this pool was re-wetted intermittently throughout 2010 (water was present in this pool during annual monitoring, Figure 3).

Zuni bluehead sucker spawning occurs between 6 – 13 º C from April through early June (Propst et al. 2001). At two sites where young-of-year were observed in 2010, a HOBO® temperature data logger had been deployed. These were Agua Remora and Río Nutría below the confluence with Tampico Draw; temperatures from 1-Apr-10 through 20-Jun-10, during the presumed spawning period, ranged from -0.06 – 19.13 ºC and -4.38 – 45.62 ºC respectively.

Temperature data at sites where it is likely that data loggers were submerged in water throughout 2009-2010 were analyzed to determine the lowest and highest water temperatures. These temperatures were considered to be a baseline with which to compare temperature data from sites where it was suspected that data loggers did not remain submerged in water throughout 2009-2010. Data loggers at both Agua Remora and at the USGS gage are assumed to have been submerged throughout the 2009-2010 deployment period. The lower and upper recordings for these sites was approximately -3.24 ºC and 24.07 ºC and considered the baseline with which to compare the data from the Río Nutría below the confluence with Tampico Draw and the Río Nutría Section 2. When comparisons were calculated, the baseline was adjusted by ± 1 ºC to take into account the possibility the lowest and highest temperature recordings (-3.25 ºC and 24.08 ºC) might still indicate the presence of water at Rio Nutria below the confluence with Tampico Draw and Rio Nutria Section 2. Thus temperature recordings from the Rio Nutria below the confluence with Tampico Draw and the Rio Nutria Section 2 were only highlighted and considered as a possible point in which the HOBO® temperature data logger was out of water when recordings were below -4.24 º C and above 25.07 º C.

It is suspected that the data logger on the Río Nutría below the confluence with Tampico Draw was out of the water from approximately 25-Apr-10 through 21-Aug-10 because at least one recording each day was consistently above 25.07 ºC during this time period. There was one event on 2-Apr-10 when temperature was below -4.24 ºC at this site during the 2009-2010 period. When the site was visited on 24-Aug-10 this data logger was submerged.

Table 3. Water chemistry variables collected by NMDGF in the Zuni River watershed 2004-2010. Dashed lines indicate that information was not collected. Shading indicates sites where Zuni bluehead sucker has not been recently verified. An asterisk indicates site was dry. Data was not collected at any site on Zuni Pueblo in 2010.

Site	Date	Temperature (°C)	Salinity (ppt)	pH	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	Conductivity (mS)	Specific Conductivity
Tampico Springs	19-Aug-07	17.0	0.2	7.0	5.7	59	418	494
	25-Aug-08	16.2	0.2	8.0	6.1	62	347	418
	19-Aug-09	15.8	0.2	8.2	10.0	99	401	486
	22-Aug-10	**15.9**	**0.2**	**----**	**5.8**	**48**	**294**	**343**
Agua Remora, Forest Service, Lower Pool	24-Aug-05	12.9	0.3	7.6	----	----	403	525
	30-Aug-06	12.6	0.3	7.4	9.3	88	438	574
	19-Aug-07	19.4	0.3	---	8.4	90	519	582
	25-Aug-08	13.0	0.2	7.4	5.9	56	368	477
	19-Aug-09	15.3	0.3	8.1	7.6	77	470	497
	22-Aug-10	**18.3**	**0.2**	**----**	**10.5**	**110**	**431**	**474**
Tampico Draw above confluence	14-Sep-04	14.9	----	8.1	12.1	157	----	----
	23-Aug-05	15.8	0.3	8.1	----	----	531	643
	31-Aug-06	14.8	0.3	8.2	8.6	86	530	667
	28-Aug-08	21.3	0.3	8.0	9.5	107	577	621
	19-Aug-09	9.9	0.3	8.2	8.1	72	476	665
	23-Aug-10	**18.1**	**0.3**	**----**	**13.2**	**144**	**521**	**603**
Río Nutría above confluence	31-Aug-06	15.8	0.1	8.1	7.1	71	243	294
	28-Aug-08	15	0.2	8	9.5	95	308	381
	2009*							
	2010*							
Río Nutría below confluence	23-Aug-05	15.4	0.3	8.4	----	----	496	607
	31-Aug-06	15.5	0.3	8.7	10.2	102	504	615
	28-Aug-08	14.6	0.3	8.0	11.3	103	464	579
	19-Aug-09	10.7	0.3	8.4	8.5	77	443	608
	23-Aug-10	**20.4**	**0.3**	**----**	**12.4**	**154**	**531**	**580**
Río Nutría in box canyon	15-Sep-04	17.6	0.3	----	6.6	70	405	504
	22-Aug-05	19.7	0.2	8.4	----	----	347	386
	29-Aug-06	13.8	0.2	9.4	8.7	84	241	306
	21-Aug-07	16.2	0.2	7.7	9.6	98	320	384
	27-Aug-08	17.2	0.2	8.2	8.3	87	315	370
	19-Aug-09	18.1	0.2	8.8	12.4	131	370	422

Table 3. Continued

Site	Date	Temperature (°C)	Salinity (ppt)	pH	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	Conductivity (mS)	Specific Conductivity
Río Nutría at USGS gage	15-Sep-04	13.7	0.3	----	3.8	36	489	625
	22-Aug-05	13.7	0.3	7.4	----	----	506	643
	29-Aug-06	13.9	0.2	8.4	1.8	18	306	388
	21-Aug-07	14.5	0.3	6.6	4.7	47	468	584
	27-Aug-08	14.9	0.3	7.6	2.5	24	472	578
	18-Aug-09	12.8	0.3	7.7	5.0	48	458	600
Río Pescado at Hwy 53	13-Sep-04	17.7	0.2	----	3.1	----	400	465
	18-Aug-09	9.7	0.3	8.0	9.6	67	373	526
Río Pescado at Hwy 602	29-Aug-06	17.8	0.2	8.4	5.9	62	316	366
	2009*							366
Zuni River at confluence	26-Aug-08	22.3	0.2	8.4	10.0	115	401	420
	17-Aug-09	22.3	0.5	8.8	9.6	110	1040	1097
Zuni River at BIA Rte 4	29-Aug-06	18.2	0.1	8.8	5.3	58	204	235
	26-Aug-08	19.7	0.2	8.3	9.4	104	296	330
	2009*							
Zuni River below Black Rock	20-Aug-07	21.0	0.5	6.3	9.4	106	866	938
Zuni R. between Black Rock & Eustace	28-Aug-06	20.3	0.5	8.8	2.9	32	855	941
	26-Aug-08	16.3	0.5	7.9	11.3	116	771	925

Figure 4. Zuni bluehead suitable sucker habitat. Río Nutría, 2008. Photo: Angela James, USFWS.

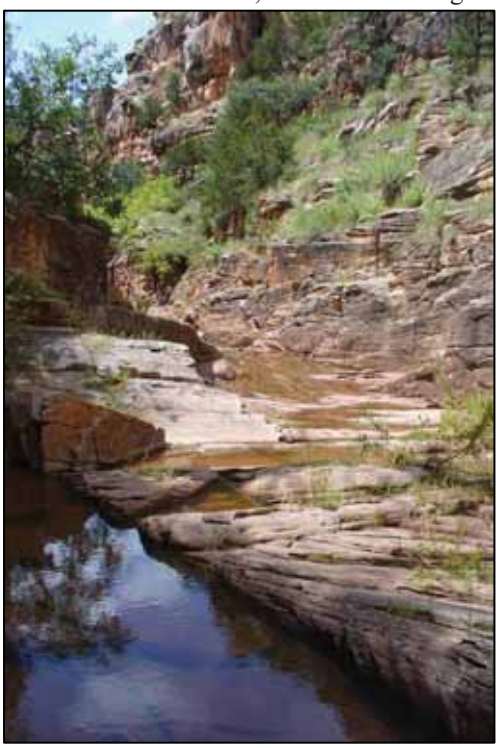


Figure 5. Zuni bluehead sucker habitat in Tampico Draw. Left: Degraded habitat with beaver dams in 2007. Photo: Martha Schumann, TNC. Right: Suitable habitat where beaver dams were washed out by high water flows, 2010. Photo: Angela James USFWS

Figure 6. The largest pool in the Río Nutría box canyon area, 2004-2010, showing changes in water levels. Photos: Angela James, USFWS.

The data logger was deployed on the Upper Río Nutría Section 2 in 2009 when no water was present in the area. Temperature remained outside of baseline temperature from deployment on 22-Aug-09 through the 28-Dec-09. From this date in December of 2009 until 4-May-10 temperatures were within adjusted baseline ranges, with two exceptions on 26 and 27-Apr-10. From the beginning of May 2010 through 21-Aug-10 (when data was downloaded) temperatures were again outside of baseline ranges a least once per day. In August of 2010, the data logger was found washed out of the pool into which it had been deployed. From this, we can estimate that this pool was consistently wet at least from January through the end of April.

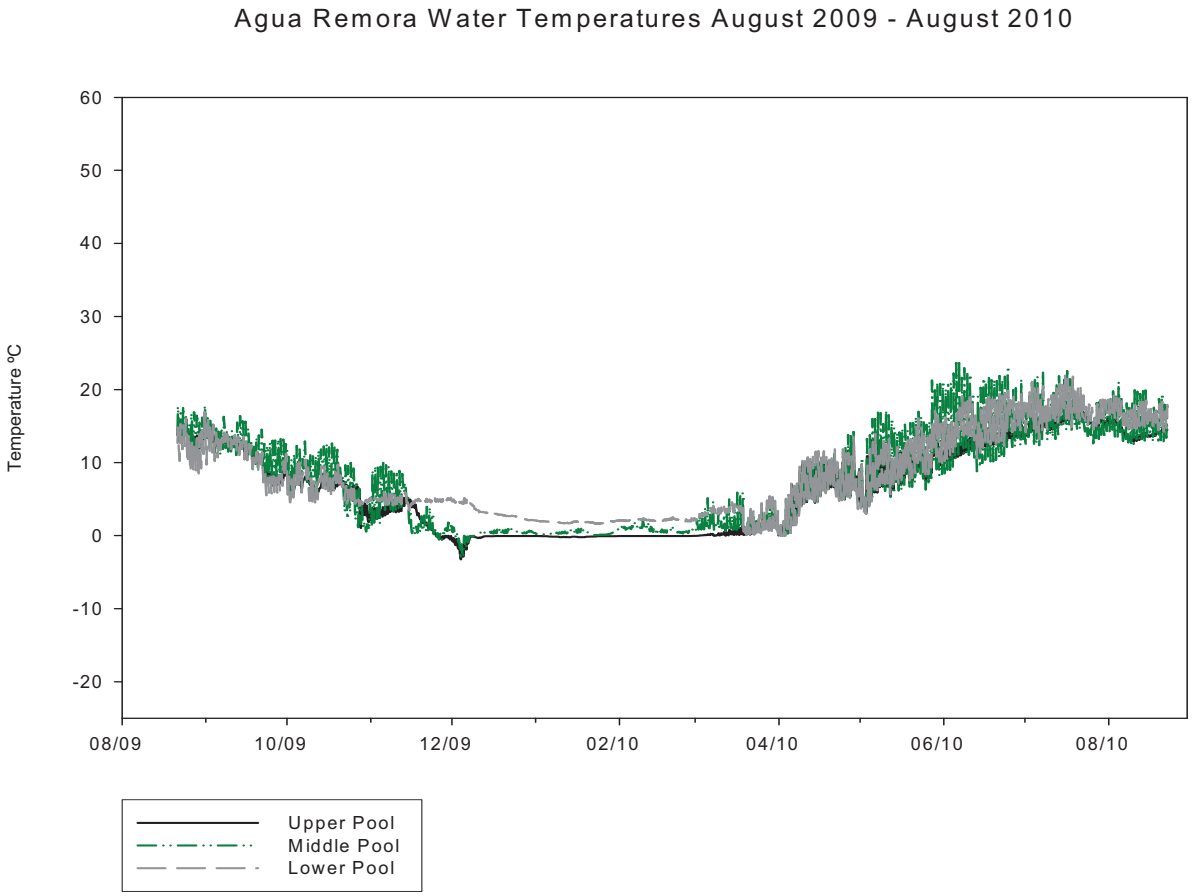
Fish Collections

During 2010 monitoring, Zuni bluehead sucker was present at all four sampled sites and at a fifth site where a visual survey was conducted. Sites in which Zuni bluehead sucker had been absent in previous years, in the lower watershed mainstem habitats on Zuni Pueblo land, were not visited (Table 4, Figure 8). Zuni bluehead sucker were also not found in the Río Nutría above the confluence, which was dry, and the Río Nutría on Section 2, which is intermittent. As in past years, Zuni bluehead sucker were collected in the Río Nutría canyon area including Tampico Draw, Agua Remora, and Tampico Springs. Visual observation in the Río Nutría on Zuni Pueblo lands confirmed presence of Zuni bluehead sucker in the canyon reach; however, no Zuni bluehead suckers were observed near the USGS gage. Zuni bluehead sucker has not been captured at this site since 2005. No speckled dace were captured during Zuni bluehead sucker monitoring. Crayfish were observed during visual surveys in the Río Nutría upstream of the USGS gage, but not at the Río Nutría box canyon site. Beaver signs were greatly decreased on the Río Nutría above the USGS gage to the confluence of the Río Nutría and Tampico Draw.

A total of 117 Zuni bluehead suckers ranging from young-of-the-year to a 214 mm Total Length (TL) adults were caught. The majority of Zuni bluehead suckers caught appeared in excellent physical condition, with spawning coloration (red lateral stripe) noted on some males at all sites except for Tampico Draw above the confluence with Río Nutría. Black spot, caused by the common fish parasitic fluke *Uvulifer*, was found on Zuni bluehead suckers in the Agua Remora, but not noted in the other populations in 2010. This was similar to 2009. No fish expressed milt in August 2010. Young-of-year (yoy) Zuni bluehead suckers were found in the Río Nutría, Tampico Draw, Tampico Springs, and for the second consecutive year, in the Agua Remora. Up until 2009 yoy had not been found in the Agua Remora since 2005 when annual monitoring began.

The fourth year of sampling was completed at Tampico Springs. When this site was visited in 2007 and 2008, the absence of large adults was notable; in 2009, several larger adults (up to 129 mm TL) were captured. In 2010 larger adults were not captured. None of the fifty-two fish captured exhibited facial deformities (misshapen mandible and twisted lips), compared to 3/77, 8/66 and 2/48 in 2007, 2008 and 2009, respectively.

Figure 7. Water temperatures; Zuni bluehead sucker annual monitoring sites 2009-2010



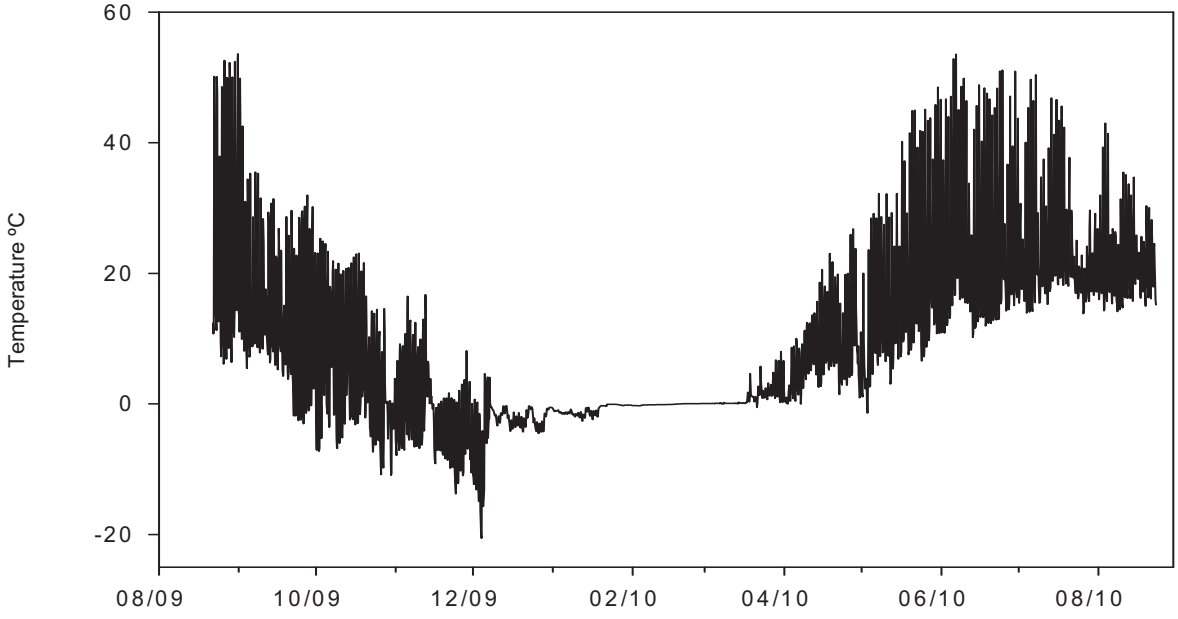
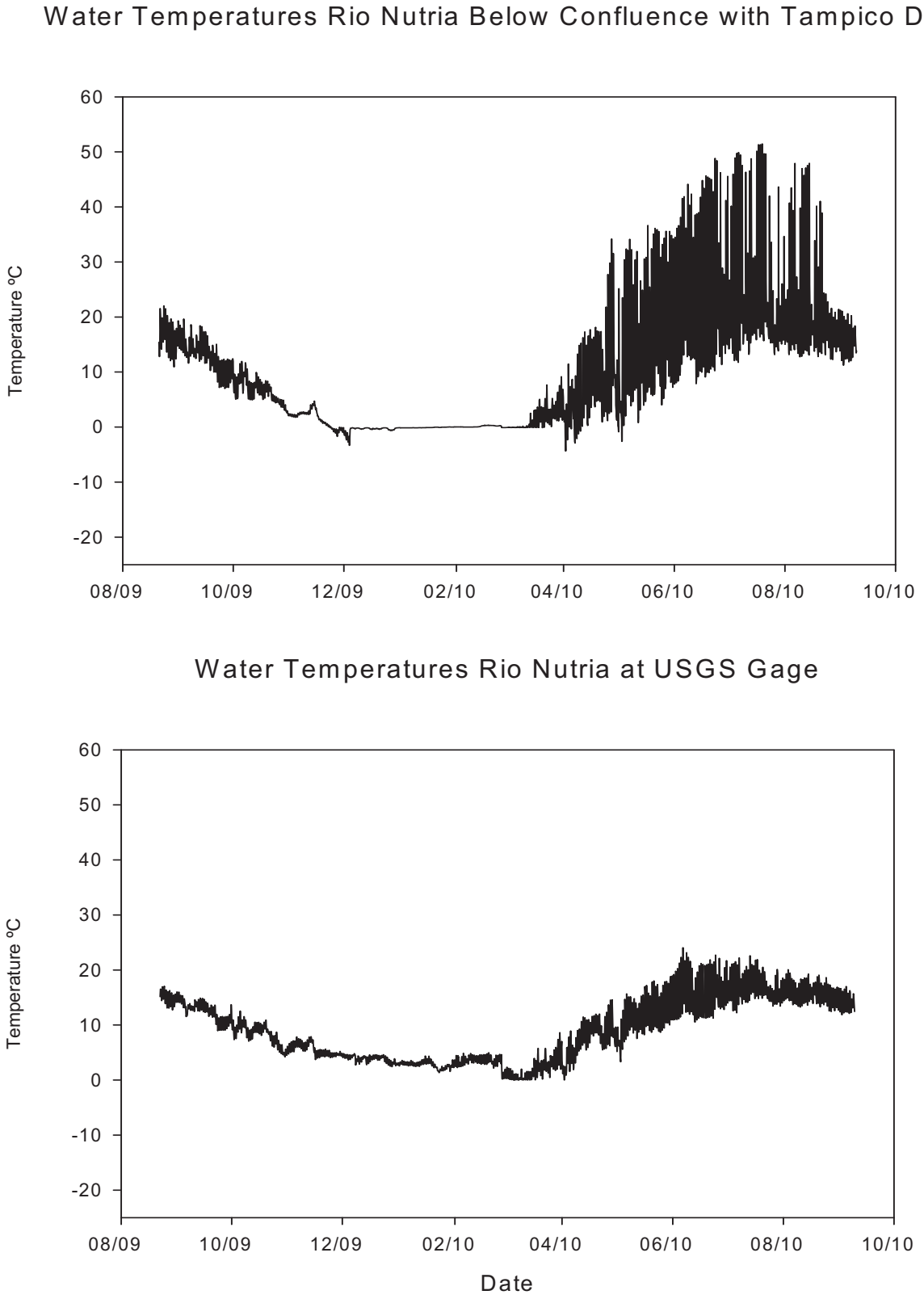


Figure 7. Cont'd



Monitoring efforts at the Agua Remora site have focused on the two lower pools, as the upper pool was fishless in 2005 and 2006. In 2006, 11 Zuni bluehead suckers captured from the middle pool were moved to the upper pool. In 2007, persistence of Zuni bluehead sucker in the upper pool was documented, with capture of four fish. In 2008, 2009, and 2010 extensive debris made sampling impossible in the upper pool. While Zuni bluehead sucker presence was visually confirmed in 2008 and 2009, visual surveys in 2010 were not able to confirm the fish's presence in the upper pool. Green sunfish has not been documented in the upper pool since monitoring began in 2005.

Directed efforts to remove green sunfish from Agua Remora pools began in 2007 (see Nonnative Species Control Efforts, page 28 for additional information) and resulted in the removal of over 80 green sunfish in 2007 and two in 2008 via angling. No green sunfish was captured in 2009 by angling or during monitoring efforts, but one green sunfish was seen in the middle pool. In 2010 one green sunfish was captured in the pool where a fish was observed in 2009. It is hoped that this may have been the last remaining sunfish in the Agua Remora pools.

Population Trends

Zuni bluehead sucker sampling has been conducted irregularly since 1990. Sampling methods were similar across years making, comparisons of several population variables possible. Herein, number of fish per second electrofishing elapsed time (catch per unit effort, CPUE) and length-frequency histograms are the metrics used to characterize population trends (Figures 10-12).

Although a slight decline has occurred in CPUE of Zuni bluehead sucker captured at Tampico Springs, the site still had the highest CPUE among sites in 2010 (Figure 9). The CPUE in Agua Remora was high in 2009 due to capture of many yoy Zuni bluehead suckers. In 2010, yoy fish were not included in CPUE computation and the CPUE was similar to previous years. At Tampico Draw, 2010 CPUE was similar to pre-2005 CPUE, before the beaver caused habitat modification. Catch rates in the Río Nutría below its confluence with Tampico Draw were similar to previous years. Zuni bluehead sucker was visually observed in the canyon-bound reach below the confluence but no CPUE was computed. No Zuni bluehead sucker was visually observed in the Río Nutría at the USGS gage; no Zuni bluehead sucker has been captured or observed at this site since 2005. No sampling or visual surveys were conducted on the mainstem of Zuni River or Rio Pescado in 2010.

Length-frequency histograms for Zuni bluehead sucker populations in the headwater springs indicate shifts in the size structure of the populations since the mid 1990s (Figures 10 and 11). From 2005 through 2008, no Zuni bluehead sucker smaller than 120 mm TL was captured in the Agua Remora during annual monitoring (larvae, however, were captured there in July 2007). Green sunfish removal efforts were initiated in 2007, leading to a decrease in abundance of the predator (see Nonnative Species Control Efforts, page 28) and an apparent response and increase by Zuni bluehead sucker. In 2009, 37 larval and yoy Zuni bluehead suckers were captured at Agua Remora. In 2010 many larvae and yoy were observed. Limited effort to capture larvae for transfer to the Albuquerque Biological Park resulted in the capture of 36 larvae. Annual monitoring showed juveniles outnumbering adults.

Comparison of 1994 with 2007, 2008 and 2010 length-frequency data from Tampico Springs indicated a decline in number of larger individuals (>100 mm TL, Figure 10); 2009 had shown the presence of larger fish. From data collected in part at Tampico Springs in the 1990s, estimated age for Zuni bluehead sucker smaller than 100 mm TL was ≤2 years (Propst et al. 2001). However, based upon presence of adult characteristics (spawning coloration, gravid females) on fish as small as 57 mm TL, it appears that adult fish are present and spawning. While fish larger than 108 mm TL were not captured in 2010, the median was 85 mm TL which was greater than that observed in 2009 (82mm) when larger fish had been captured. The truncated size distribution of fish in Tampico Springs may be a consequence of greater fish density coupled with reduced habitat size. The presence of gravid females, males with spawning coloration, and larvae and occurrence of multiple, if compressed, size-classes in 2007 through 2010 indicate that spawning and recruitment occurred in Tampico Springs.

Length-frequency histograms for Zuni bluehead sucker in the Río Nutría indicate that although there have been minor shifts in length-class frequency distribution, populations in the canyon continue to be comprised of multiple size classes (Figure 12 and 13). The presence of small fish (<50 mm TL), presumably larvae and yoy, indicated the species successfully reproduced in the Río Nutría in 2010. The collection of adults and yoy suckers, and observation of larvae at the Tampico Draw above the confluence with the Río Nutría in 2010 indicated that reproduction and recruitment also occurred in this area.

Figure 8. Fish assemblage by site in the Zuni River watershed, 2004-2010.

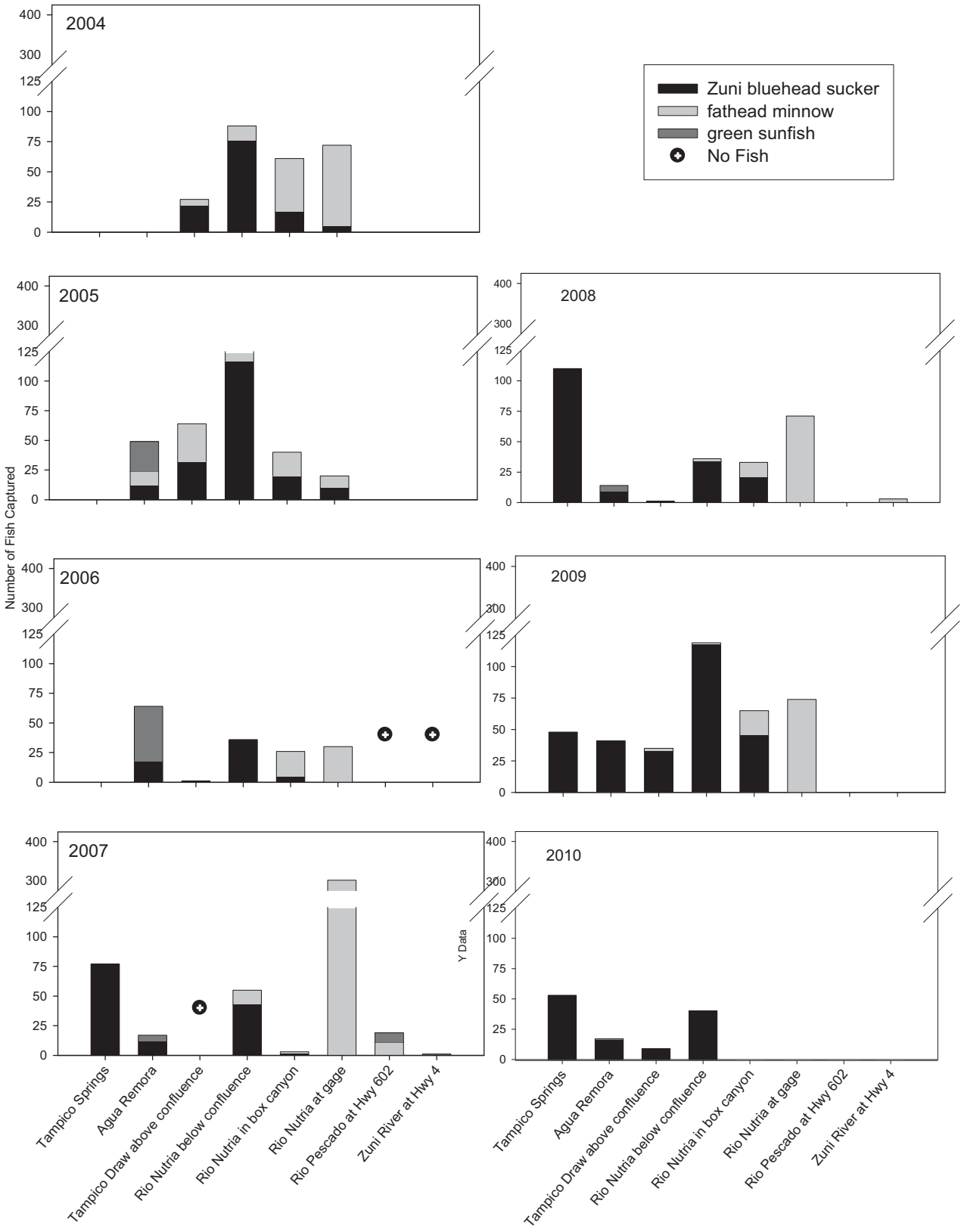


Table 4. Fish collected in the Zuni River watershed, August 2010. Range of Zuni bluehead sucker total length (mm) in parentheses. Visual survey conducted in Río Nutría box canyon. Dashed lines indicate no surveys (shocking or visual) were conducted in 2010.

Site	Effort (Shocking Seconds)	Zuni Bluehead Sucker	Fathead Minnow	Green Sunfish	Plains Killifish	Crayfish
Tampico Springs	326	53 (yoy-117)				
Agua Remora on Forest Service	535	16 (yoy-214)		1		
Tampico Draw above confluence	290	9 (yoy-168)				
Río Nutría below confluence	790	40 (yoy-186)				
Río Nutría in box canyon	Observed	Present	Present			Present
Río Nutría at USGS gage	---					
Río Pescado at Hwy 53	---					
Zuni River at confluence	----					
Totals	1941	118		1		

Figure 9. Catch per unit effort (seconds electrofishing) in the Zuni River Watershed, 1991-2010. In 2006, Rio Pescado and the Zuni River were sampled, but no fish was collected. In 2007, Tampico Draw was sampled, but no fish was collected. No sampling was conducted in waters within Zuni Pueblo in 2010 (highlighted in gray).

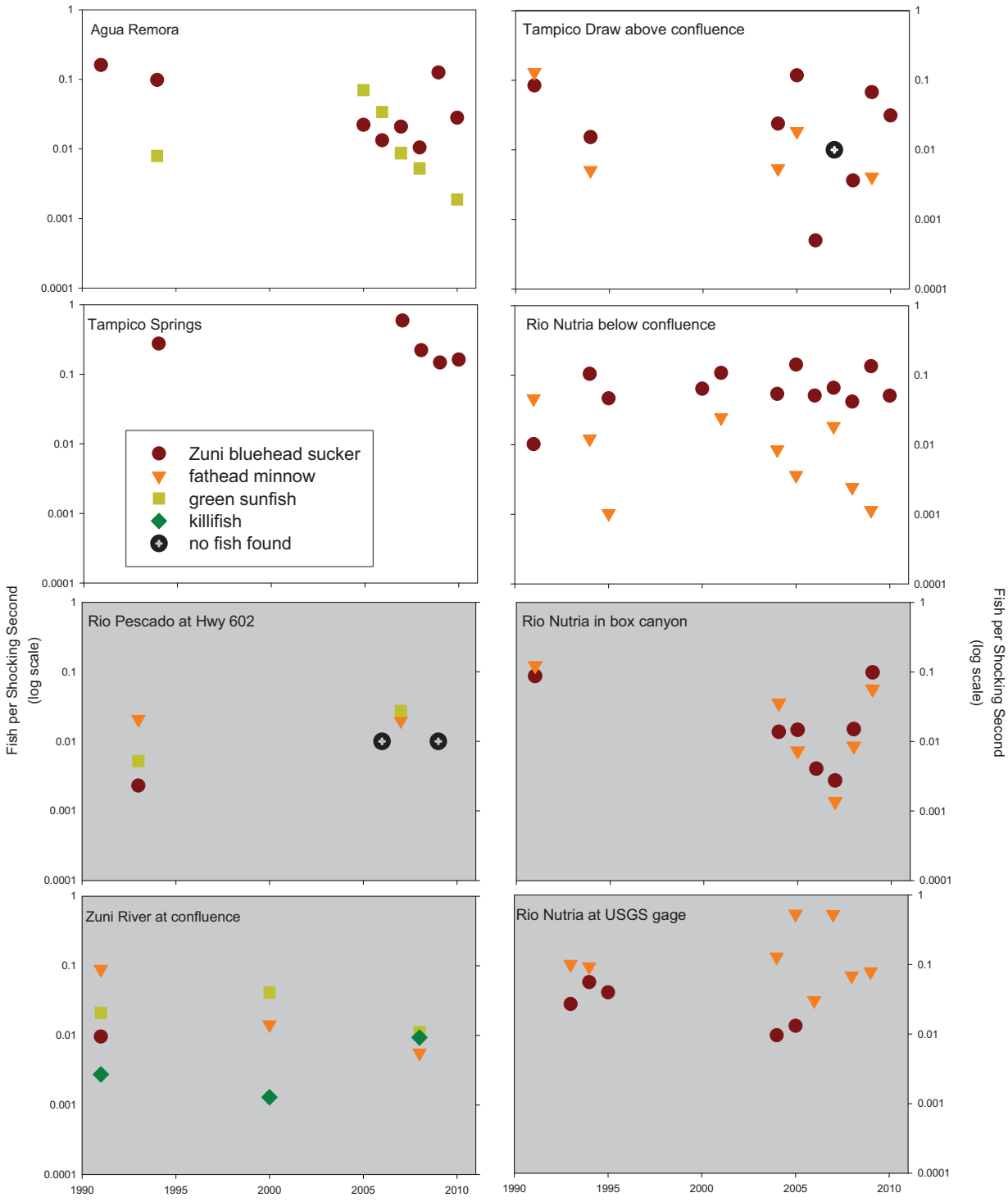


Figure 10. Length-frequency of Zuni bluehead sucker collected from headwater springs, Tampico Springs, 1994 and 2007-2010

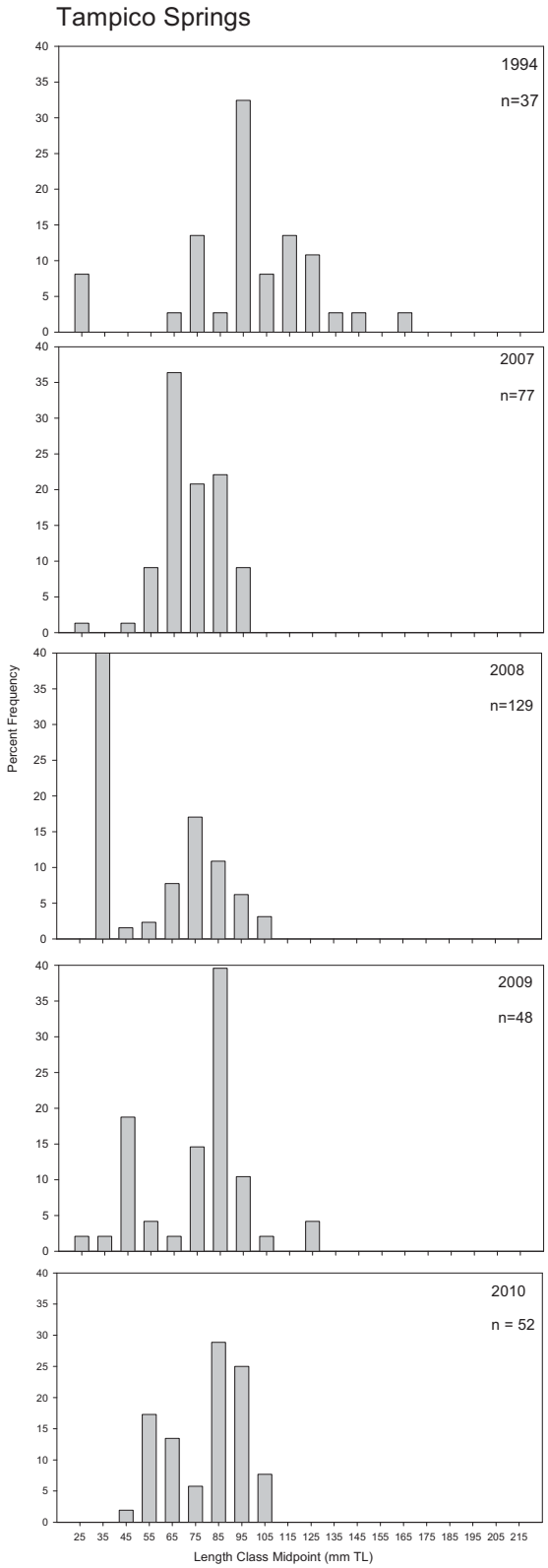


Figure 11. Length-frequency of Zuni bluehead sucker collected from headwater springs, Agua Remora, 1991 and 2007 - 2010

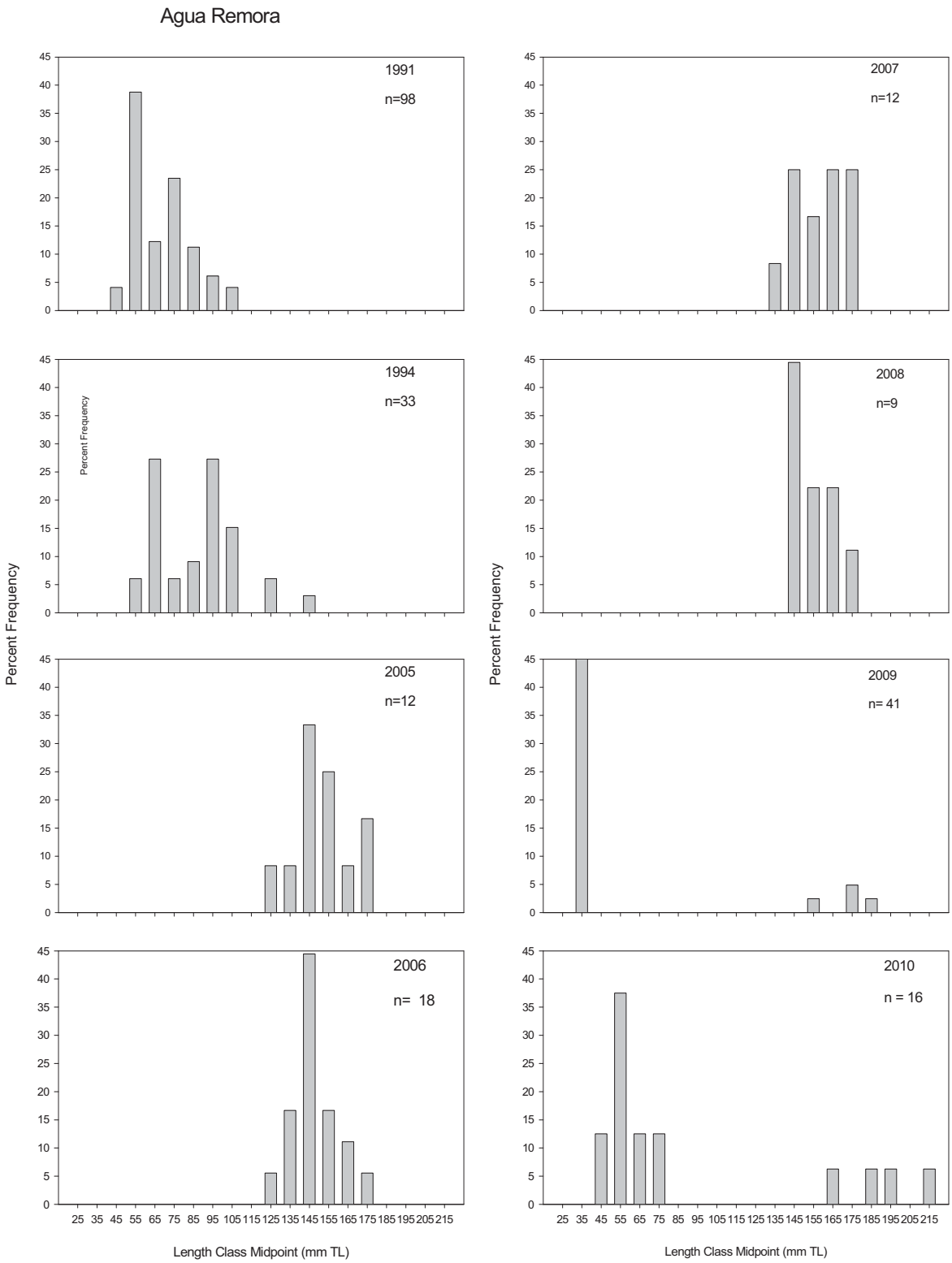


Figure 12 Length-frequency of Zuni bluehead sucker collected from Río Nutría, 2000 and 2007-2010.

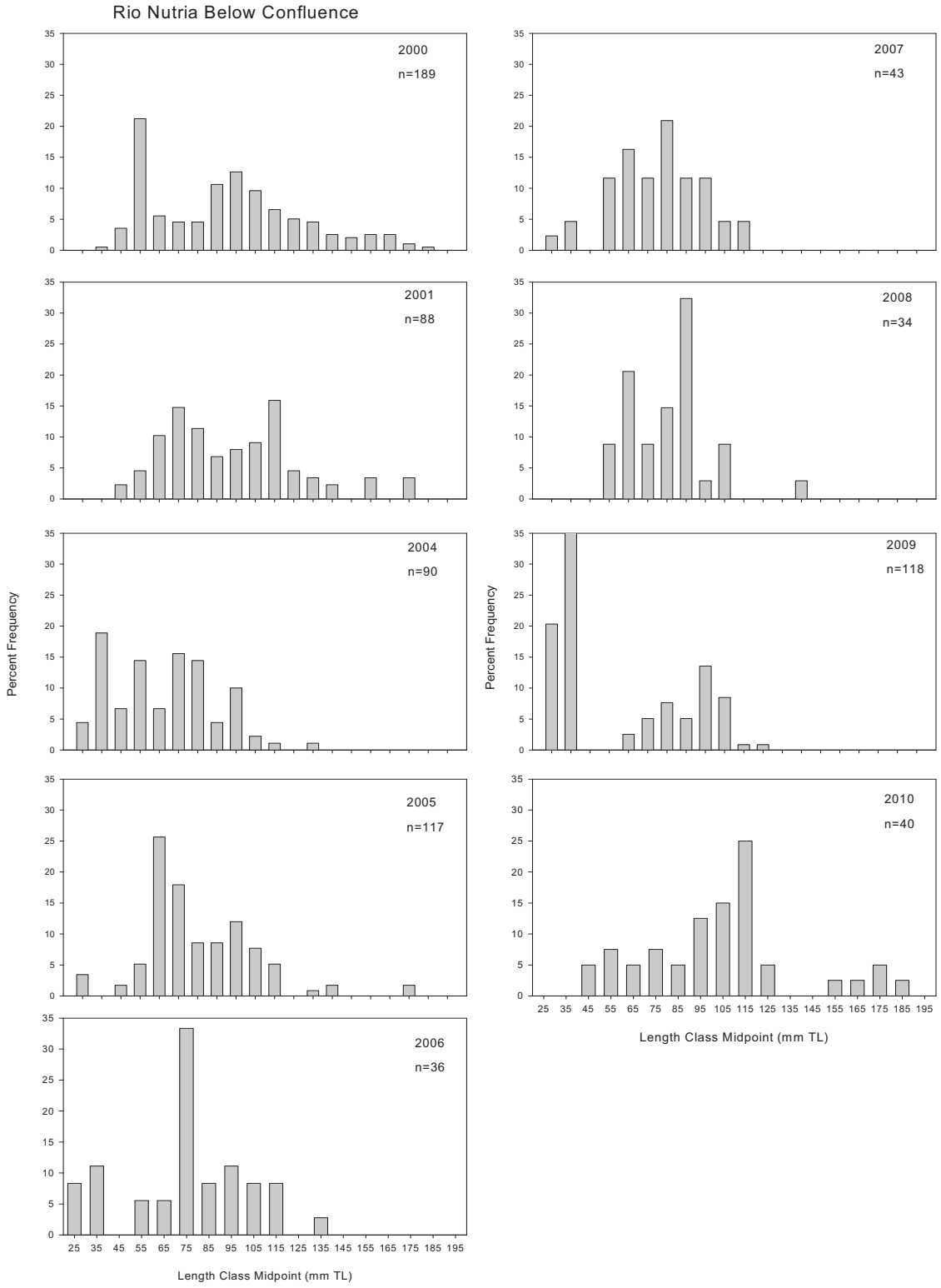
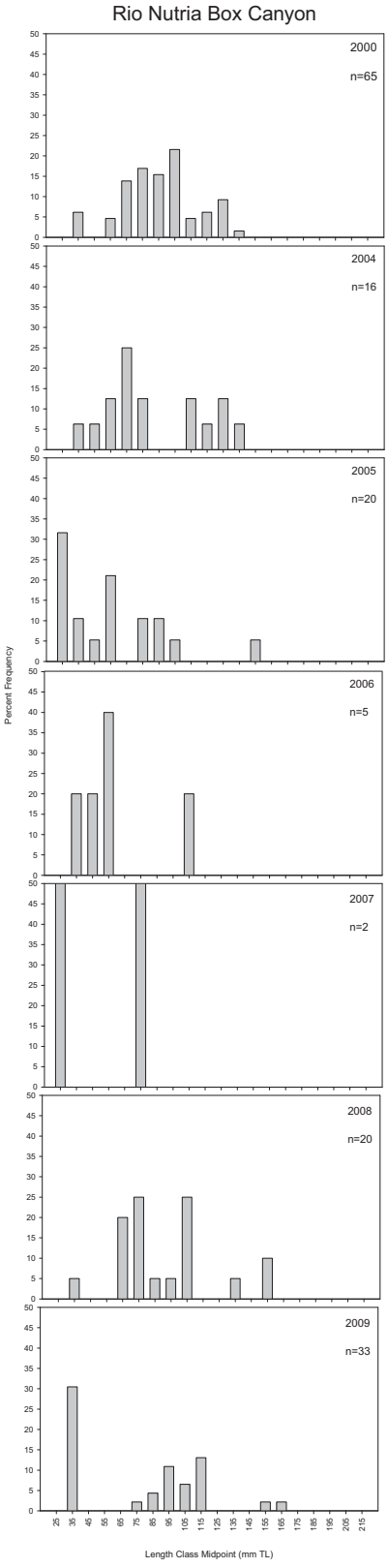


Figure 13 Length-frequency of Zuni bluehead sucker collected from Río Nutría box canyon , 2000 and 2004-2009. Monitoring surveys were not conducted in 2010 at this site.



NONNATIVE SPECIES CONTROL EFFORTS

Nonnative crayfish *Orconectes virilis* was reported and confirmed in the Río Nutría at the USGS gage in 2004. Since 2004, crayfish have been found approximately 100 m further upstream and have not been found at any of the sites regularly monitored for Zuni bluehead sucker (they are common in downstream historical habitat). This crayfish occupies a wide range of habitats and is an opportunistic omnivore, feeding on a variety of foods including macrophytes, invertebrates, fish eggs, fish larvae, and dead or dying fish, making it a serious threat to native stream fish (Childs 1999). Reduction or elimination of crayfish in the Río Nutría will be difficult. Modified minnow traps (opening widened) set in 2004 captured Zuni bluehead sucker as well as crayfish. A review of crayfish control methods found that there is no effective method to eliminate crayfish without adverse affects on other aquatic animals (Hyatt 2004). For example, intense trapping may depress a crayfish population, but without sustained efforts, populations quickly rebound. Chemical methods, such as rotenone, insecticides, or other toxicants, can be effective at removing crayfish, but also affect non-target animals, such as fish and aquatic insects. Based on the summary presented in *Investigation of Crayfish Control Technology* (Hyatt 2004), it appears that sustained, intensive trapping with modified minnow traps (PVC pipe inserted to prevent capture of fish; Morgan et al. 2001) is the best option for crayfish control. In 2008, a project to control crayfish with these methods was planned, but not completed. The only known populations of crayfish occur on Zuni Pueblo lands. In 2010, Zuni Pueblo requested that no removal of this species be conducted.

Although rare or absent in the 1990s, green sunfish was more common than Zuni bluehead sucker in Agua Remora in 2005 and 2006. The lack of small (< 125 mm TL) Zuni bluehead sucker in the Agua Remora suggested green sunfish may be preying upon young Zuni bluehead sucker and limiting recruitment. Piscivory by green sunfish has been implicated in the decline of several native southwestern species (Marsh and Langhorst 1988, Fausch and Bramblett 1991, Dudley and Matter 2000). However repeated examination of green sunfish stomachs did not reveal predation on Zuni bluehead sucker. Rapid digestion is likely the reason no Zuni bluehead sucker remains were found in examined green sunfish digestive tracts rather than absence of predation.

Intensive efforts to remove green sunfish from the Agua Remora occurred on 24-25 May 2007, 2-3 July 2007, and 27-28 June 2008 during annual monitoring. Mechanical removal (electroshocking, seining, trammel netting, angling), although difficult because of large amounts of cattail and submerged vegetation and debris, was used to limit adverse affects to Zuni bluehead sucker. In 2007, various methods were attempted, with angling being noticeably more effective: angling captured 67 green sunfish with no capture of Zuni bluehead sucker. Three pass electroshocking of the pools yielded 14 green sunfish and 18 Zuni bluehead suckers; passes had to be separated by approximately eight hours because sediment disturbance diminished visibility. Seining efforts (two kick seines of each pool) yielded three Zuni bluehead suckers and no green sunfish and caused turbidity. Trammel nets, set for one hour at dusk, yielded no fish. In 2008, nine person-hours of angling yielded only two green sunfish. In 2009, no green sunfish were captured during annual monitoring, although one was seen in the middle pool. During 2010 annual monitoring activities, one sunfish was captured and removed from the middle pool where the single green sunfish was seen in 2009. No other green sunfish were observed.

In previous annual monitoring efforts, nonnative fathead minnow numerically dominated the fish catch in the lower sections of the Río Nutría canyon. Fathead minnow may negatively affect Zuni bluehead sucker and are removed when found. No fathead minnow were captured or removed during 2010, as the habitat they are found in was not sampled by request of Zuni Pueblo.

GENETIC INVESTIGATIONS

Genetic investigations of bluehead suckers in the Lower Colorado River have been ongoing for several years at Arizona State University by Dr. Thomas Dowling. Preliminary analysis of DNA sequences indicated mountain sucker (subgenus *Pantosteus*) of the Little Colorado River basin (LCR) share a complex evolutionary history that has important ramifications for Zuni bluehead sucker. Patterns of mitochondrial and nuclear DNA sequence variation identified an undescribed form of *Catostomus* in East Clear and Silver creeks in Arizona that is distinct from *C. discobolus*. Other populations in the headwaters of the LCR show admixture between individuals of this undescribed *Catostomus* and *C. discobolus* of the mainstem Colorado River. Samples typically assigned to Zuni bluehead sucker (from the Zuni and Kinlichee drainages of the LCR) show admixture of genetic material from these two forms and *C. plebeius*, consistent with the distinctiveness and hypothesized hybrid origin of the latter form (T. Dowling, pers.comm. January 2008).

A similar pattern of variation was also found in a few individuals from the adjacent Chinle drainage (Wheatfields area in Arizona), indicating that introgression of *C. plebeius* alleles has extended further west of the Continental Divide than previously believed. Samples from the Chinle drainage also exhibited unique mitochondrial DNA alleles that are exclusive to that drainage and the headwaters of the LCR. These results: 1) indicate Chinle populations have been isolated from the San Juan River drainage for some time, 2) identify a past connection between headwaters of the LCR and Chinle drainage allowing movement of genetic material in both directions, and 3) indicate Chinle populations should also receive special consideration when developing management strategies (T. Dowling, pers.comm.., January 2008).

In 2009, a study was completed by Dr. Tom Turner and Wade Wilson at the University of New Mexico investigating the effects of isolation on Zuni bluehead sucker populations, particularly those in the headwater spring habitats. Genetic material was provided from the two headwater populations (Tampico Springs and Agua Remora) and the Río Nutría to document levels of genetic variability and distinctiveness among populations, to determine the relative importance of founder effects and bottlenecks on genetic diversity in these populations, and assist in identifying appropriate donor stock for re-establishment of populations or brood stock for hatchery supplementation of wild populations to maintain natural levels of genetic variability. Genetic analysis indicated that individuals from Tampico Springs and Agua Remora exhibited lower levels of genetic diversity than Río Nutría at all loci studied, in part because the headwater fish exhibited very few alleles/haplotypes that are of *C. plebius* origin (Turner and Wilson 2009). It is unclear why *C. plebius* alleles are lacking in the upstream populations; there could have been a barrier to gene flow or they may have been purged by genetic drift or natural selection. Tampico Springs and Agua Remora fishes are genetically nearly identical at the loci studied and based on this information, could be used as donor populations for each other if needed.

However, the authors advised against introducing fish from the Río Nutría into the headwater populations until it is clear why *C. plebius* alleles are lacking. The report is available at http://www.wildlife.state.nm.us/conservation/documents/ConservationGeneticsZuniBlueheadSucker.pdf. No other genetic investigations were begun or continued during 2010.

CAPTIVE REARING INVESTIGATIONS

Husbandry of Zuni bluehead sucker is an unknown science and given the fish's extremely limited distribution and the magnitude of threats to its persistence in the wild, captive holding may be a necessary recovery action. In 2007 NMDGF contracted the Albuquerque BioPark to investigate rearing and holding practices for imperiled aquatic species in the state, including Zuni bluehead sucker. Priorities included collection of fish from the Agua Remora and Tampico Springs as these are the most remote and isolated Zuni bluehead sucker populations and access is irregular. Collections of larval, juvenile, and adult fish were made in 2007, 2008 and 2010 (Table 5).

In April 2009, the Tampico Springs fish (lots ABP07-016, ABP08-010, ABP08-017, total 43 fish) were moved into an outdoor variable-depth mesocosm at the Albuquerque BioPark. The system contained a variety of substrates including concrete, flagstone, pea gravel, and river rock, with plankton and algae as food sources. In May 2009, at least 50 larval Zuni bluehead suckers (ABP09-001) were discovered in the system, indicating successful spawning. These larval fish were provided a diet of brine shrimp nauplii fed through a 24-hour drip system, algae, and plankton. The Tampico Springs fish have continued to be housed in at the Albuquerque BioPark with low mortality.

Mortalities of captive fish occurred primarily in the Agua Remora fish in 2009. When possible, fish were preserved in formalin and transferred to the Museum of Southwestern Biology at The University of New Mexico. Fin clips were also taken when possible, preserved in ethanol and delivered to the fish genetics lab (Turner) at the University of New Mexico. Necropsies were performed on some fish, either by the BioPark or the New Mexico Department of Agriculture Veterinary Diagnostic Services. These exams indicated lipidosis as a predominant disease process in the adult fish examined, while a nutritional deficiency was indicated in the juvenile fish examined. Diets were adjusted to halt these processes.

Currently, there are two groups of Zuni bluehead sucker held at Albuquerque BioPark in separate outdoor mesocosms: Tampico Springs and Agua Remora (Table 5). Separation of lineages will continue until additional information regarding conservation genetics of the species is available. There are no plans to release captive fish or their offspring into natural habitats.

Table 5. Zuni bluehead sucker lots at the Albuquerque BioPark as of January 2011.

Lot Designation	Origin	Collection Date	Collection Lifestage	Collection Number	Current Number
ABP07-101/SMC07-003	Tampico Springs	3 Jul 2007	Larvae	18	0
ABP07-011/SMC07-002	Agua Remora	2 Jul 2007	Larvae	27	2
ABP07-016/SMC07-008	Tampico Springs	19 Aug 2007	Adults	19	8
ABP08-010/SMC08-004	Tampico Springs	28 Jun 2008	Larvae	21	3
ABP08-015/SMC08-008	Agua Remora	25 Aug 2008	Adults	5	0
ABP08-017/SMC08-009	Tampico Springs	25 Aug 2008	Juveniles/Adults	20/10	18
ABP09-001	Captive (Tampico Springs parents)	May 2008	Larvae	50	20
ABP10-010/SMC10-010	Agua Remora	22 Aug 2010	Juveniles	36	27
ABP11-010/SMC10-010	Agua Remora	22 Aug 2010	Adults	8	8

RESTORATION OF HISTORICAL POPULATIONS AND HABITAT AND ESTABLISHMENT OF REFUGE POPULATIONS

In 2008, NMDGF and TNC completed the purchase of land in the upper Río Nutría, including the stream segments where a life history study was completed in the early 1990s (Propst et al. 2001). When the site was visited in August 2005, the stream was wetted, but Zuni bluehead sucker were not observed. Neighboring landowners reported that the Río Nutría in this section was subject to periodic drying during the early 2000s, which likely explains the absence of Zuni bluehead sucker. Restoration of a population to this area was a priority action identified in 2008. In the spring of 2009, many wetted pools over bedrock were observed, several over 10 m in diameter with small connections between them, but no fish was present (Figure 3). Emergent vegetation (*Thypha* spp.) was present in several pools, suggesting perennial water. In June 2009, fish from the Río Nutría below the confluence with Tampico Draw were captured and transferred to the wetted pools on the upper Río Nutría. At that time wetted habitat was reduced from that noted in the spring of that year. During annual monitoring in 2009 wetted habitat was not present. No fish were seen at the site during the 2009 monitoring. During annual summer monitoring in 2010 this site was wetted, although at lower levels than in the April observations (Figure 3). These observations, coupled with the data from the HOBO temperature logger, indicate that this stretch of the upper Río Nutría may be seasonally intermittent. In 2010 it was noted that the wetted pools harbored a large number of bullfrog tadpoles. The data logger will continue to be deployed near the cattails (presumably the most permanent of the pools) and should provide additional information on the intermittency of water, using temperature as a surrogate for water presence.

No habitats on the Rio Pescado were visited in 2010. Areas in the upper Río Pescado on Zuni Pueblo lands had been visited in 2009. These areas are perennial, with clear water of 0.5 to 1 m in depth over silt and boulder substrate. Water quality measurements were similar to those found in occupied Zuni bluehead sucker spring habitats. Invertebrate and algae life was abundant. One spring pool was fishless; the other contained a large population of speckled dace. With cooperation of Zuni Pueblo, these spring pools may provide suitable habitat for establishment of Zuni bluehead sucker refuge populations. Additionally, speckled dace found in the spring pool may be useful in restoring this species throughout its historical range in the Zuni River watershed.

HABITAT STATUS

Development, Access, and Acquisitions

Housing development in the Zuni River watershed has been increasing in recent years and increased threats to Zuni bluehead sucker habitat from water withdrawal (ground-water pumping) and habitat degradation by siltation and pollution from increased road and home density are a concern. In 2007, Tampico Springs Ranch Subdivision, a ranchette community northwest of occupied Zuni bluehead sucker habitat, was proposed for a total of 490 lots, varying from 3 to 11.9 acres, each with a well and septic system. In early 2008, Phase I, 173 lots from 2.92 to 6.58 acres, was presented to and approved by McKinley County. The Geohydrologic Investigation Report prepared for Phase I of the subdivision states "Pumpage is likely to affect flow at Brennan and Tampico springs" (MJDarrconsult, Inc. 2007). Phase I of the subdivision was approved with conditions, including metering of water wells to enforce the 0.3 acre-feet per year per household restriction. McKinley County is encouraging cooperation between the subdivision and the Pueblo of Zuni on watershed issues and NMDGF on wildlife concerns.

In 2009, the Trust for Public Lands working with the USFS secured Congressional funding for the purchase of the portion of Tampico Springs Ranch Subdivision closest to Zuni bluehead sucker habitat (section 27 and the southern portion of section 33). The purchase was completed in August 2009 and provides permanent protection for 1,280 acres as part of the Cibola National Forest.

In 2008, the USFS began the process to grant an easement to McKinley County for access across FR 191 and 191D and reassign an existing easement across private lands that the Forest Service holds to McKinley County. The granting of the easement will allow McKinley County to upgrade FR 191D and take over the maintenance of FR 191 and FR 191D. The final Draft Environmental Impact Statement was published 2 April 2010 and included mitigation measures such as installation of groundwater monitoring wells. The document is available at: http://a123.g.akamai.net/7/123/11558/abc123/forestservic.download.akamai.com/11558/www/nepa/50531_FSPLT1_026217.pdf

In 2008, NMDGF and TNC utilized Natural Lands Protection Act funding to purchase approximately one mile of canyon-bound habitat in the upper Río Nutría for inclusion in the TNC Río Nutría Preserve. TNC completed the management plan for the Río Nutría Preserve, including forest and watershed management actions, as well as those targeted for Zuni bluehead sucker (Río Nutría Management Plan 2009). Zuni bluehead sucker was documented as recently as 1995 in this area (Propst et al. 2001), but has not been confirmed since. Water appears to be intermittent or ephemeral in this area.

In 2009, additional road easements were established to allow for permanent access across private lands to USFS and TNC in-holdings, particularly the Agua Remora and upper Río Nutría. In 2010 the USFS completed all necessary requirements to clear a road along the easement. A ¾ mile low-standard administrative-use-only road was cleared and provides permanent access to the Agua Remora population.

Isolated Spring Habitats

Agua Remora on Forest Service land was visited multiple times in the summers of 2007, 2008, 2009 and 2010 for annual monitoring efforts, nonnative removal, and collection of fish for captive rearing investigations. In July 2007 and August 2009, the lower pool at Agua Remora was nearly dry; on each occasion, fish were salvaged and moved into the middle pool (Figure 14). According to a local landowner, decline in water depth and wetted area at the lower pool is common in summer months prior to monsoons. Deeper areas in the lower pool remained wetted and Zuni bluehead sucker persistence was confirmed in the months following drying, when water depth was similar to previous years. In 2008 and 2010 such drying was not noted. In 2010 larvae, yoy and adults suckers were captured and many more observed.

When Agua Remora was first visited in 2005, three distinct pools were present, with an area of intermittently damp meadow between. Since 2008, the connections between the pools have been increasing, leading to a nearly continuous channel between the pools as well as vegetated wetland area (Figure 14).

Figure 14. Habitat changes in Agua Remora. Left: Larval fish salvage from drying lower pool at Agua Remora, July 2007. Right: New channel between middle and upper pools, May 2010. Bottom: Channel between middle and upper pools highly vegetated with evidence of elk use 2010. Photos Angela James, USFWS.

As noted previously, the upper pool at Agua Remora is heavily laden with woody debris and highly organic and was found fishless in 2005. To determine if water quality is being affected by amount of decomposition, and potentially a limiting factor for Zuni bluehead sucker persistence in the upper pool, water quality data were collected at three pools in the Agua Remora throughout day and night in July 2007. Dissolved oxygen was similar in the upper and lower pools (20-65% saturation), with the highest values occurring in the middle pool (45-80% saturation). Salinity and conductivity were similar among the three pools and showed little diel fluctuation, ranging from 0.22-0.24 ppt and 359-428 mS, respectively.

The habitat at Agua Remora is facing increasing sedimentation and loss of optimal Zuni bluehead sucker habitat (permanent, clear flowing water over hard substrate). According to a local landowner, the pools at Agua Remora were dug out by USFS in the 1970s. While this has not been confirmed in files, given the location and dimensions of the pools, it seems likely such occurred. Discussions began with the USFS in 2009 about potential methods to protect or enhance the Agua Remora habitat. In May 2010, USFS proposed to protect and enhance the Agua Remora habitat in future years by pool restoration, installation of sediment control structures throughout the watershed, and removal of cattails and excessive woody debris. In 2010, USFS personnel, volunteers from the Albuquerque Wildlife Federation and the New Mexico Department of Game and Fish repaired the fencing around the three pools.

Tampico Springs was also visited multiple times in the summers of 2007 through 2009. Habitat was similar to Agua Remora, consisting of two semi-isolated pools about 1 m wide and 15 m long throughout 2007. However, in 2008 and 2009, open water was substantially reduced; only one pool was present, approximately 1 m x 15 m. There appeared to be more wetted areas forming down-drainage.

It is likely that fluctuations in the extent and location of spring habitats is natural in the upper watershed area. Reports are often received of remnant spring habitats with Zuni bluehead sucker throughout the upper watershed area. These areas likely represent refuges for the species, which grow and lessen with changing hydrologic conditions. Given the increased pressure on water resources in the upper watershed, documentation of spring locations and groundwater levels and movement is a priority. To begin this effort, USFS, in cooperation with USFWS and NMDGF, is leading the effort to install piezometers and monitor ground water levels throughout the upper Zuni River watershed.

Support from local landowners in conservation for Zuni bluehead sucker is central to recovery of the species. Many landowners have been proud stewards of the species for generations and have been working with land and species managers to restore the watershed. Forest management on private lands in the upper watershed is ongoing, utilizing a variety of state and federal resources. Working with the Natural Resources Conservation Service and New Mexico State Forestry, a private landowner is attempting to restore forested areas including selective harvesting of timber and installation of wildlife friendly fencing.

Additional contacts have recently been established with landowners in the upper Zuni River watershed for conservation of the species. Most are concerned for the survival of the species, have been willing to allow surveys on their land and are receptive to conservation efforts. Some

have expressed an interest in potentially placing a conservation easement on their property in order to assist with recovery efforts should their economic circumstances warrant doing so.

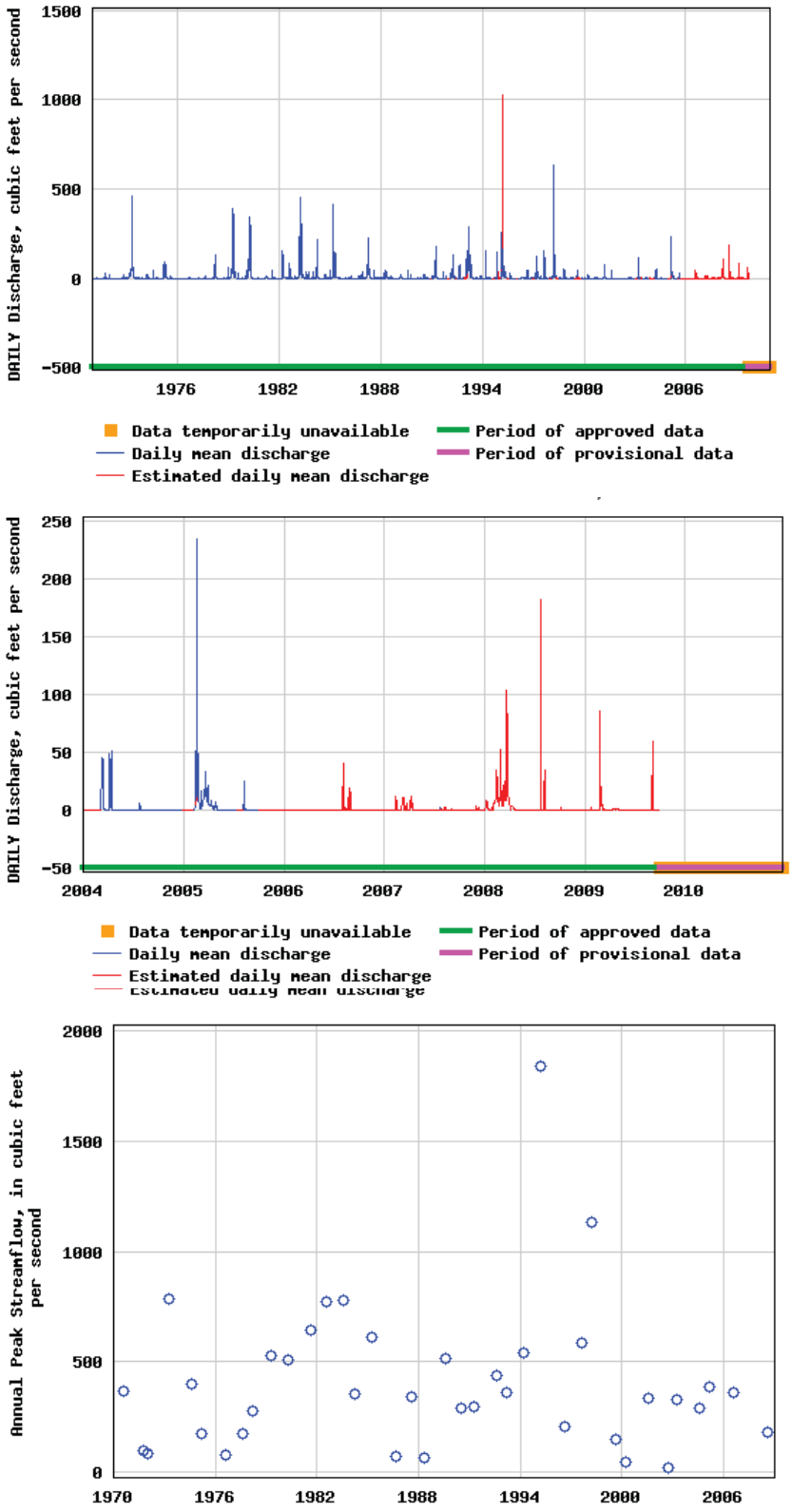
Canyon Bound Habitats

Tampico Draw and upper Río Nutría currently represent the stronghold of Zuni bluehead sucker. The habitat, canyon-bound cascading pools over exposed bedrock, is considered the preferred habitat for the species. Flushing spring and monsoon flows are necessary to mobilize and transport silt from occupied habitats. Summary data available from the USGS gage on the Río Nutría (#09386900) indicate that large flood events, usually occurring in the early spring (snowmelt) and mid-summer (monsoon), have occurred with less frequency and intensity in the past 10 years (Figure 15). These high volume events are important in maintaining the clean, hard substrate habitat where Zuni bluehead sucker are most commonly found. However, recent data from the USGS gage are unreliable because of pooling. Repair, or relocation, of this gage should be a priority.

Beaver numbers have increased in the upper Río Nutría since the early 1990s, when the species was restored to Pueblo of Zuni. Loss of wetted habitat in the Río Pescado and Zuni River has led to a surplus of beavers in the area, leading to near-complete impoundment of the Río Nutría below the mouth of the canyon and presence of dams throughout the canyon into Tampico Draw and upper Río Nutría. Beaver control efforts were undertaken by the Zuni Department of Fish and Wildlife in summer 2007 through 2010 resulting in removal of five beavers from the Río Nutría in the box canyon and willow wetland on Pueblo of Zuni land. In 2007, immediate effects on the habitat were not apparent and removal efforts continued in 2008, with removal of three beavers from the Río Nutría on Pueblo of Zuni land. In 2008, less silt and pooling was observed in Zuni bluehead sucker habitat, possibly a result of fewer beavers and increased flushing flows. In 2009, an additional three beavers were removed. There was less beaver sign in August 2009 in the Río Nutría upstream of the USGS gage, but this may be related to significantly lower water levels.

In 2010, Zuni Fish and Wildlife staff removed a total of eleven beavers along Río Nutría on Zuni tribal land: five beavers near the USGS gage site on the Río Nutría and six at the Diversion dam below to the upper Río Nutría village bridge. Beavers had dammed areas along the Río Nutría below the confluence with Tampico Springs. In 2010 these dams were not observed and it appears that high water flows blew out the beaver dams. Large pools and the layers of silt and sedimentation which had covered the bedrock were much reduced in these areas. Twice in the spring of 2010, Zuni Fish and Wildlife staff hiked the Río Nutría up to its confluence with Tampico Draw and did not observe any new sign of beaver activity. All beavers are removed lethally and resources are utilized by Zuni Pueblo aviary operations and pelts are given to tribal members for use in construction of cultural items.

Figure 15. Daily mean discharge (1970-2008 and 2004-2010 and annual peak springflow (1970-2008) discharge in the Río Nutría, from the USGS gaging station #09386900, Río Nutría at the bottom of the box canyon. Data were accessed and graphed on 23 December 2010 at http://waterdata.usgs.gov/nwis/uv?09386900



Mainstem Habitat

Historical Zuni bluehead sucker habitats in the mainstem Zuni, Pescado and Nutría rivers, as determined by previous annual surveys, are nolonger suitable for Zuni bluehead sucker. Perennial reaches in these rivers were shown in past monitoring events to be numerically dominated by nonnative species, including green sunfish. Other areas, such as the Zuni River below the confluence of Ríos Pescado and Nutría, are not permanently wetted. Additionally, these sites are dominated by silty substrates and habitat rehabilitation would likely be necessary for Zuni bluehead sucker re-establishment. The upper Pescado River, from Hwy 53 upstream to the springs, is perennial, currently has few nonnative fishes, and may offer an opportunity for restoration.

OUTREACH AND EDUCATION

Outreach and education on Zuni bluehead sucker has increased greatly in the past few years. During 2008 and 2009 monitoring, the NMDGF videographer took footage and interviews of the partnership working for conservation of this fish. The footage was used for segments on the NMDGF Wild! television program in 2009 and 2010 and is online at http://www.youtube.com/NMGameandFish#p/u/98/RBx5V_DbsaQ . Additionally, articles about the species and the conservation partnership appeared in newspapers throughout the west. A presentation to the Albuquerque Wildlife Federation was given in 2010. Volunteers from this organization then assisted in habitat restoration efforts conducted on Agua Remora. These efforts help increase public awareness about the species and will hopefully lead to increased protection and sensitivity.

2010 MANAGEMENT RECOMMENDATIONS

- Cooperative efforts to monitor and manage Zuni bluehead sucker on tribal lands should be facilitated between tribal, state, and federal partners.
- Coordination and cooperation among the Pueblo of Zuni, U.S. Forest Service, The Nature Conservancy, U.S. Fish and Wildlife Service, NMDGF, and private landowners should continue and be formalized through the development of a Cooperative Agreement.
- Cooperators should work to ensure that consideration for Zuni bluehead sucker recovery is included in all projects in the watershed. Partnerships with local, state, and federal agencies such as McKinley County and NRCS, should be sought.
- Permanent legal access for monitoring and management purposes should be achieved for all current and historical habitats.
- The Cibola National Forest should be encouraged to initiate a boundary survey of recently acquired property in Sections 27 and 33, Township 13N, Range 16W, NMPM. Delineating the new Cibola National Forest boundary in this area and restricting vehicular access is essential to the protection of the sole remaining habitat of the fish. These measures will prevent the establishment of recreational use patterns which encourage unauthorized entry to the Rio Nutria Preserve and permit the Forest Service to consider placing vehicular access restrictions on adjacent public lands acquired in part to protect remaining habitat.
- Habitat protection and restoration projects should continue across the watershed. Funding should be sought for both large multi-jurisdictional and small private projects, including through State Landowner Incentive and Tribal Landowner Incentive programs. Potential projects include:
    - Installation of ground and surface water quantity meters, such as pizometers, and repair/re-installation or relocation of USGS gage on the Río Nutría
    - Installation of surface water quality meters in key habitats to monitor dissolved oxygen and temperature
    - Physical rehabilitation/improvement of the Agua Remora
    - Sediment transport abatement in the upper watershed, including forest restoration and sediment traps in ephemeral watercourses
    - Restoration of historical habitat in the upper Río Pescado
- Habitat, especially presence of wetted habitat, should be surveyed and monitored in the upper Río Nutría on TNC Río Nutría Preserve. If perennial habitat is found, efforts to move Zuni bluehead sucker from lower in the Río Nutría (box canyon) should be initiated.
- The programs to remove nonnative species should be continued or initiated:
    - Intensive crayfish removal initiated in the Río Nutría
    - Removal of green sunfish in the Agua Remora
- Conservation genetic research continued to guide management decisions regarding captive holding and assisted movement of Zuni bluehead suckers in natural habitat.
- Rearing investigations should be continued to assist in maintenance of a refuge population. This includes collections of additional fish from all populations, especially the Agua Remora.
- Efforts to restore Zuni bluehead sucker to historical, suitable habitat should continue, particularly in the upper Río Nutría if found perennial.

- Efforts to create secure refuge populations within the natural distribution should begin.
- Beaver removal and relocation efforts should be continued to lessen the impacts of stream impoundment in Zuni bluehead sucker habitat in the Río Nutría. With increased water availability in historically occupied areas of the Río Pescado and Zuni River, relocation of beavers into these areas may be appropriate. Water retention through beaver dams in these areas may help with retention of water in downstream reaches, potentially leading to restoration of historical Zuni bluehead sucker habitat.

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REFERENCES

Carman, S.M. 2004. Zuni bluehead sucker (*Catostomus discobolus yarrowi*) recovery plan. New Mexico Department of Game and Fish, Conservation Services Division, Santa Fe, New Mexico.

Childs, M.R. 1999. Literature review and field and laboratory studies of Northern Crayfish, *Orconectes virilis*, in Arizona. IIPAM Project No QGR6912. Arizona Game and Fish Department, Heritage Program, Phoenix, Arizona.

Dudley, R.K. and W.J. Matter. 2000. Effects of small green subfish (*Lepomis cyanellus*) on recruitment of Gila chub (*Gila intermedia*) in Sabino Creek, Arizona. 45(1): 24-29.

Fausch, K.D. and R.G.Bramblett. 1991. Disturbance and fish communities in intermittent tributaries of a western Great Plains river. *Copeia* 1999:659-674.

Hyatt, M.W. 2004. Investigation of crayfish control technology. Final Report for Cooperative Agreement No. 1448-20181-02-J850. Arizona Game and Fish Department, Phoenix, Arizona.

Marsh, P.C. and D.R. Langhorst. 1988. Feeding and fate of wild larval razorback sucker. *Environmental Biology of Fishes.* 21:59-67.

MJDarrconsult, Inc. 2007. Geohydrologic Investigation Report: Proposed "Tampico Springs Ranch" Subdivision – Phase 1 McKinley County, New Mexico. MJDarrconsult, Inc: Groundwater Hydrology Services, Los Ranchos de Albuquerque, New Mexico.

Morgan, K.B., K.D. Hilwig, and T.A. Burke. 2001. A modified minnow trap to reduce fish entrapment during crayfish removal efforts. Fisheries Technical Report 01-03. Statewide Fisheries Investigations, Federal Aid Project F-7-M-42. Arizona Game and Fish Department, Phoenix, Arizona.

Propst, D.L., A.L. Hobbes, and T.L. Stroh. 2001. Distribution and notes on the biology of Zuni bluehead sucker, *Catostomus discobolus yarrowi*, in New Mexico. *The Southwestern Naturalist* 46 (2): 158-170.

TNC Río Nutría Preserve Management Plan 2009. A cooperative effort of The Nature Conservancy of New Mexico, New Mexico Department of Game and Fish, New Mexico Energy, Minerals and Natural Resource Department, and the Zuni Tribe

Turner, Thomas F. and Wade D. Wilson. 2009. Conservation genetics of Zuni bluehead sucker (*Catostomus discobolus yarrowi*) in New Mexico. Final Report submitted to Conservation Services Division, New Mexico Department of Game and Fish, Santa Fe, New Mexico.