Gila River Basin Native Fish Monitoring

2019 Annual Report

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Introduction

Long-term monitoring at multiple spatial scales through time (i.e., temporal) provides important insight on the distribution, abundance, and dynamics of stream fish communities. In 1994, a long-term monitoring program was initiated by the Bureau of Reclamation (BOR) as a requirement imposed by the Fish and Wildlife Service (FWS) to monitor fish populations in selected waters of the Gila River basin due to impacts of the Central Arizona Project (CAP) on federally-listed fishes (FWS 1994, 2001, 2008). For example, the canal and its interconnected channels degraded fish habitat and provides a mechanism for the dispersal of non-native fishes into surrounding aquatic systems. The initial objective of the monitoring program was to provide baseline data on the distribution and abundance of non-native fishes in the CAP canal system and surrounding tributaries. In 2012, BOR and FWS in collaboration with Arizona Game and Fish Department (AZGFD) and New Mexico Game and Fish Department (NMGFD) shifted focus further upstream of the CAP to gather information on the status of wild populations of federal-listed/candidate fishes.

The primary objective of the current monitoring program is to detect the presence of each focal species in each stream and determine the distributional extent within occupied streams. Secondarily, evaluate fish community structure to determine the relative abundance of the focal species relative to co-occurring fishes. This report summarizes monitoring activities conducted by Marsh & Associates, LLC (M&A) during calendar year 2019 for the Gila River Basin Native Fish Monitoring project (GRBMP). Here, detailed trip summaries with catch data are reported, results are summarized across sub-basins, species distribution maps were constructed, sampling gears were qualitatively evaluated, and a preliminary multivariate analysis of fish community composition was used to reveal complex patterns and relationships.

Surveys were conducted in selected streams of major drainages throughout the Gila River basin (Figure 1) that were not being surveyed by others (e.g., agencies, institutions, and private contractors). The focal species in each stream is one or more of five native species currently listed as threatened or endangered: Gila Chub *Gila intermedia,* Spikedace *Meda fulgida*, Loach Minnow *Tiaroga cobitis*, and Gila Topminnow *Poeciliopsis occidentalis,* plus imperiled Roundtail Chub *Gila robusta*.

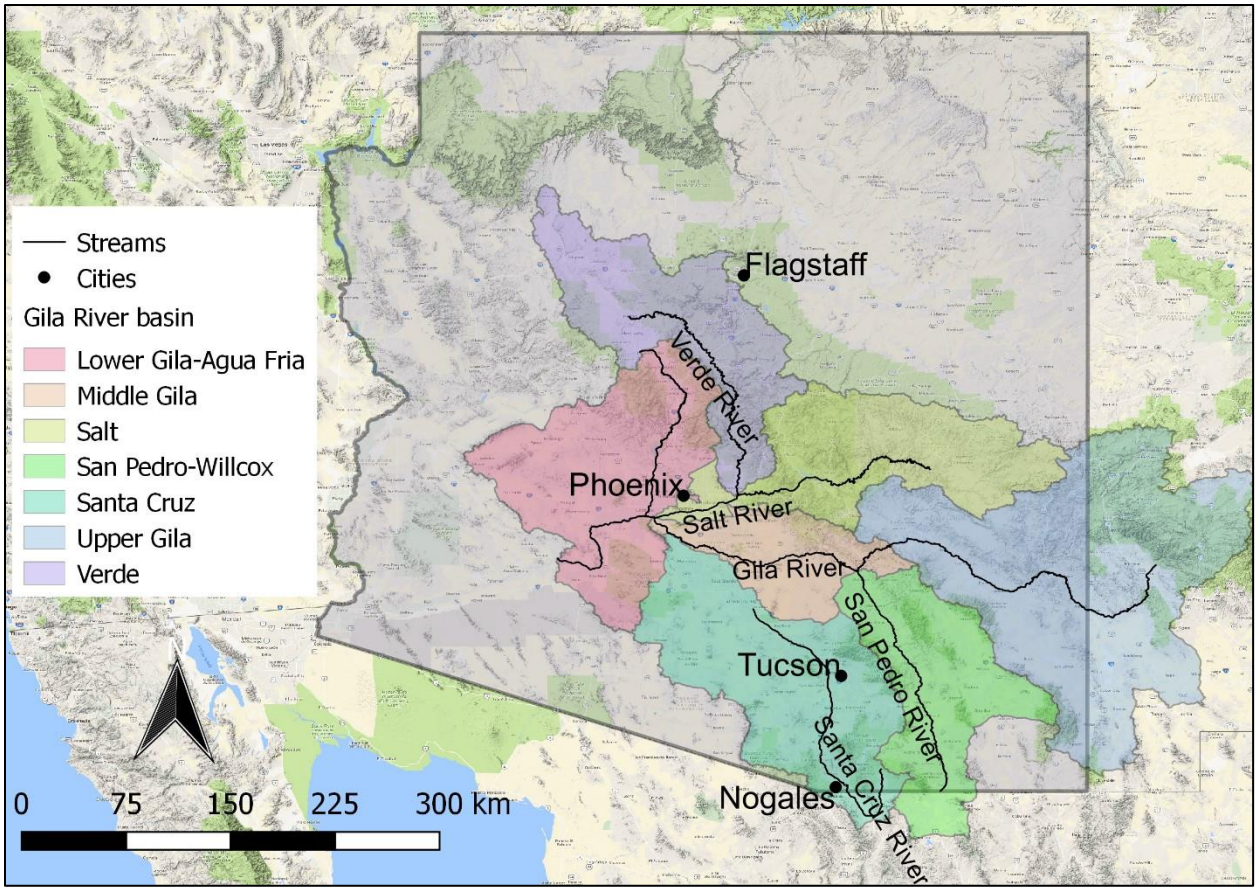

Figure 1. Major drainages of the Gila River basin, Arizona and New Mexico, where stream surveys were conducted in 2019.

Methods

Sampling

Sampling gear selection was based on the focal species at each site in addition to local habitat characteristics and distance required to access the sampling site. Primary methods of sampling were backpack electrofishing ([BPEF]; Smith-Root LR-20B Electrofisher), large hoop nets (29 in x 24 in, ¼ in mesh), Promar collapsible hoop nets (hereafter Promar nets; 12 in x 24 and 35 in, 1.5 in mesh), seines (20 ft x 6 ft, 0.236 in mesh; 13 ft x 4 ft, 0.078 in mesh; and 12 ft x 4 ft, 0.118 in mesh) and Gee style minnow traps (hereafter minnow traps; 10 in x 18 in, 1/8 in mesh). Angling via fly rod was used in situations where other gear was not effective (e.g., deep pools in remote locations).

Monitoring protocol followed Clarkson et al. (2011) and any deviations are reported in the trip summaries section below. For clarification, definitions of terms are discussed that are commonly used throughout the report. Stream reach refers to a specific stretch of river denoted by watershed position (i.e., lower, middle, upper), and site refers to a location within a stream reach where sampling occurred. The minimum number of required sites for each stream system was determined based on the length of the stream. Typically, streams that were less than 8 kilometers (km) require one site at minimum, streams that were greater than 8 km but less than 16 km are designated a minimum of two sites, and streams

greater than 16 km were assigned three sites. However, minimum sites also are determined based on accessibility, need of sampling, and perennial streamflow.

The priority upon arrival at a site was to determine the presence of the focal species at a site. Opportunistic sampling was conducted through a 500-meter (m) site with focus on the preferred habitat of the focal species. All fishes encountered during this initial pass were identified to species (Table 1), enumerated, and partitioned into age classes (i.e., for large-bodied species; age-0 [young-of-year] and age-1+ [age 1 and older individuals]; small-bodied fishes are not classified and labeled as SB). If the focal species was detected, a 100 m site was established at the point of detection and continued upstream. During this survey, mesohabitats (i.e., riffle, run, and pool) and dry sections were delineated, and species and effort were counted separately within each mesohabitat.

Sites were measured using a Garmin 64st GPS unit. The UTM coordinates of the upper and lower boundaries of each reach were recorded in NAD83 datum. Habitat photographs were taken at each site as well as some specimen photos of species of interest. At sites where the focal species was detected and ≥25 individuals were captured, photographs were taken at the upper and lower boundaries of both the upstream and downstream view for future reference of fixed sites.

Table 1. List of fish species encountered during surveys throughout the Gila River Basin in 2019.

Common name	Code	Scientific name
Rainbow Trout	ONMY	*Oncorhynchus mykiss*
Longfin Dace	AGCH	*Agosia chrysogaster*
Gila Chub	GIIN	*Gila intermedia*
Roundtail Chub	GIRO	*Gila robusta*
Speckled Dace	RHOS	*Rhinichthys osculus*
Loach Minnow	TICO	*Tiaroga cobitis*
Red Shiner	CYLU	*Cyprinella lutrensis*
Fathead Minnow	PIPR	*Pimephales promelas*
Sonora Sucker	CAIN	*Catostomus insignis*
Desert Sucker	PACL	*Pantosteus clarki*
Yellow Bullhead	AMNA	*Ameiurus natalis*
Sailfin Molly	POLA	*Poecilia latipinna*
Western Mosquitofish	GAAF	*Gambusia affinis*
Gila Topminnow	POOC	*Poeciliopsis occidentalis*
Brook Stickleback	CUIN	*Culaea inconstans*
Green Sunfish	LECY	*Lepomis cyanellus*
Redeye Bass	MICO	*Micropterus coosae*
Largemouth Bass	MISA	*Micropterus salmoides*
Bluegill	LEMA	*Lepomis macrochirus*

Data summary and analyses

Fish capture data were summarized and compiled in tabular form, separately for each stream, that provides numerical, catch-per-unit effort (CPUE), and relative abundance for each species and each age (size) class. Also, a narrative text summarized trip details and fish community composition. Status of the focal species was assessed in contexts of physical habitat conditions, the local fish community, proximate or perceived threats, and other relevant conservation concerns. Solutions implemented (or recommended) to remedy any problems were described, and additional recommendations were offered that might contribute to program improvement. Distribution maps were constructed for each focal species in QGIS (QGIS Development Team 2019).

Results

Across all streams, a total of 6,984 individuals and 19 fish species (8 native and 11 non-native) were captured (Table 2; Appendix A, Figures A6-A7). No new taxa were detected for the Gila River basin, but Brook Stickleback was recorded for the first time in Whitewater Creek, NM (see page 53). Also, Redeye Bass in Wet Beaver Creek may have been historically misidentified as Smallmouth Bass (see page 63). Native taxa accounted for 78% of total catch, while non-native taxa accounted for 22%. Backpack electrofishing was the primary sampling gear, which accounted for 60% (n=4,209) of total catch (Appendix A, Figure A7). Backpack electrofishing was effective at capturing both age classes (i.e., Age-0 and Age-1+) and small-bodied fishes. However, BPEF was not effective in stream reaches with deep pools or high turbidity. Minnow traps were used to target Gila Topminnow and were employed at seven sites, which accounted for 25% (n=1756) of total catch (Appendix A, Figure A8). Seining was employed in pools and runs where fish were visually present and other gears were less effective, such as in Monkey Spring and Fresno Canyon, and accounted for 8% (n=571) of total catch (Appendix A, Figure A9). Small-bodied fishes, particularly Gila Topminnow, were effectively captured with seines. Some large-bodied fishes also were captured in seines, but their abundance was likely underrepresented. Promar hoop nets generally were used to sample *Gila* spp. when BPEF was not feasible, or when sampling sites were in remote locations. Promar hoop nets were employed at three sites and accounted for 4% (n=269) of total catch (Appendix A, Figure A10). Aside from deeper bodied fish such as Green Sunfish, the larger mesh in the Promar Nets potentially allows age-0 fish to escape resulting in gear bias. All other gears (e.g., dip-nets, large hoop nets) accounted for <3% of total catch.

Table 2. Summary of species detected (+) and not detected (-) by stream reach; all in Arizona unless otherwise indicated. Focal species for each stream are highlighted in yellow. Species codes are listed in Table 1.

Stream and reach	ONMY*	AGCH	GIIN	GIRO	RHOS	TICO	CYLU*	PIPR*	CAIN	PACL	AMNA*	POLA*	GAAF*	POOC	CUIN*	LECY*	MICO*	MISA*	LEMA*
Buckhorn Spring	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Chalky Spring	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tule Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Salome Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Lower Salt River (upper)	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	+	-	+	+
Lower Salt River (middle)	-	+	-	-	-	-	+	-	+	+	+	+	+	-	-	-	-	+	-
Lower Salt River (lower)	-	-	-	-	-	-	+	-	+	+	+	+	+	-	-	+	-	+	+
Bass Canyon	-	-	+	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Cherry Spring Canyon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O'Donnell Canyon	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Swamp Springs Canyon	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Coal Mine Canyon	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Fresno Canyon	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Monkey Spring	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Redrock Canyon	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Romero Canyon	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bear Creek, NM	-	+	-	-	-	+	-	-	-	+	-	-	+	-	-	-	-	-	-
Harden Cienega	-	+	+	-	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-
Turkey Creek, NM	-	+	+	-	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-
Upper Blue River	-	+	-	-	+	+	-	-	+	+	-	-	-	-	-	-	-	-	-
Whitewater Creek, NM	+	+	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-
Lower Wet Beaver Creek	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-

*Non-native species

(+) detected

(-) not detected

Trip Summaries

Agua Fria River Basin

Chalky Spring February 13, 2019

12S NAD83 Lower boundary: 378694E, 3746751N Upper boundary: 378706E, 3746836N

Chalky Spring (Maricopa County, AZ) is a tributary to Morgan City Wash ~6 km west of Lake Pleasant (Figure 2). Approximately 1,200 Gila Topminnow were stocked into Chalky Spring in 2009 (Pearson et al. 2013). This system was last sampled for the GRBMP in 2014 and was sampled in subsequent years by U.S. Bureau of Land Management (Timmons et al. 2015; Gray 2018). Sampling in 2014 utilized seines and aquarium nets, whereas sampling in 2015-2017 employed minnow traps. Gila Topminnow (i.e., focal species) were not detected at Chalky Spring after 2015 despite considerable effort.

Chalky Spring was accessed by parking along N Castle Hot Springs Rd. (12S 377641E 3746072N) and hiking through Morgan City Wash to Chalky Spring. Habitat consisted of a small pool at the head of the spring and perennial water extended downstream for ~100 m. An initial attempt was made to visually detect Gila Topminnow, but none were observed, and nine minnow traps were set and fished for 2 hours (hr); no fish were detected. However, an unidentified species of tadpole was captured (n=80). Water temperature and conductivity were not recorded. Photographs of targeted habitat are provided in Figures 3-4.

Gila Topminnow appeared to have been extirpated from this site. Disappearance of this population could be due to habitat modification caused by flooding, which likely would have washed Gila Topminnow into more ephemeral, downstream reaches (Gray 2018).

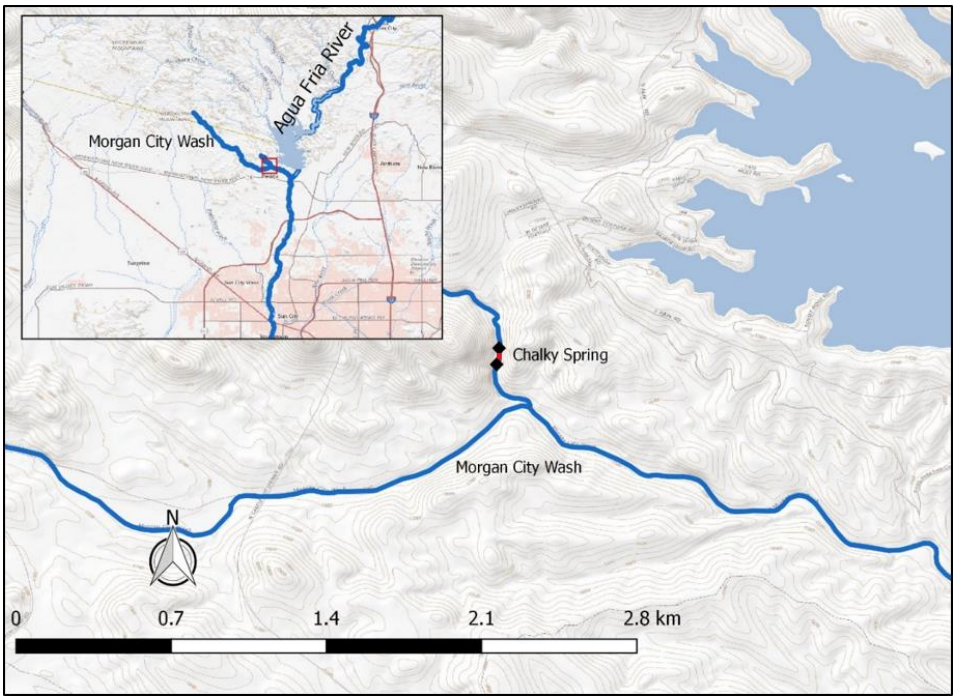

Figure 2. Location of 100 m sampling site in Chalky Spring, sampled February 13, 2019.

Figure 3. Example of targeted habitat in Chalky Spring.

Figure 4. Example of targeted habitat in Chalky Spring.

Buckhorn Spring April 23, 2019

12S NAD83 Lower boundary: 364309E, 3763874N Upper boundary: 364318E, 3763778N

Buckhorn Spring (Maricopa County, AZ) is located northwest of Lake Pleasant (Figure 5) and is tributary to Castle Creek, which flows directly into Lake Pleasant. Gila Topminnow were stocked into Buckhorn Spring in 2011, 2014, and 2014 with a total of 1,739 individuals stocked (Gray 2018). All perennial water is located within a fenced livestock exclosure and is isolated from non-native fishes by ~25 km of dry streambed. Buckhorn Spring was last surveyed for the GRBMP in 2016.

On April 23, 2019, Buckhorn Spring was accessed from Buckhorn Creek Road from Castle Hot Springs Road. To best match previous sampling efforts of this site, seining was the initial survey method used. After capturing Gila Topminnow (n=14; 18.18%) in 100 m, seining continued for 500 m upstream, an additional 14 seine hauls were unsuccessful in finding additional topminnow, so it was determined that minnow trapping would be the most effective method of capture at this site. Fifteen minnow traps baited with pet food were set for 2 hr in the 100 m site and captured Gila Topminnow (n=63; 81.82%). Gila Topminnow was the only species detected in this survey with no observations of exotics or other native species. Catch data were summarized in Tables 3-4.

Habitat consisted of several open pools connected by shallow, narrow riffles. Pools that were sampled ranged from 1 to 3 m deep. Gila Topminnow were not observed in the uppermost bedrock pools that are vertically separated from one another as described in the 2016 report (Timmons and Paulus 2016). Water temperature and conductivity were recorded at 18.8 °C and 422 µS, respectively. Photographs of the upper and lower extent of the survey are provided below (Figures 6-9).

Gila Topminnow were detected at this site; however, they do not appear to be as abundant as described in previous sampling efforts (Timmons et al. 2017). There was nothing directly observed to indicate a reason for a reduced population size such as reduction in habitat or detection of exotics. Significant winter flooding could be a cause for reduced numbers. This site should be continually sampled on a three-year basis to closely monitor this population due to the short lifespan and vulnerability of this species.

Table 3. Summary of catch in Buckhorn Spring by minnow traps. Total effort was 30 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
POOC	SB	63	100.00	2.100
Total		**63**	**100**	**2.100**

Table 4. Summary of catch in Buckhorn Spring by seine. Total effort was 3 seine hauls.

Species	Age	Count	% of total catch	CPUE (fish/net haul)
POOC	SB	14	100.00	4.667
Total		**14**	**100**	**4.667**

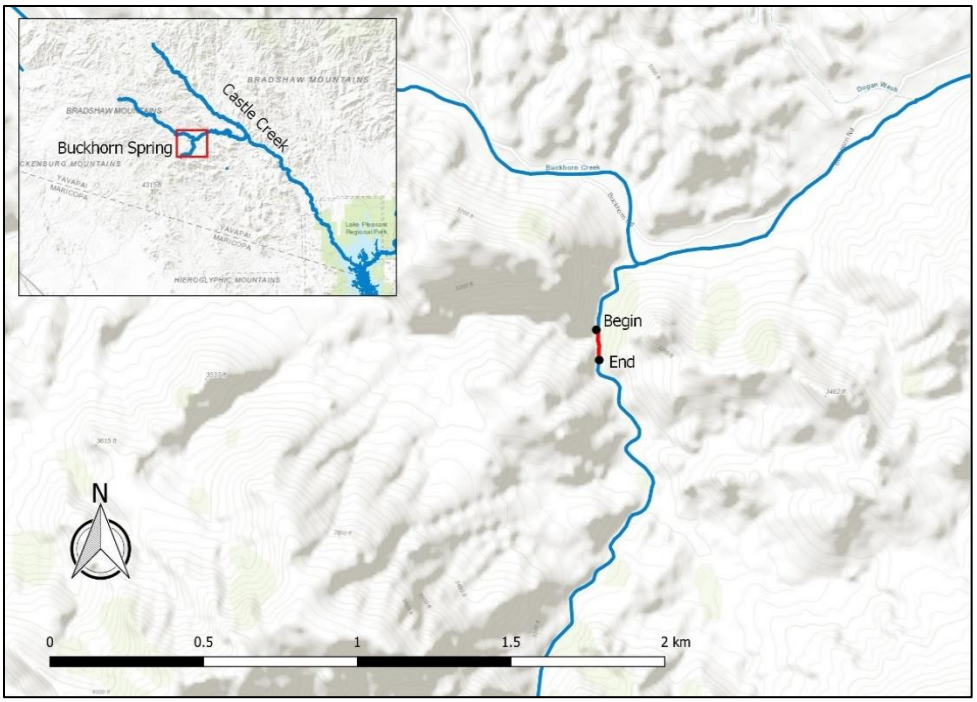

Figure 3. Location of 100 m sampling site in Buckhorn Spring, sampled April 23, 2019.

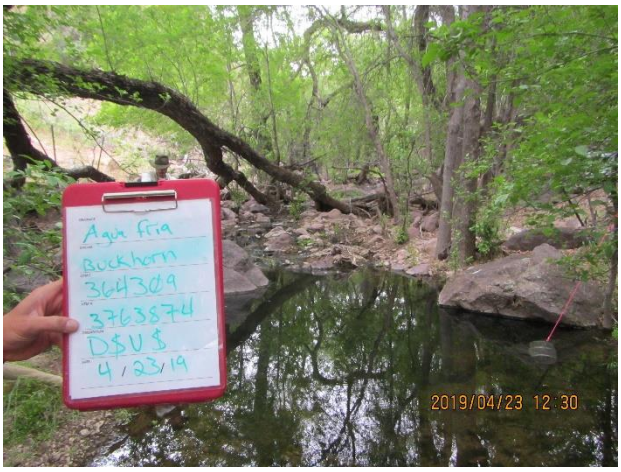

Figure 4. Downstream to upstream view of the 100 m sampling site in Buckhorn Spring.

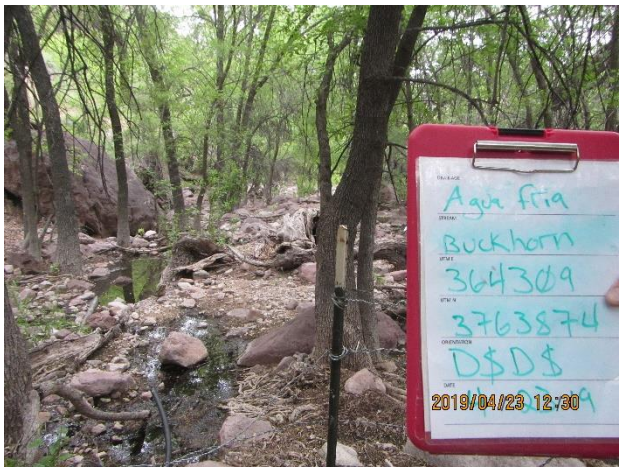

Figure 5. Downstream to downstream view of the 100 m sampling site in Buckhorn Spring.

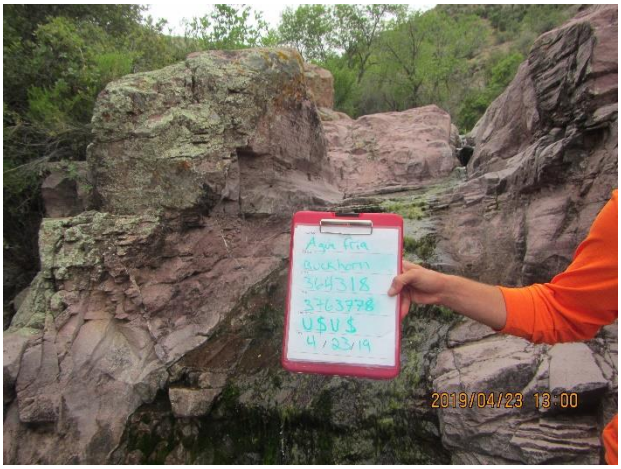

Figure 8. Upstream to upstream view of the 100 m sampling site in Buckhorn Spring.

Figure 9. Upstream to downstream view of the 100 m sampling site in Buckhorn Spring.

Tule Creek April 24, 2019

12S NAD83 Lower boundary: 382308E, 3763893N Upper boundary: 382322E, 3764001N

Tule Creek (Maricopa County, AZ) is a tributary to the Agua Fria River and located north of Lake Pleasant in the foothills of the Bradshaw Mountains (Figure 10). Perennial water from a spring is found approximately 9 km upstream of the Agua Fria and flows for about 800 m. This portion of stream is protected by a 70-acre livestock exclosure fence. In addition, a fish barrier is present to prevent invasion of non-natives from Lake Pleasant. One thousand Gila Topminnow were stocked into Tule Creek in 1981 and the population persists today (Gray 2018). Tule Creek was last surveyed for the GRBMP in 2015.

On April 24, 2019, M&A and BOR personnel accessed Tule Creek from Cow Creek Road via Castle Hot Springs Road. It is recommended to acquire a Utility Task Vehicle (UTV) to help access this site from a closer location. We did not have access to a UTV, so our vehicle was parked along a wash just below the Old China Dam (12S 380507 3759231) and we hiked ~7.2 km to the lower boundary of this site. Upper and lower boundaries of this site were set based on detection of Gila Topminnow in previous sampling efforts for the GRBMP (Timmons and Upton 2013; Timmons and Paulus 2016). Fourteen steel minnow traps baited with pet food were set for 2 hr within the previously established 100 m site, which captured Gila Topminnow (n=23; 21.10%). After processing the minnow traps, it appeared seining would be more effective. Four seine hauls were pulled, capturing Gila Topminnow (n=86; 78.90%). It was assured that topminnow were not counted twice because all minnow trap specimens were preserved for a BOR genetics study. Catch data were summarized in Tables 5-6.

Habitat consisted of moderately sized pools ranging from 1 to 3 m deep near the start of the 100 m site. Described in previous reports (Timmons and Upton 2013; Timmons and Paulus 2016) available habitat has declined since 2012 restricting open water to fewer pools than previously sampled. Cattails (*Typha* sp.) have started choking the pools and reducing the amount of surface water in the few pools that are left. Despite the declining habitat Gila Topminnow were still abundant and observed outside of the 100 m site. Water temperature and conductivity were 24.8 °C and 530 µS, respectively. Photographs of the upper and lower extent of the survey are provided below (Figures 11-14).

Gila Topminnow were visually observed ~300 m below the lower boundary of this site. Abundance of topminnow appeared to be lower than was observed at this site in the past; however, due to changes in habitat, climate, and flooding the distribution may have changed and topminnow may be more abundant downstream of the site. A case like this where the focal species is still observed but in fewer numbers than the past may not reflect a dwindling population, but a change in distribution throughout the creek system. The future sampling design should take this into consideration. Gila Topminnow at this location appear to be healthy and inhabit more habitat than the 100 m sampled. It is recommended that this site is continually sampled due to the short lifespan and vulnerability of this species.

Table 5. Summary of catch in Tule Creek by minnow traps. Total effort was 28 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
POOC	SB	23	100.00	0.821
Total		**23**	**100**	**0.821**

Table 6. Summary of catch in Tule Creek by seine. Total effort was four seine hauls.

Species	Age	Count	% of total catch	CPUE (fish/net haul)
POOC	SB	86	100.00	21.500
Total		**86**	**100**	**21.500**

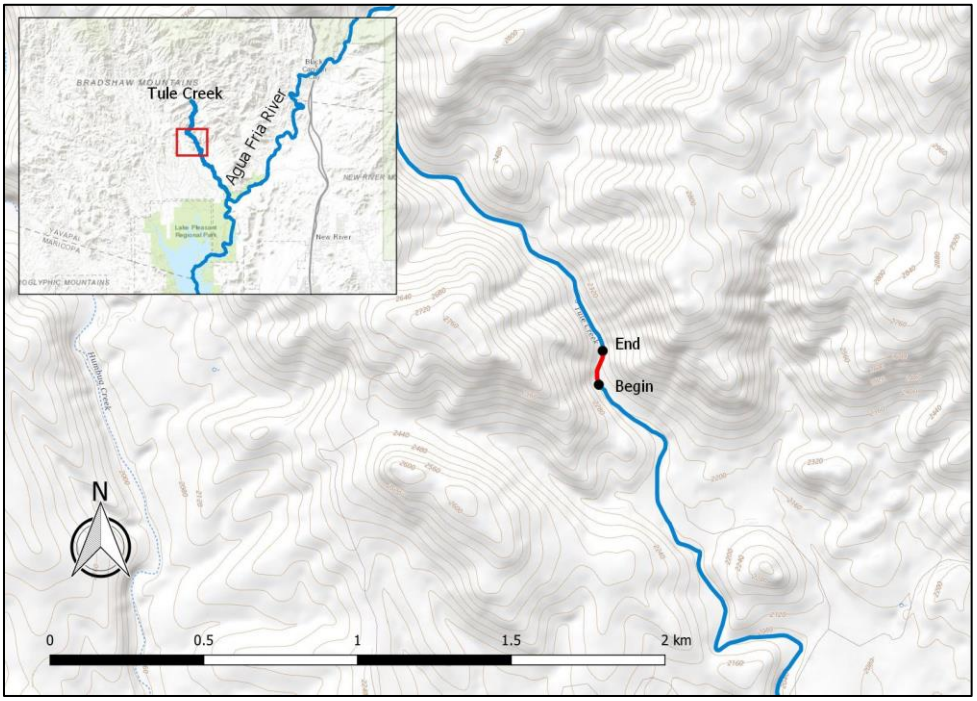

Figure 6. Location of 100 m sampling site in Tule Creek, sampled on April 24, 2019.

Figure 7. Downstream to downstream view of the 100 m sampling site in Tule Creek.

Figure 8. Downstream to upstream view of the 100 m sampling site in Tule Creek.

Figure 10. Upstream to Upstream view of the 100 m sampling site in Tule Creek.

Figure 9. Upstream to downstream view of the 100 m sampling site in Tule Creek.

Salt River Basin

Lower Salt River

The Salt River (Maricopa County, AZ) is formed by confluence of the White River and Black River and flows southwest ~322 km, making it the longest tributary of the Gila River. The Salt River basin drains portions of the Mogollon Rim, Natanes Mountains, and Natanes Plateau. The historical fish community consisted of 15 native fishes (Gilbert and Scofield 1898), but by 1926 it had been reduced to eight native and two introduced species (Miller 1961; Minckley and Deacon 1968). Over the next three decades, non-native fish diversity increased while the number of native fishes was reduced to seven in the Phoenix Metropolitan Area (Marsh and Minckley 1982). In 1963 to 1967, surveys near Phoenix in the Salt River recorded 29 fish species, five of which were native and widely distributed (Marsh and Minckley 1982). In 1981, fish community composition showed an abrupt shift, with distribution and abundance of native fishes showing little resemblance to historical structure (Marsh and Minckley 1982). The lower Salt River is delineated for the purposes of this program downstream of Stewart Mountain Dam to Granite Reef Dam (21 km). Recent GRBMP surveys of lower Salt River detected a suite of non-native taxa and three native taxa (i.e., Sonora Sucker, Desert Sucker, and Longfin Dace). Roundtail Chub (i.e., focal species) was last detected in lower Salt River in 2000 according to GRBMP database.

Lower Salt River (Upstream Reach) – Stewart Mountain Dam January 9, 2019

12S NAD83	Lower boundary 1: 449646E, 3712833N	Upper boundary 1: 450085E, 3713140N
	Lower boundary 2: 450241E, 3713097N	Upper boundary 2: 450709E, 3713217N
	Lower boundary 3: 450601E, 3713351N	Upper boundary 3: 450360E, 3713802N

The lower Salt River downstream of Stewart Mountain Dam was accessed by parking at Water Users Recreation Site and wading upstream. All sites were sampled with BPEF. Three 500 m sites were sampled targeting Roundtail Chub and all sites overlapped with sampling performed by AZGFD in 2013, 2014, and 2016 (Figure 15). However, they sampled with a canoe electrofishing unit, trammel nets, hoop nets, and minnow traps (Timmons et al. 2014; Timmons et al. 2015; Timmons et al. 2017).

The first 500 m site was established near Water Users Recreation Site and sampled via BPEF for a total of 1,554 seconds (sec), which captured age-0 Largemouth Bass (n=11; 100%). A second 500 m site was established ~160 m upstream and sampled via BPEF for a total of 820 sec, which captured Largemouth Bass (n=21; 87.5%), Green Sunfish (n=1; 4.2%), Bluegill (n=1; 4.2%), and Western Mosquitofish (n=1; 4.2%). A third 500 m site was established ~160 m upstream and sampled via BPEF for a total of 822 sec, which captured Western Mosquitofish (n=21; 56.8%), Bluegill (n=11; 29.7%), Largemouth Bass (n=4; 10.8%), and Yellow Bullhead (n=1; 2.7%). For reporting purposes, catch data were summarized across sites in Table 7. Fishes were apparently sparse, and most were captured in a connected off-channel pool within the second site on the right bank. Northern Crayfish (*Orconectes virilis*) were also observed throughout this reach. Sonora Sucker and Desert Sucker were not detected despite being captured in previous surveys. Submerged aquatic vegetation was not as abundant compared to downstream reaches where suckers were commonly captured, which may explain the failed detection. Additionally, the failed detection may be due to proximity of Stewart Mountain Dam and sampling limitations (e.g., depth).

Stream habitat was consistent across all sites. Mesohabitats consisted of riffle, run, and pools comprised predominately of cobble and boulder substrate. Algae was abundant and attached to large substrate, making it difficult to wade. There were two large pools that were not effectively sampled by BPEF. Stream discharge recorded at the time of sampling was nine cubic feet per sec (cfs; 0.25 cubic m per sec [cms]). Water temperature recorded at 10:15 was 16 °C. Photographs of available habitat are provided in Figures 16-17.

Lack of detection of Roundtail Chub is consistent with past surveys indicating their status is poor in the lower Salt River. Overall, there were no native fishes detected across all three sites below Stewart Mountain dam, which differs from past GRBMP surveys where Sonora Sucker and Desert Sucker were captured, although intermittently and in low numbers. Saguaro Lake immediately upstream of this section is managed as a sport fishery and is a primary source of nonnatives into this section of river.

Table 7. Summary of catch in the lower Salt River below Stewart Mountain Dam by BPEF. Total effort was 3,196 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AMNA	1+	1	1.39	0.0003
GAAF	SB	22	30.56	0.0069
LECY	0	1	1.39	0.0003
LEMA	1+	12	16.67	0.0038
MISA	0	28	38.89	0.0088
MISA	1+	8	11.11	0.0025
Total		**72**	**100**	**0.023**

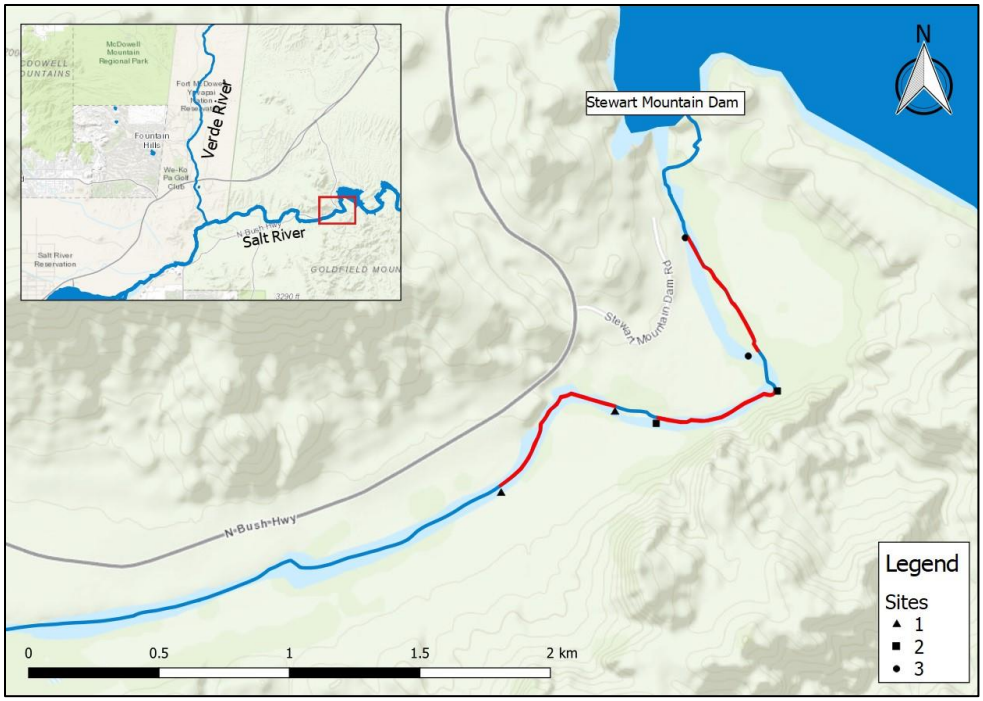

Figure 15. Location of three 500 m sampling sites in the lower Salt River below Stewart Mountain Dam, sampled January 9, 2019.

Figure 16. Example of targeted habitat at the lower Salt River below Stewart Mountain Dam.

Figure 17. Example of targeted habitat at the lower Salt River below Stewart Mountain Dam.

Lower Salt River (Middle Reach) – Goldfield Recreation Site January 10, 2019

12S NAD83	Lower boundary 1: 442200E, 3713121N	Upper boundary 1: 442646E, 3713363N
	Lower boundary 2: 442866E, 3713440N	Upper boundary 2: 443481E, 3713482N
	Lower boundary 3: 443716E, 3713160N	Upper boundary 3: 443766E, 3712580N

The lower Salt River at Goldfield Recreation Site (GRS) was accessed from the GRS parking lot. All sites were sampled with BPEF. Three 500 m sites were sampled targeting Roundtail Chub (Figure 18). The two upstream sites overlapped with GRBMP sampling performed by AZGFD in 2013, 2014, and 2016, while the most downstream site was established near GRS. Previous sampling by AZGFD was performed exclusively with a canoe electroshocking unit (Timmons et al. 2014; Timmons et al. 2015; Timmons et al. 2017).

The first 500 m site was established near GRS and sampled via BPEF for a total of 555 sec, which captured Sailfin Molly (n=32; 60.4%), Desert Sucker (n=10; 18.9%), Red Shiner (n=9; 17.0%), and Largemouth Bass (n=2; 3.8%). A second 500 m site was established ~225 m upstream and sampled via BPEF for a total of 666 sec, which captured Sailfin Molly (n=38; 42.2%), Sonora Sucker (n=22; 24.4%), Western Mosquitofish (n=11; 12.2%), Desert Sucker (n=7; 7.8%), Longfin Dace (n=6; 6.7%), Red Shiner (n=3; 3.3%), Largemouth Bass (n=2; 2.2%), and Yellow Bullhead (n=1; 1.1%). A third 500 m site was established ~400 m upstream and sampled via BPEF for a total of 865 sec, which captured Red Shiner (n=33; 52.4%), Desert Sucker (n=12; 19.0%), Sonora Sucker (n=7; 11.1%), Sailfin Molly (n=6; 9.5%), and Largemouth Bass (n=5; 7.9%). For reporting purposes, catch data were summarized across sites in Table 8. Species captured within this reach that were not detected in the upstream reach (i.e., Stewart Mountain Dam) include Sailfin Molly, Red Shiner, Longfin Dace, Desert Sucker, and Sonora Sucker. Sailfin Molly was the most abundant taxon (42.2%) within the middle reach, which was not consistent with previous surveys. Abundance patterns of Sailfin Molly may be reflective of the gear type used. For example, surveys performed by AZGFD within the middle reach were preformed exclusively with a canoe electrofishing unit, whereas BPEF was deployed in 2019. Sailfin Molly were associated with submerged aquatic vegetation in shallow pools. Desert Sucker and Sonora Sucker were abundant and readily captured in shallow pools associated with submerged aquatic vegetation. Longfin Dace were captured from a single locality in a swift run. This stream reach supported markedly higher numbers and diversity of fishes compared to the upstream reach. There was only one large pool within the second site that was not effectively sampled. Unidentified dead fish were noted throughout the sampling reach, but the cause of their mortality was unknown.

Stream habitat was consistent across all sites. Mesohabitats consisted of riffle, run, and pools comprised of cobble, boulder, pebble, gravel, and sand substrate. Algae was abundant and attached to cobble and boulders. Substrate size was markedly smaller than the upstream reach with greater habitat heterogeneity. Submerged aquatic vegetation was abundant in shallow pools and along the margins. Water temperature recorded at 9:54 was 14 °C. Photographs of available habitat are provided in Figures 19-20. Predacious non-native fishes continue to be the greatest threat towards Roundtail Chub and other native fishes in the lower Salt River.

Table 8. Summary of catch in the lower Salt River near Goldfield Recreation Site by BPEF. Total effort was 2,086 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	SB	6	2.91	0.0029
AMNA	1+	1	0.49	0.0005
CAIN	1+	29	14.08	0.0139
CYLU	SB	45	21.84	0.0216
GAAF	SB	11	5.34	0.0053
MISA	0	3	1.46	0.0014
MISA	1+	6	2.91	0.0029
PACL	0	1	0.49	0.0005
PACL	1+	28	13.59	0.0134
POLA	SB	76	36.89	0.0364
Total		**206**	**100**	**0.099**

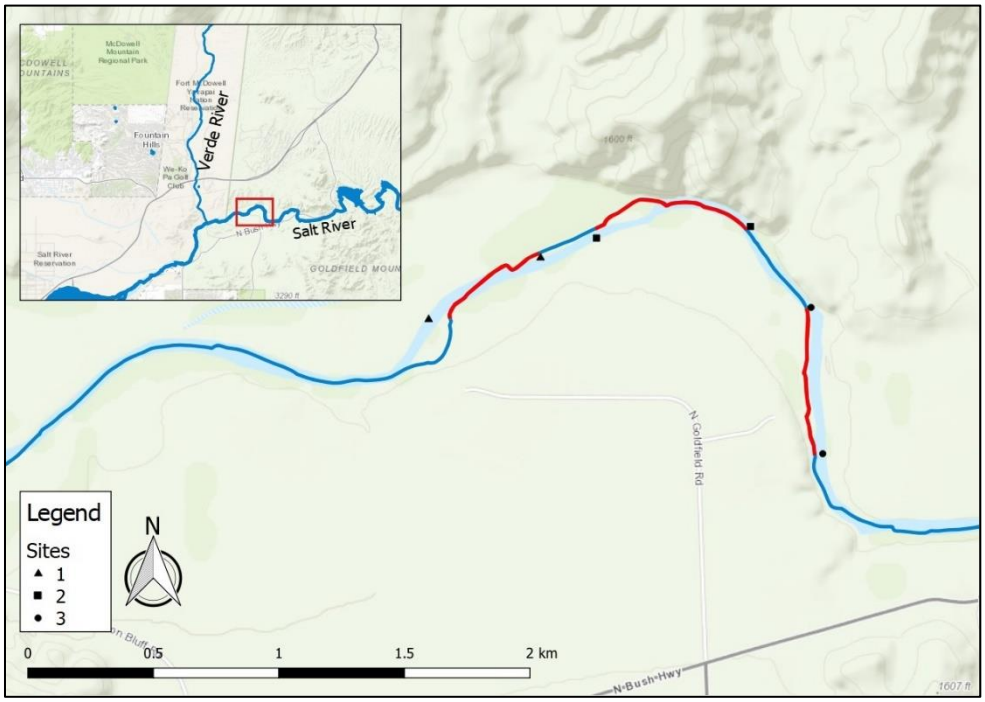

Figure 18. Location of three 500 m sampling sites in the lower Salt River near Goldfield Recreation Site, sampled January 10, 2019.

Figure 11. Example of targeted habitat in the lower Salt River near Goldfield Recreation site.

Figure 20. Example of targeted habitat in the lower Salt River near Goldfield Recreation site.

Lower Salt River (Downstream Reach) – Phon D Sutton/Coon Bluff January 11, 2019

12S NAD83	Lower boundary 1: 438813E, 3712127	Upper boundary 1: 439201E, 3712300
	Lower boundary 2: 440131E, 3712266	Upper boundary 2: 440582E, 3712593
	Lower boundary 3: 440854E, 3712845	Upper boundary 3: 441329E, 3713030

The lower Salt River at Phon D Sutton and Coon Bluff were accessed from a large parking area. Three, 500 m sites were established targeting Roundtail Chub (Figure 21). All sites were sampled via BPEF. One site was established at Phon D Sutton Recreation Area and two sites were established upstream at Coon Bluff Recreation Site. After an initial attempt to wade upstream from Phon D Sutton, it was discovered that there was a wide pool with mud substrate that made wading upstream with a BPEF unfeasible. Therefore, the two upstream sites were accessed from Coon Bluff. Sampling sites overlapped with sampling performed by AZGFD in 2014 and 2016. However, they sampled with a canoe electrofisher (Timmons et al. 2015; Timmons et al. 2017).

The first site was sampled via BPEF for a total of 793 sec, which captured Largemouth Bass (n=11; 37.9%), Sonora Sucker (n=7; 24.1%), Green Sunfish (n=6; 20.7%), Yellow Bullhead (n=3; 10.3%), Bluegill (n=1; 3.4%), and Red Shiner (n=1; 3.4%). The second site was established ~850 m upstream and sampled via BPEF for a total of 527 sec, which captured Sailfin Molly (n=18; 34.6%), Red Shiner (n=17; 32.7%), Western Mosquitofish (n=11; 21.2%), Desert Sucker (n=2; 3.8%), Largemouth Bass (n=2; 3.8%), Sonora Sucker (n=1; 1.9%), and Yellow Bullhead (n=1; 1.9%). The third site was established ~400 m upstream and sampled via BPEF for a total of 744 sec, which captured Sailfin Molly (n=54; 34.4%), Largemouth Bass (n=37; 23.6%), Western Mosquitofish (n=24; 15.3%), Sonora Sucker (n=15; 9.6%), Desert Sucker (n=11; 7.0%), Red Shiner (n=6; 3.8%), Yellow Bullhead (n=6; 3.8%), and Green Sunfish (n=4; 2.5%). For reporting purposes, catch data were summarized across sites in Table 9. Overall, fish community composition showed high resemblance to the middle reach.

Stream mesohabitats consisted of riffle, run, and pools comprised of cobble, boulder, pebble, gravel, and sand substrate. However, gravel and sand occupied a higher percentage of area compared to the middle reach. The first pool encountered upstream of Phon D Sutton was composed entirely of mud substrate and cattails on the margins. While the pool was shallow at ~0.3 m, the mud was waist deep making it impassable with a BPEF. Additionally, there was no feasible route around the pool that was discovered. In the two upstream sites, there were long shallow riffles composed of cobble, pebble, and gravel that supported few fishes. Most fish were captured in shallow pools with submerged aquatic vegetation. Water temperature recorded at 10:00 was 12 °C. Photographs of available habitat are provided in Figures 22-23. Our findings were consistent with past GRBMP surveys, specifically with the lack of Roundtail Chub detection and the absence of any age-0 native fishes. As with the other two lower Salt River reaches, the greatest threat to native fishes is the abundance of non-native predators.

Table 9. Summary of catch in lower Salt River near Phon D Sutton/Coon Bluff. Total effort was 2,064 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AMNA	1+	10	4.20	0.005
CAIN	1+	23	9.66	0.011
CYLU	1+	24	10.08	0.012
GAAF	SB	35	14.71	0.017
LECY	1+	10	4.20	0.005
LEMA	0	1	0.42	0.000
MISA	0	2	0.84	0.001
MISA	1+	48	20.17	0.023
PACL	1+	13	5.46	0.006
POLA	SB	72	30.25	0.035
Total		**238**	**100**	**0.115**

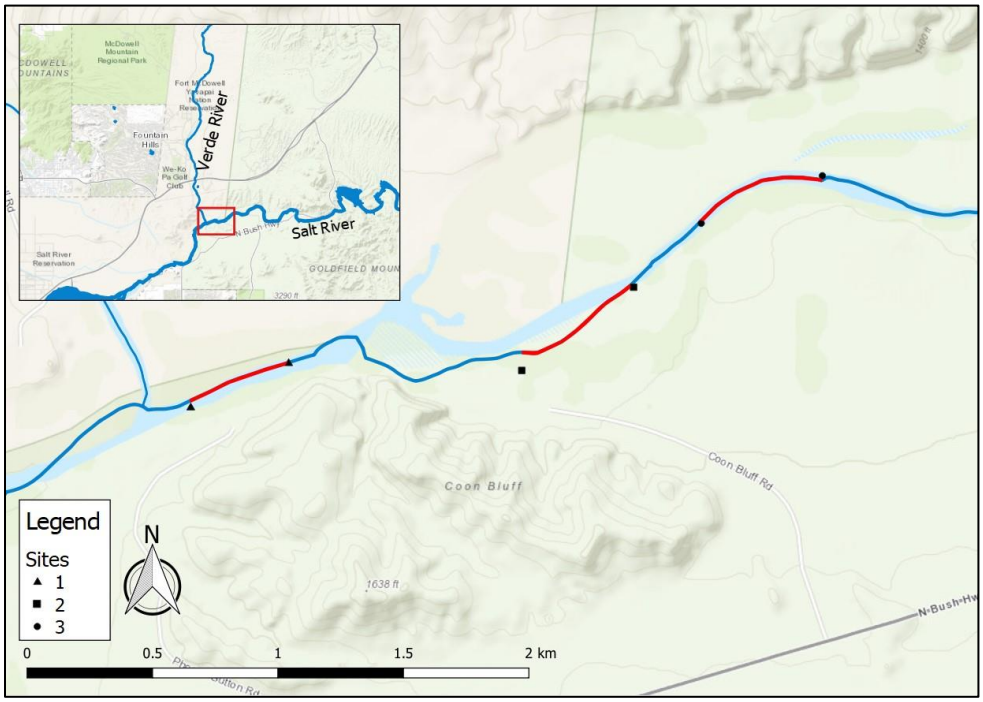

Figure 21. Location of three 500 m sampling sites in the lower Salt River at Phon D Sutton/Coon Bluff, sampled January 11, 2019.

Figure 22. Example of targeted habitat in the lower Salt River at Phon D Sutton/Coon Bluff

Figure 23. Example of targeted habitat in the lower Salt River at Phon D Sutton/Coon Bluff

Salome Creek August 14, 2018 & June 5, 2019

12S NAD83	Lower boundary 1: 496233E, 3752566N	Upper boundary 1: 495906E, 3752955N
	Lower boundary 2: 496133E, 3751882N	Upper boundary 2: 496477E, 3752040N
	Lower boundary 3: 488862E, 3736373N	Upper boundary 3: 488862E, 3736373N

Salome Creek (Gila County, AZ) is located within Tonto National Forest and flows into Roosevelt Lake (Figure 24). Salome Creek was last surveyed for the GRBMP in 2014. The focal species for Salome Creek is Roundtail Chub.

Salome Creek has been designated a minimum of three sites for the objectives of this contract. M&A personnel surveyed one mid-drainage site on August 14, 2018 and two sites in upper Salome Creek on June 5, 2019. For reporting purposes all three sites are summarized here. The upper two sites were accessed off Forest Road (FR) #486, which was reached by taking FR 609 off HWY 288 between Globe and Young, AZ.

The most upstream site is located east of JR Ranch and was sampled by BPEF for 461 sec over 500 m. This differed from past survey efforts which utilized angling, gill nets, and hoop nets. Habitat consisted of mostly isolated pools, many of which were fishless. Water became scarcer upstream, with the pools looking stagnant and discolored. The only species captured was Green Sunfish (n=98; 100.00%; Table 10). The majority of fish came from larger pools near the downstream end of the site. Electrofishing was effective as water was not deep and fish could not escape the isolated pools.

The second site was located 1.2 km downstream from the upstream site and was sampled for 500 m. The site was sampled by BPEF for 896 sec. Only Green Sunfish were captured (n=352; 100.00%; Table 11). Water was continuous throughout this section with large bedrock pools connected by shallow riffles. Water temperature and conductivity for the upper sites were recorded at 17°C and 174µS respectively.

The most downstream site was located below "The Jug" and was sampled in 2018. This site was accessed via Jug Trail #68 at the Salome Wilderness parking area. Past survey efforts at this site utilized angling and seining and were ineffective (Timmons et al. 2015). For this survey, eight Promar nets were set in the pool immediately below the falls, which captured Green Sunfish (n=66; 100.00%; Table 12). Water temperature and conductivity were recorded at 25.8°C and 622µS respectively.

Photographs depicting available habitat can be found in Figures 25-27. While adequate habitat exists within the drainage, current abundance of Green Sunfish is the greatest threat to survival of any Roundtail Chub in Salome Creek.

Table 10. Summary of catch in Salome Creek (upper site) near JR Ranch by BPEF. Total effort was 461 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
LECY	0	17	17.35	0.037
LECY	1+	81	82.65	0.176
Total		**98**	**100**	**0.213**

Table 11. Summary of catch in Salome Creek (middle site) near JR Ranch by BPEF. Total effort was 896 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
LECY	0	25	7.10	0.028
LECY	1+	327	92.90	0.365
Total		**352**	**100**	**0.393**

Table 12. Summary of catch in Salome Creek (lower site) below 'The Jug' by Promar nets. Total effort was 16 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
LECY	0	5	7.58	0.313
LECY	1+	61	92.42	3.813
Total		**66**	**100**	**4.125**

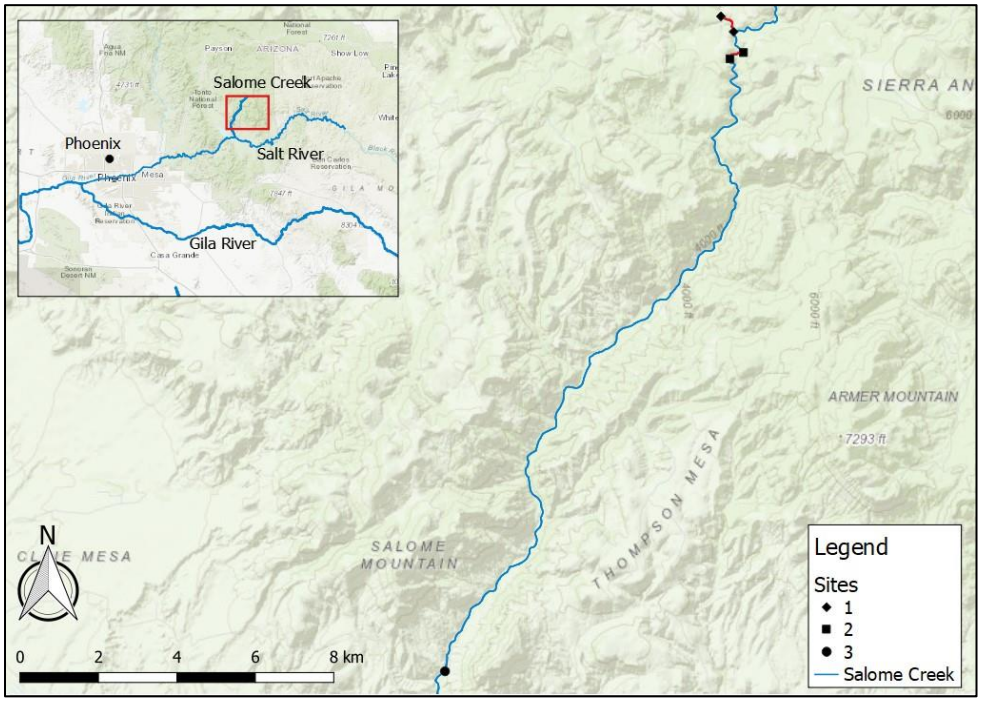

Figure 12. Location of three sampling sites in Salome Creek, sampled on August 14, 2018 and June 5, 2019.

Figure 25. Example of habitat in Salome Creek (upper site).

Figure 26. Example of habitat in Salome Creek (middle site)

Figure 27. Example of habitat in Salome Creek (lower site).

San Pedro River Basin

O'Donnell Canyon May 21, 2019

12R NAD83 Lower boundary: 544832E, 3492215N Upper boundary: 544792E, 3492135N

O'Donnell Canyon is a tributary to the Babocomari River and located on the Canelo Hills Cienega Reserve managed by The Nature Conservancy (Figure 28). The focal species at O'Donnell Canyon is Gila Chub.

On May 21, 2019, O'Donnell Canyon was accessed via State Route (SR)-83 south of Sonoita. Efforts were coordinated with The Nature Conservancy while on the property. Promar nets were set overnight throughout a 500 m site as it was not known if ≥ 25 Gila Chub would be captured within 100 m; however, efforts were concentrated in the first 100 m. Upper and lower boundaries of the 100 m site were set based on previous sampling under this contract in 2013 and 2016. Fifteen Promar nets were set overnight capturing adult Gila Chub (n=93; 86.11%) and adult Sonora Sucker (n=15; 13.89%). The rest of the 500 m site was below the dam and hoop and Promar nets were used to sample this area. Two hoop nets caught young-of-year Gila Chub (n=6; 16.22%) and adult Gila Chub (n=31; 83.78%). Eight Promar nets caught adult Gila Chub (n=52; 80.00%) and adult Sonora Sucker (n=13; 20.00%). Sonora Mud Turtles (*Kinosternon sonoriense*) and northern crayfish were observed in both the 100 m and throughout the 500 m site. Catch and effort data for 100 and 500 m surveys are summarized in Tables 13-15.

Habitat at this site consists of a series of pools connected by short runs. Water temperature and conductivity were not recorded. Vegetation surrounding the stream is densely overgrown resulting in heavy shade over the stream. Photographs of the upper and lower extent of the survey are provided below (Figures 29-32). Previous GRBMP surveys detected Western Mosquitofish within this site (Timmons et al. 2014); however, they were not detected during this survey. This result and low numbers of age-0 Gila Chub captured could be due to size of net mesh used, resulting in gear bias. Overall, O'Donnell Canyon provides suitable habitat for Gila Chub and the population appears to be doing well.

Table 13. Summary of catch in O'Donnell Creek by Promar nets in 100 m site. Total effort was 285 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
GIIN	1+	93	86.11	0.326
CAIN	1+	15	13.89	0.053
Total		**108**	**100**	**0.379**

Table 14. Summary of catch in O'Donnell Creek by Promar nets in 500 m site. Total effort was 152 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
GIIN	1+	52	80.00	0.342
CAIN	1+	13	20.00	0.086
Total		**65**	**100**	**0.428**

Table 15. Summary of catch in O'Donnell Creek by hoop nets in 500 m site. Total effort was 38 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
GIIN	1+	31	83.78	0.816
GIIN	0	6	16.22	0.158
Total		**37**	**100**	**0.974**

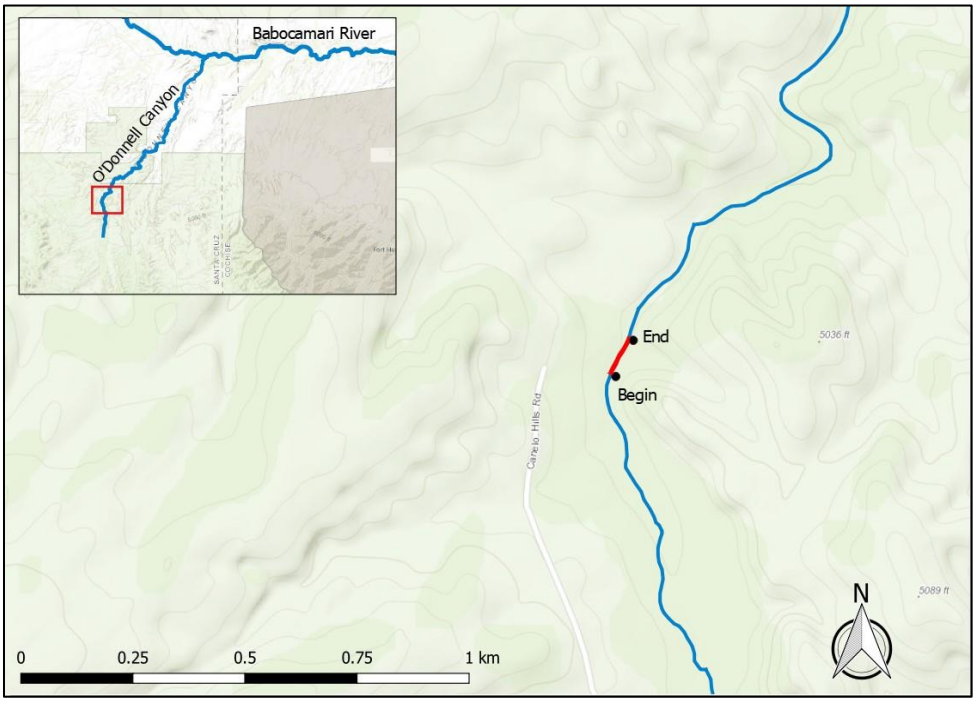

Figure 28. Location of 100 m sampling site in O'Donnell Canyon, sampled on May 21, 2019.

Figure 29. Downstream to downstream view of the 100 m sampling station in O'Donnell Canyon.

Figure 30. Downstream to upstream view of the 100 m sampling station in O'Donnell Canyon.

Figure 31. Upstream to downstream view of the 100 m sampling station in O'Donnell Canyon.

Figure 32. Upstream to upstream view of the 100 m sampling station in O'Donnell Canyon.

Bass Canyon August 27, 2019

12S NAD 83 Lower boundary: 571961E, 3579663N Upper boundary: 572038E, 3579706N

Bass Canyon (Cochise County, AZ) is a tributary to Hot Springs Canyon in the San Pedro drainage located within Muleshoe Ranch Cooperative Management Area (Figure 33). Bass Canyon is located approximately 40 km north of Benson, AZ.

The sampling site at Bass Canyon was accessed by hiking 0.5 km upstream from the Muleshoe Ranch Road crossing. A BPEF was used to sample at this site targeting Gila Chub. A previous GRBMP survey established a 100-m site in 2014 (Timmons et al. 2015). This site was repeated, and 70 adult Gila Chub (60.34%) were captured compared to 62 in 2014. However, only six age-0 Gila Chub (5.17%) were captured compared to 44 captured in 2014. Stream flow appeared higher than usual and several pools could not be sampled due to depth. Many more Gila Chub were observed in these pools. Other species captured were Speckled Dace (n=38; 32.76%) and Sonora Sucker (n=2; 1.72%). Total catch and effort for this site are summarized in Table 16. No non-natives were captured or observed at this site. Habitat at this site was comprised mainly of pool mesohabitat separated by short runs and riffles. Water temperature and conductivity were recorded at 25°C and 393µS respectively. The native fish population at Bass Canyon is protected from an invasion of non-natives by a concrete fish barrier downstream in Hot Springs Canyon. Photographs of the upper and lower boundaries are provided below (Figures 34-37).

Table 16. Summary of catch in Bass Canyon by BPEF. Total effort was 642 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
CAIN	1+	2	1.72	0.003
GIIN	0	6	5.17	0.008
GIIN	1+	70	60.34	0.089
RHOS	SB	38	32.76	0.048
Total		**116**	100.00	0.148

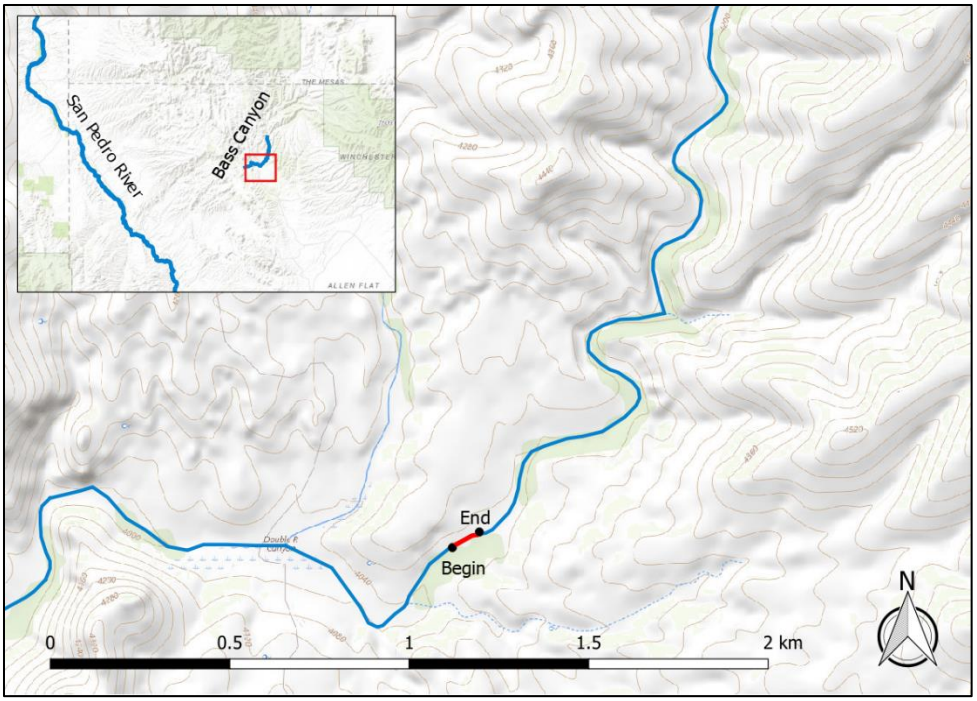

Figure 33. Location of 100 m sampling site in Bass Canyon, sampled on August 27, 2019.

Figure 13. Downstream to downstream view of the 100 m sampling station in Bass Canyon.

Figure 35. Downstream to upstream view of the 100 m sampling station in Bass Canyon.

Figure 36. Upstream to downstream view of the 100 m sampling station in Bass Canyon.

Figure 37. Upstream to upstream view of the 100 m sampling station in Bass Canyon.

Swamp Springs Canyon August 28, 2019

12S NAD 83 Lower boundary: 566510E, 3589053N Upper boundary: 566603E, 3589086N

Swamp Springs Canyon (Graham County, AZ) is a tributary to Redfield Canyon, which flows into the San Pedro River. It is located within Muleshoe Ranch Conservation Management Area and Redfield Canyon Wilderness (Figure 38). Swamp Springs Canyon was stocked with Gila Topminnow in 2007 and 2008 and the species continues to persist at this site (Gray 2018).

Swamp Springs Canyon was accessed via a 2.7 km hike down the dry stream bed from where the drainage crosses FR 691. Road conditions are poor and access using ATVs or UTVs would be preferred. Previous GRBMP surveys established a 100-m site where the species was previously stocked (2013, 2016), and this survey was conducted in the same location. Minnow traps and dip nets sweeps were used to target Gila Topminnow. Eight minnow traps were dispersed across two distinct pool complexes and fished for 2.5 hr capturing Gila Topminnow (n=284; 30.64%) and Longfin Dace (n=643; 69.34%). Habitat downstream of the pools consisted of braided riffles. Eight dip net sweeps throughout this site captured additional Gila Topminnow (n=48; 87.27%) and Longfin Dace (n=7; 12.73%). No non-native fish were observed or captured at this site. Catch and effort data are summarized in Tables 17-18. Water temperature and conductivity were recorded at 26°C and 382µS respectively. Upper and lower boundary photographs are provided below (Figures 39-42).

Past surveys found a much higher relative abundance of Gila Topminnow (Timmons et al. 2017; Timmons et al. 2014). It should be noted that 50 Gila Topminnow were collected near this site for genetics three weeks prior to the survey which may have led to a slightly reduced catch. Nevertheless, it appears that Longfin Dace are becoming the dominant species at this site. While Gila Topminnow are still present and abundant, this site should be closely monitored to ensure that the increased Longfin Dace population does not negatively affect Gila Topminnow.

Table 17. Summary of catch in Swamp Springs Canyon by minnow trap. Total effort was 17 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
AGCH	SB	643	69.36	38.002
POOC	SB	284	30.64	16.785
Total		**927**	100.00	54.787

Table 18. Summary of catch in Swamp Springs Canyon by dipnet. Total effort was 8 dipnet sweeps.

Species	Age	Count	% of total catch	CPUE (fish/net sweep)
AGCH	SB	7	12.73	0.875
POOC	SB	48	87.27	6
Total		**55**	100.00	6.875

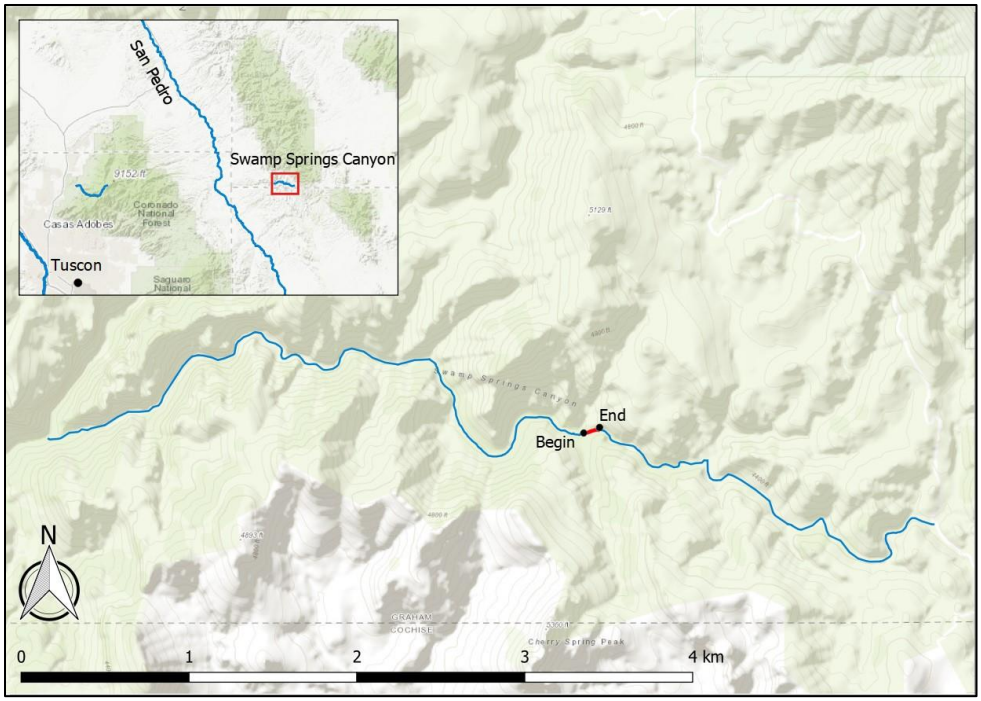

Figure 38. Location of 100 m sampling site in Swamp Springs Canyon, sampled on August 28, 2019.

Figure 14. Downstream to downstream view of the 100 m sampling site in Swamp Springs Canyon

Figure 40. Downstream to upstream view of the 100 m sampling site in Swamp Springs Canyon

Figure 41. Upstream to upstream view of the 100 m sampling site in Swamp Springs Canyon

Figure 42. Upstream to downstream view of the 100 m sampling site in Swamp Springs Canyon

Cherry Spring Canyon August 29, 2019

12S NAD 83 Lower boundary: 565420E, 3586925N Upper boundary: 565979E, 3587073N

Cherry Spring Canyon (Cochise County, AZ) is located in the Muleshoe Ranch Cooperative Management Area and is a tributary to Soza Wash in the San Pedro River drainage (Figure 43). Cherry Spring Canyon was historically fishless and was stocked with Gila Topminnow and Desert Pupfish in 2007 and 2008. Desert Pupfish did not persist, and Gila Topminnow numbers have declined over the years with the last individual captured in 2013 (Gray 2018).

Cherry Spring Canyon was accessed via a 4.5 km hike from the drainage crossing at Pride well. Minnow traps and dip net sweeps were used targeting Gila Topminnow. The only perennial water in this system consists of a 50-m long tinaja complex at the base of a cliff and a spring pool approximately 600 m upstream surrounded by thick vegetation. Eight minnow traps were set for 2.5 hr capturing zero fish and one unidentified frog tadpole at the lower pool complex. Five dip net sweeps captured zero fish in the upstream spring pool. A Sonoran Desert Toad (*Incilius alvarius*) and two Sonora Mud Turtles were observed upstream of the survey site. Water temperature and conductivity were recorded at 22°C and 601µS respectively. Photographs of available habitat are provided below (Figures 44-45).

Cherry Spring Canyon also was fishless in 2016 when it was last assessed for GRBMP and it is believed that Gila Topminnow no longer occur at this site (Timmons et al. 2017). This site does not provide adequate habitat for Gila Topminnow as it is heavily shaded, which may not support enough primary productivity for food sources. Past surveys have also noted low dissolved oxygen levels and reported a strong and unpleasant odor from the water (Timmons et al. 2014).

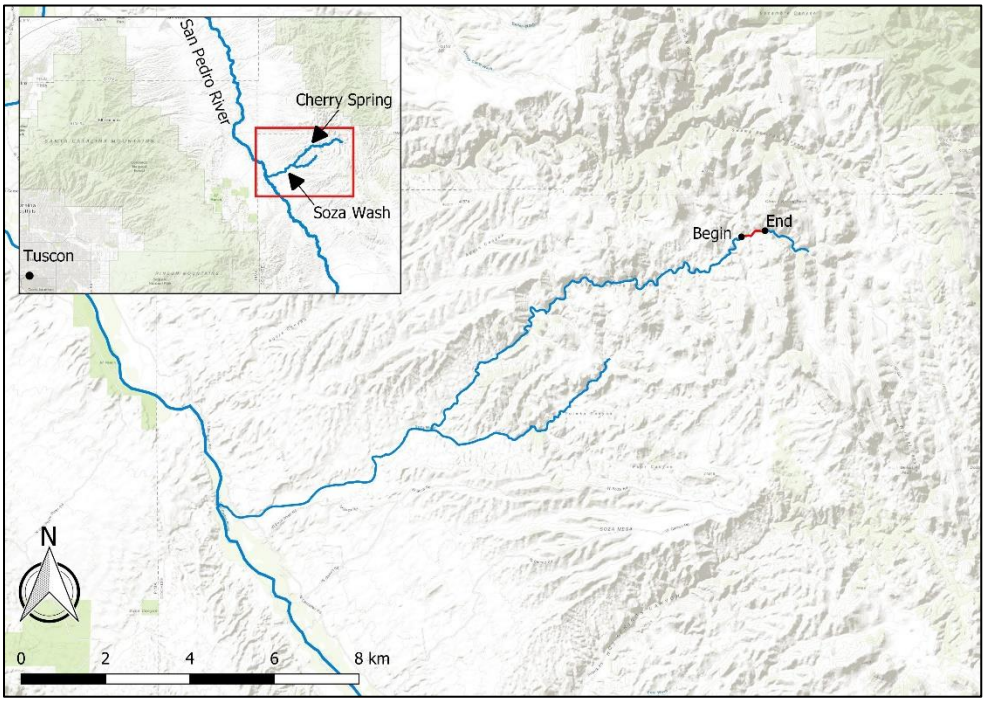

Figure 43. Location of sampling site in Cherry Spring Canyon, sampled on August 29, 2019.

Figure 44. Example of targeted habitat in Cherry Spring Canyon.

Figure 45. Example of targeted habitat in Cherry Spring Canyon.

Santa Cruz River Basin

Monkey Spring April 29, 2019

12R NAD83 Lower boundary: 528085E, 3499707N Upper boundary: 528075E, 3499794N

Monkey Spring (Santa Cruz County, AZ) is a tributary to Sonoita Creek near Patagonia, AZ (Figure 46). Monkey Spring has long been recognized as a unique habitat. The natural population of Gila Topminnow here has been the source of many wild replicate stockings around the state (Weedman 1999). It also was occupied historically by Santa Cruz (Monkey Spring) pupfish (*Cyprinodon arcuatus*) and a morphologically distinct form of Gila Chub, both of which are extirpated from this site. The focal species at Monkey Spring for this contract is Gila Topminnow.

On April 29, 2019, Monkey Spring was accessed via the Rail X Ranch just off SR-82. This site is on private property and landowner permission is required to access this sampling location. This site consisted of three main areas that were sampled: the spring inside the fence, the cement canal outside the fence, and the diverted water away from the canal outside the fence. Upper and lower boundaries of this site were set based on detection of Gila Topminnow in previous sampling efforts for the GRBMP (2014). Inside the fenced spring 12, 1-m long dipnet sweeps captured Gila Topminnow (n= 6; 2.02%). Dip-netting did not appear to be the most effective method outside of the spring, so a seine was hauled three times capturing only Gila Topminnow (n= 43; 14.48%). A seine then was hauled seven times in the canal outside the fence capturing only Gila Topminnow (n= 248; 83.50%). The creek that was diverted away from the cement canal was sampled with three seine hauls but did not detect any fish. Flow was relatively high and did appear to be good habitat for topminnow only having fast, shallow riffles and no deep pools with slow moving water. Young-of-year Gila Topminnow were observed throughout the sampling site and they were visually observed ~200 m downstream of the site but not quantitatively sampled. Catch data were summarized in Tables 19-20.

Spring habitat consisted of connected slow moving small pools inside the fence. Outside the fence there was a concrete canal that was ~15 cm deep and the diverted creek was fast moving water with connected riffles and no pool habitat. Water temperature and conductivity were not recorded at this site. Pictures of upstream and downstream boundaries of the site can be found below (Figures 47-50).

Abundance of Gila Topminnow throughout the spring and canal, observation of young-of-year fish, and no perceived direct threats are signs that this population is stable. This site should continue to be monitored every three years if the current landowner continues their careful management.

Table 19. Summary of catch in Monkey Spring by dipnet. Total effort was 12 dipnet sweeps.

Species	Age	Count	% of total catch	CPUE (fish/net sweep)
POOC	SB	6	100.00	0.500
Total		**6**	**100**	**0.500**

Table 20. Summary of catch in Monkey Spring by seine. Total effort was 13 seine hauls.

Species	Age	Count	% of total catch	CPUE (fish/net haul)
POOC	SB	291	100.00	22.385
Total		**291**	**100**	**22.385**

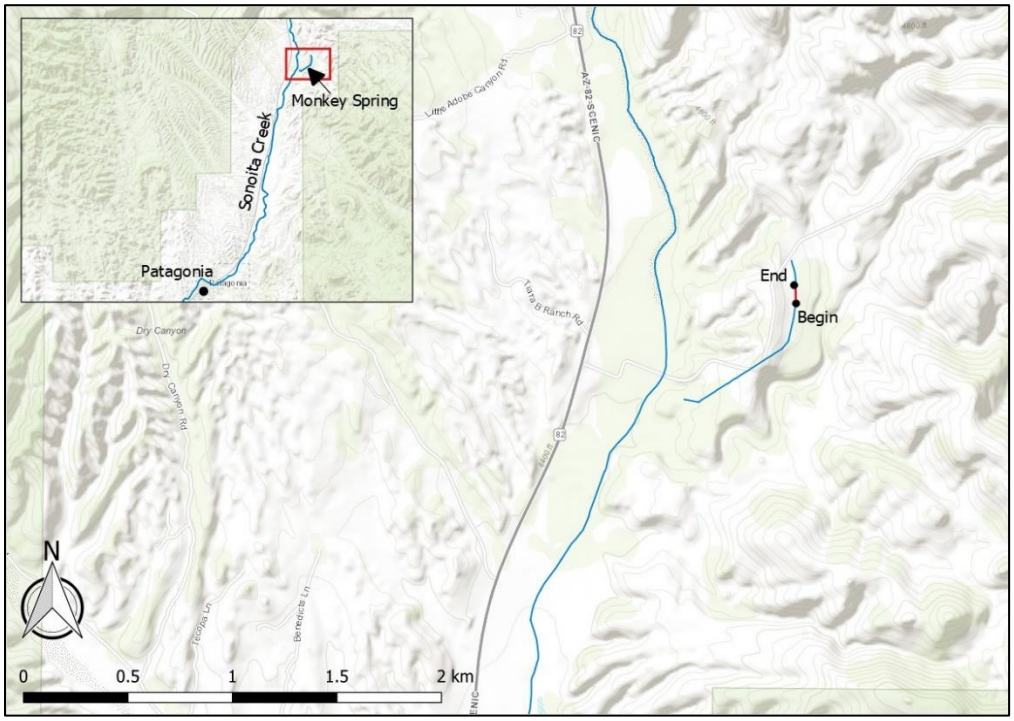

Figure 46. Location of sampling site in Monkey Spring, sampled on April 29, 2019.

Figure 15. Upstream to upstream view of the sampling station in Monkey Spring.

Figure 48. Upstream to downstream view of the sampling station in Monkey Spring.

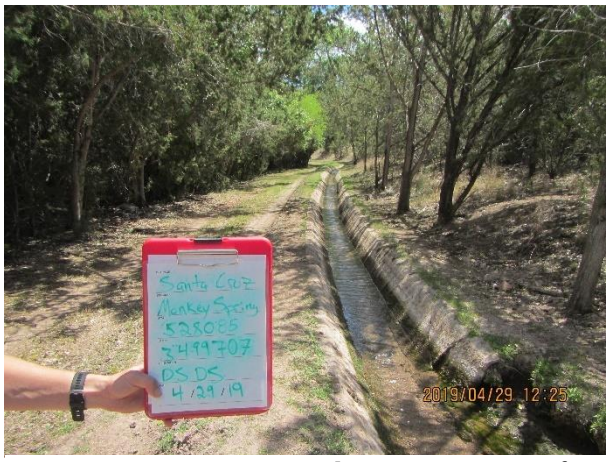

Figure 49. Downstream to downstream view of the sampling station in Monkey Spring.

Figure 50. Downstream to upstream view of the sampling station in Monkey Spring.

Fresno Canyon April 30, 2019

12R NAD83 Lower boundary: 507750E, 3485956N Upper boundary: 507847E, 3485980N

Fresno Canyon (Santa Cruz County, AZ) is tributary to Sonoita Creek downstream of Patagonia Lake (Figure 51). A natural population of Gila Topminnow was discovered in Fresno Canyon in 1992 (Weedman, 1999). Due to presence of predatory non-natives such as Green Sunfish and Largemouth Bass, Fresno Canyon was treated with Rotenone in 2007 (Mitchell 2007). In the first post-treatment monitoring in November 2007, three Gila Topminnow were detected and were believed to have dispersed downstream from Coal Mine Canyon. An additional 1,000 Gila Topminnow and 75 Longfin Dace from Coal Mine Canyon were translocated into Fresno Canyon in 2008 (Gray 2018).

On April 30, 2019, Fresno Canyon was accessed via Blue Haven Road in Patagonia, AZ. This was followed to Solero Ranch Road and then Montezuma Well Road was taken to the fenced in Coal Mine Canyon site where the vehicle was parked. We then hiked ~ 5.6 km along the drainage ending at Fresno Canyon. Access to this location required coordination with the Sonoita Creek State Natural Area to acquire a permit to park on the preserve property, and a separate permit was also required from Arizona State Parks and Trails to approve scientific sampling in this area. A private landowner gate is present near the start of Montezuma Well Road and requires a gate code to proceed on the road. Contacts with AZGFD should be able to provide details for this gate and coordination with the landowner. Montezuma Well Road is extremely rough and a UTV or ATV is recommended for this road; however, it is possible to travel this road with a 4X4 truck, but the drive is slow going and tough on vehicles.

Upper and lower boundaries for this 100 m site were set based on previous sampling for the GRBMP in 2012 and 2016. Fourteen steel minnow traps baited with pet food were set for 2 hr and captured Gila Topminnow (n=112; 36.96%) and Longfin Dace (n=25; 8.25%). A seine net was hauled five times capturing Gila Topminnow (n=147; 48.51%) and Longfin Dace (n=19; 6.27%). Juvenile and adult crayfish were visually observed at this site. Gila Topminnow were visually assessed downstream of the 100 m site to observe if they were present outside of the site. Thousands of Gila Topminnow were visually observed in pools ~ 500 m below the sampling site. It appears that Gila Topminnow below this sampling site were in higher abundance than in pools that were sampled; however, no quantifiable sampling was conducted outside the 100 m site. To get a better understanding of distribution in a drainage, especially with Gila Topminnow sites, reworking the protocol should be considered to gather more useful data that will be beneficial to this species. Catch and effort data were summarized in Tables 21-22.

Habitat consisted of intermittent bedrock pools ranging in 1 to 2 m deep. It appears these pools would be connected during flood events after visually observing Gila Topminnow ~ 500 m below the site. Water temperature and conductivity was recorded at 19°C and 470µS respectively. Pictures of upstream and downstream boundaries of the site are provided in Figures 52-55.

Gila Topminnow appear to have healthy and stable populations at this site with high abundance and distribution throughout this drainage. This population appears well protected by 2.5 km reaches of dry stream bed from an invasion of non-native species that occur in Sonoita Creek. In addition, during periods of high flow a natural waterfall barrier forms near the confluence due to the concentration of large boulders in the narrows portion of the canyon.

Table 21. Summary of catch in Fresno Canyon by minnow trap. Total effort was 28 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
POOC	SB	112	81.75	4.000
AGCH	SB	25	18.25	0.893
Total		**137**	**82**	**4.893**

Table 22. Summary of catch in Fresno Canyon by seine haul. Total effort was five seine hauls.

Species	Age	Count	% of total catch	CPUE (fish/haul)
POOC	SB	147	88.55	29.400
AGCH	SB	19	11.45	3.800
Total		**166**	**100**	**33.200**

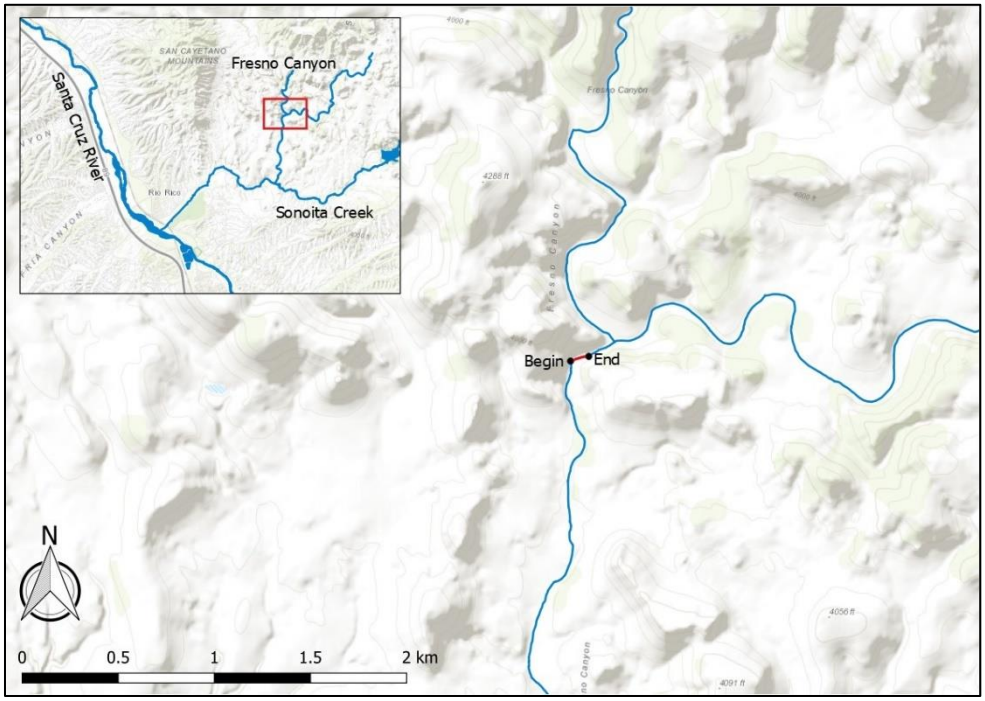

Figure 51. Location of 100 m sampling site in Fresno Canyon, sampled on April 30, 2019.

Figure 52. Upstream to upstream view of the 100 m sampling site in Fresno Canyon.

Figure 53. Upstream to downstream view of the 100 m sampling site in Fresno Canyon

Figure 54. Downstream to upstream view of the 100 m sampling site in Fresno Canyon

Figure 55. Downstream to downstream view of the 100 m sampling site in Fresno Canyon

Coal Mine Canyon April 30, 2019

12R NAD83 Lower boundary: 510438E, 3487948N Upper boundary: 510504E, 3488025N

Coal Mine Canyon (Cochise County, AZ) is a tributary to Fresno Canyon, which flows into Sonoita Creek downstream of Patagonia Lake (Figure 56). A natural population of Gila Topminnow was discovered in Coal Mine Canyon in 1996 (Weedman, 1999). Much of this canyon is ephemeral; however, there are several perennial pools near springs.

On April 30, 2019 Coal Mine Canyon was accessed via Montezuma Well Road. Fresno Canyon also was accessed by parking the vehicle at this location. Reference the Fresno Canyon trip summary for specific driving directions and coordination for this site. Upper and lower boundaries for this 100 m site were set based on previous sampling for the GRBMP in 2012 and 2016. Fifteen minnow traps baited with pet food were set for 2 hr capturing Gila Topminnow (n=227; 91.90%). Eleven dipnet sweeps of approximately 1 m captured Gila Topminnow (n=20; 8.10%). Gila Topminnow was the only fish species captured at this location. Catch and effort data are summarized in Tables 23-24. Dip-netting also captured juvenile Northern Crayfish. Due to high abundance of Gila Topminnow at this site it did not appear that crayfish were influencing the population but should be closely watched to ensure the non-natives are not negatively impacting these fish enough to cause a population decline.

Habitat consisted of one large deep pool ~ 30 m in length. All other pools were small, shallow, and stagnant appearing to have low oxygen levels due to high temperature and low volume. The only pools within the 100 m site were within the fenced area. Water temperature was recorded at 24 °C. Pictures of the upstream and downstream boundaries of the site can be found below (Figures 57-60).

Gila Topminnow appear to have healthy and stable populations at this site but are still vulnerable to threats such as habitat degradation, presence of cattle, and the potential threat of coexisting crayfish. Gila Topminnow were collected in higher abundance in this survey compared to the last time sampled in 2016, with the caveat that minnow traps were the primary gear used instead of a dip net (Timmons et al. 2017). Gila Topminnow were also detected 1.15km downstream of this sampling site in another isolated pool within Coal Mine Canyon (12R 510039E, 3487101N).

Table 23. Summary of catch in Coal Mine Canyon by minnow trap. Total effort was 30 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
POOC	SB	227	100.00	7.567
Total		**227**	**100**	**7.567**

Table 24. Summary of catch in Coal Mine Canyon by dipnet. Total effort was 11 dipnet sweeps.

Species	Age	Count	% of total catch	CPUE (fish/net sweep)
POOC	SB	20	100.00	1.818
Total		**20**	**100**	**1.818**

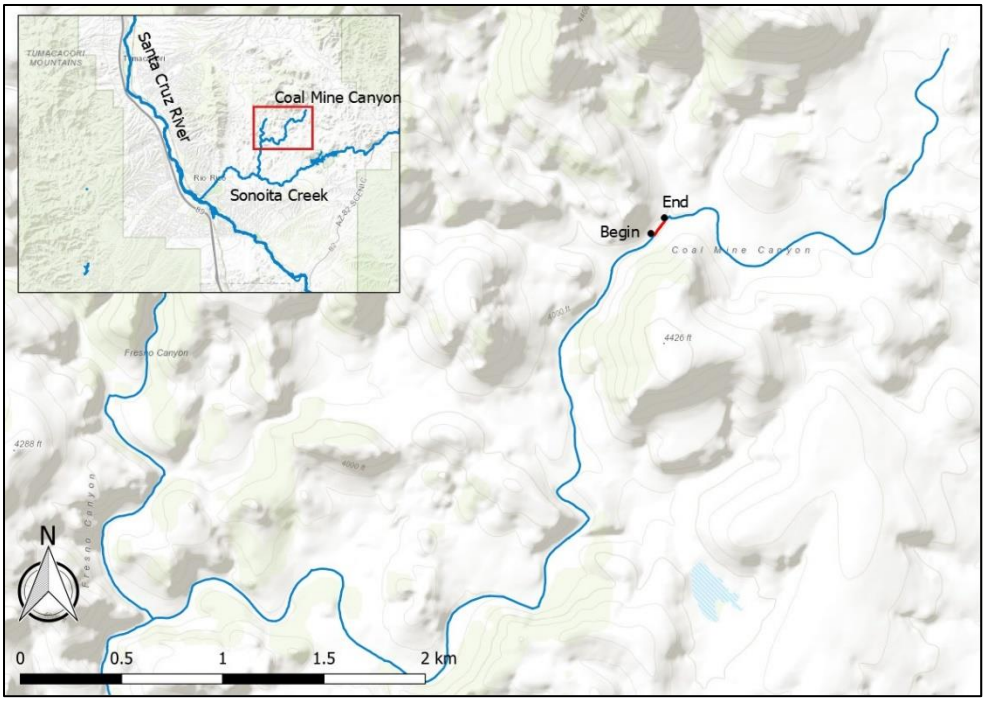

Figure 56. Location of 100 m sampling site in Coal Mine Canyon, sampled on April 30, 2019.

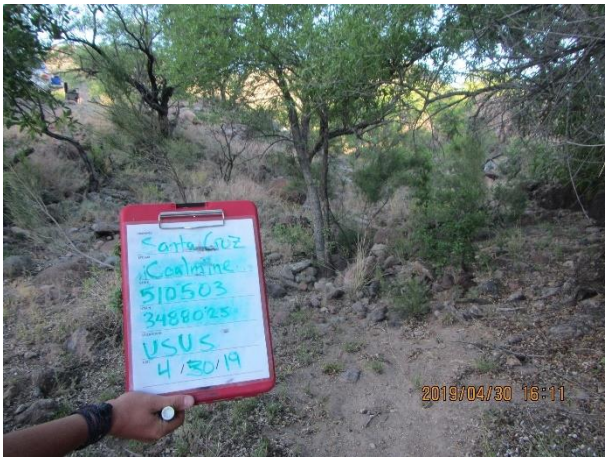

Figure 57. Upstream to upstream view of 100 m sampling site at Coal Mine Canyon.

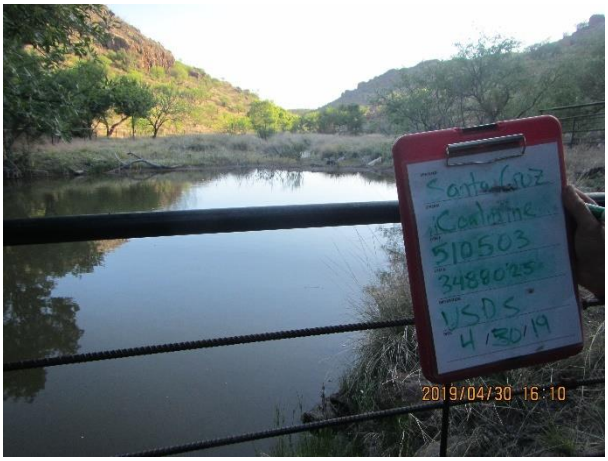

Figure 58. Upstream to downstream view of 100 m sampling site at Coal Mine Canyon.

Figure 59. Downstream to upstream view of 100 m sampling site at Coal Mine Canyon.

Figure 60. Downstream to downstream view of 100 m sampling site at Coal Mine Canyon.

Romero Canyon May 28, 2019

12S NAD83 Lower boundary: 511540E, 3586855N Upper boundary: 511585E, 3586782N

Romero Canyon (Pima County, AZ) is located within Santa Catalina Mountains and is tributary to Sutherland Wash in the Santa Cruz River drainage (Figure 61). Romero Canyon can be accessed via the Romero Canyon Trailhead in Coronado National Forest. Gila Chub were stocked into Romero Canyon in 2005 and the population appears stable (FWS, 2015). An effort to expand their distribution via stocking further upstream is currently underway.

M&A personnel completed sampling of Romero Canyon on May 28, 2019. The 100 m site established in the 2012 GRBMP survey was repeated. The most recent GRBMP survey in 2015 was ineffective due to hazardous field conditions (Timmons and Paulus 2016). Seine nets, dipnets, Promar traps, and angling were used to detect Gila Chub at this site. Angling was not effective due to the smaller size Gila Chub that were encountered. A seine net was pulled through two pools capturing adult Gila Chub (n=11;100.00); however, pulling a seine through a deep slippery bedrock pool did not appear to be the most effective way of capturing chub. Promar nets (n=13) baited with pet food and set for 3 hr were dispersed across three separate pools in the 100 m site capturing adult Gila Chub (n=30;100.00%). Gila Chub were visually observed in all pools that were sampled. Six dipnet sweeps captured young-of- year (n=7; 77.78%) and adult Gila Chub (n=2; 22.22%). There were no non-native fishes captured at this site and it appears that the Gila Chub population is healthy and stable. Complete capture and effort summaries are listed below (Tables 25-27). Water temperature and conductivity were recorded at 24°C and 87µS respectively. Upper and lower boundary photos can be found below (Figures 62-65).

Table 25. Summary of catch in Romero Canyon by dipnet. Total effort was 11 dipnet sweeps.

Species	Age	Count	% of total catch	CPUE (fish/sweep)
GIIN	0	7	77.78	1.000
GIIN	1+	2	22.22	0.286
Total		**9**	**100**	**1.286**

Table 26. Summary of catch in Romero Canyon by seine. Total effort was two seine hauls.

Species	Age	Count	% of total catch	CPUE (fish/net haul)
GIIN	1+	11	100.00	5.500
Total		**11**	**100**	**5.500**

Table 27. Summary of catch in Romero Canyon by minnow trap. Total effort was 39 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
GIIN	1+	30	100	0.769
Total		**30**	**100**	**0.769**

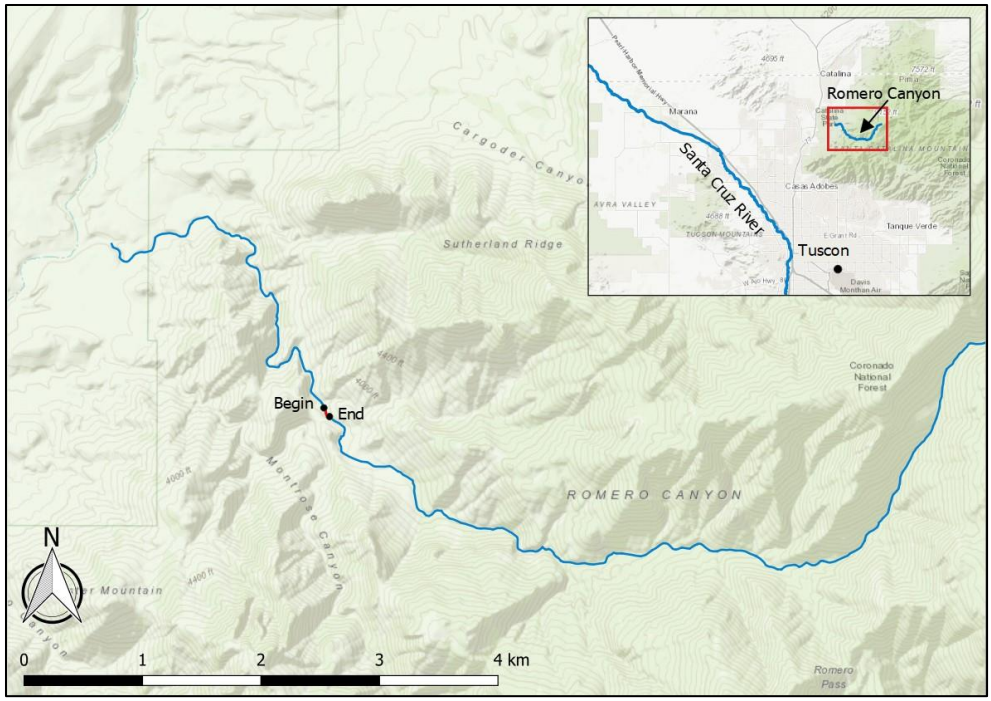

Figure 61. Location of 100 m sampling site in Romero Canyon, sampled on May 28, 2019.


Figure 62. Upstream to upstream view of 100 m sampling site in Romero Canyon.


Figure 63. Upstream to downstream view of 100 m sampling site in Romero Canyon.

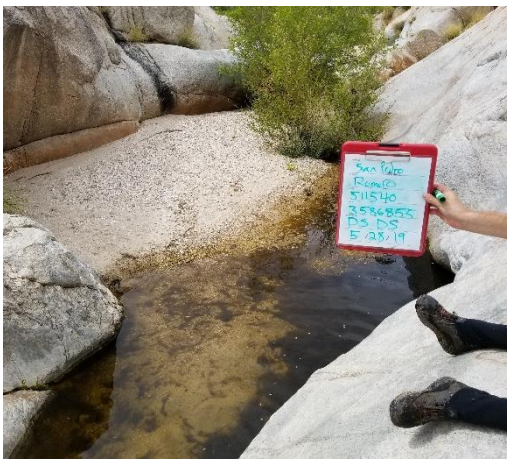

Figure 64. Downstream to downstream view of 100 m sampling site in Romero Canyon.

Figure 6516. Downstream to upstream view of 100 m sampling site in Romero Canyon.

Redrock Canyon October 1-3, 2019

12R NAD83	Lower boundary 1: 528526E, 3491428N	Upper boundary 1: 529047E, 3491291N
	Lower boundary 2: 529752E, 3490517N	Upper boundary 2: 530530E, 3489738N
	Lower boundary 3: 533108E, 3488743N	Upper boundary 3: 533335E, 3488355N
	Lower boundary 4: 536219E, 3486872N	Upper boundary 4: 536215E, 3486456N

Redrock Canyon (Santa Cruz County, AZ) is located in the Canelo Hills east of Patagonia, AZ and is a tributary to Sonoita Creek in the Santa Cruz River drainage (Figure 66). A natural population of Gila Topminnow was historically present in Redrock Canyon. However, this population has functionally been lost since 1999 and Gila Topminnow have not been detected in Redrock Canyon since 2005 (Duncan 2013). Primary reasons for its decline were the presence of non-native fishes, specifically Western Mosquitofish, and drought that exacerbates non-native impacts due to increased competition for resources and decreased avoidance.

M&A personnel completed sampling in Redrock Canyon on October 1-3, 2019. While all sites are within Coronado National Forest, the road accessing this area passes through private land and required coordination with local landowners to access Redrock Canyon Road. Seining, minnow traps, visual surveys, and dip net sweeps were used to sample four sites targeting Gila Topminnow. The sites included the three previously established sites at Pig Camp, the Falls, and Cott Tank, as well as an additional site near Gate Springs. Due to recent rains, there was significant flowing surface water throughout all sites. Opportunistic sampling also was conducted where there was adequate habitat while hiking up canyon between Gate Springs and the Cott Tank drainage, which resulted in the capture of one Western Mosquitofish.

Pig Camp was accessed via Red Rock Canyon Road. The downstream end of the site was extended to include an additional 200 m of flowing water. No fish were caught or observed throughout the entire 700 m surveyed. A total of 24 dip net sweeps and three seine hauls were conducted primarily in pool habitats. This section of the canyon was reportedly dry prior to the recent rains. Water temperature and conductivity were 23°C and 1100µS respectively.

The site at the Falls exclosure was accessed via a 0.6 km hike on the Arizona Trail off Red Rock Canyon Road. Due to significant surface water being present, this site was extended until the stream went dry. A total of 1.35 km was surveyed, encompassing the pools at the Falls. A total of 35 dip net sweeps and five seine hauls captured zero fish and no fish were visually observed. Water temperature and conductivity were 22°C and 847µS respectively.

Gate Springs was accessed via a 3 km hike on the Arizona Trail off Red Rock Canyon Road. The site's start and end points were located at the downstream and upstream exclosure fence. This 600-m segment of continuous flowing water was surveyed with 21 dip net sweeps. No fish were caught or visually observed. Water temperature and conductivity were 20°C and 955µS respectively.

Due to the presence of flowing surface water, it was decided to hike upstream from Gate Springs to Cott Tank drainage and opportunistically sample pools that appeared to be suitable for Gila Topminnow. This 3.5 km stretch was primarily dry with 100-200 m stretches of continuous surface water. A single Western Mosquitofish was captured by dip net just upstream of Kennedy Spring drainage. No other species were captured or observed.

The previously GRBMP-established 500-m site at Cott Tank was revisited and Western Mosquitofish were observed to be abundant. Minnow traps were most effective at capturing Western Mosquitofish. Four minnow traps were set for 1.25 hr and captured a total 382 individuals in a single large pool. Eight dip net sweeps and two seine pulls captured 52 and three additional Western Mosquitofish, respectively. No other species were captured. Catch and effort summaries for Cott Tank are below (Tables 28-30). Water temperature and conductivity were 20°C and 1275µS respectively.

Photographs depicting available habitat at the four sites are below (Figures 67-70). The lack of Gila Topminnow in Redrock Canyon is consistent with past surveys. Gila Topminnow no longer occur in Redrock Canyon.

Table 28. Summary of catch in Redrock Canyon – Cott Tank by minnow traps. Total effort was 5 net hr.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
GAAF	SB	382	100.00	76.400
Total		**382**	**100**	**76.400**

Table 29. Summary of catch in Redrock Canyon – Cott Tank by seine. Total effort was two seine hauls.

Species	Age	Count	% of total catch	CPUE (fish/seine)
GAAF	SB	3	100.00	1.500
Total		**3**	**100**	**1.500**

Table 30. Summary of catch in Redrock Canyon – Cott Tank by dip netting. Total effort was 8 dip net sweeps.

Species	Age	Count	% of total catch	CPUE (fish/sweep)
GAAF	SB	52	100.00	6.500
Total		**52**	**100**	**6.500**

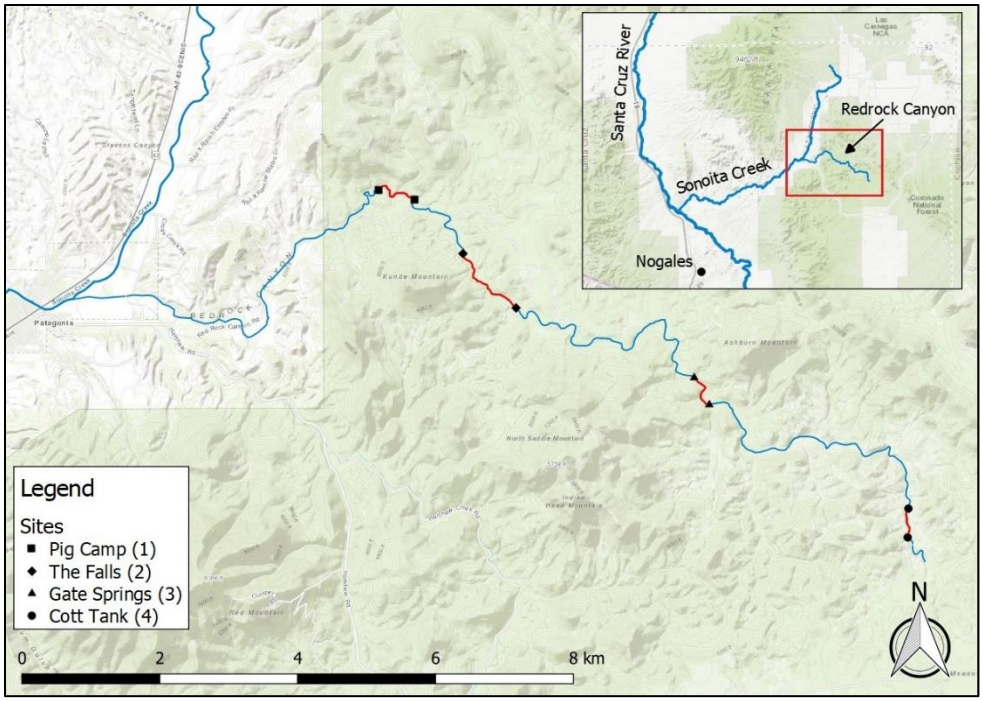

Figure 66. Location of four sampling sites in Redrock Canyon, sampled October 1-3, 2019.

Figure 67. Example of targeted habitat in Redrock Canyon – Pig Camp.

Figure 68. Example of targeted habitat in Redrock Canyon – The Falls.

Figure 69. Example of targeted habitat in Redrock Canyon – Gate Springs.

Figure 70. Example of targeted habitat in Redrock Canyon – Cott Tank.

Upper Gila River Basin

Bear Creek June 24, 2019

12S NAD 83 Lower Boundary: 732513E, 3651215N Upper boundary: 732469E, 3651304N

Bear Creek (Grant County, NM) is located north of Silver City, NM in the Pinos Altos Mountain Range and is tributary to the Gila River (Figure 71). The focal species in Bear Creek is Loach Minnow. The species is generally associated with swift riffles over pebble, cobble, or gravel (Barber and Minckley 1966, Turner and Tafanelli 1983, Rinne 1989, Propst and Bestgen 1991). Loach Minnow were first collected in Bear Creek in 2005, near Dorsey Springs (Menzie and Hopkins 2009). Bear Creek has not been sampled previously for the GRBMP.

Bear Creek was accessed at the New Mexico Department of Game and Fish (NMDGF) Double E Ranch property beginning at the downstream property boundary. Efforts were coordinated with NMDGF personnel. Loach Minnow were captured almost immediately, and a 100 m site was established. The 100 m site was electrofished for 1169 sec and Loach Minnow (n=83; 19.17%) were captured including 1 young-of-year. Other native fished captured included Desert Sucker (n=46; 10.62) and Longfin Dace (n=303; 69.98%). Non-native fish captured consisted of Western Mosquitofish (n=1; 0.23%; Table 31). Water temperature and conductivity were recorded at 27°C and 440µS respectively. Upper and lower boundary photos can be found below (Figures 72-75).

A second site further upstream was attempted at two locations. The first location was at Horseshoe Bend (12S 751018, 3643810), which was dry. The second location was below Dorsey Springs (12S 743848, 3645647), but we were unable to sample in this area due to restricted access through private land.

Loach Minnow appear to be locally abundant at the Double EE Ranch site, with evidence of recruitment as well. Past NMDGF surveys (Watson 2017) identified Loach Minnow as rare throughout the Double EE Ranch property, therefore it may be possible that this population is increasing in size. Future surveys should attempt to gain access to the Dorsey Springs area, where Loach Minnow were first discovered in Bear Creek.

Table 31. Summary of catch in Bear Creek at Double E Ranch site by BPEF. Total effort was 1169 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	SB	303	69.98	0.259
GAAF	SB	1	0.23	0.001
PACL	0	21	4.85	0.018
PACL	1+	25	5.77	0.021
TICO	SB	83	19.17	0.071
Total		**433**	100.00	0.370

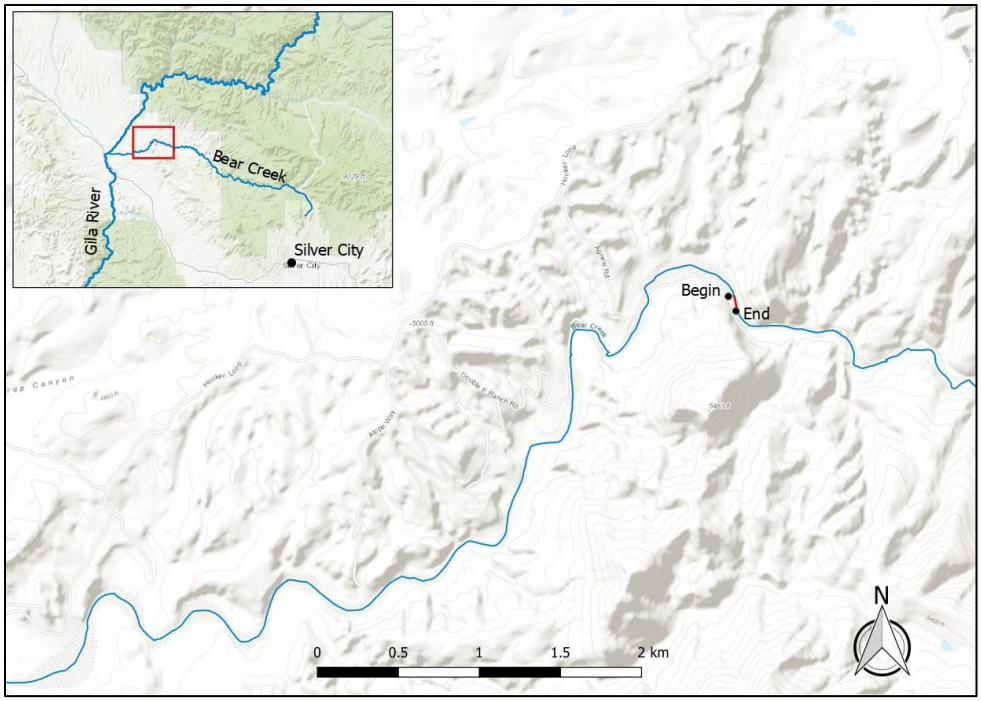

Figure 18. Location of 100 m sampling site in Bear Creek, sampled on June 24, 2019.

Figure 19. Downstream to upstream view of the 100 m sampling site in Bear Creek.

Figure 17. Downstream to downstream view of the 100 m sampling site in Bear Creek.

Figure 21. Upstream to upstream view of the 100 m sampling site in Bear Creek.

Figure 20. Upstream to downstream view of the 100 m sampling site in Bear Creek.

Whitewater Creek June 25-26, 2019

12S NAD 83	Lower boundary 1: 697325E, 3688729N	Upper boundary 1: 697576E, 3688937N
12S NAD 83	Lower boundary 2: 700576E, 3694327N	Upper boundary 2: 700845E, 3694757N

Whitewater Creek (Catron County, NM) is located near Glenwood, NM and is a tributary to the San Francisco River (Figure 76). Whitewater Creek was last surveyed for the GRBMP in 2014 and it was found fishless (Timmons et al. 2015). Current efforts are underway to remove non-native trout from upper Whitewater Creek in order to restore Gila Trout and other native fishes including Desert Sucker, Sonora Sucker, and Speckled Dace (U.S. Forest Service 2017).

M&A personnel completed sampling at Whitewater Creek on June 25 & 26, 2019. Two sites were sampled targeting Loach Minnow. The first site was accessed below the road crossing at the Catwalk National Recreation Area parking lot and continued upstream for 500 m. This site was established in the 2014 GRBMP survey and was the only one completed that year. A BPEF was used to sample for 815 sec and only native fish were captured including Speckled Dace (n=243; 57.72%), Longfin Dace (n=147; 34.92%), and Desert Sucker (n=31; 7.37%; Table 32). Available mesohabitat consisted primarily of riffles, with loose cobble substrate. Water temperature and conductivity were recorded at 21°C and 95µS respectively.

A second site was established further downstream, approximately 1 km from the San Francisco River confluence. This site is located behind the NMDGF Glenwood Hatchery at the downstream property boundary and continued 325 m to the upstream property boundary. Additional sampling upstream of this point was not completed due to the stream becoming dry. The second site was electrofished for 827 sec. Native fishes captured consisted of Speckled Dace (n=98; 39.20), Longfin Dace (n=143; 57.20), and Desert Sucker (n=7; 2.80%). Two non-native species also were caught including Rainbow Trout (n=1; 0.40%) and Brook Stickleback (n=1; 0.40%; Table 33). Water temperature and conductivity were recorded at 16°C and 110µS respectively.

A third site was planned between these two sites, but Whitewater Creek was dry in between. Photographs of available habitat at both sites are provided in Figures 77-78.

Brook Stickleback have not been previously detected in Whitewater Creek. The only other previous detection in the Gila River basin is at two localities in Tularosa River, a San Francisco River tributary, sometime after 2001 (D. Meyers, USFS, pers. comm. to Paul Marsh, M&A). The Tularosa River confluence is approximately 67 km upstream of the Whitewater Creek confluence, so it is possible that the Brook Stickleback range is expanding.

Loach Minnow appear to no longer be present in Whitewater Creek, despite adequate habitat and low density of non-native fishes. Future restoration efforts should also consider Loach Minnow in the lower portions of Whitewater Creek.

Table 32. Summary of catch in Whitewater Creek (upper site) at the Catwalk National Recreation Area by BPEF. Total effort was 815 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	SB	147	34.92	0.180
PACL	0	18	4.28	0.022
PACL	1+	13	3.09	0.016
RHOS	SB	243	57.72	0.298
Total		**421**	100.00	0.517

Table 33. Summary of catch in Whitewater Creek (lower site) near NMDGF Glenwood Hatchery by backpack electrofishing in 325 m site. Total effort was 827 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	SB	143	57.20	0.173
CUIN	SB	1	0.40	0.001
PACL	0	5	2.00	0.006
PACL	1+	2	0.80	0.002
ONMY	1+	1	0.40	0.001
RHOS	SB	98	39.20	0.119
Total		**250**	100.00	0.302

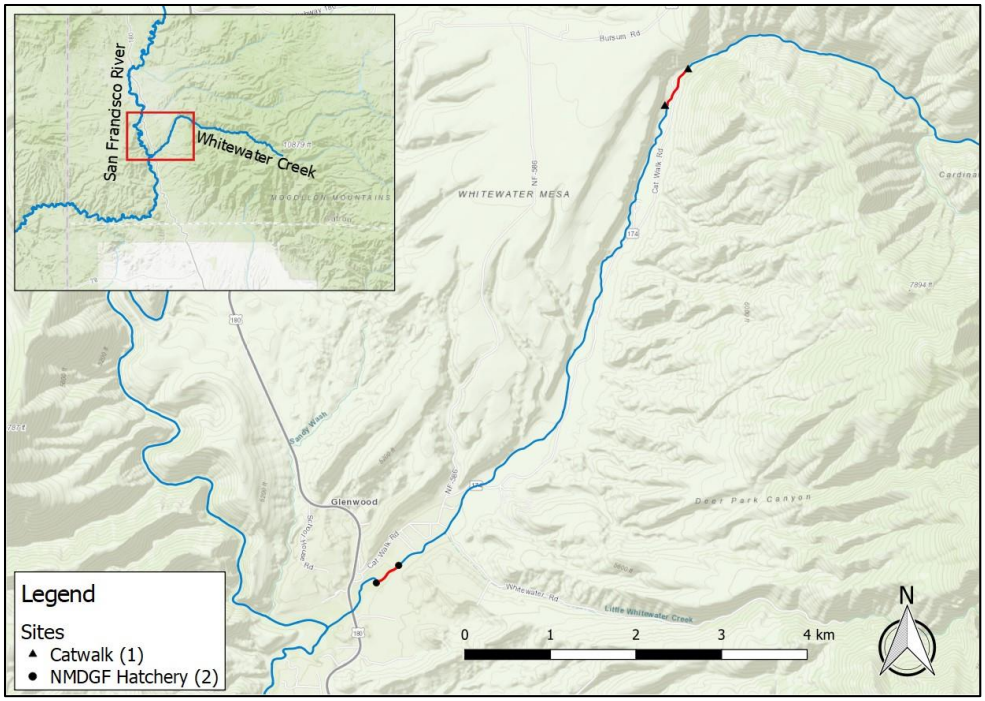

Figure 76. Location of two sampling sites in Whitewater Creek, sampled on June 25-26, 2019.


Figure 22. Example of targeted habitat in Whitewater Creek – Catwalk Recreation Area


Figure 78. Example of targeted habitat in Whitewater Creek – NMDGF Hatchery

Blue River (Upper) July 23-24, 2019

12S NAD 83	Lower Boundary 1: 677295E, 3727352N	Upper boundary 1: 677517E, 3727793N
	Lower Boundary 2: 678300E, 3729453N	Upper boundary 2: 678670E, 3729765N
	Lower Boundary 3: 680669E, 3732195N	Upper boundary 3: 681087E, 3732417N

The Blue River (Apache County, AZ) flows through Apache-Sitgreaves National Forest and is a tributary to the San Francisco River (Figure 79). Sampling for GRBMP is focused on the upper section of the river, which was last surveyed in 2016. Much of the Blue River and its tributaries are designated as critical habitat for Loach Minnow and is home to one of the highest diversities of native fishes in Arizona (FWS 2012).

M&A personnel completed the sampling of the upper Blue River on July 23-24. A BPEF was used to sample three sites targeting Loach Minnow. All sites were accessed from FR 281. Habitat at all three sites was comprised mainly of riffle and run mesohabitats; no non-native fishes were captured or observed at any site. A 500-m site was established at Jones Canyon. This site was sampled by BPEF for 2212 sec and Loach Minnow (n=21; 9.91%) were captured. Other species captured included Speckled Dace (n=115; 54.25%), Longfin Dace (n=67; 31.60%), Desert Sucker (n=8; 3.78%), and Sonora Sucker (n=1; 0.47%; Table 34). Water temperature and conductivity were recorded at 28°C and 373µS respectively.

A previous GRBMP survey established a 100-m site downstream of Upper Blue Campground where 48 Loach Minnow were caught in 2016. This site was repeated and only 1 Loach Minnow was found and so the survey was extended to complete 500 m. An additional six Loach Minnow were caught. Other species captured were Speckled Dace (n=72; 72.00), Longfin Dace (n=10; 10.00%), Desert Sucker (n=10; 10.00%), and Sonora Sucker (n=1; 1.00%; Table 35). Sampling was made difficult due to a heavy rainstorm that began partway through the survey and water clarity was poor. The majority of fish captured were young-of-year. Water conductivity was recorded at 394µS. Water temperature was not recorded.

The third and final site was located at Bobcat Flat, which was established in the previous GRBMP survey. This 500-m site was sampled by BPEF for 1599 sec and one Loach Minnow (0.37%) was captured. This site ended at a large beaver dam complex. Other species captured were Speckled Dace (n=206; 76.01%), Longfin Dace (n=42; 15.50%), Desert Sucker (n=21; 7.75%), and Sonora Sucker (n=1; 0.37%; Table 36). Water temperature and conductivity were recorded at 19°C and 392µS respectively.

Photographs depicting available habitat at the three sites are provided in Figures 80-82. Loach Minnow are still present in the upper Blue River (Figure 83). Lower numbers observed this year likely were due to the poor field conditions at the campground site. Loach Minnow numbers at Jones Canyon and Bobcat Flat sites are consistent with past survey efforts (Humphrey et al., 2015; Timmons et al. 2017).

Table 34. Summary of catch in the Blue River (lower site) at Jones Canyon by BPEF. Total effort was 2212 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	SB	67	31.60	0.030
CAIN	1+	1	0.47	0.000
TICO	SB	21	9.91	0.009
PACL	0	5	2.36	0.002
PACL	1+	3	1.42	0.001
RHOS	SB	115	54.25	0.052
Total		**212**	100.00	0.096

Table 35. Summary of catch in the Blue River (middle site) at Upper Blue Campground by BPEF. Total effort was 1306 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	SB	10	10.00	0.008
CAIN	1+	1	1.00	0.001
TICO	SB	7	7.00	0.005
PACL	1+	2	2.00	0.002
PACL	0	8	8.00	0.006
RHOS	SB	72	72.00	0.055
Total		**100**	100.00	0.077

Table 36. Summary of catch in the Blue River (upper site) at Bobcat Flat by BPEF. Total effort was 1599 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	SB	42	15.50	0.026
CAIN	1+	1	0.37	0.001
TICO	SB	1	0.37	0.001
PACL	0	6	2.21	0.004
PACL	1+	15	5.54	0.009
RHOS	SB	206	76.01	0.129
Total		**271**	100.00	0.169

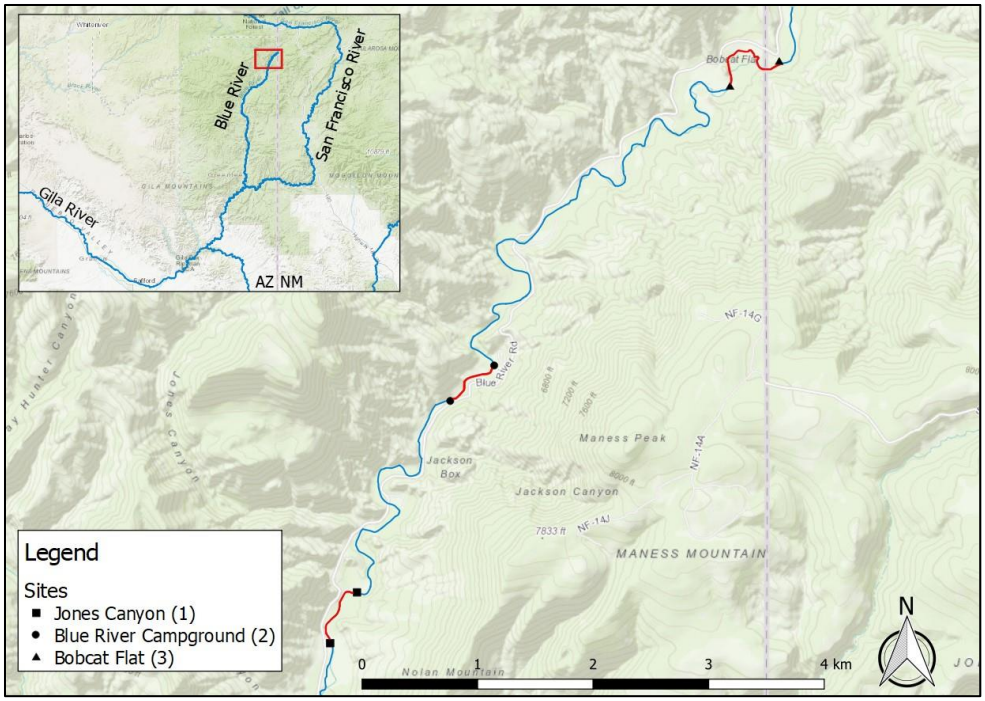

Figure 23. Location of three 500 m sampling sites in the upper Blue River, sampled July 23-24, 2019.

Figure 80. Example of targeted habitat in the upper Blue River – Jones Canyon.

Figure 81. Example of targeted habitat in the upper Blue River – Blue River Campground.

Figure 82. Example of targeted habitat in the upper Blue River – Bobcat Flat.

Figure 83. Loach Minnow captured in the upper Blue river – Jones Canyon.

Harden Cienega August 13, 2019

12S NAD 83 Lower boundary: 674782E, 3674586N Upper boundary: 674870E, 3674584N

Harden Cienega Creek (Greenlee County, AZ) is a tributary to the San Francisco River located in Apache-Sitgreaves National Forest (Figure 84). Harden Cienega was last surveyed for the GRBMP in 2016.

Harden Cienega Creek was accessed via a short hike along the San Francisco River from San Francisco Camp off Martinez Ranch Road. A BPEF was used to sample at this site targeting Gila Chub. The previous GRBMP survey established a 100-m site approximately 1.6 km upstream from the confluence with the San Francisco River where 28 Gila Chub were caught in 2016 (Timmons et al. 2017). This site was repeated, and 42 Gila Chub (17.79%) were captured. Other species captured were Speckled Dace (n=76; 32.20%), Longfin Dace (n=10; 4.24%), Desert Sucker (n=96; 40.68%), and Sonora Sucker (n=12; 5.09%; Table 37). No non-natives were captured or observed at this site. Habitat at this site was comprised mainly of riffle and run mesohabitats with one large pool where the majority of adult Gila Chub were captured. Water temperature and conductivity were recorded at 25°C and 292µS respectively. Upper and lower boundary photos can be found below (Figures 85-88).

Harden Cienega Creek was dry at the San Francisco River confluence and water did not begin until 0.4 km from the mouth of the canyon. Opportunistic sampling in these isolated pools did not detect any non-natives; however, non-natives could move into this system during periods of high flow.

Table 37. Summary of catch in Harden Cienega by BPEF. Total effort was 785 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	SB	10	4.24	0.013
CAIN	0	2	0.85	0.003
CAIN	1+	10	4.24	0.013
GIIN	1+	30	12.71	0.038
GIIN	0	12	5.08	0.015
PACL	1+	72	30.51	0.092
PACL	0	24	10.17	0.031
RHOS	SB	76	32.20	0.097
Total		**236**	100.00	0.301

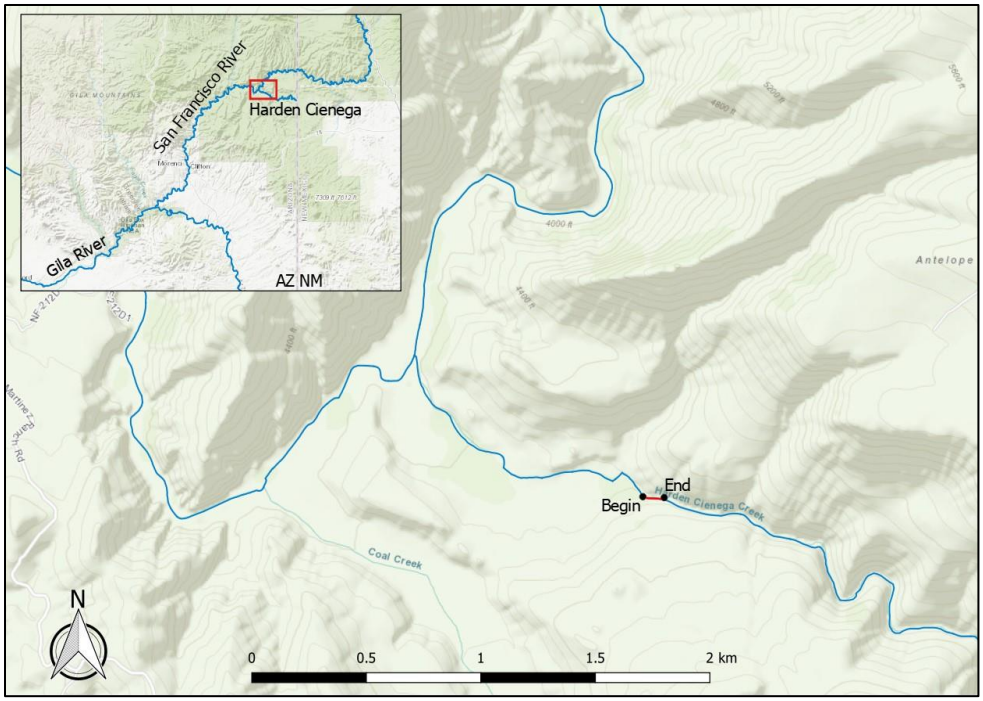

Figure 24. Location of 100 m sampling site in Harden Cienega, sampled on August 13, 2019.

Figure 85. Upstream to upstream view of the 100 m sampling site in Harden Cienega.

Figure 86. Upstream to downstream view of the 100 m sampling site in Harden Cienega.

Figure 87. Downstream to upstream view of the 100 m sampling site in Harden Cienega.

Figure 88. Downstream to downstream view of the 100 m sampling site in Harden Cienega.

Turkey Creek August 14, 2019

12S NAD 83	Lower boundary 1: 734539E, 3663861N	Upper boundary 1: 734570E, 3663954N
	Lower boundary 2: 734857E, 3665866N	Upper boundary 2: 734912E, 3665969N

Turkey Creek (Catron County, NM) is a tributary to the Gila River and located about 13 km northwest of Cliff, NM (Figure 89). Turkey Creek was a new addition to the GRBMP for 2019 and has not been previously surveyed under this program.

Turkey Creek was accessed via hiking on Turkey Creek Trail at the end of Turkey Creek Road. Two 100-m sites were established on Turkey Creek with the upper site being located approximately 4 km upstream from the Gila River confluence. This site was chosen as it was the furthest upstream point that was easily accessible with sampling gear within 8 km of the trailhead. The lower site was established approximately 2.1 km downstream of the upper site. This site was chosen as it was the furthest downstream location that had suitable chub habitat. Below this point, habitat consisted of shallow riffles with isolated stagnant pools and was completely dry 300 m further downstream. Gila Chub were targeted at Turkey Creek.

The upper site was sampled by BPEF for 655 sec and a total of 123 Gila Chub (74.10%) were captured. Other species captured included Desert Sucker (n=41; 24.70%), and Sonora Sucker (n=2; 1.20%; Table 38). No non-natives were captured or observed at this site. Habitat consisted of large pools separated by short run and riffle mesohabitats. The site ended at a large waterfall and pool complex that could not be sampled effectively. Water temperature and conductivity were recorded at 30°C and 380µS respectively. Upper and lower boundary photos of the upper site can be found below (Figures 90-93).

The lower site was sampled by BPEF for 596 sec and a total of 74 Gila Chub (15.74%) were captured. Other native species captured were Speckled Dace (n=1; 0.21%), Longfin Dace (n=165; 35.11%), Desert Sucker (n=179; 38.09%), and Sonora Sucker (n=45; 9.57%). Non-native species consisting of Red Shiner (n=3; 0.64%) and Fathead Minnow (n=3; 0.64%; Table 39) also were captured. Parasitic anchor worm (*Lernaea cyprinacea*) was observed on one adult Gila Chub and one Red Shiner. Habitat consisted of long run and riffle mesohabitats separated by a deep pool. Water temperature and conductivity were recorded at 25°C and 347µS respectively. Upper and lower boundary photos of the upper site can be found below (Figures 94-97).

Upper and Lower boundary photos were taken at each site (Figures 90-93). Gila Chub appear to be doing well in Turkey Creek. Both adult and age-0 chub were abundant. Adults were mainly found in larger pools that were more difficult to sample underrepresenting their presence. Non-native fishes present at the lower site show that a connection to the Gila River during periods of high flows allows for movement of non-natives.

Table 38. Summary of catch in Turkey Creek (upper site) by BPEF. Total effort was 655 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
CAIN	1+	2	1.20	0.003
GIIN	1+	15	9.04	0.023
GIIN	0	108	65.06	0.165
PACL	1+	24	14.46	0.037
PACL	0	17	10.24	0.026
Total		**166**	100.00	0.253

Table 39. Summary of catch in Turkey Creek (lower site) by BPEF. Total effort was 596 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	SB	165	35.11	0.277
CAIN	0	45	9.57	0.076
CYLU	SB	3	0.64	0.005
GIIN	0	51	10.85	0.086
GIIN	1+	23	4.89	0.039
PACL	0	165	35.11	0.277
PACL	1+	14	2.98	0.023
PIPR	SB	3	0.64	0.005
RHOS	SB	1	0.21	0.002
Total		**470**	100.00	0.789

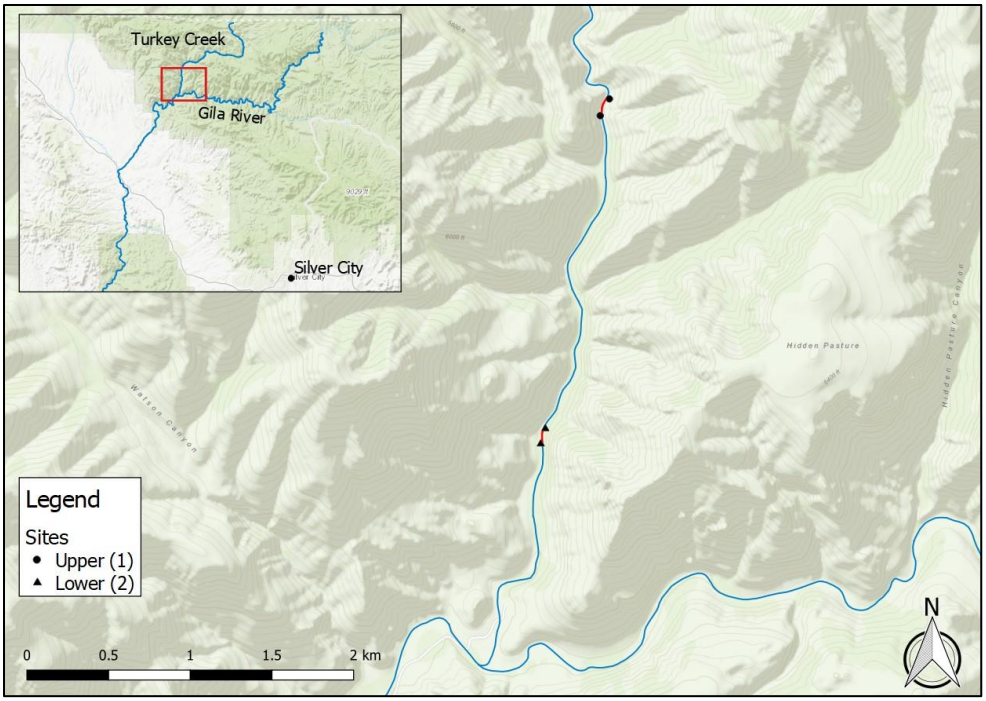

Figure 25. Location of two 100 m sampling sites in Turkey Creek, sampled on August 14, 2019.


Figure 90. Upstream to upstream view of the 100 m sampling site in Turkey Creek (upper).

Figure 91. Upstream to downstream view of the 100 m sampling site in Turkey Creek (upper).

Figure 92. Downstream to upstream view of the 100 m sampling site in Turkey Creek (upper).

Figure 93. Downstream to downstream view of the 100 m sampling site in Turkey Creek (upper).

Figure 94. Upstream to upstream view of the 100 m sampling site in Turkey Creek (lower).

Figure 95. Upstream to downstream view of the 100 m sampling site in Turkey Creek (lower).

Figure 96. Downstream to upstream view of the 100 m sampling site in Turkey Creek (lower).

Figure 97. Downstream to downstream view of the 100 m sampling site in Turkey Creek (lower).

Verde River Basin

Wet Beaver Creek (Lower) September 25-26, 2019

12S NAD 83	Lower boundary 1: 437967E, 3837337N	Upper boundary 1: 438402E, 3837194N
	Lower boundary 2: 436854E, 3837698N	Upper boundary 2: 437309E, 3837728N
	Lower boundary 3: 434458E, 3836371N	Upper boundary 3: 434734E, 3836781N

Wet Beaver Creek (Yavapai County, AZ) is located in Coconino National Forest in the Verde River drainage (Figure 98). While the past three GRBMP surveys have not detected Roundtail Chub within the lower section of the creek, other surveys have identified Roundtail Chub in upper Wet Beaver Creek (Timmons et al. 2017, Rinker 2012). The 2016 GRBMP report recommended that efforts should focus on the most upstream extent of the lower portion of Wet Beaver Creek to possibly identify the lowermost sections of stream occupied by Roundtail Chub.

M&A personnel completed sampling lower Wet Beaver Creek on September 25-26. A BPEF was used to sample three sites targeting Roundtail Chub. Habitat at all three sites was comprised mainly of riffle and run mesohabitats separated by long, deep pools.

The most upstream site was established 500-m below the U.S. Geological Survey gauging site, which is considered the boundary between lower and upper reaches of Wet Beaver Creek. This site was accessed by hiking approximately 3.6 km on the Bell trail. The entire 500-m site was sampled by BPEF for 1159 sec. No Roundtail Chub were detected. Species captured include Desert Sucker (n=236; 97.52) and Redeye Bass (n=6; 2.48%; Table 40). Water temperature and conductivity were recorded at 19°C and 271µS respectively.

The middle site was established just upstream of Beaver Creek Ranch and continued to Casner Canyon and was accessed via the Bell trail. This 500-m site was sampled by BPEF for 1653 sec. No Roundtail Chub were detected. Species captured were Desert Sucker (n=102; 60.00%), and Redeye Bass (n=68; 40.00; Table 40). Water temperature and conductivity were recorded at 19°C and 284µS respectively.

The third and most downstream site was completed at Beaver Creek Day Use area (formerly Beaver Creek Campground). A 500-m site was sampled by BPEF for 1778 sec. No Roundtail Chub were detected. Species captured were Desert Sucker (n=59; 37.21%), Redeye Bass (n=96; 60.38%), and Rainbow Trout (n=4; 2.52%). Water temperature and conductivity were recorded at 19°C and 325µS respectively.

Past surveyors may have misidentified Redeye Bass in Wet Beaver Creek as Smallmouth Bass (*Micropterus dolomieu)*. Fin clip and eDNA samples processed by researchers at Embry-Riddle Aeronautical University in Prescott, AZ have been detecting Redeye Bass throughout the Verde River system. The bass captured in Wet Beaver Creek in 2019 were determined to be Redeye Bass visually and then morphometrically confirmed (Figure 102). Although, the possibility of Smallmouth/Redeye hybrids cannot be ruled out.

Northern Crayfish were abundant at all three sites. While Roundtail Chub persist in upper reaches of Wet Beaver Creek, the abundance of non-native predators remains the biggest threat to survival of Roundtail

Chub in lower Wet Beaver Creek. Photographs depicting available habitat at the three sites are provided in Figures 99-101.

Table 40. Summary of catch in lower Wet Beaver Creek (upper site) by BPEF. Total effort was 1,159 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
PACL	1+	26	10.74	0.022
PACL	0	210	86.78	0.181
MICO	0	5	2.07	0.004
MICO	1+	1	0.41	0.001
Total		**242**	100.00	0.209

Table 41. Summary of catch in lower Wet Beaver Creek (middle site) by BPEF. Total effort was 1,653 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
PACL	1+	2	1.18	0.001
PACL	0	100	58.82	0.060
MICO	0	66	38.82	0.040
MICO	1+	2	1.18	0.001
Total		**170**	100.00	0.103

Table 42. Summary of catch in lower Wet Beaver Creek (lower site) by BPEF. Total effort was 1,778 sec.

Species	Age	Count	% of total catch	CPUE (fish/sec)
PACL	1+	14	8.81	0.008
PACL	0	45	28.30	0.025
MICO	0	94	59.12	0.053
MICO	1+	2	1.26	0.001
ONMY	1+	4	2.52	0.002
Total		**159**	100.00	0.089

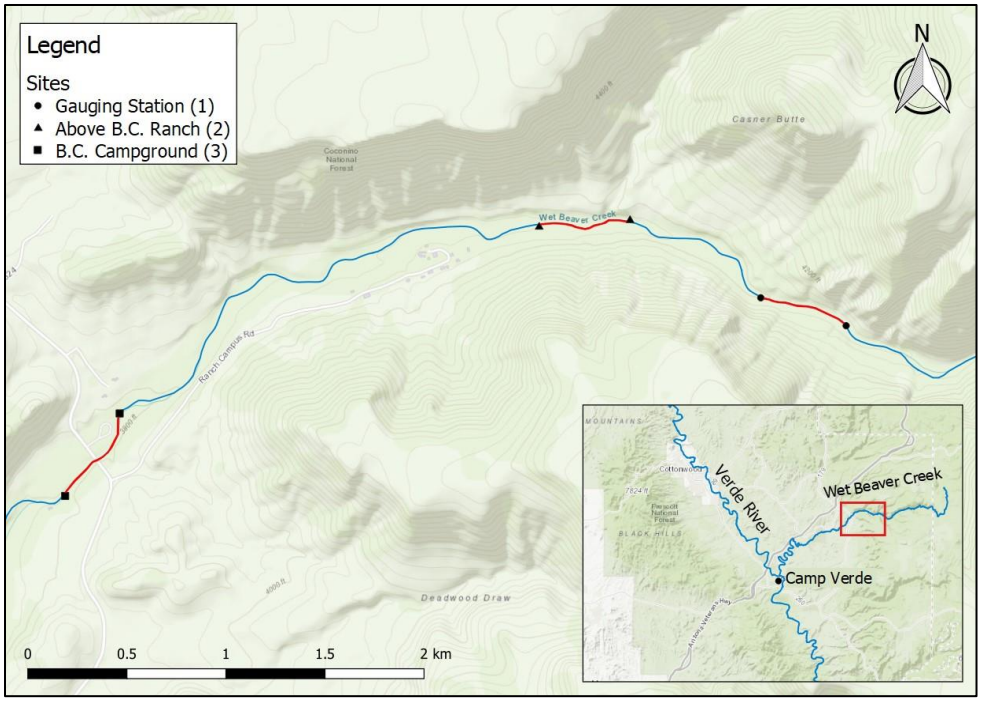

Figure 26. Location of three 500 m sampling sites in lower Wet Beaver Creek, sampled September 25-26, 2019.

Figure 99. Example of targeted habitat in lower Wet Beaver Creek – USGS Gauging station.

Figure 100. Example of targeted habitat in lower Wet Beaver Creek – Above B.C. Ranch.

Figure 101. Example of targeted habitat in lower Wet Beaver Creek – B.C. Campground.

Figure 102. Redeye Bass captured in lower Wet Beaver Creek – Above B.C Ranch on September 25, 2019

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Appendix A – supplementary graphs

List of figures

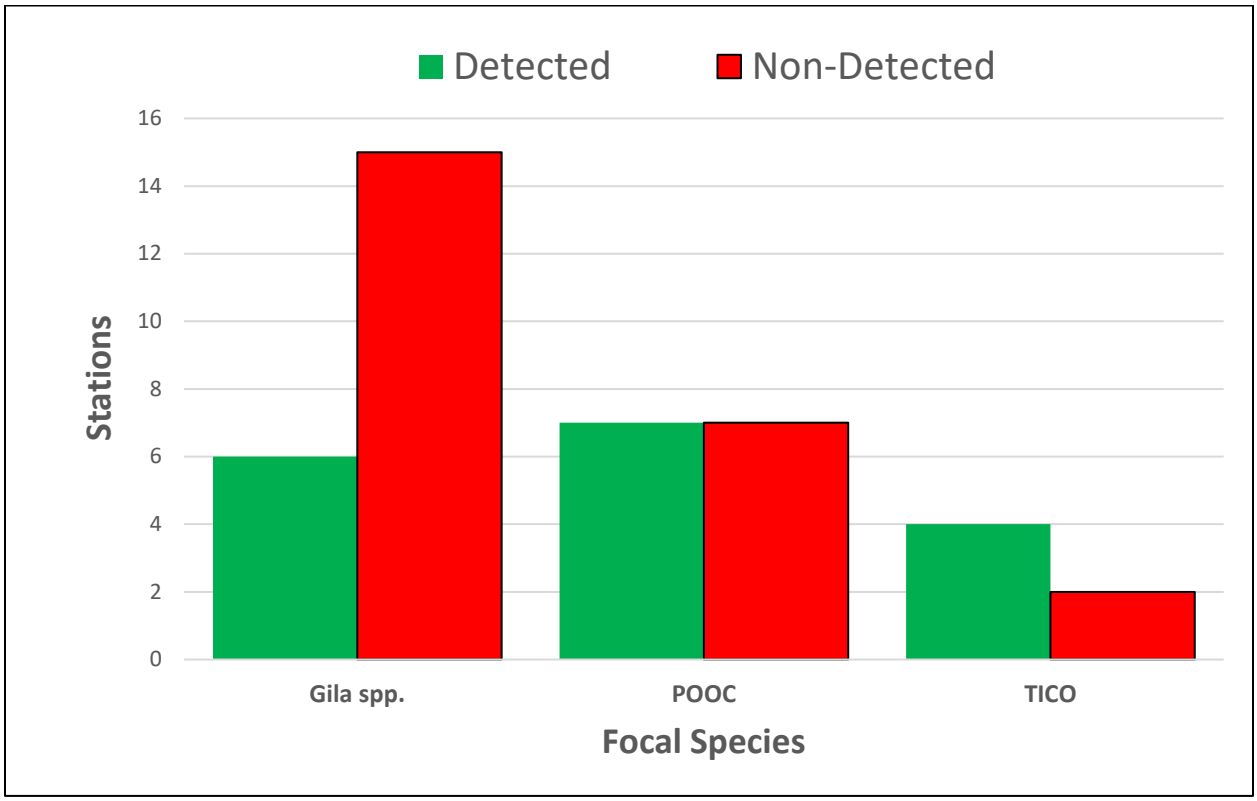

Figure A1. Number of stations where focal species were detected or not detected in selected streams of Gila River basin, 2019; see Table 1 for species codes.

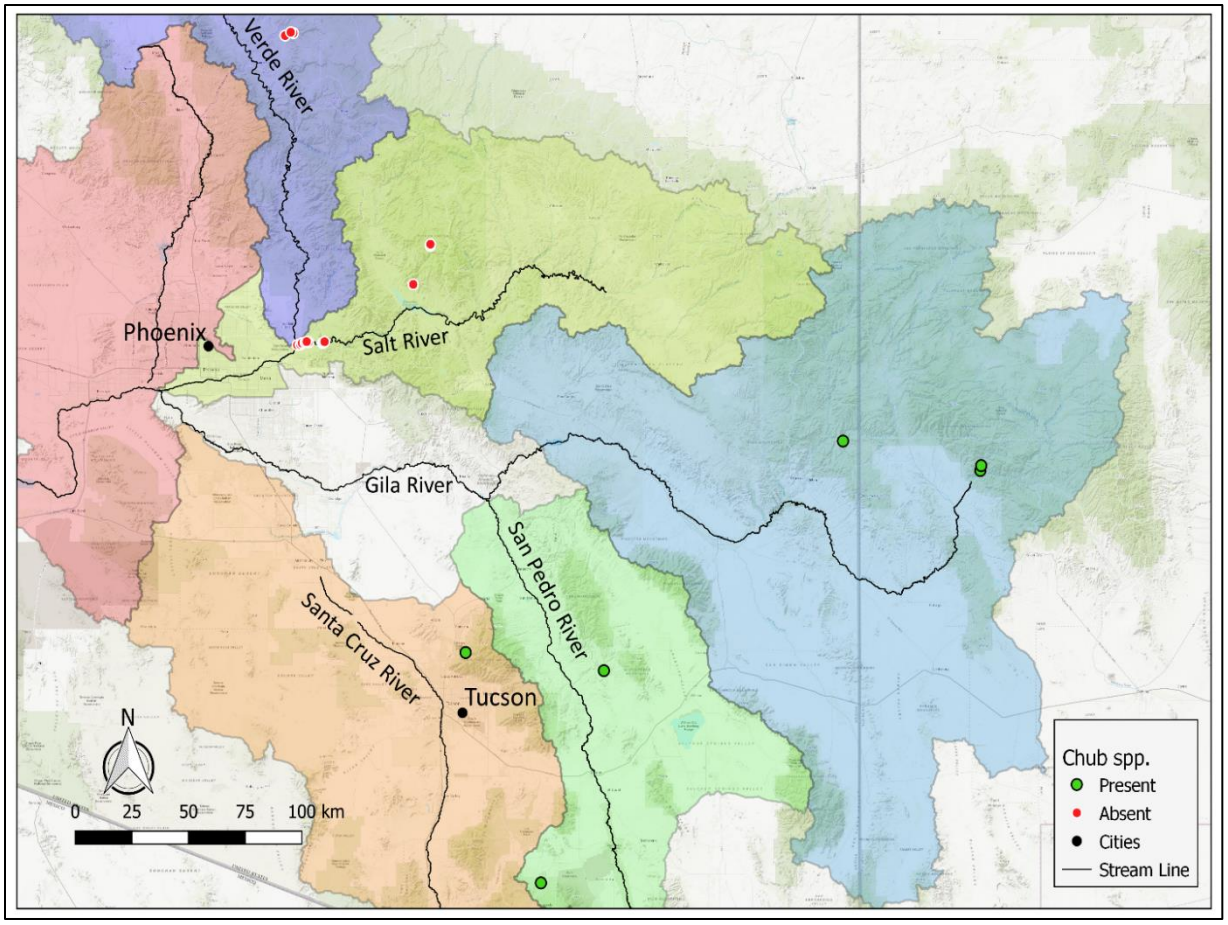

Figure A2. Location of sampling stations where *Gila* spp. were targeted and detected or not detected in Gila River basin, 2019.

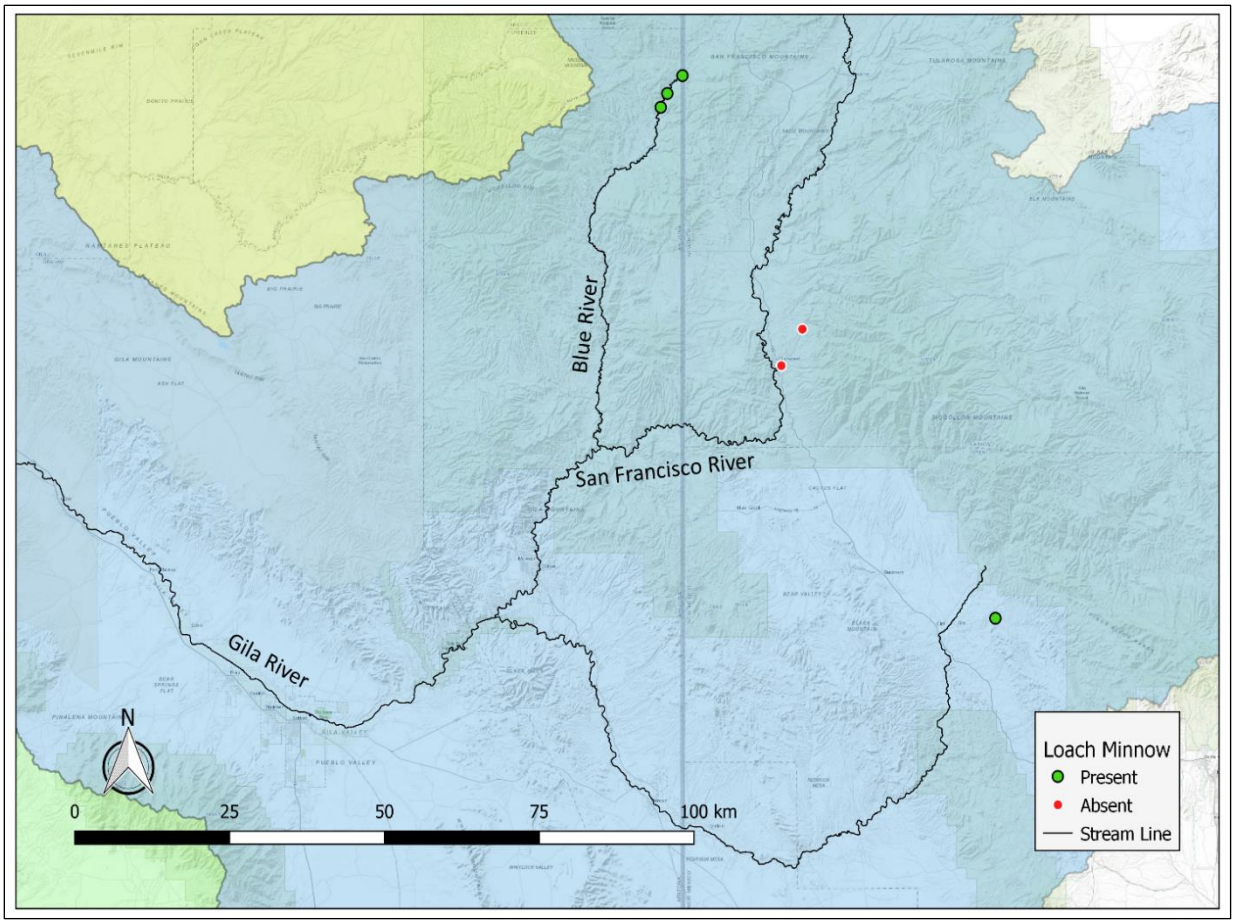

Figure A3. Location of sampling stations where Loach Minnow were targeted and detected or not detected in Gila River basin, 2019.

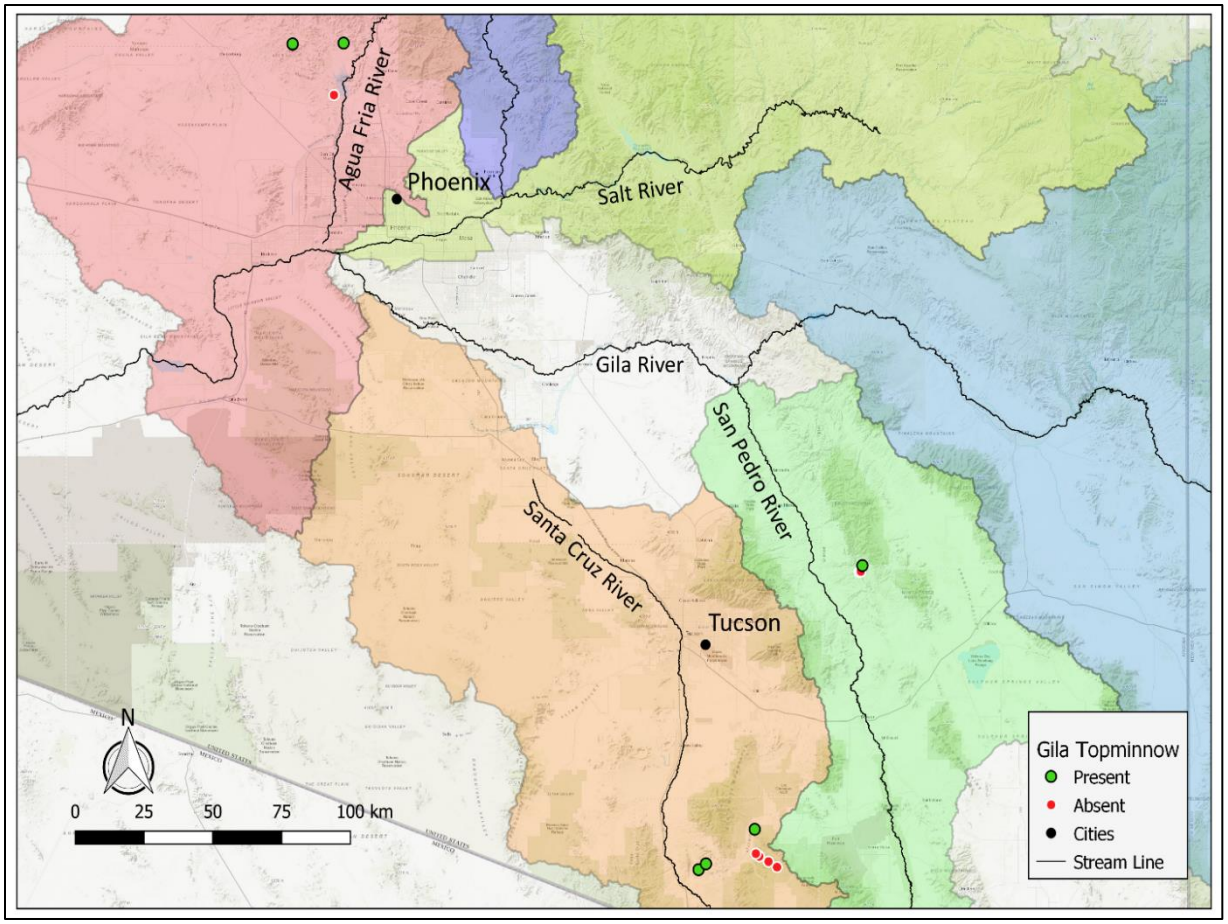

Figure A4. Location of sampling stations where Gila Topminnow were targeted and detected or not detected in Gila River basin, 2019.

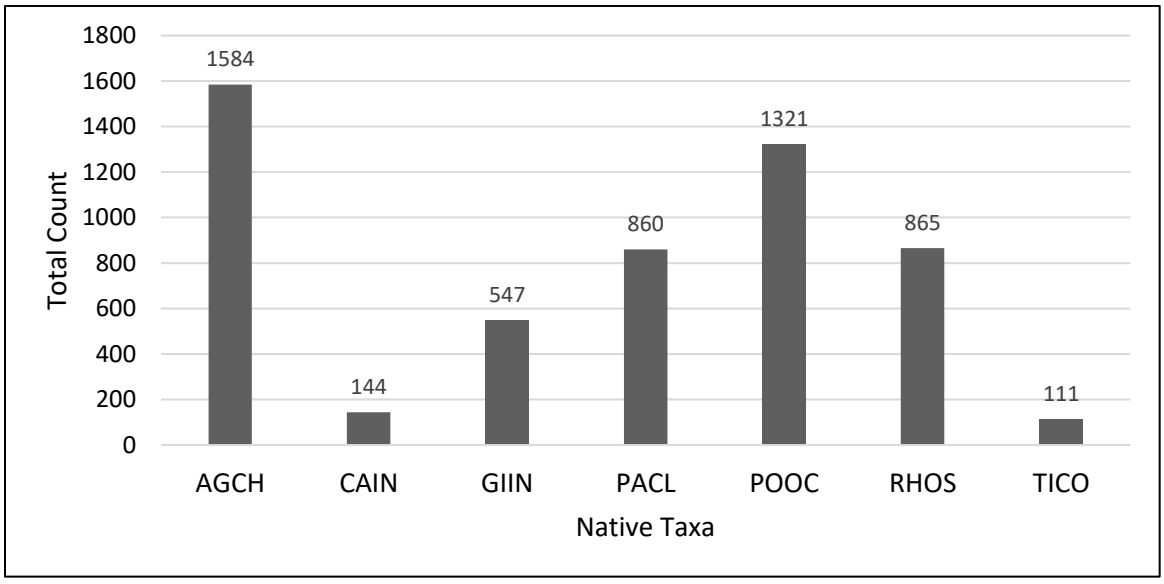

Figure A5. Total number of native taxa captured in selected streams of Gila River basin, 2019; see Table 1 for species codes.

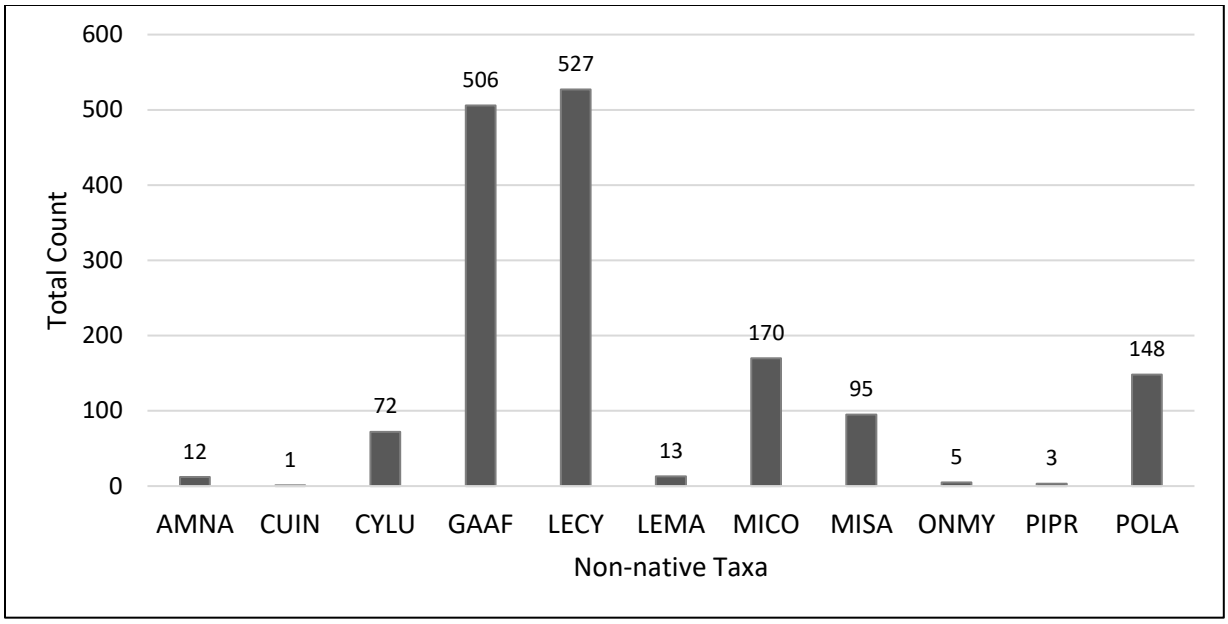

Figure A6. Total number of non-native taxa captured in selected streams of Gila River basin, 2019; see Table 1 for species codes.

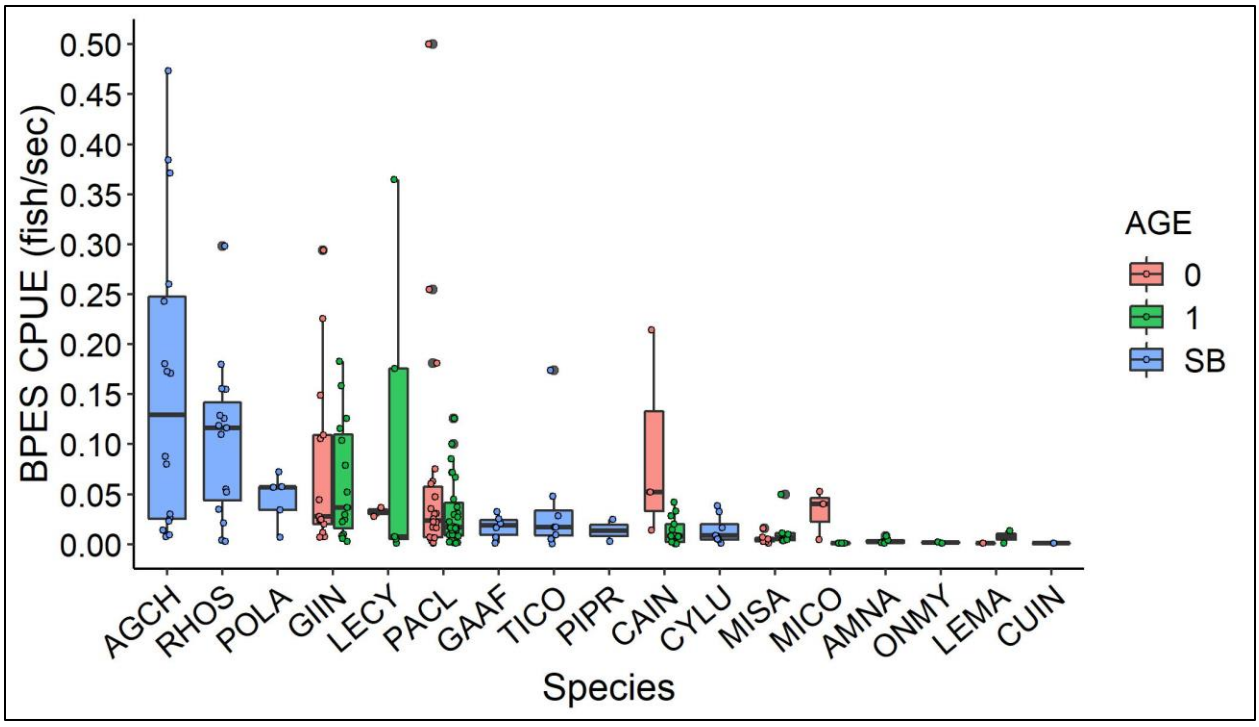

Figure A7. Backpack electrofishing CPUE for all taxa captured in selected streams of Gila River basin, 2019; see Table 1 for species codes; age classes are defined on page 11.

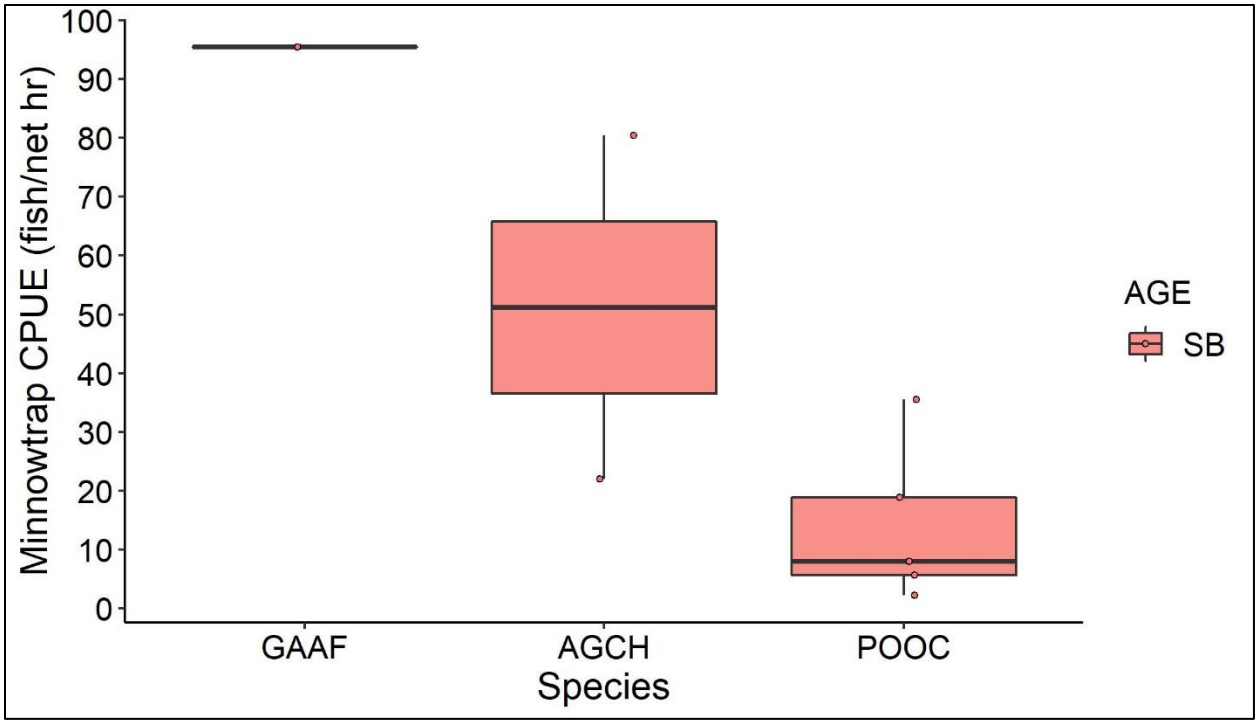

Figure A8. Minnow trap CPUE for all taxa captured in selected streams of Gila River basin, 2019; see Table 1 for species codes; age classes are defined on page 11.

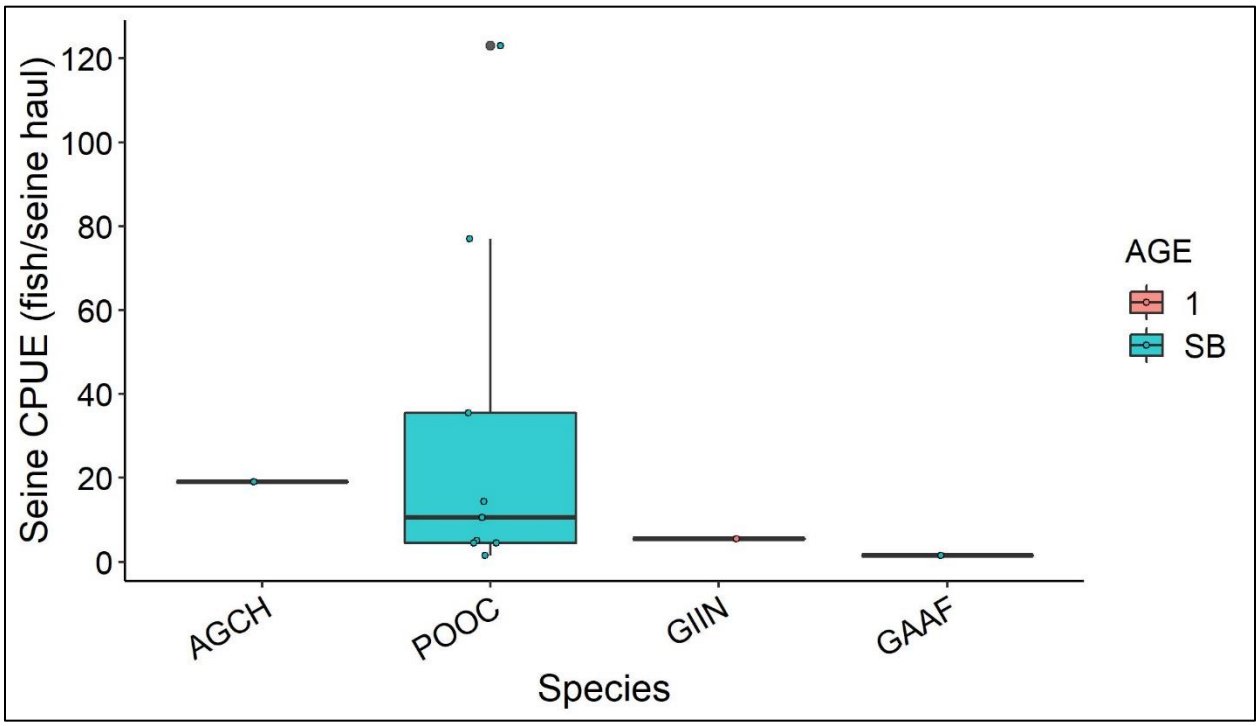

Figure A9. Seine CPUE for all taxa captured in selected streams of Gila River basin, 2019; see Table 1 for species codes; ages classes are defined on page 11.

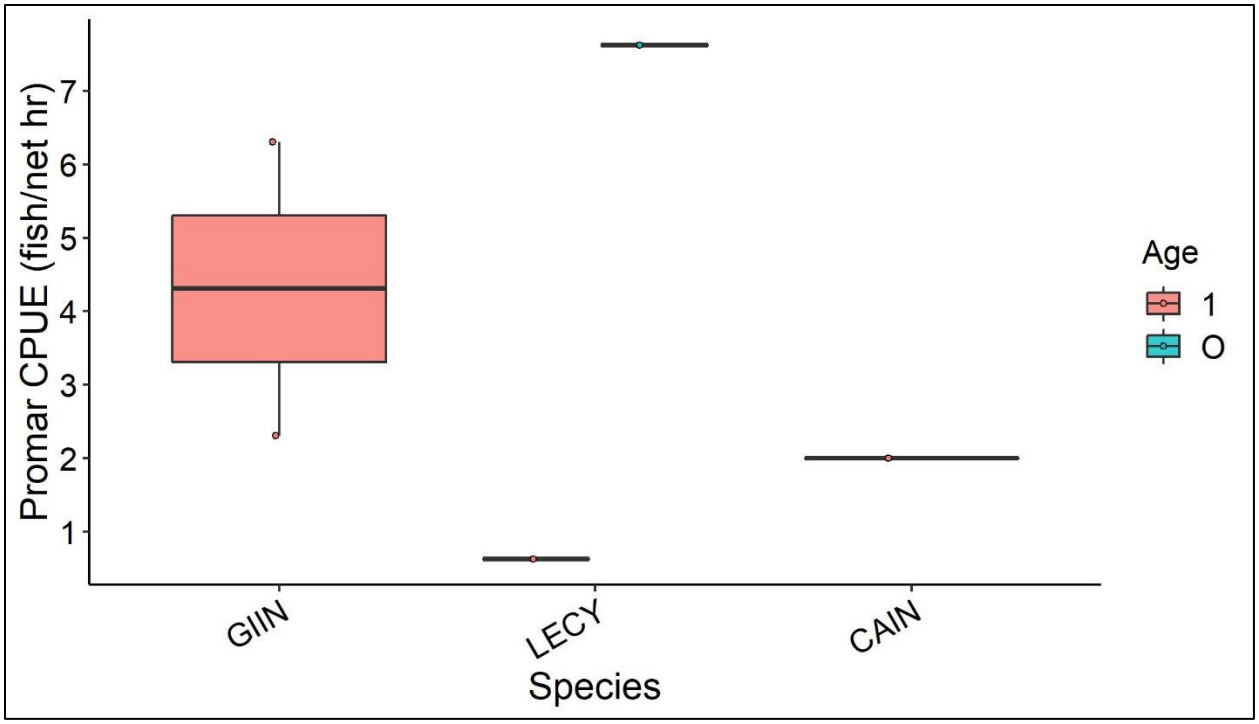

Figure A3. Promar hoop net CPUE for all taxa captured in selected streams of Gila River basin, 2019; see Table 1 for species codes; age classes are defined on page 11.