Gila River Basin Native Fish Monitoring

2021 Final Annual Report

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Introduction

Long-term monitoring at multiple spatial scales through time (i.e., temporal) provides important insight on distribution, abundance, and dynamics of stream fish communities. In 1994, a long-term monitoring program was initiated by Bureau of Reclamation (Reclamation) as a requirement imposed by 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). FWS determined that the canal and its interconnected channels had the potential to degrade fish habitat as the CAP provided a mechanism for dispersal of non-native fishes into surrounding aquatic systems. The initial monitoring program objective was to provide baseline data on distribution and abundance of non-native fishes in the CAP canal system and its primary connected waters. In 2012, Reclamation 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 canal system to gather information on status of wild populations of federal-listed/candidate fishes.

The primary objective of the current monitoring program is to detect presence of each focal species in each stream and determine their distributional extent within occupied streams. Secondarily, evaluate fish community structure to determine relative abundance of the focal species within the community of co-occurring fishes. Moving forward, the program goal will be to better assess conservation status of federally listed focal species by calculating population size indices, determining fish assemblage structure including non-natives, documenting reproduction and recruitment, and determining geographic extent for each focal species (Mosher et al. 2020). Species specific objectives and standardized protocols will assist with meeting this goal.

This report summarizes monitoring activities conducted by Marsh & Associates, LLC (M&A) during calendar year 2021 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 trends of recruitment and size-structure were examined where possible.

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 four native species currently listed as threatened or endangered: Gila Chub *Gila intermedia,* Spikedace *Meda fulgida*, Loach Minnow *Tiaroga cobitis*, and Gila Topminnow *Poeciliopsis occidentalis.*

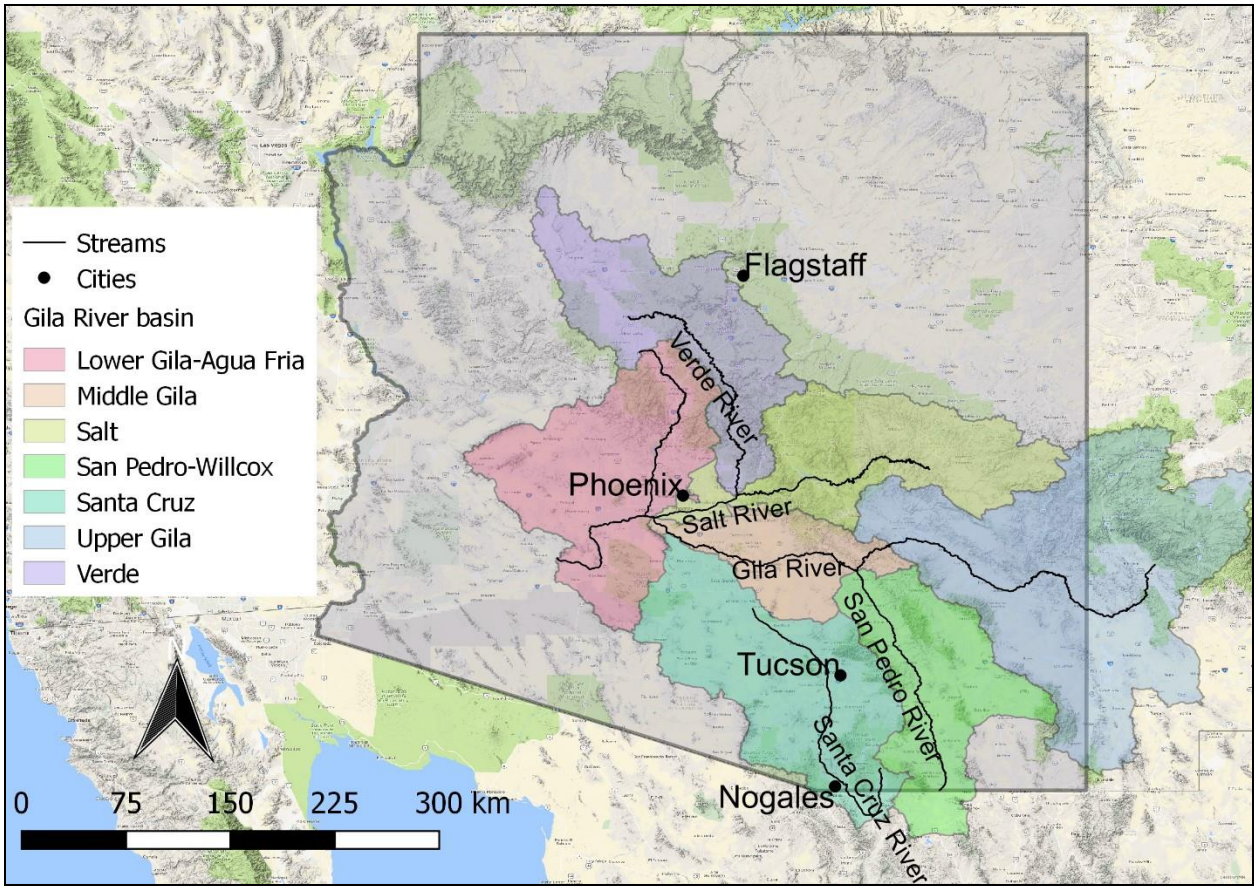

Figure 1. Major drainages of the Gila River basin, where stream surveys were conducted in 2021.

Methods

A new generalized sampling design and methodology, including site-specific monitoring protocols, was enacted in 2021. Sampling methodologies followed Mosher et al. (2020) and any deviations are reported in the trip summaries section below. These new methods will help improve consistency regarding survey timing, effort, and sampling locations moving forward. 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 mini-hoop nets (hereafter mini-hoop nets 12 in x 24 and 36 in, ½ in mesh), Gee style minnow traps (hereafter minnow traps; 10 in x 18 in, 1/8 in mesh), dip nets (1.16 ft x 1 ft, 1/8 in mesh), and 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).

Site-specific monitoring protocols were established for each stream (Mosher et al. 2020); however, gear selection was determined by focal species and habitat type. In addition, protocols differed slightly for Arizona versus New Mexico streams. In New Mexico, all survey stations were 200-meters (m) in length compared to 100-m in Arizona (except for the lower Blue River which has 200-m survey stations). Total length of stream sampled during a given study year is enough cover at least 20% of available habitat at a site. There was at least one fixed station at every site and remaining stations were randomly selected 100-m intervals, which were generated using QGIS software. Potential survey stations were numbered

beginning at 01 for the most upstream station and continuing downstream. A random number generator was used to assign random stations to be completed this year.

Survey stations were broken up into major habitat types (Riffle, Run, Pool). In addition, efforts were recorded individually. For example, at the end of each habitat break during an electrofishing survey, electrofishing seconds were recorded, all fishes captured were processed, and information such as habitat type, length, width, depth of pool were recorded. Catch totals and effort were recorded individually for each mini-hoop net or minnow trap set, dip net sweep, and seine haul.

At each processing point, fishes were identified to species (Table 1), and counted. All Spikedace, Loach Minnow, Gila Chub, and non-native piscivores captured were measured for total length (millimeters [mm]). In addition, Gila Chub were weighed to the nearest gram. Lengths of other species were categorized into general size classes: ≤20 mm and >20 mm for Gila Topminnow and Western Mosquitofish, ≤40 mm and >40 mm for small-bodied fishes (e.g., Speckled Dace *Rhinichthys osculus* and Longfin Dace *Agosia chrysogaster*, and ≤50, 51-100 and >100 mm for large-bodied fishes (e.g., Desert Sucker *Pantosteus clarkii* and Roundtail Chub *Gila robusta*).

Station lengths were measured in the field using a Garmin 64st GPS unit. UTM coordinates of upper and lower boundaries of each reach were recorded in NAD83 datum. Habitat photographs were taken at each random station as well as specimen photos of species of interest. At fixed stations, photographs were taken at upper and lower boundaries of both upstream and downstream views. At stream sites, discharge was measured at fixed stations across 10 intervals using a HACH® FH950. Discharge protocol was a modified version of that developed by U.S. Environmental Protection Agency (Lazorchak et al. 1998).

Table 1. List of species encountered during surveys throughout the Gila River Basin in 2021.

Common name	Code	Scientific name
Brown Trout	SATR	*Salmo trutta*
Longfin Dace	AGCH	*Agosia chrysogaster*
Gila Chub	GIIN	*Gila intermedia*
Roundtail Chub	GIRO	*Gila robusta*
Fathead Minnow	PIPR	*Pimephales promelas*
Speckled Dace	RHOS	*Rhinichthys osculus*
Loach Minnow	TICO	*Tiaroga cobitis*
Sonora Sucker	CAIN	*Catostomus insignis*
Desert Sucker	PACL	*Pantosteus clarkii*
Yellow Bullhead	AMNA	*Ameiurus natalis*
Western Mosquitofish	GAAF	*Gambusia affinis*
Gila Topminnow	POOC	*Poeciliopsis occidentalis*
Green Sunfish	LECY	*Lepomis cyanellus*
Lowland Leopard Frog	RAYA	*Rana yavapaiensis*
Northern Crayfish	ORVI	*Orconectes virilis*

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. Length-frequency graphs are included where possible to evaluate size-structure and reproduction. Also, a narrative text summarized trip details and fish community composition. Status of focal species was assessed in contexts of physical habitat conditions, 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 2021) and are included in the appendix.

Results

A total of 105 sampling stations were completed across 23 streams. Gila Chub were detected at 37 of 47 stations (8 of 8 streams) where they were a focal species, Gila Topminnow were detected at 19 of 38 stations (11 of 11 streams), Loach Minnow were detected at 8 of 43 stations (2 of 7 streams), and Spikedace were not detected at any of the 24 stations (2 streams) where they were a focal species (Appendix A, Figure A1).

Across all streams, a total of 12,578 individuals and 13 fish species (8 native and 5 non-native) were captured (Table 2; Appendix A, Figures A5-A6). No new taxa were detected for the Gila River basin. Native taxa accounted for 98.86% of total catch. BPEF was the primary sampling gear and was used at 60 sampling stations. BPEF was effective at capturing both large and small-bodied fishes and accounted for 43.04% (n=5414) of total catch (Appendix A, Figures A7-A8). However, BPEF was not effective in stream reaches with deep pools or high turbidity. Minnow traps were used to target Gila Topminnow and young-of-year Gila Chub in pools and were employed at 35 stations. Minnow traps were the most productive sampling gear, accounting for 49.56% (n=6,234) of total catch (Appendix A, Figures A9-A10). Other gears were used less frequently, such as dip-net sweeps that were utilized to target Gila Topminnow in shallow, vegetated margins of streams at 10 stations and accounted for 2.41% (n=303) of total catch (Appendix A, Figure A12). Seining was employed at five stations in deeper pools and flowing habitat with smooth substrate and accounted for 3.3% (n=415) of total catch (Appendix A, Figure A13). Mini-hoop nets were employed to target adult Gila Chub in springs and deep pools at 17 different stations and accounted for 1.69% (n=212) of total catch (Appendix A, Figure A11).

Post-fire flooding appears to have impacted fish populations across several streams surveyed this year. Lower Blue River was impacted severely by the 2020 Cow Canyon Fire and subsequent monsoon floods, with this year's catch being reduced 99% compared to 2020 and the notable absence of Spikedace and Loach Minnow. The 2020 Bighorn fire in the Catalina Mountain Range combined with an above average monsoon season this year impacted Gila Chub in Romero Canyon, and to a lesser extent, in Sabino and Bear canyons as well. Gila Chub and other common species in Turkey Creek, NM were far less abundant this year compared to 2019 due to impacts from the Johnson Fire. Prior to the monsoon season, severe drought led to low water availability and poor habitat conditions at several spring fed Gila Topminnow sites, such as Fresno Canyon, Coal Mine Canyon, and Tule Creek.

Table 2. Summary of fish species captured by stream. Focal species for each stream are highlighted in yellow. Streams listed in alphabetic order; species codes are in Table 1.

Stream	SATR*	AGCH	GIIN	GIRO	PIPR*	RHOS	TICO	CAIN	PACL	AMNA*	GAAF*	POOC	LECY*
AD Wash	-	-	-	-	-	-	-	-	-	-	-	670	-
Bass Canyon	-	1	305	-	-	143	-	33	21	-	-	17	-
Bear Canyon	-	-	42	-	-	-	-	-	-	-	-	-	-
Bear Creek, NM	-	1481	-	-	-	-	203	145	779	-	-	-	-
Boneyard Creek	37	-	-	-	1	87	-	1	1	-	-	-	-
Buckhorn Spring	-	-	-	-	-	-	-	-	-	-	-	99	-
Cienega Creek	-	103	-	-	-	-	-	-	-	-	-	26	-
Coal Mine Canyon	-	-	-	-	-	-	-	-	-	-	-	452	-
Cottonwood Spring	-	-	-	-	-	-	-	-	-	-	-	155	-
Coyote Creek	1	-	-	-	5	19	-	-	3	-	-	-	-
Dix Creek	-	95	83	-	-	168	-	15	34	-	-	-	-
East Fork Black River	38	-	-	-	-	188	-	-	24	-	-	-	-
Fresno Canyon	-	308	-	-	-	-	-	-	-	-	-	24	-
Hot Springs Canyon	-	335	160	-	-	406	17	13	126	-	-	-	-
Lower Blue River	-	6	-	2	-	5	-	1	19	-	-	-	-
Lower Turkey Creek, NM	-	-	17	-	-	-	-	9	41	1	2	-	-
Monkey Spring	-	-	-	-	-	-	-	-	-	-	-	284	-
Morgan City Wash	-	1192	-	-	-	-	-	-	-	-	24	1898	14
North Fork East Fork Black River	19	-	-	-	-	418	-	3	101	-	-	-	-
Romero Canyon	-	-	41	-	-	-	-	-	-	-	-	-	-
Sabino Canyon	-	-	143	-	-	-	-	-	-	-	-	217	-
Sheehy Spring	-	-	43	-	-	-	-	-	-	-	1	-	-
Tule Creek	-	-	-	-	-	-	-	-	-	-	-	1213	-

*Non-native species

Trip Summaries

Agua Fria River Basin

Morgan City Wash May 11, 2021

Station		Lower Boundary	Upper Boundary
MW01	12S NAD83	381098E, 3745372N	381065E, 3745451N
MW08 (Fixed)		381541E, 3744965N	381485E, 3745002N
MW12		381772E, 3744681N	381694E, 3744744N

Morgan City Wash (Maricopa County, AZ) is a tributary to Agua Fria River located just SW of Lake Pleasant. Perennial water exists for 1.5 km in the lower portion of the wash. Gila Topminnow was the focal species for this survey. Gila Topminnow (Sharp Spring lineage) were stocked into Morgan City Wash in 2009 and 2010 and have persisted there ever since (Gray 2018). Desert Pupfish *Cyprinodon macularius* also were stocked but did not successfully establish (Pearson et al. 2013). Morgan City Wash was last surveyed for GRBMP in 2020, resulting in the capture of 37 Gila Topminnow (Shollenberger et al. 2021).

M&A and Reclamation personnel completed sampling of Morgan City Wash on May 11, 2021. All stations were accessed by hiking from Old Lake Pleasant Road. One fixed and two random stations were surveyed (Figure 2). Ten minnow traps were set in each station. Across the three stations, totals of 1,898 Gila Topminnow, 1,192 Longfin Dace, 14 Green Sunfish, and 24 Western Mosquitofish were captured.

Random station MW12 was located 320-m downstream from the weir. Western Mosquitofish (n=24; 63.16%) and Green Sunfish (n=14; 36.84%) were captured at this station with an effort of 31.19 trap hours. In the fixed station, MW08, Gila Topminnow (n=51; 7.82%), Longfin Dace (n=591; 90.64%), and Lowland Leopard Frog *Lithobates yavapaiensis* tadpoles (n=10; 1.53%) were captured. Total effort was 31.47 trap hours. The final random station, MW01, was located near the upper extent of perennial water. Gila Topminnow (n=1,847; 69.67%), Longfin Dace (n=601; 22.67%), and Lowland Leopard Frog tadpoles (n=203; 7.66%) were captured. Total effort was 31.19 trap hours. Combined catch and effort totals for the three stations are summarized in Table 3.

The primary mesohabitat in stations MW01 and MW08 was shallow pool with depths between 40 centimeters (cm) and 69 cm. Station MW12 was predominated by narrow runs. Stream discharge was measured at the downstream boundary of MW08 and calculated to be 0.02 m^3/s. Water temperature, dissolved oxygen, pH, and conductivity were recorded at 23.3 °C, 11.9 mg/L, 8.05, and 1,085 µS, respectively. Photographs of upper and lower extents of the fixed station are provided below (Figures 3-6).

Gila Topminnow catch was higher than last year's survey when 37 Gila Topminnow were captured and the highest it has been since the 2010 stocking. It appears that Gila Topminnow have rebounded from the large flood that affected this drainage in autumn 2019. Also, for the second year in a row, no non-natives were detected upstream of the weir. However, the weir itself is still in need of repair and currently would not restrict upstream movement of non-natives during periods of higher flow. Any movement of Green

Sunfish and Mosquitofish further upstream would certainly jeopardize the Gila Topminnow population in Morgan City Wash.

Table 3. Summary of catch in Morgan City Wash at one fixed and two random stations by minnow trap, surveyed on May 11, 2021. Total effort was 99.87 net hours.

Station	Statistic	POOC (<20)	POOC (≥20)	AGCH	LECY	GAAF	RAYA	Total
MW01 (37.21 hrs)	Count	92	1755	601	0	0	203	2651
	% total catch	3.47%	66.20%	22.67%	0.00%	0.00%	7.66%	100.00%
	CPUE (ind/net hr)	2.47	47.16	16.15	0.00	0.00	5.46	71.24
MW08* (31.47 hrs)	Count	0	51	591	0	0	10	652
	% total catch	0.00%	7.82%	90.64%	0.00%	0.00%	1.53%	100.00%
	CPUE (ind/net hr)	0.00	1.62	18.78	0.00	0.00	0.32	20.72
MW12 (31.19 hrs)	Count	0	0	0	14	24	0	38
	% total catch	0.00%	0.00%	0.00%	36.84%	63.16%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	0.00	0.00	0.45	0.77	0.00	1.22
Total	Count	92	1806	1192	14	24	213	3341
	% total catch	2.75%	54.06%	35.68%	0.42%	0.72%	6.38%	100.00%
	CPUE (ind/net hr)	0.92	18.08	11.94	0.14	0.24	2.13	33.45

*Denotes fixed station

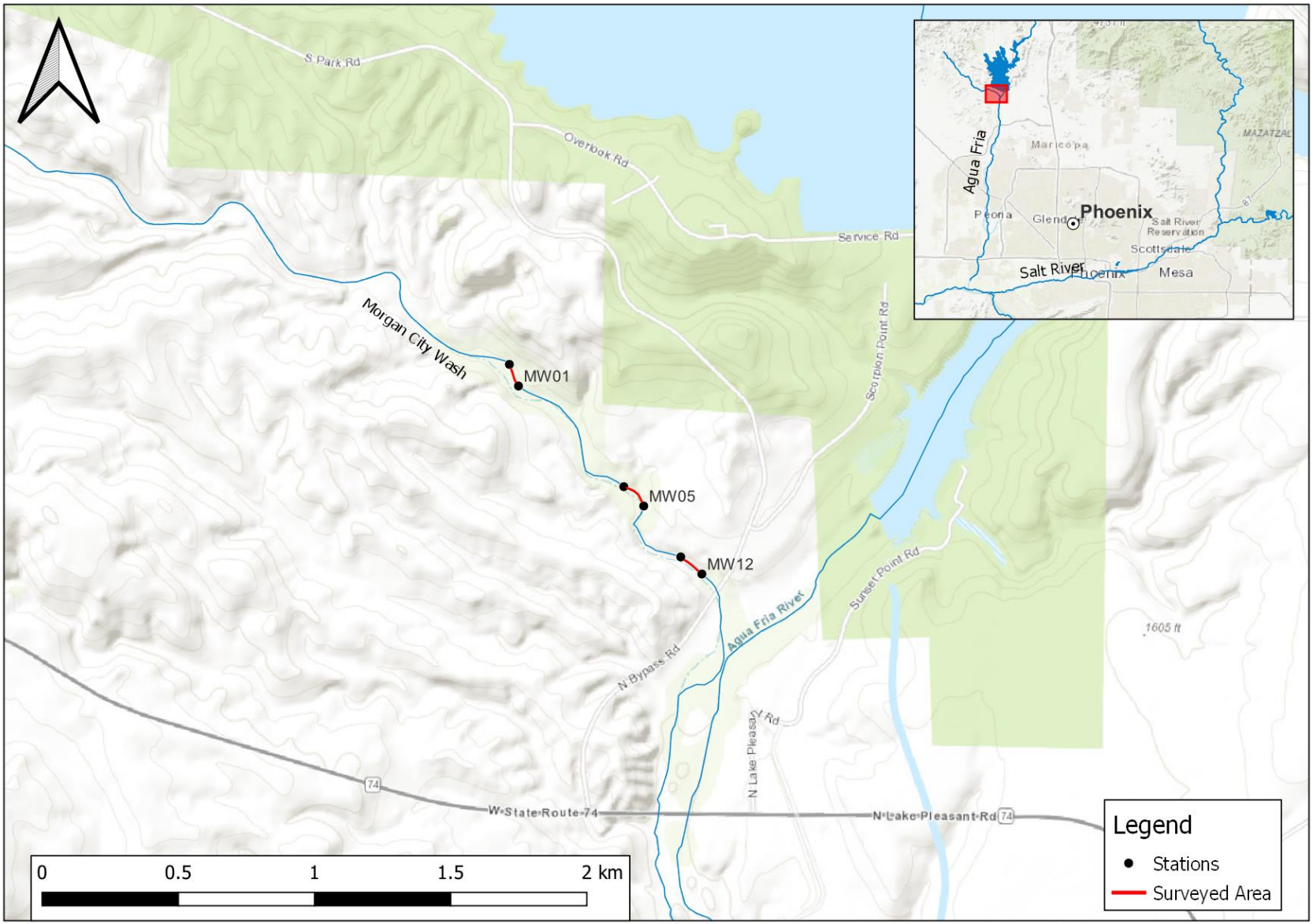

Figure 2. Location of sampling stations in Morgan City Wash, sampled May 11, 2021.

Figure 3. Downstream to downstream view of fixed station MW08 in Morgan City Wash.

Figure 4. Downstream to upstream view of fixed station MW08 in Morgan City Wash.

Figure 5. Upstream to upstream view of fixed station MW08 in Morgan City Wash.

Figure 6. Upstream to downstream view of fixed station MW08 in Morgan City Wash.

AD Wash May 12, 2021

Station		Lower Boundary	Upper Boundary
AD01 (Fixed)	12S NAD83	368318E, 3761547N	368312E, 3761533N
AD02 (Fixed)		368410E, 3761595N	368318E, 3761548N
AD03 (Fixed)		368442E, 3761676N	368418E, 3761589N

AD Wash (Maricopa County, AZ) is located approximately 18 km northwest of Lake Pleasant. A 500-m perennial section is located 6 km upstream of its confluence with Castle Creek. This section is within a stretch of steep canyon containing bedrock pools that typically are connected by shallow riffles. Gila Topminnow was the focal species for this survey. Sharp Spring lineage Gila Topminnow were stocked into AD Wash in 1993 and a population has been established ever since (Gray 2018). AD wash was last surveyed for GRBMP in 2018, resulting in capture of 212 Gila Topminnow (Burgad et al. 2019).

M&A personnel surveyed AD Wash on May 12, 2021. This site was accessed by hiking up drainage from Castle Hot Springs Road. Three, consecutive 100-m fixed stations were surveyed (Figure 7). A total of 670 Gila Topminnow were captured across all stations.

The entirety of station AD01 was unable to be sampled due to an impassable waterfall. The pool at the bottom of the waterfall was greater than 3m deep. Seven traps were set within the first 34-m of this station, which resulted in capture of 28 Gila Topminnow (100%). The middle station, AD02, was mostly dry and three traps were set across two small pools. These traps also were left for two hours and captured 42 Gila Topminnow (100%). The most downstream station, AD03, contained most of the available habitat present throughout the perennial extent. AD03 contained three large pools varying from 1.1 – 1.6 m in depth. Ten traps were set in this station for approximately two hours and captured 600 Gila Topminnow (100%). Catch and effort totals for all stations are summarized in Table 4. Numerous Gila Topminnow also were observed in an isolated pool 580-m downstream of our monitoring extent, however this pool will did not appear large enough to support perennial habitat.

At the time of survey, there was little surface connection between pools. Nearly 75% of the extent that was surveyed was dry. Average water temperature, dissolved oxygen, pH, and conductivity across the three fixed stations were 19.9 °C, 7.6 mg/L, 7.70, and 713 µS, respectively. Photographs of upper and lower extents of each fixed station are provided below (Figures 8-19).

Previous GRBMP surveys in 2018 and 2015 captured 212 and 1,716 Gila Topminnow respectively in a single 100-m station. This population has shown high variability from year to year but appeared resilient to drought conditions this year.

Table 4. Summary of catch at three fixed stations within AD Wash by minnow trap, surveyed on May 12, 2021. Total effort was 36.76 hours.

Station	Statistic	POOC (<20)	POOC (≥20)	Total
AD01* (11.8 hrs)	Count	0	28	28
	% total catch	0.00%	100.00%	100.00%
	CPUE (ind/net hr)	0.00	2.37	2.37
AD02* (5.73 hrs)	Count	1	41	42
	% total catch	2.38%	97.62%	100.00%
	CPUE (ind/net hr)	0.17	7.16	7.33
AD03* (19.23 hrs)	Count	2	598	600
	% total catch	0.33%	99.67%	100.00%
	CPUE (ind/net hr)	0.10	31.10	31.20
Total	Count	3	667	670
	% total catch	0.45%	99.55%	100.00%
	CPUE (ind/net hr)	0.08	18.14	18.23

*Denotes fixed station

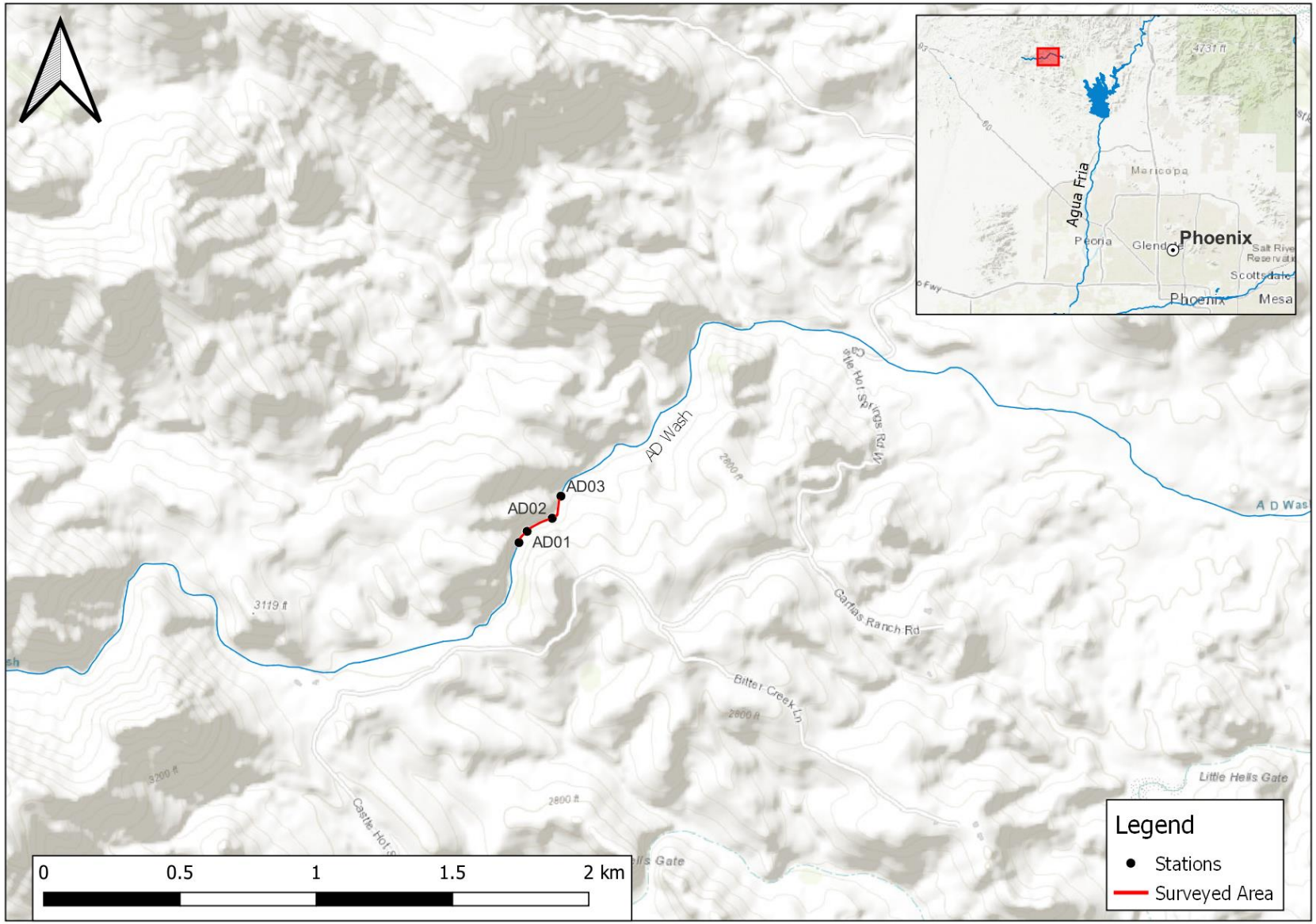

Figure 7. Location of sampling stations in AD Wash, sampled May 12, 2021.

Figure 8. Downstream to downstream view of fixed station AD01 in AD Wash.

Figure 9. Downstream to upstream view of fixed station AD01 in AD Wash.

Figure 10. Upstream to downstream view of fixed station AD01 in AD Wash.

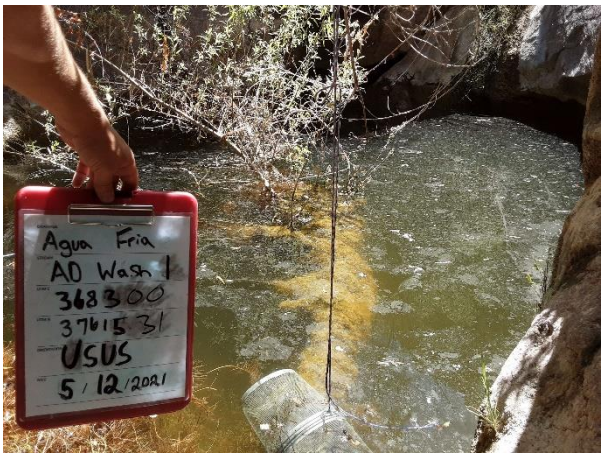

Figure 11. Upstream to upstream view of fixed station AD01 in AD Wash.

Figure 12. Downstream to upstream view of fixed station AD02 in AD Wash.

Figure 13. Downstream to downstream view of fixed station AD02 in AD Wash.

Figure 14. Upstream to downstream view of fixed station AD02 in AD Wash.

Figure 15. Upstream to upstream view of fixed station AD02 in AD Wash.

Figure 16. Downstream to downstream view of fixed station AD03 in AD Wash.

Figure 17. Downstream to upstream view of fixed station AD03 in AD Wash.

Figure 18. Upstream to downstream view of fixed station AD03 in AD Wash.

Figure 19. Upstream to upstream view of fixed station AD03 in AD Wash.

Buckhorn Spring May 12, 2021

Station		Lower Boundary	Upper Boundary
BH01 (Fixed)	12S NAD83	364312E, 3763821N	364324E, 3763741N
BH02 (Fixed)		364320E, 3763917N	364307E, 3763822N

Buckhorn Spring (Maricopa County, AZ) is located 21 km northwest of Lake Pleasant and is a tributary to Buckhorn Creek in the Castle Creek drainage. Perennial water at this site is located within a 40-acre livestock exclosure. The focal species at Buckhorn Spring was Gila Topminnow. This site was fishless prior to 2011, when Gila Topminnow first were stocked (Sharp Spring lineage). Supplemental stockings occurred in 2013 and 2014 (Gray 2018).

M&A personnel surveyed Buckhorn Spring on May 12, 2021. This site was accessed via a short hike from Buckhorn Road. Two continuous fixed 100-m stations were surveyed using minnow traps (Figure 20). This survey encompassed the entirety of available surface water. A total of 99 Gila Topminnow were captured across both stations.

The majority of station BH01 was dry, and water that was present was discolored and appeared unsuitable for fish. Seven traps were set throughout this station. No fish were observed or captured; however, 20 unidentified tadpoles were captured. Ten traps were set throughout station BH02. A total of 99 Gila Topminnow (64.29%) and 55 tadpoles (35.71%) were captured in this station. Much of this station was dry as well, and 90% of Gila Topminnow were detected in a 7.7-m (L) x 4.5-m (W) x 0.74-m (D) pool located immediately upstream of the fence. Catch and effort totals for both stations are summarized in Table 5.

The last GRBMP survey in 2019 detected 74 Gila Topminnow and noted a decrease in abundance compared to a previous survey in 2016 (Shollenberger et al. 2020). The Gila Topminnow population in Buckhorn Spring appears to be small, but stable and should persist as long as suitable habitat remains protected from cattle impacts. Average water temperature, dissolved oxygen, pH, and conductivity across the two fixed stations were 17.3 °C, 2.9 mg/L, 7.55, and 589 µS, respectively. Photographs of upper and lower extents of each fixed station are provided below (Figures 21-28).

Table 5. Summary of catch within two fixed stations at Buckhorn Spring by minnow trap, surveyed on May 12, 2021. Total effort was 32.96 net hours.

Station	Statistic	POOC (<20)	POOC (≥20)	Rana spp. (Tadpole)	Total
BH01* (13.48 hrs)	Count	0	0	20	20
	% total catch	0.00%	0.00%	100.00%	100.00%
	CPUE (ind/net hr)	0.00	0.00	1.48	1.48
BH02* (19.48 hrs)	Count	4	95	55	154
	% total catch	2.60%	61.69%	35.71%	100.00%
	CPUE (ind/net hr)	0.21	4.88	2.82	7.91
Total	Count	4	95	75	174
	% total catch	2.30%	54.60%	43.10%	100.00%
	CPUE (ind/net hr)	0.12	2.88	2.28	5.28

*Denotes fixed station

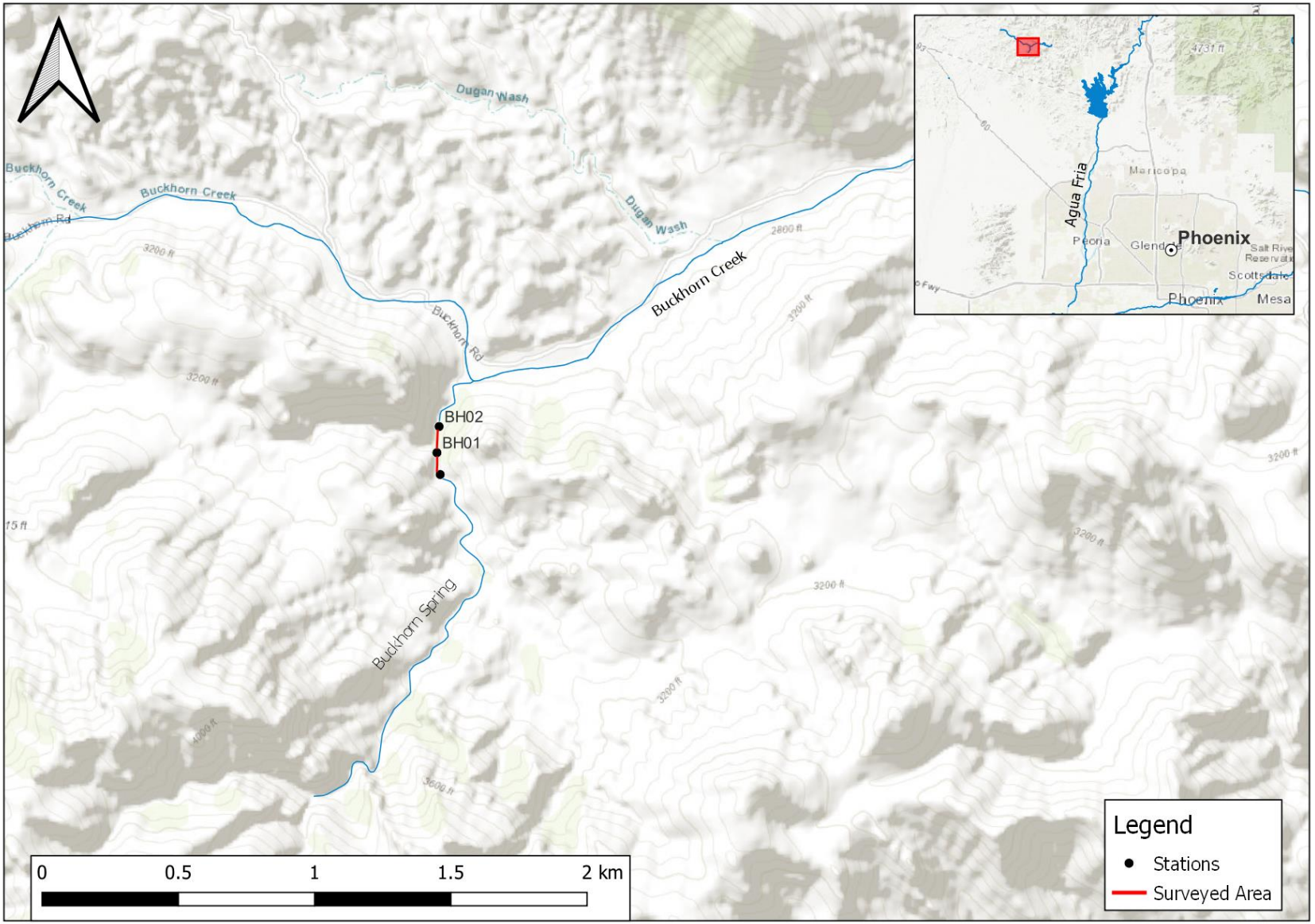

Figure 20. Location of sampling stations in Buckhorn Spring, sampled May 12, 2021.

Figure 21. Downstream to downstream view of fixed station BH02 in Buckhorn Wash.

Figure 22. Downstream to upstream view of fixed station BH02 in Buckhorn Wash.

Figure 23. Upstream to downstream view of fixed station BH02 in Buckhorn Wash.

Figure 24. Upstream to upstream view of fixed station BH02 in Buckhorn Wash.

Figure 25. Downstream to downstream view of fixed station BH01 in Buckhorn Wash.

Figure 26. Downstream to upstream view of fixed station BH01 in Buckhorn Wash.

Figure 27. Upstream to upstream view of fixed station BH01 in Buckhorn Wash.

Figure 28. Upstream to downstream view of fixed station BH01 in Buckhorn Wash.

Tule Creek May 18, 2021

Station		Lower Boundary	Upper Boundary
TU01	12S NAD83	382296E, 3764067N	382250E, 3764153N
TU03 (Fixed)		382312E, 3763886N	382326E, 3764000N
TU05		382469E, 3763749N	382379E, 3763813N

Tule Creek (Maricopa County, AZ) is a tributary to Agua Fria River north of Lake Pleasant in the Bradshaw Mountains foothills. An 800-m stretch of perennial water exists 8.8 km upstream from the confluence. This section is protected by a 70-acre livestock exclosure. A fish barrier is present just upstream of the Lake Pleasant high-water mark to prevent movement of non-native fishes during periods of connectivity. The focal species for this survey was Gila Topminnow. Gila Topminnow (Monkey Spring lineage) were stocked into Tule Creek in 1981 and have persisted since. Tule Creek was last surveyed for GRBMP in 2019, resulting in capture of 109 Gila Topminnow (Shollenberger et al. 2020).

M&A personnel surveyed Tule Creek on May 18, 2021. This site was accessed by parking near Old China Dam (12S 380292/ 3759906) and hiking approximately 6.5 km to Fort Tule Homestead Riparian Area. It is recommended that an offroad vehicle, such as a UTV, be acquired to help access this site in the future. One fixed and two random stations were surveyed at Tule Creek (Figure 29). Available water throughout random station TU05 was discolored and appeared unsuitable for fish. Seven seine hauls were conducted where possible and resulted in zero fish captured. Random station TU01 did not contain any sampleable habitat, so no effort was undertaken. Ten traps were set throughout fixed station TU03 for approximately two hours. A total of 1,213 Gila Topminnow (100%) were captured. This station encompassed the entirety of suitable habitat present for Gila Topminnow throughout the perennial extent. Catch and effort totals are summarized in Table 6. This It has been noted in past GRBMP surveys that available habitat has been declining due to cattail and sedge growth (Timmons and Paulus 2016). This trend is continuing, as pools had little open water and were choked with cattails. Gila Topminnow were concentrated where they were found, which may explain the higher catch this year.

While catch totals this year were the highest they have been since 2012, the outlook at this site appears poor unless corrective action is taken. Suitable habitat is dwindling due to encroachment of emergent aquatic vegetation. This is leading to a decrease in open water habitat and water quality. In addition, cattle were observed within the exclosure indicating that the fence may need repair. Water temperature, dissolved oxygen, pH, and conductivity at the fixed station were recorded at 23 °C, 5.5 mg/L, 7.84, and 1,753 µS, respectively. Photographs of upper and lower extents of the fixed station are provided below (Figures 30-33).

Table 6. Summary of catch across three stations at Tule Creek by minnow trap and seine, surveyed on May 18, 2021. Total effort was 20.02 net hours and seven, 1-m seine hauls.

Gear	Station	Statistic	POOC (<20)	POOC (≥20)	Total
Minnow Trap	TU03* (20.02 hrs)	Count	63	1150	1213
		% total catch	5.19%	94.81%	100.00%
		CPUE (ind/net hr)	3.15	57.44	60.59
Seine	TU05 (25.6 m^2)	Count	0	0	0
		% total catch	0.00%	0.00%	0.00%
		CPUE (ind/m^2)	0.00	0.00	0.00
Not Surveyed (Dry)	TU01	Count	-	-	-
		% total catch	-	-	-
		CPUE	-	-	-

*Denotes fixed station

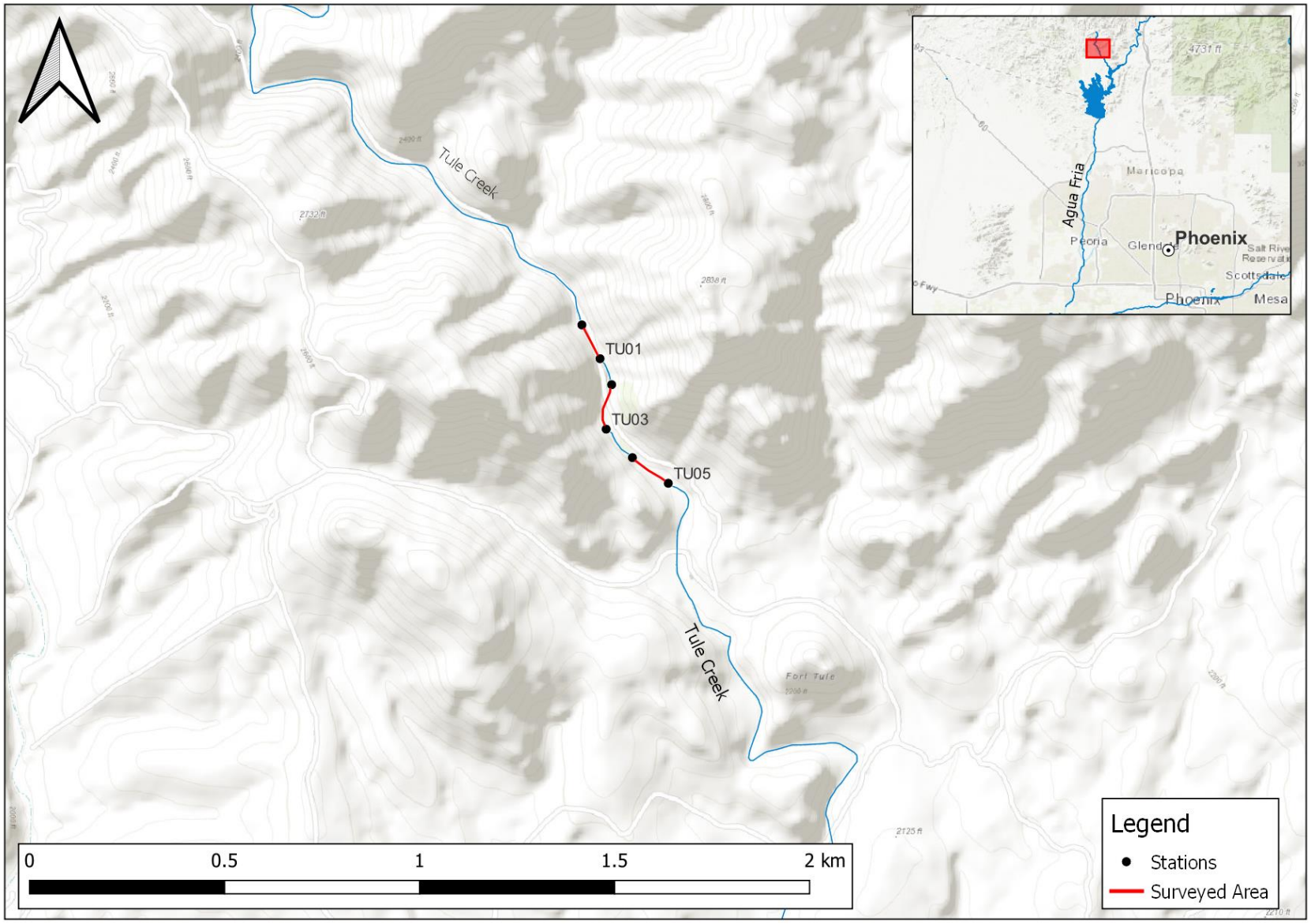

Figure 29. Location of sampling stations in Tule Creek, sampled May 18, 2021.

Figure 30. Downstream to downstream view of fixed station TU03 in Tule Creek.

Figure 31. Downstream to upstream view of fixed station TU03 in Tule Creek.

Figure 32. Upstream to downstream view of fixed station TU03 in Tule Creek.

Figure 33. Upstream to upstream view of fixed station TU03 in Tule Creek.

Salt River Basin

East Fork Black River Drainage (Three Forks) August 2-6, 2021

Stream	Station		Lower Boundary	Upper Boundary
EF Black River	EF07	12S NAD83	656037E, 3746710N	656091E, 3746792N
EF Black River	EF13 (Fixed)		656387E, 3746984N	656317E, 3746920N
EF Black River	EF19		656706E, 3746574N	656655E, 3746660N
EF Black River	EF25		656420E, 3746113N	656403E, 3746214N
EF Black River	EF36		656166E, 3745291N	656191E, 3745369N
NFEF Black River	NFEF12		653886E, 3750762N	653989E, 3750752N
NFEF Black River	NFEF21		653494E, 3750005N	653569E, 3750075N
NFEF Black River	NFEF26		653582E, 3749602N	653517E, 3749680N
NFEF Black River	NFEF30		653871E, 3749330N	653787E, 3749393N
NFEF Black River	NFEF40		654615E, 3748906N	654530E, 3748872N
NFEF Black River	NFEF66 (Fixed)		655900E, 3747342N	655866E, 3747433N
Boneyard Creek	BY13		656595E, 3748023N	656678E, 3748009N
Boneyard Creek	BY19		656260E, 3747650N	656257E, 3747750N
Boneyard Creek	BY21 (Fixed)		656103E, 3747556N	656184E, 3747610N
Coyote Creek	CY02		656977E, 3746544N	657076E, 3746559N

The “Three Forks” area in the East Fork Black River drainage (Apache County, AZ) is located south of Springerville-Eager, AZ in the Salt River sub-basin. It is the location of the confluence of Boneyard Creek and North Fork East Fork Black River, which form East Fork Black River. Coyote Creek is tributary to East Fork Black River and located 2 km downstream. Loach Minnow was the focal species for these four streams. Loach Minnow were last detected in this area in 2005 (Robinson 2016). The Three Forks area was last surveyed for GRBMP in 2015, however that survey did not include Coyote or Boneyard creeks (Timmons and Paulus 2016).

M&A personnel completed sampling of the East Fork Black River drainage on August 2-6, 2021. Sampling was completed via BPEF at 15, 100-m stations (Figure 34). All stations were accessed by hiking from the parking area near the Three Forks Road bridge. Visibility was poor due to turbidity associated with heavy rains on 8/2, however conditions improved as the week went on. Across all stations, totals of 712 Speckled Dace, 129 Desert Sucker, 95 Brown Trout, 6 Fathead Minnow, and 4 Sonora Sucker were captured. Loach Minnow were not detected.

One fixed and four random stations were sampled within East Fork Black River. Two stations were located downstream of the Coyote Creek confluence. Three stations were located between Coyote Creek and Three Forks Road bridge. Electrofishing effort totaled 3,672 seconds across the five stations. Species captured were Speckled Dace (n=188; 75.20%), Desert Sucker (n=24; 9.60%), and Brown Trout (n=38; 15.20%). Stream discharge was measured near the upstream boundary of EF13 and calculated to be 0.36 m^3/s. Water temperature, dissolved oxygen, pH, and conductivity measured at BY21 were 19.7 °C, 10.3 mg/L, 8.33, and 135 µS, respectively.

One fixed and five random stations were sampled within North Fork East Fork Black River. Stations were located throughout 6.5 km of stream beginning immediately upstream of the Three Forks Road bridge. Electrofishing effort totaled 3,745 seconds across all six stations. Species captured were Speckled Dace (n=418; 77.26%), Desert Sucker (n=101; 18.67%), Sonora Sucker (n=3; 0.55%) and Brown Trout (n=19; 3.51%). Stream discharge was measured near the upstream boundary of NFEF66 and was calculated to be 0.1 m^3/s. Water temperature, dissolved oxygen, pH, and conductivity measured at NFEF66 were 14.5 °C, 11.4 mg/L, 8.11, and 155 µS, respectively.

One fixed and two random stations were surveyed within Boneyard Creek. Electrofishing effort totaled 1,582 seconds across the three stations. Species captured were Speckled Dace (n=87; 68.51%), Desert Sucker (n=1; 0.79%), Sonora Sucker (n=1; 0.79%), Brown Trout (n=37; 29.13%), and Fathead Minnow (n=1; 0.79%). Stream discharge was measured near the upstream boundary of BY21 and calculated to be 0.06 m^3/s. Water temperature, dissolved oxygen, pH, and conductivity measured at BY21 were 16.0 °C, 12.3 mg/L, 8.31, and 154 µS, respectively.

A single random station, CY02, was surveyed at Coyote Creek. This station was located 400-m upstream of the confluence with East Fork Black River. Electrofishing effort totaled 564 seconds. Species captured were Speckled Dace (n=19; 67.85%), Desert Sucker (n=3; 10.71%), Fathead Minnow (n=5; 17.86%), and Brown Trout (n=1; 3.57%).

Combined catch and effort totals for all stations across the four streams are summarized in Table 7. While not a focal species, Roundtail Chub have been captured in low numbers during previous surveys but were not detected this year. Invasive Northern Crayfish *Orconectes virilis* were abundant throughout all surveyed stations. Going forward, the protocol at this stream will include eDNA sampling to further verify the presence/absence of Loach Minnow. During this survey, Reclamation staff collected eDNA samples at roughly 1 km intervals throughout the sampled reaches: six samples in NFEF Black River (plus two samples outside the sampling reach near FR-285), four in EF Black River, five in Boneyard Creek, and two in Coyote Creek. Three samples were also taken near the spring-fed pond at Three Forks. No Loach Minnow DNA was detected at any of the locations sampled. Photographs of upper and lower extents of each fixed station are provided below (Figures 35-46).

Table 7. Summary of catch across 15 stations near the "Three Forks" region of the East Fork Black River by BPEF, surveyed on August 2-6, 2021. Catch and effort totals are grouped by stream.

Stream	Station(s)	Statistic	RHOS	CAIN	PACL	SATR	PIPR	Totals
EF Black River (3,672 sec)	EF07 EF13* EF19 EF25 EF36	Count	188	0	24	38	0	250
		% total catch	75.20%	0.00%	9.60%	15.20%	0.00%	100.00%
		CPUE (ind/min)	3.07	0.00	0.39	0.62	0.00	4.08
NFEF Black River (3,745 sec)	NFEF12 NFEF21 NFEF26 NFEF30 NFEF40 NFEF66*	Count	418	3	101	19	0	541
		% total catch	77.26%	0.55%	18.67%	3.51%	0.00%	100.00%
		CPUE (ind/min)	6.70	0.05	1.62	0.30	0.00	8.67
Boneyard Creek (1,582 sec)	BY13 BY19 BY21*	Count	87	1	1	37	1	127
		% total catch	68.50%	0.79%	0.79%	29.13%	0.79%	100.00%
		CPUE (ind/min)	3.30	0.04	0.04	1.40	0.04	4.82
Coyote Creek (564 sec)	CY02	Count	19	0	3	1	5	28
		% total catch	67.86%	0.00%	10.71%	3.57%	17.86%	100.00%
		CPUE (ind/min)	2.02	0.00	0.32	0.11	0.53	2.98
Total		Count	712	4	129	95	6	946
		% total catch	75.26%	0.42%	13.64%	10.04%	0.63%	100.00%
		CPUE (ind/min)	4.47	0.03	0.81	0.60	0.04	5.94

*Denotes fixed station

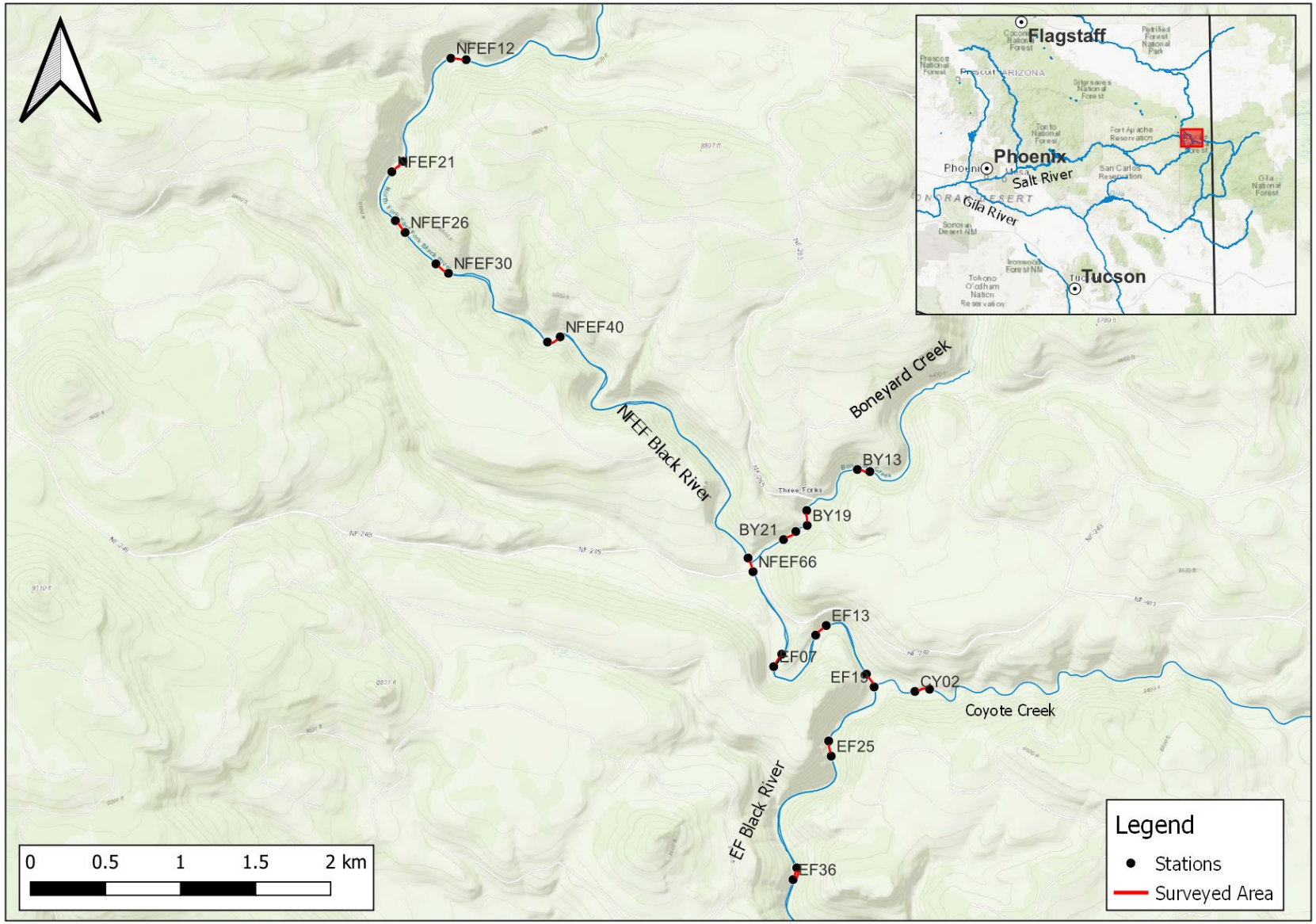

Figure 34. Location of sampling stations throughout the Three Forks area of the East Fork Black River drainage, sampled August 2-6, 2021.

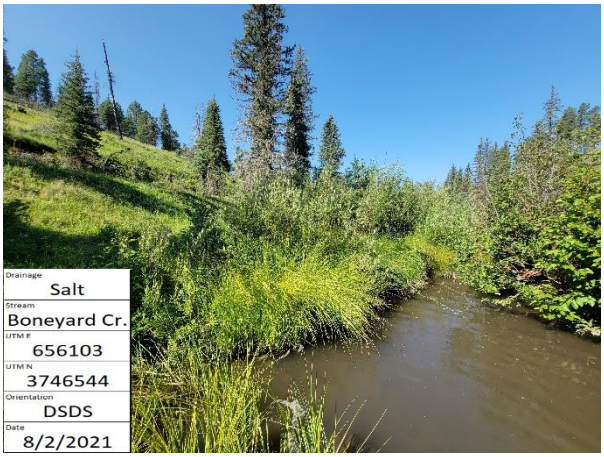

Figure 35. Downstream to downstream view of fixed station BY21 in Boneyard Creek.

Figure 36. Downstream to upstream view of fixed station BY21 in Boneyard Creek.

Figure 37. Upstream to downstream view of fixed station BY21 in Boneyard Creek.

Figure 38. Upstream to upstream view of fixed station BY21 in Boneyard Creek.

Figure 39. Downstream to downstream view of fixed station EF13 in East Fork Black River.

Figure 40. Downstream to upstream view of fixed station EF13 in East Fork Black River.

Figure 41. Upstream to upstream view of fixed station EF13 in East Fork Black River.

Figure 42. Upstream to downstream view of fixed station EF13 in East Fork Black River.

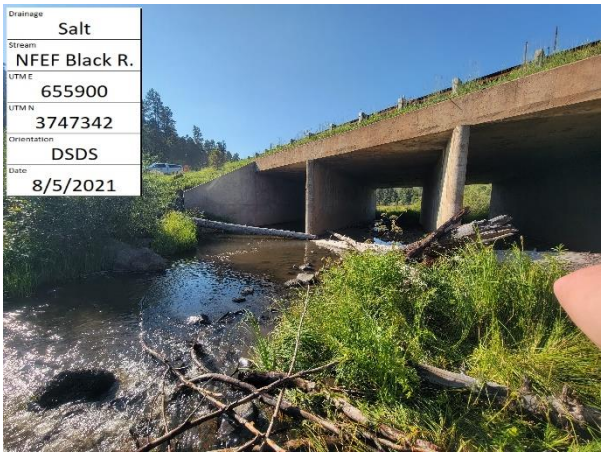

Figure 45. Downstream to downstream view of fixed station NFEF66 in North Fork East Fork Black River.

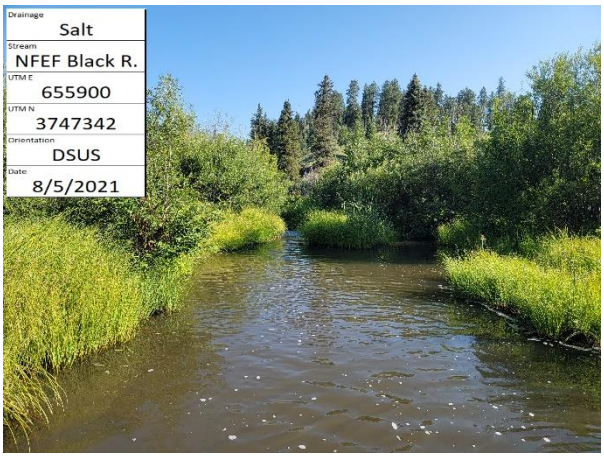

Figure 44. Downstream to upstream view of fixed station NFEF66 in North Fork East Fork Black River.

Figure 43. Upstream to downstream view of fixed station NFEF66 in North Fork East Fork Black River.

Figure 46. Upstream to upstream view of fixed station NFEF66 in North Fork East Fork Black River.

San Pedro River Basin

Bass Canyon September 20 & 22, 2021

Station		Lower Boundary	Upper Boundary
BS15	12S NAD83	572390E, 3580156N	572352E, 3580231N
BS19		572305E, 3579970N	572395E, 3579983N
BS24 (Fixed)		571943E, 3579651N	572023E, 3579687N
BS27		571025E, 3579795N	571081E, 3579732N
BS29		570855E, 3579788N	570936E, 3579810N

Bass Canyon (Cochise County, AZ) is a tributary to Hot Springs Canyon within the Muleshoe Ranch Cooperative Management Area (CMA) in the San Pedro sub-basin. There is 1.6 km of perennial water upstream of the FR-691 road crossing and a separate 300-m section downstream of the road. Gila Topminnow (Bylas Spring lineage) were stocked into Bass Canyon in 2014, with supplemental stockings in 2015 and 2016 (Gray 2018). The Gila Topminnow population in Bass Canyon now is considered established (B. Hickerson, personal communication, September 1, 2021). The focal species at Bass Canyon were Gila Chub and Gila Topminnow. Bass Canyon was last surveyed for Gila Chub as part of GRBMP in 2019, resulting in capture of 76 Gila Chub (Shollenberger et al. 2020). Bass Canyon has not been previously surveyed for Gila Topminnow as part of this contract.

M&A personnel completed sampling of Bass Canyon on September 20 & 22, 2021. Sampling at Bass Canyon was completed with a combination of minnow traps and BPEF. One fixed and four random stations were sampled in Bass Canyon (Figure 48). All stations were accessed by hiking up and downstream from FR-691. BPEF was conducted at all five stations to target Gila Chub. Electrofishing effectiveness was limited due to the depth of pools at the time of this survey. Minnow traps were set following completion of BPEF survey at stations BS24, BS27, and BS29 to target Gila Topminnow. Due to this approach, minnow trap catch totals are interpreted as a separate survey because double sampling could have occurred. Across all stations, totals of 149 Gila Chub, 107 Speckled Dace, 30 Sonora Sucker, 19 Desert Sucker, 4 hybrid suckers, and 1 Longfin Dace were captured via BPEF. Catch and effort totals for the five BPEF stations in Bass Canyon are summarized in Table 8. Totals of 156 Gila Chub, 17 Gila Topminnow, 36 Speckled Dace, and 1 Desert Sucker were captured via Minnow Trap. Catch and effort totals by minnow trap for three stations in Bass Canyon are summarized in Table 9.

Specifically, the BPEF survey at fixed station BS24 resulted in capture of 64 Gila Chub (62.13%), 31 Speckled Dace (30.09%), 4 Sonora Suckers (3.88%), 2 Desert Suckers (1.94%), and 2 hybrid suckers (1.94%). Electrofishing effort totaled 1,307 seconds. Ten minnow traps were then set throughout BS24 for approximately three hours. These traps resulted in capture of 139 Gila Chub (85.27%), 15 Gila Topminnow (9.2%), and 9 Speckled Dace (5.52%).

Stream discharge was measured at the upstream boundary of BS24 and calculated to be 0.03 m^3/s. Water temperature, dissolved oxygen, pH, and conductivity measured at the fixed station were 19.9 °C, 8.1 mg/L, 7.98, and 246 µS, respectively. A length-frequency histogram for all Gila Chub captured at Bass Canyon is included below (Figure 47). Photographs of upper and lower extents of the fixed station and an example of a presumed CAIN x PACL habitat are provided below (Figures 49-53).

Table 8. Summary of catch by BPEF at five stations at Bass Canyon, surveyed on September 20 & 22, 2021. Total effort was 4,199 seconds.

Station	Statistic	GIIN	AGCH	RHOS	CAIN	PACL	CAIN x PACL	Total
BS15 (635 sec)	Count	14	0	4	9	1	0	28
	% total catch	50.00%	0.00%	14.29%	32.14%	3.57%	0.00%	100.00%
	CPUE (ind/min)	1.32	0.00	0.38	0.85	0.09	0.00	2.65
BS19 (1,026 sec)	Count	43	0	5	13	0	1	62
	% total catch	69.35%	0.00%	8.06%	20.97%	0.00%	1.61%	100.00%
	CPUE (ind/min)	2.51	0.00	0.29	0.76	0.00	0.06	3.63
BS24* (1,307 sec)	Count	64	0	31	4	2	2	103
	% total catch	62.14%	0.00%	30.10%	3.88%	1.94%	1.94%	100.00%
	CPUE (ind/min)	2.94	0.00	1.42	0.18	0.09	0.09	4.73
BS27 (535 sec)	Count	10	1	39	1	5	1	57
	% total catch	17.54%	1.75%	68.42%	1.75%	8.77%	1.75%	100.00%
	CPUE (ind/min)	1.12	0.11	4.37	0.11	0.56	0.11	6.39
BS29 (696 sec)	Count	18	0	28	3	11	0	60
	% total catch	30.00%	0.00%	46.67%	5.00%	18.33%	0.00%	100.00%
	CPUE (ind/min)	1.55	0.00	2.41	0.26	0.95	0.00	5.17
Total	Count	149	1	107	30	19	4	310
	% total catch	48.06%	0.32%	34.52%	9.68%	6.13%	1.29%	100.00%
	CPUE (ind/min)	2.13	0.01	1.53	0.43	0.27	0.06	4.43

*Denotes fixed station

Table 9. Summary of catch by minnow trap at three stations at Bass Canyon, surveyed on September 20 & 22, 2021. Total effort was 66.9 hours.

Station	Statistic	POOC (<20)	POOC (≥20)	GIIN	RHOS	PACL	Total
BS24* (28.5 hrs)	Count	7	8	139	9	0	163
	% total catch	4.29%	4.91%	85.28%	5.52%	0.00%	100.00%
	CPUE (ind/net hr)	0.25	0.28	4.88	0.32	0.00	5.72
BS27 (18.17 hrs)	Count	0	2	4	9	0	15
	% total catch	0.00%	13.33%	26.67%	60.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	0.11	0.22	0.50	0.00	0.83
BS29 (20.23 hrs)	Count	0	0	13	18	1	32
	% total catch	0.00%	0.00%	40.63%	56.25%	3.13%	100.00%
	CPUE (ind/net hr)	0.00	0.00	0.64	0.89	0.05	1.58
Total	Count	7	10	156	36	1	210
	% total catch	3.33%	4.76%	74.29%	17.14%	0.48%	100.00%
	CPUE (ind/net hr)	0.10	0.15	2.33	0.54	0.01	3.14

*Denotes fixed station

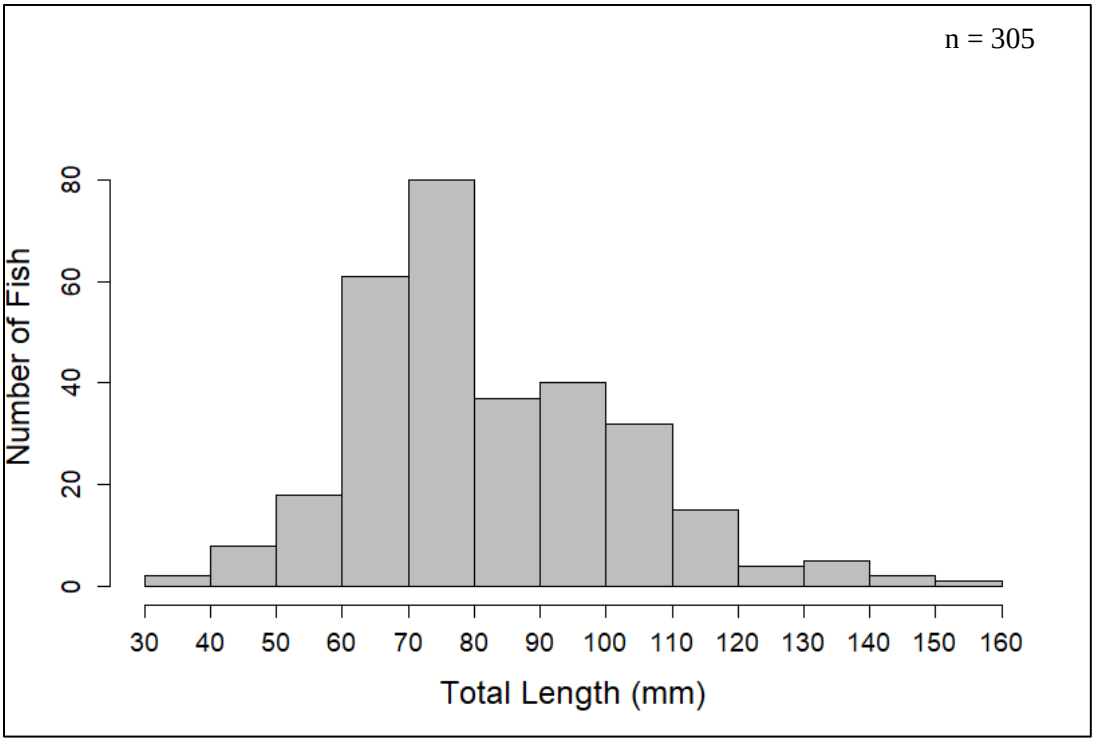

Figure 47. Length-frequency distribution for Gila Chub captured at Bass Canyon, sampled on September 20 & 22, 2021.

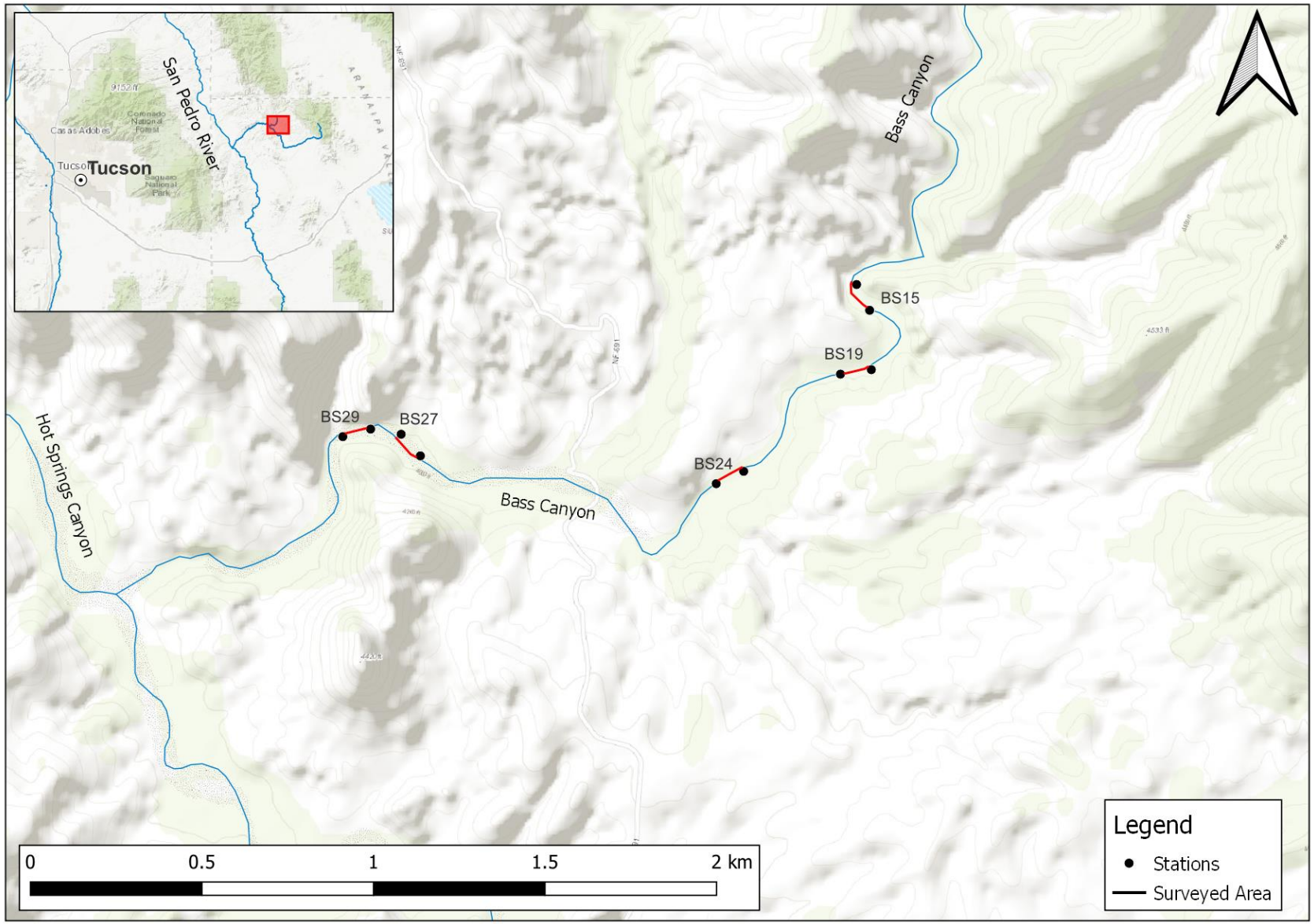

Figure 48. Location of sampling stations in Bass Canyon, sampled on September 20 and 22, 2021.

Figure 49. Downstream to downstream view of fixed station BS24 in Bass Canyon.

Figure 50. Downstream to upstream view of fixed station BS24 in Bass Canyon.

Figure 51. Upstream to downstream view of fixed station BS24 in Bass Canyon.

Figure 52. Upstream to upstream view of fixed station BS24 in Bass Canyon.

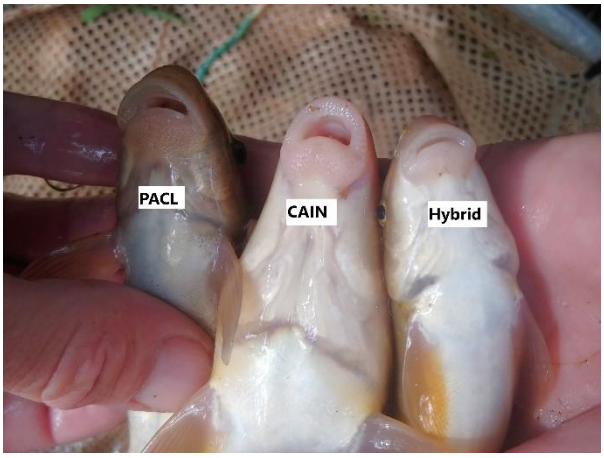

Figure 53. Example of hybrid suckers detected in Bass Canyon.

Hot Springs Canyon September 21-22, 2021

Reach	Station		Lower Boundary	Upper Boundary
1	HS02	12S NAD83	569625E, 3579848N	569713E, 3579827N
1	HS04		569518E, 3579993N	569583E, 3579924N
1	HS06 (Fixed)		569370E, 3579960N	569440E, 3579940N
2	HS18		568494E, 3580117N	568507E, 3580022N
2	HS20		568346E, 3580104N	568422E, 3580157N
2	HS25 (Fixed)		568053E, 3580022N	568114E, 3580083N
3	HS29		567941E, 3580089N	567959E, 3579995N
3	HS33 (Fixed)		567653E, 3580052N	567739E, 3580065N
3	HS34		567579E, 3580089N	567654E, 3580054N

Hot Springs Canyon (Cochise County, AZ) originates from western slopes of the Winchester Mountains and is a tributary to the San Pedro River. A 3.4 km section of perennial stream is located within the Muleshoe Ranch CMA. Hot Springs Canyon is protected from the invasion of non-native species by a fish barrier located 9 km upstream from the San Pedro confluence. Loach Minnow and Spikedace were stocked into Hot Springs Canyon every year from 2007-2011. Loach Minnow are considered established in Hot Springs Canyon as evidence of recruitment has been found every year since the last stocking. It is unclear if Spikedace have established as annual monitoring efforts have noted a steady decrease in numbers since 2012 and recruitment has not been detected every year. These populations were augmented with 300 Loach Minnow and 333 Spikedace in May 2020 near the confluence with Wildcat Canyon (Hickerson et al. 2021). Loach Minnow, Spikedace, and Gila Chub were the target species for Hot Springs Canyon. Hot Spring Canyon monitoring efforts have been conducted annually since 2011.

M&A and The Nature Conservancy personnel completed the sampling of Hot Springs Canyon on September 21 and 22, 2021. Sampling was completed by BPEF. Nine, 100-m stations were sampled throughout reaches 1-3 in Hot Springs Canyon (Figure 56). One fixed and two randomly selected stations were sampled in each reach. Stations were accessed by hiking downstream from Muleshoe Ranch Headquarters.

Totals of 17 Loach Minnow, 160 Gila Chub, 406 Speckled Dace, 335 Longfin Dace, 126 Desert Sucker, and 13 Sonora Sucker were captured across all nine stations. Catch and effort totals are summarized by reach below (Table 10). No non-native species were captured or observed. Loach Minnow were detected at four of nine stations. Gila Chub were detected throughout eight of nine stations and in greater numbers than last year when 59 individuals were captured (Shollenberger et al. 2021). Spikedace were not captured during annual monitoring for the second year in a row. Spikedace were last detected in 2019 when two individuals were captured (Hickerson et al. 2020). Loach Minnow catch was lower than last year, likely due to recent flood events. Multiple size-classes of Loach Minnow were observed indicating recruitment is still occurring. A length-frequency histogram for all Gila Chub and Loach Minnow captured at Hot Springs Canyon is included below (Figures 54-55).

Flows appeared higher than last year and there was more run and pool habitat available, which likely contributed to higher Gila Chub and sucker catch. Average stream discharge across three fixed stations was calculated to be 0.05 m^3/s. Average water temperature, dissolved oxygen, pH, and conductivity

across three fixed stations were 21.7 °C, 6.6 mg/L, 8.44, and 526 µS, respectively. Photographs of upper and lower extents of each fixed station are provided below (Figures 57-68).

Table 10. Summary of catch all stations at Hot Springs Canyon by BPEF. Total effort was 4,374 seconds.

Reach	Stations	Statistic	AGCH	CAIN	GIIN	PACL	TICO	RHOS	Total
1 (1,132 sec)	HS02 HS04 HS06*	Count	89	3	77	48	6	151	374
		% total catch	23.80%	0.80%	20.59%	12.83%	1.60%	40.37%	100.00%
		CPUE (ind/min)	4.72	0.16	4.08	2.54	0.32	8.00	19.82
2 (1,311 sec)	HS18 HS20 HS25*	Count	93	10	63	69	11	200	446
		% total catch	20.85%	2.24%	14.13%	15.47%	2.47%	44.84%	100.00%
		CPUE (ind/min)	4.26	0.46	2.88	3.16	0.50	9.15	20.41
3 (1,931 sec)	HS29 HS33* HS34	Count	153	0	20	9	0	55	237
		% total catch	64.56%	0.00%	8.44%	3.80%	0.00%	23.21%	100.00%
		CPUE (ind/min)	4.75	0.00	0.62	0.28	0.00	1.71	7.36
Total		Count	335	13	160	126	17	406	1057
		% total catch	31.69%	1.23%	15.14%	11.92%	1.61%	38.41%	100.00%
		CPUE (ind/min)	4.60	0.18	2.19	1.73	0.23	5.57	14.50

*Denotes fixed station

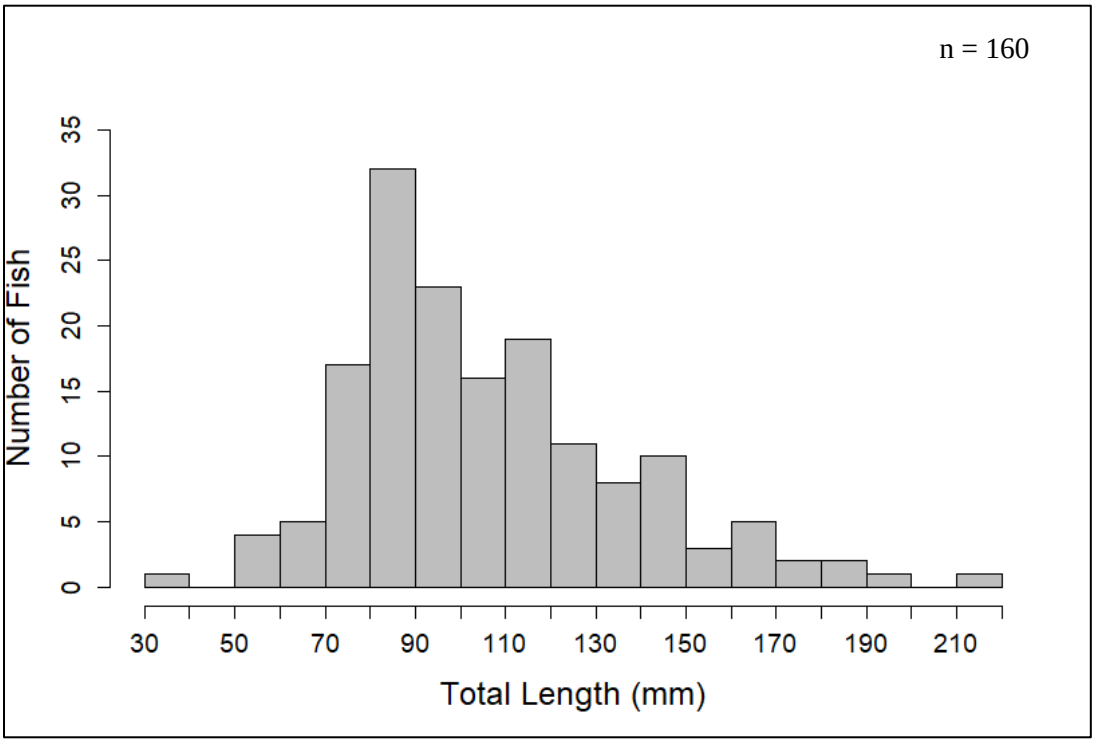

Figure 54. Length-frequency distribution for Gila Chub captured at Hot Springs Canyon, sampled on September 21-22, 2021.

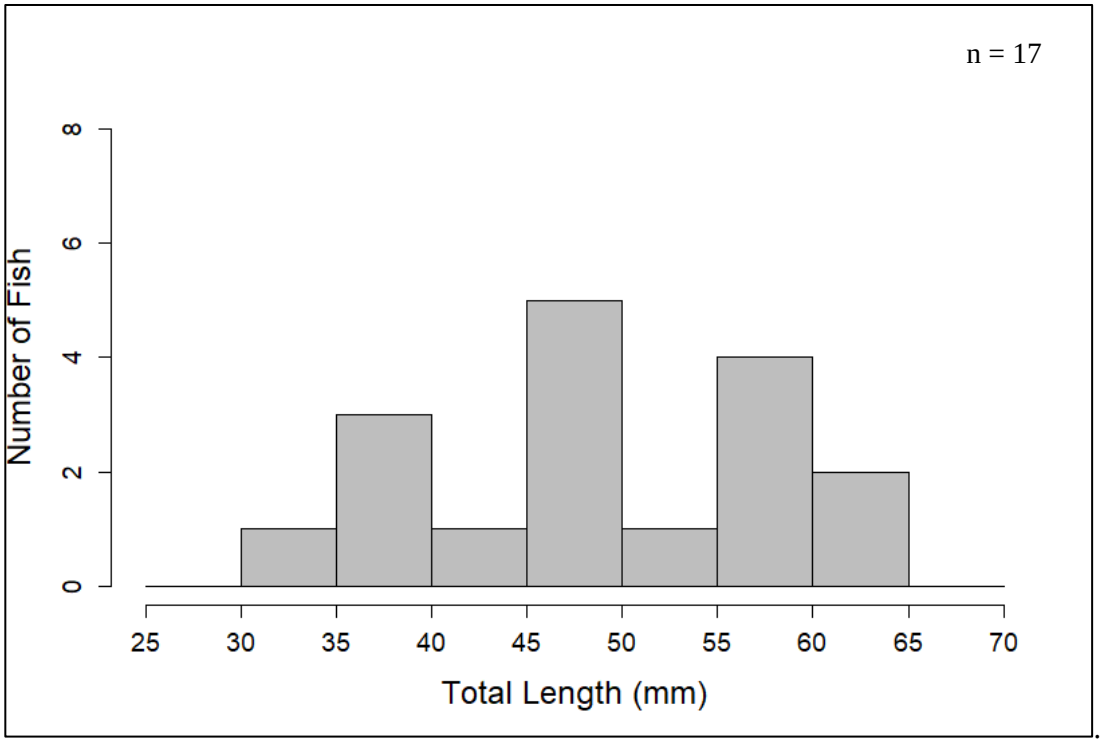

Figure 55. Length-frequency distribution for Loach Minnow captured at Hot Springs Canyon, sampled on September 21-22, 2021.

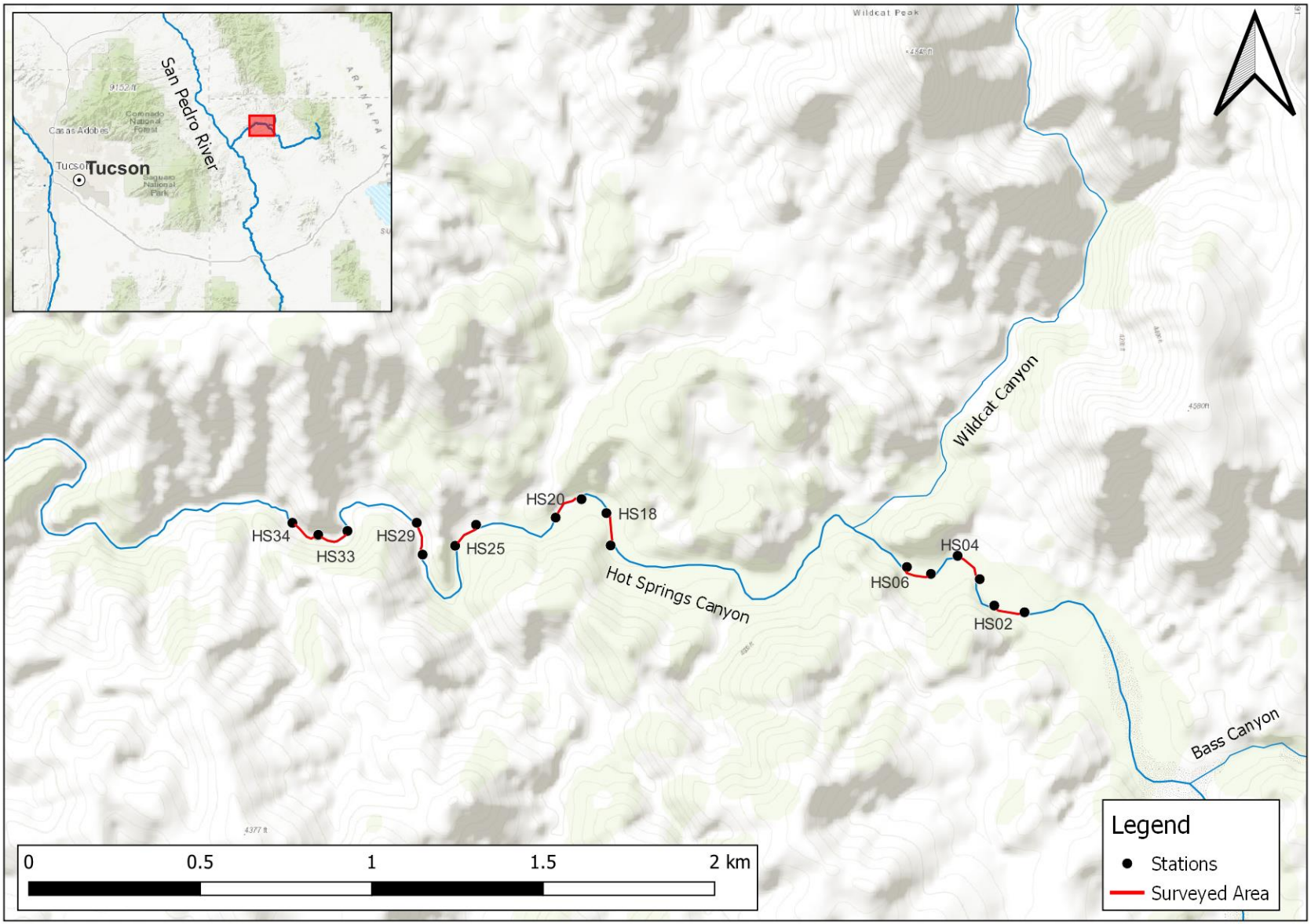

Figure 56. Location of sampling stations in Hot Springs Canyon, surveyed on September 21 & 22, 2021

Figure 57. Downstream to downstream view of fixed station HS06 in Hot Springs Canyon.

Figure 58. Downstream to upstream view of fixed station HS06 in Hot Springs Canyon.

Figure 59. Upstream to downstream view of fixed station HS06 in Hot Springs Canyon.

Figure 60. Upstream to upstream view of fixed station HS06 in Hot Springs Canyon.

Figure 61. Downstream to downstream view of fixed station HS25 in Hot Springs Canyon.

Figure 62. Downstream to upstream view of fixed station HS25 in Hot Springs Canyon.

Figure 63. Upstream to downstream view of fixed station HS25 in Hot Springs Canyon.

Figure 64. Upstream to upstream view of fixed station HS25 in Hot Springs Canyon.

Figure 65. Downstream to downstream view of fixed station HS33 in Hot Springs Canyon.

Figure 66. Downstream to upstream view of fixed station HS33 in Hot Springs Canyon.

Figure 67. Upstream to downstream view of fixed station HS33 in Hot Springs Canyon.

Figure 68. Upstream to upstream view of fixed station HS33 in Hot Springs Canyon.

Santa Cruz River Basin

Sheehy Spring April 19-20, 2021

Station		Lower Boundary	Upper Boundary
SS01 (Fixed)	12S NAD83	540096E, 3470464N	540193E, 3470477N
SS02 (Fixed)		539998E, 3470436N	540096E, 3470464N

Sheehy Spring (Santa Cruz County, AZ) is a tributary to the Santa Cruz River in San Rafael Valley near Lochiel, AZ. This site is on private land and permission to access the spring must be acquired from San Rafael Cattle Company. Gila Chub was the focal species for this survey. A natural population of Gila Chub was first discovered at Sheehy Spring in 1939. Gila Topminnow also existed at this site, however the population declined and eventually disappeared after introduction of Western Mosquitofish in 1988 (Weedman et al. 1996). Sheehy Spring was last surveyed for GRBMP in 2014, resulting in capture of 90 Gila Chub (Timmons et al. 2015).

M&A and FWS personnel completed sampling of Sheehy Spring on April 19 and 20, 2021. Sampling was completed by mini-hoop nets and dip net sweeps. Available habitat was mostly limited to one large pool in a 200-m perennial section surrounding the spring. The area surrounding Sheehy Spring is heavily impacted by grazing cattle, however dense woody vegetation protects the pool from direct impacts.

Two, 100-m fixed stations were sampled at Sheehy Spring (Figure 70). These stations were immediately adjacent to each other and encompassed the majority of surface water present. Ten mini-hoop nets were set throughout a 45 m long series of connected pools located in the lower station, SS02. Algal mats, which covered much of the open water, were cleared from the surface before setting mini-hoop nets. Nets were set overnight for approximately 16 hours. Remaining surface water consisted of shallow runs and mud puddles. A total of 43 Gila Chub (100%) were captured from the downstream station. Sonoran Mud Turtles and American Bullfrog tadpoles also were detected. Mini-hoop nets could not be set in station SS01 due to limited surface water, so 10 dip net sweeps were conducted where possible. Dip net sweeps captured 1 Western Mosquitofish. Catch and effort totals for SS02 and SS01 are summarized in Tables 11-12.

Water temperature, dissolved oxygen, pH, and conductivity at fixed station SS01 were recorded at 23 °C, 6.3 mg/L, 8.3, and 520 µS, respectively. Due to technical difficulties, photographs of upper and lower extents were not saved. A length-frequency histogram for all Gila Chub captured at Sheehy Spring is included below (Figure 69).

Table 11. Summary of catch at fixed station SS02 at Sheehy Spring by mini-hoop net, surveyed on April 19 & 20, 2021. Total effort was 163.9 hours.

Station	Statistic	GIIN (51-100)	GIIN (>100)	Total
SS02* (163.9 hrs)	Count	9	34	43
	% total catch	20.93%	79.07%	100.00%
	CPUE (ind/net hr)	0.05	0.21	0.26

*Denotes fixed station

Table 12. Summary of catch at fixed station SS01 at Sheehy Spring by dip net, surveyed on April 20, 2021. Total effort was 10, 1-m sweeps.

Station	Statistic	GAAF	Total
SS01* ($3.53\ m^2$)	Count	1	1
	% total catch	100.00%	100.00%
	CPUE (ind/m^2)	0.28	0.28

*Denotes fixed station

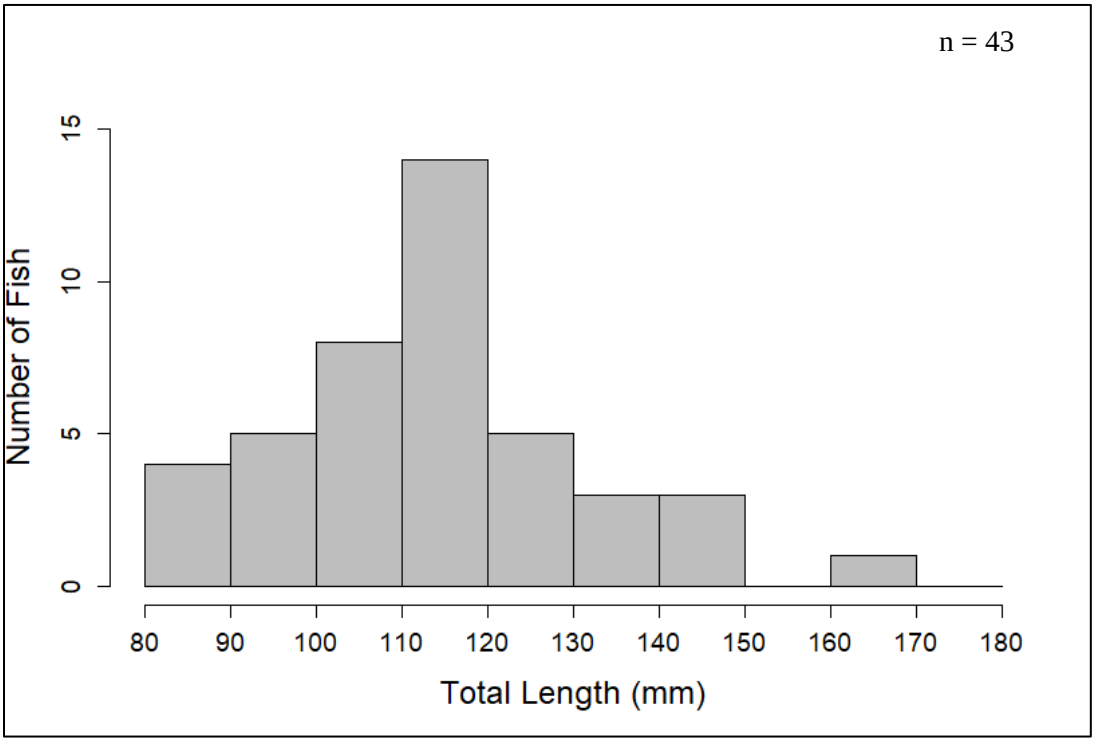

Figure 69. Length-frequency distribution for Gila Chub captured at Sheehy Spring, sampled on April 19-20, 2021.

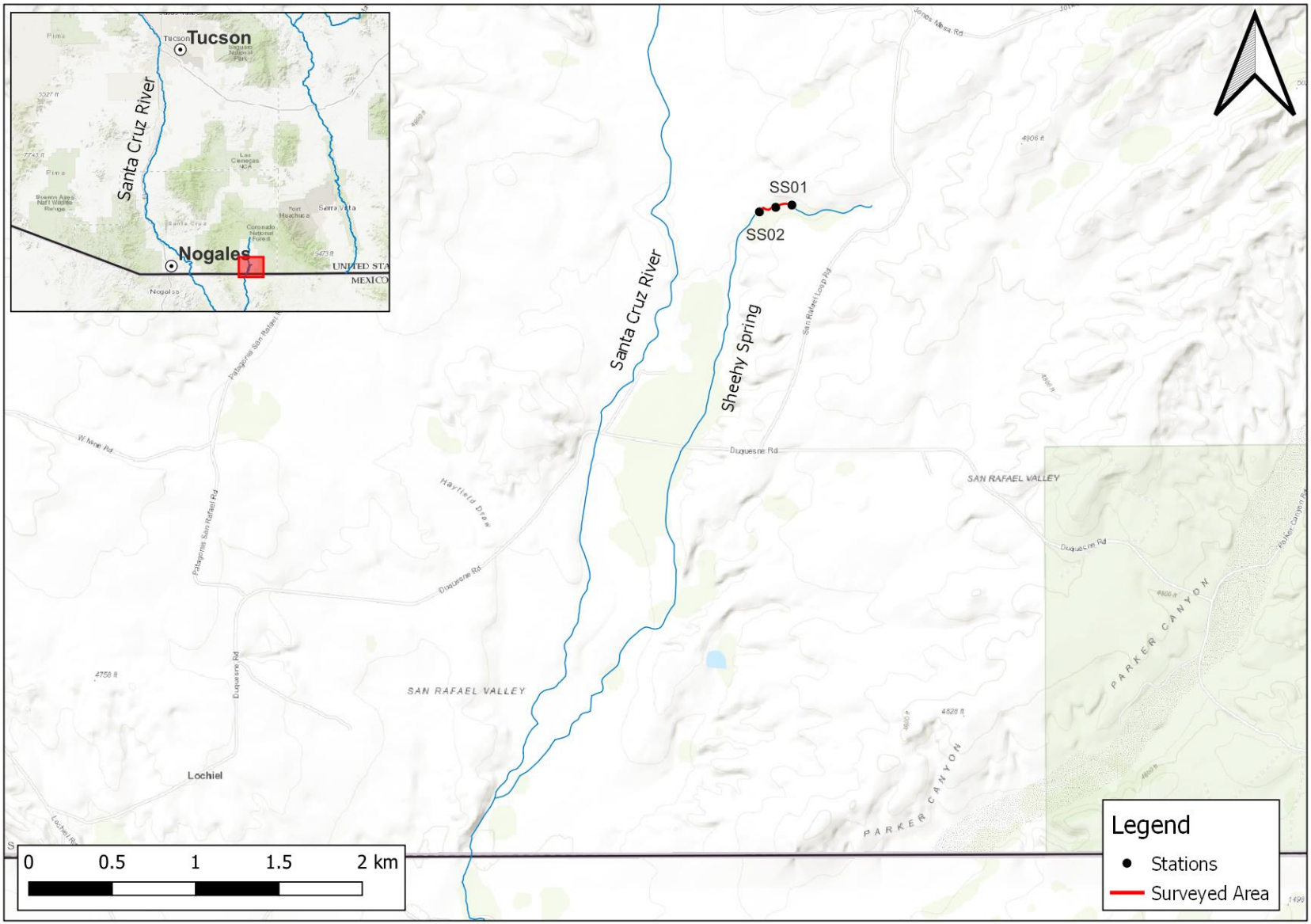

Figure 70. Location of sampling stations at Sheehy Spring, surveyed on April 19 & 20, 2021

Cottonwood Spring June 17, 2021

Station		Lower Boundary	Upper Boundary
CT01 (Fixed)	12S NAD83	527489E, 3502126N	527552E, 3502054N

Cottonwood Spring (Santa Cruz County, AZ) is a tributary to Sonoita Creek located between the towns of Patagonia and Sonoita. The entire length of stream is approximately 100-m, however the majority of water is diverted into a pipe 60 m downstream of the spring and the remainder flows 40 m in a ditch that empties into Sonoita Creek. The focal species for this survey was Gila Topminnow. A small but stable natural population of Gila Topminnow is present in Cottonwood Spring and sometimes occupies pools in Sonoita Creek when habitat is available (Weedman 1999). Cottonwood Spring was last surveyed for GRBMP in 2020, resulting in capture of 192 Gila Topminnow (Shollenberger et al. 2021).

M&A personnel completed sampling of Cottonwood Spring on June 17, 2021. Sampling was completed by dip net sweeps. The spring was accessed via a short hike from HWY 82. Cottonwood Spring is located on private land. The Partners for Wildlife cooperative management agreement at this site has expired and permission from the landowner now is required to access this site.

One fixed station, CT01, was surveyed beginning at the springhead and ending below the diversion ditch (Figure 71). A total of 155 Gila Topminnow (100%) were captured. Total effort was 25, 1-m dip net sweeps. Catch and effort totals for CT01 are summarized in Table 13. All fish were captured in the approximately 60-m long reach between the diversion box and the springhead pool. The remainder of the 100-m site below the diversion box was dry. Cottonwood Spring appeared to have been recently dredged as there was little aquatic vegetation present compared to last year and there were large piles of dirt adjacent to the spring channel. No other fish species were detected during this survey; however, Longfin Dace and Sonora Mud Turtles were observed in Sonoita Creek just upstream from the confluence with Cottonwood Spring. Total catch was lower than last year, however, this is due to the difference in effort. Overall, CPUE increased this year by 5.69 individuals per m^2. This small and isolated population remains stable.

Water temperature, dissolved oxygen, pH, and conductivity at the fixed station were recorded at 26 °C, 2.1 mg/L, 7.25, and 1,631 µS, respectively. Photographs of upper and lower extents of the fixed station are provided below (Figures 72-75).

Table 13. Summary of catch at fixed station CT01 at Cottonwood Spring by dip net. Total effort was 25, 1-m sweeps.

Station	Statistic	POOC (<20)	POOC (≥20)	Total
CT01* (8.84 m^2)	Count	64	91	155
	% total catch	41.29%	58.71%	100.00%
	CPUE (ind/m^2)	7.24	10.30	17.54

*Denotes fixed station

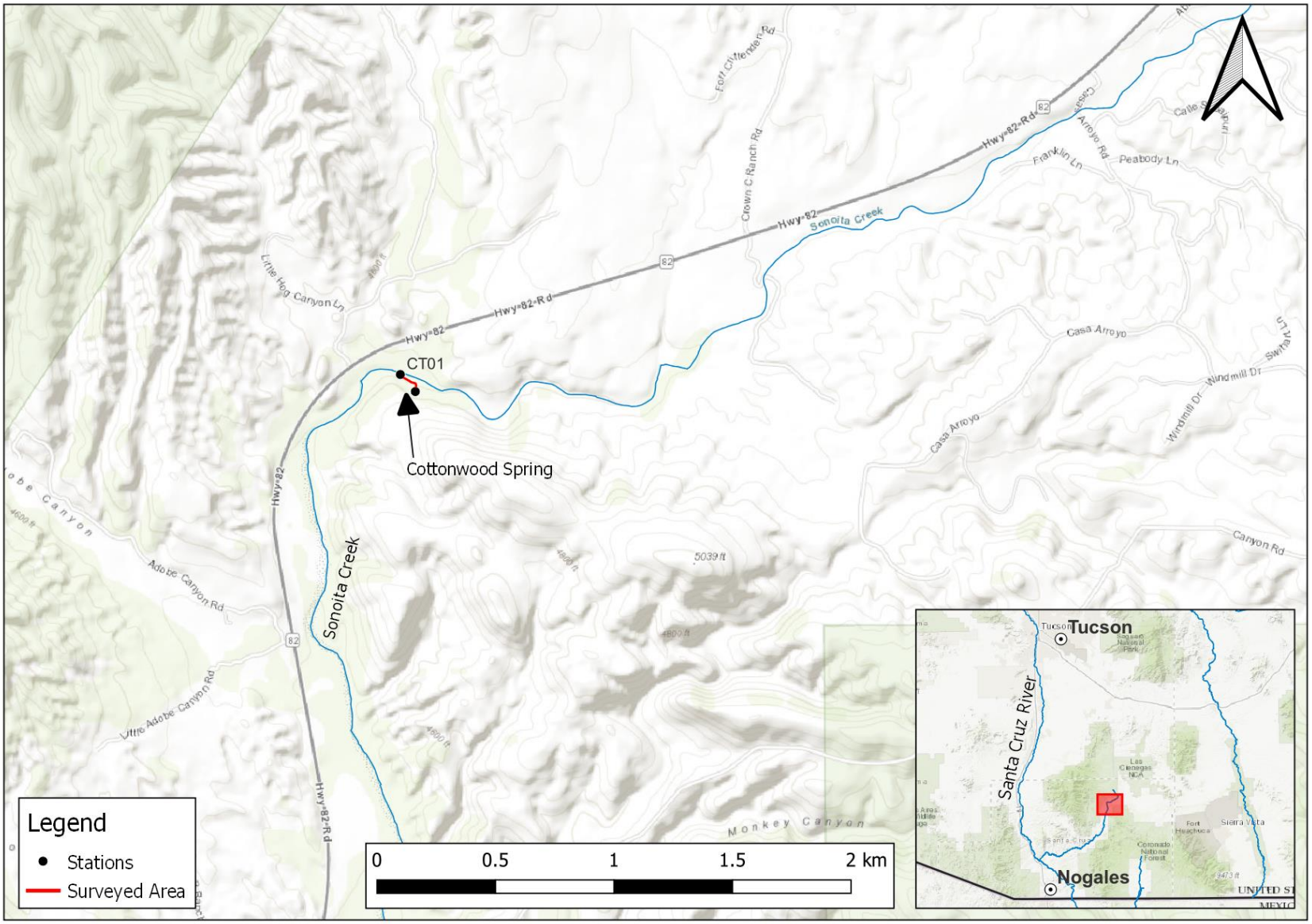

Figure 71. Location of fixed sampling station at Cottonwood Spring, surveyed on June 17, 2021.

Figure 72. Downstream to downstream view of fixed station CT01 at Cottonwood Spring.

Figure 73. Downstream to upstream view of fixed station CT01 at Cottonwood Spring.

Figure 74. Upstream to upstream view of fixed station CT01 at Cottonwood Spring.

Figure 75. Upstream to downstream view of fixed station CT01 at Cottonwood Spring.

Monkey Spring June 17, 2021

Station		Lower Boundary	Upper Boundary
MS01 (Fixed)	12S NAD83	528083E, 3499693N	528069E, 3499802N

Monkey Spring (Santa Cruz County, AZ) is a tributary to Sonoita Creek near Patagonia, AZ (Figure 76). 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 pupfish is extinct. The focal species at Monkey Spring was Gila Topminnow. This site was last sampled for GRBMP in 2019, resulting in capture of 297 Gila Topminnow (Shollenberger et al. 2020).

M&A personnel completed sampling of Monkey Spring on June 17, 2021. Sampling was completed by seine hauls. 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.

One fixed sampling station, MS01, was surveyed. This station encompassed the entirety of the pipe rail-enclosed spring and approximately 60 m of cement canal immediately downstream of the spring. Ten 1-m seine hauls were completed, five within the cement canal and five in the enclosed spring. A total of 284 Gila Topminnow was captured (100%). No other fish species were detected. Catch and effort totals for MS01 are summarized in Table 14. The majority (77.81%) of Gila Topminnow were captured in the cement canal below the enclosed spring. Unlike previous surveys, there was no surface water present outside of the cement canal and enclosed spring.

Water temperature, pH, and conductivity at the fixed station were recorded at 27.5 °C, 7.15, and 1,279 µS, respectively. Dissolved oxygen was not recorded. Photographs of upper and lower extents of the fixed station are provided below (Figures 77-80).

Table 14. Summary of catch at fixed station MS01 at Monkey Spring by seine. Total effort was 10, 1-m hauls.

Station	Statistic	POOC (<20)	POOC (≥20)	Total
MS01* (36.58 m^2)	Count	112	172	284
	% total catch	39.44%	60.56%	100.00%
	CPUE (ind/m^2)	3.06	4.70	7.76

*Denotes fixed station

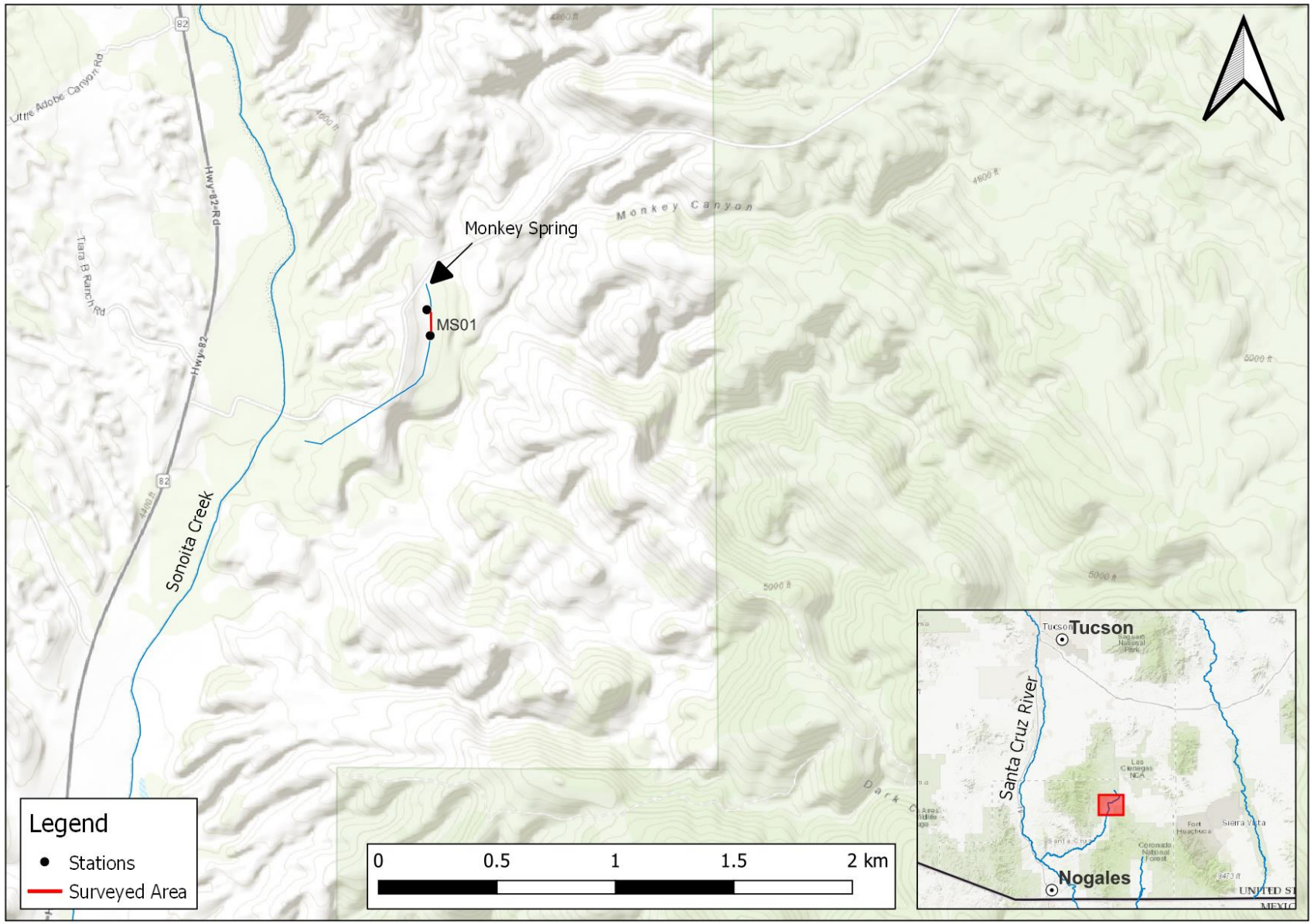

Figure 76. Location of fixed sampling station MS01 at Monkey Spring, surveyed on June 17, 2021.

Figure 77. Downstream to downstream view of fixed station MS01 at Monkey Spring.

Figure 78. Downstream to upstream view of fixed station MS01 at Monkey Spring.

Figure 79. Upstream to downstream view of fixed station MS01 at Monkey Spring.

Figure 80. Upstream to upstream view of fixed station MS01 at Monkey Spring.

Coal Mine Canyon June 22, 2021

Station		Lower Boundary	Upper Boundary
CM01 (Fixed)	12S NAD83	510445E, 3487949N	510506E, 3488023N
CM02 (Fixed)		510048E, 3487033N	510031E, 3487114N

Coal Mine Canyon (Cochise County, AZ) is a tributary to Fresno Canyon in the Sonoita Creek drainage and is located north of Patagonia Lake State Park. A natural population of Gila Topminnow was first discovered in Coal Mine Canyon in 1996 and has continued to persist (Weedman 1999). Surface water is absent throughout most of Coal Mine Canyon aside from two perennial pools associated with springs. Gila Topminnow was the focal species at Coal Mine Canyon. This site was last surveyed for GRBMP in 2019, resulting in capture of 247 Gila Topminnow (Shollenberger et al. 2020).

M&A personnel surveyed Coal Mine Canyon on June 22, 2021. This site 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. A private landowner gate is present near the start of Montezuma Well Road and requires a gate code to proceed on the road. Access to this location also required coordination with Arizona State Parks to acquire a permit to conduct scientific sampling in this area. 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. Two, 100-m fixed stations were surveyed, with each station encompassing one of the perennial pools (Figure 81). A total of 506 Gila Topminnow were captured across both stations.

The upstream station, CM01, was located at the large fenced-in spring pool. This pool contained the only available surface water within the 100-m station and water levels appeared lower compared to past survey efforts. This pool was approximately 1/3 the size compared to conditions present during the previous survey in 2019. Only five minnow traps could be set within this station, which resulted in capture of Gila Topminnow (n=197; 98.5%) and Northern Crayfish (n=3; 1.5%). There was no evidence of cattle impacts within the exclosure.

The second station, CM02, was located approximately 1 km downstream from CM01. This station consisted of a single pool about 15 m in length and 1.9 m deep. Ten minnow traps were set, which resulted in capture of Gila Topminnow (n=255; 83.3%) and Northern Crayfish (n=51; 10.7%). Catch and effort totals for both stations are summarized in Table 15.

While the upstream exclosure at Coal Mine Canyon remains intact and effective, the remainder of Coal Mine drainage had evidence of significant cattle grazing impacts and damaged fencing near CM02. This is the third consecutive monitoring effort at Coal Mine Canyon that failed to detect Longfin Dace, which were abundant during the 2012 survey. Longfin Dace still occur downstream in Fresno Canyon but may be extirpated from Coal Mine Canyon. The Gila Topminnow population in Coal Mine Canyon still appears to be stable despite the decrease in water availability.

Average water temperature, dissolved oxygen, pH, and conductivity across the two fixed stations were recorded at 25.8 °C, 12.8 mg/L, 9.11, and 467 µS, respectively. Photographs of upper and lower extents of each fixed station are provided below (Figures 82-89).

Table 15. Summary of catch at both fixed stations at Coal Mine Canyon by minnow trap. Total effort was 31.05 hours.

Station	Statistic	POOC (<20)	POOC (≥20)	ORVI	Total
CM01* (10.22 hrs)	Count	26	171	3	200
	% total catch	13.00%	85.50%	1.50%	100.00%
	CPUE (ind/net hr)	2.54	16.74	0.29	19.58
CM02* (20.83 hrs)	Count	77	178	51	306
	% total catch	25.16%	58.17%	16.67%	100.00%
	CPUE (ind/net hr)	3.70	8.54	2.45	14.69
Total	Count	103	349	54	506
	% total catch	20.36%	68.97%	10.67%	100.00%
	CPUE (ind/net hr)	3.32	11.24	1.74	16.30

*Denotes fixed station

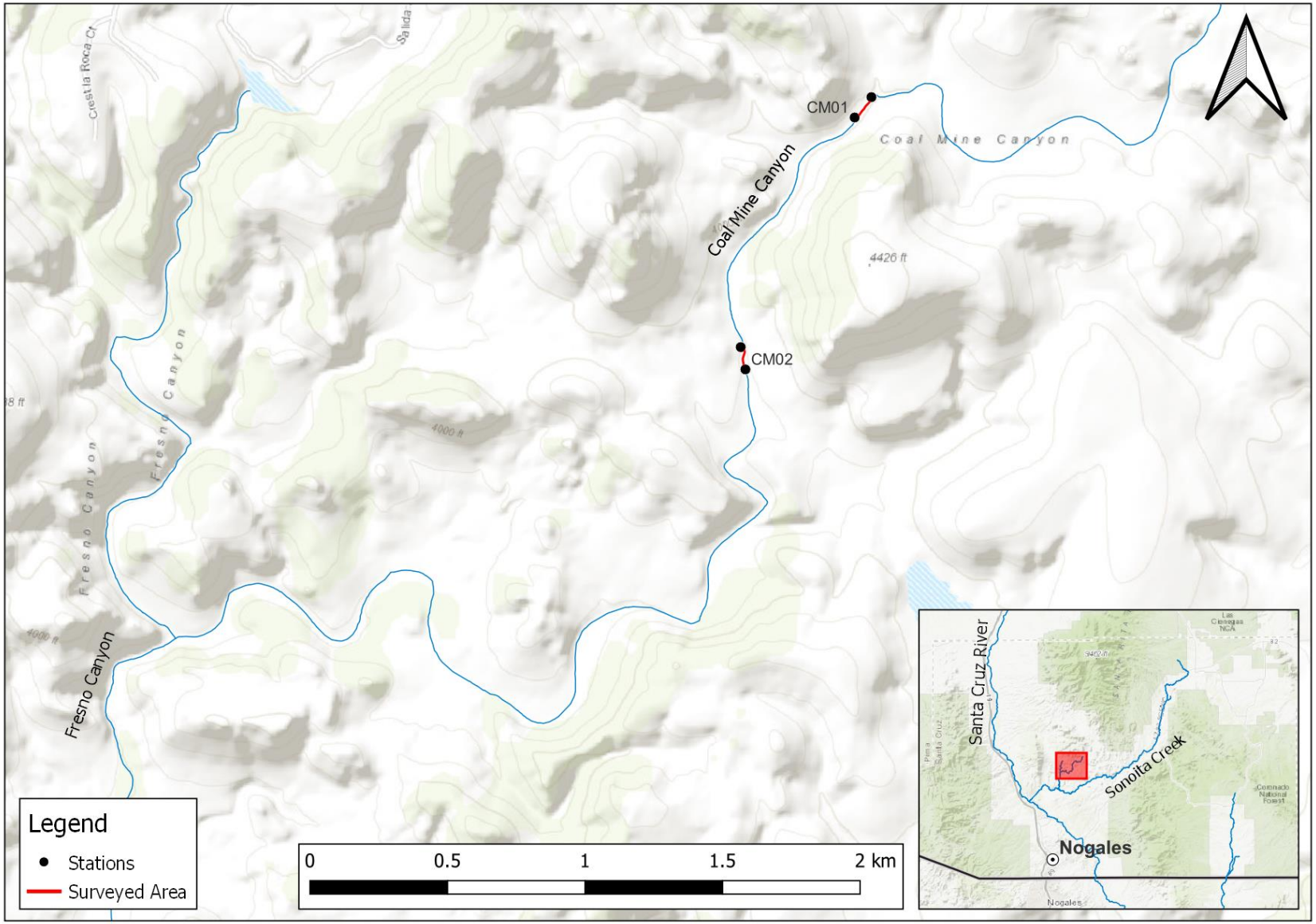

Figure 81. Location of fixed sampling stations at Coal Mine Canyon, surveyed on June 22, 2021.

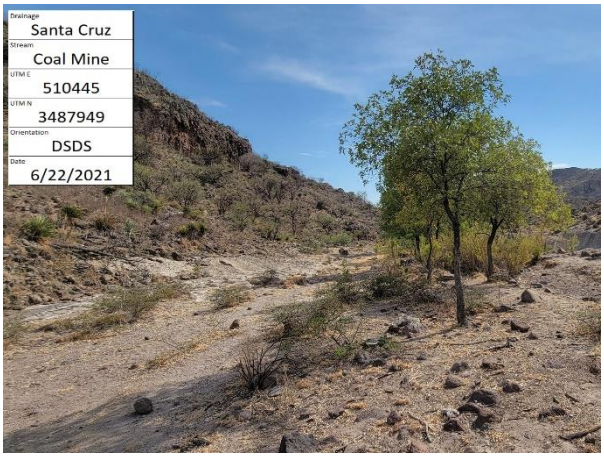

Figure 82. Downstream to downstream view of fixed station CM01 at Coal Mine Canyon.

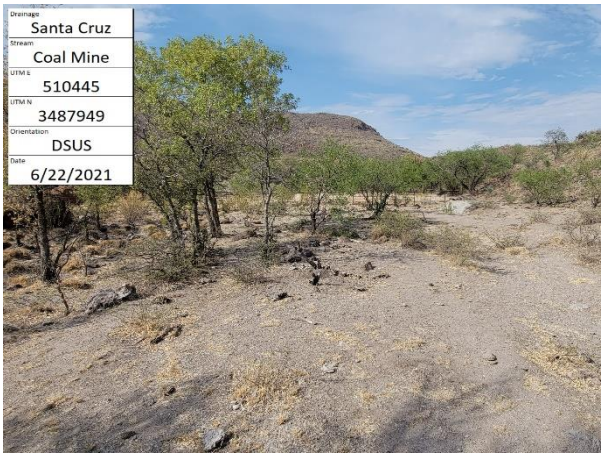

Figure 83. Downstream to upstream view of fixed station CM01 at Coal Mine Canyon.

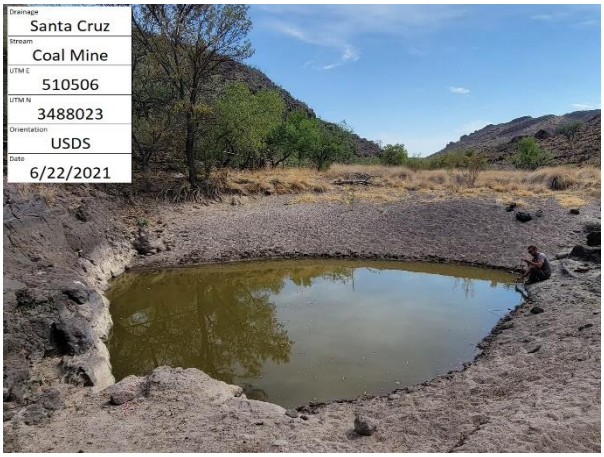

Figure 84. Upstream to downstream view of fixed station CM01 at Coal Mine Canyon.

Figure 85. Upstream to upstream view of fixed station CM01 at Coal Mine Canyon.

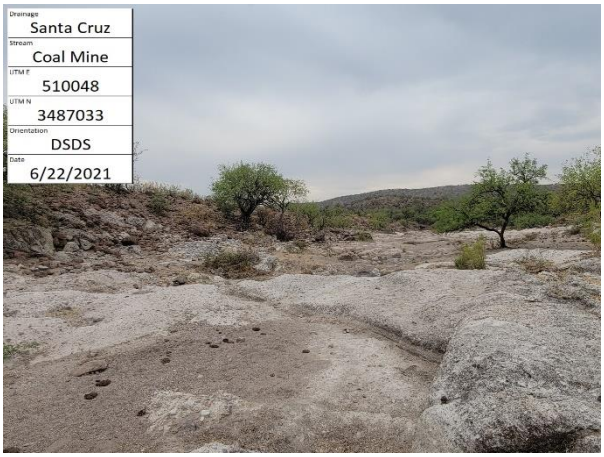

Figure 86. Downstream to downstream view of fixed station CM02 at Coal Mine Canyon.

Figure 87. Downstream to upstream view of fixed station CM02 at Coal Mine Canyon.

Figure 88. Upstream to upstream view of fixed station CM02 at Coal Mine Canyon.

Figure 89. Upstream to downstream view of fixed station CM02 at Coal Mine Canyon.

Fresno Canyon June 23, 2021

Station		Lower Boundary	Upper Boundary
FC01 (Fixed)	12S NAD83	507753E, 3485957N	507842E, 3485977N
FC02 (Fixed)		507735E, 3485872N	507752E, 3485954N
FC03 (Fixed)		507748E, 3485718N	507727E, 3485858N

Fresno Canyon (Santa Cruz County, AZ) is a tributary to Sonoita Creek downstream of Patagonia Lake in the Santa Cruz sub-basin. 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). Gila Topminnow was the focal species for this survey. This site was last monitored for GRBMP in 2019, resulting in capture of 259 Gila Topminnow (Shollenberger et al. 2020).

M&A personnel surveyed Fresno Canyon on June 23, 2021. Fresno Canyon was accessed by hiking from the end of Montezuma Well Road. Reference the Coal Mine Canyon trip summary for specific driving directions and coordination for this site. Three consecutive, 100-m fixed stations were surveyed (Figure 90). Water was intermittent throughout all stations and much of the available surface water was completely covered with duckweed. A total of 24 Gila Topminnow and 308 Longfin Dace were captured across all stations.

The upstream station, FC01, contained the most suitable habitat. Ten traps were set here and captured Gila Topminnow (n=11; 4.7%), Longfin Dace (n=204; 87.2%), and Northern Crayfish (n=19; 8.1%). A single dip net sweep in a shallow pool captured additional Gila Topminnow (n=13; 100%). The fence near the upper portion of this perennial stretch was blown out, and there were other sections of fence that also were down in this area. Only six traps were set within the middle station due to limited habitat. These resulted in capture of Longfin Dace (n=38; 100%). Ten minnow traps were set within the most downstream station. Longfin Dace (n=66; 98.5%) and Northern Crayfish (n=1; 1.5%) were captured. Catch and effort totals for all stations are summarized in Tables 16-17.

Catch totals for Fresno Canyon were the lowest they have been since the rotenone treatment. The drainage showed significant cattle grazing impacts. Vegetation was grazed down to dirt and what little aquatic habitat remains in this area was well trampled. Cows were observed near the Fresno Canyon sampling stations. We also discovered cow and bull carcasses within Fresno Canyon. The impacts of drought and grazing appear to be negatively affecting the Gila Topminnow population in Fresno Canyon.

Stream discharge measurements were not taken as there was no flowing water. Average water temperature, dissolved oxygen, pH, and conductivity across the three fixed stations were recorded at 22.4 °C, 3.3 mg/L, 7.45, and 541 µS, respectively. Photographs of upper and lower extents of each fixed station are provided below (Figures 91-102).

Table 16. Summary of catch at three fixed stations at Fresno Canyon by minnow trap. Total effort was 20.87 hours.

Station	Statistic	POOC (≥20)	AGCH	ORVI	Total
FC01* (20.87 hrs)	Count	11	204	19	234
	% total catch	4.70%	87.18%	8.12%	100.00%
	CPUE (ind/net hr)	0.53	9.78	0.91	11.21
FC02* (11.42 hrs)	Count	0	38	0	38
	% total catch	0.00%	100.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	3.33	0.00	3.33
FC03* (20.05 hrs)	Count	0	66	1	67
	% total catch	0.00%	98.51%	1.49%	100.00%
	CPUE (ind/net hr)	0.00	3.29	0.05	3.34
Total	Count	11	308	20	339
	% total catch	3.24%	90.86%	5.90%	100.00%
	CPUE (ind/net hr)	0.21	5.89	0.38	6.48

*Denotes fixed station

Table 17. Summary of catch at FC01 at Fresno Canyon by dip net. Total effort was 1, 1-m sweep.

Station	Statistic	POOC (≥20)	Total
FC01* (0.35 m^2)	Count	13	13
	% total catch	100.00%	100.00%
	CPUE (ind/m^2)	36.77	36.77

*Denotes fixed station

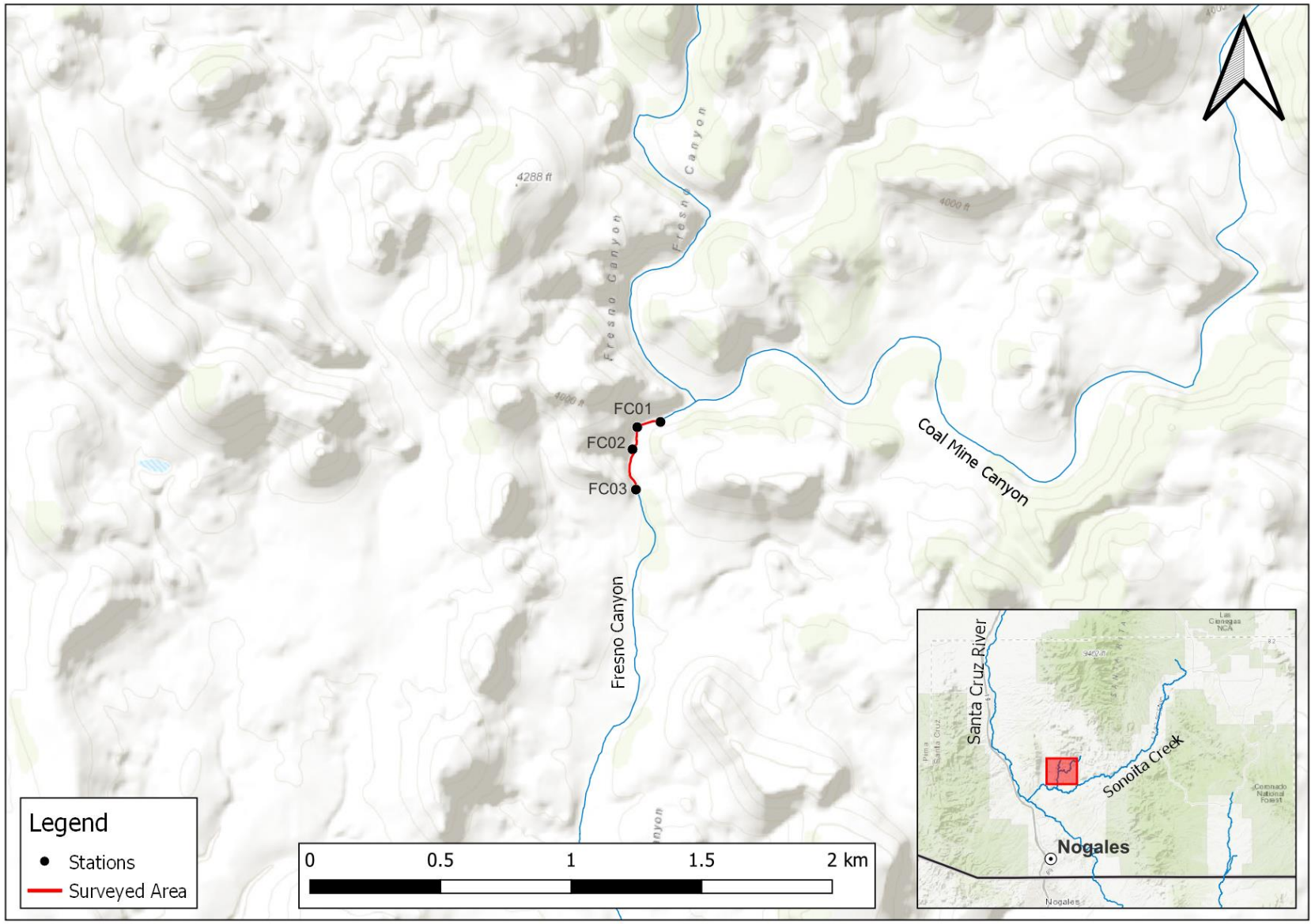

Figure 90. Location of fixed sampling stations at Fresno Canyon, surveyed on June 23, 2021.

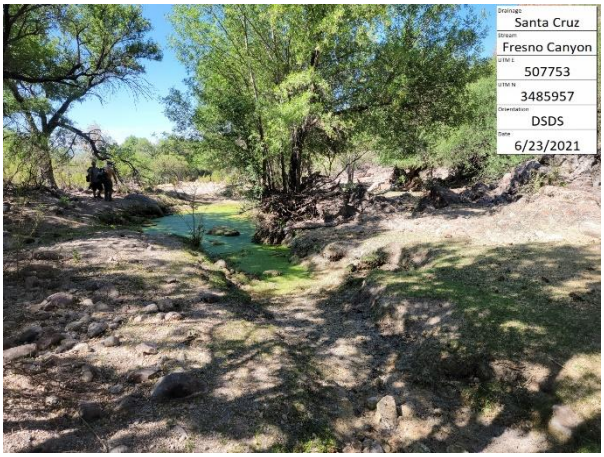

Figure 91. Downstream to downstream view of fixed station FC01 at Fresno Canyon.

Figure 92. Downstream to upstream view of fixed station FC01 at Fresno Canyon.

Figure 93. Upstream to downstream view of fixed station FC01 at Fresno Canyon.

Figure 94. Upstream to upstream view of fixed station FC01 at Fresno Canyon.

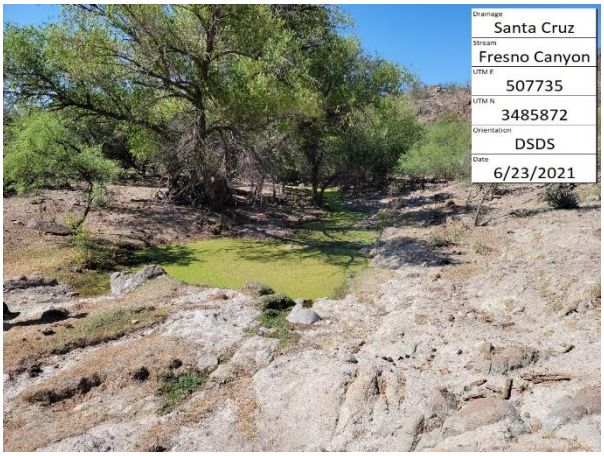

Figure 95. Downstream to downstream view of fixed station FC02 at Fresno Canyon.

Figure 96. Downstream to upstream view of fixed station FC02 at Fresno Canyon.

Figure 97. Upstream to downstream view of fixed station FC02 at Fresno Canyon.

Figure 98. Upstream to upstream view of fixed station FC02 at Fresno Canyon.

Figure 99. Downstream to upstream view of fixed station FC03 at Fresno Canyon.

Figure 100. Downstream to downstream view of fixed station FC03 at Fresno Canyon.

Figure 101. Upstream to downstream view of fixed station FC03 at Fresno Canyon.

Figure 102. Upstream to upstream view of fixed station FC03 at Fresno Canyon.

Station		Lower Boundary	Upper Boundary
CC02	12S NAD83	535757E, 3541931N	535830E, 3541987N
CC04 (Fixed)		535597E, 3541858N	535696E, 3541860N
CC07		535315E, 3541933N	535413E, 3541906N
Three Bridges		533361E, 3542709N	533491E, 3542651N

Cienega Creek (Pima County, AZ) is located on Pima County's Cienega Creek Natural Preserve near Vail, AZ. It is a tributary to Pantano Wash in the Santa Cruz sub-basin. Gila Topminnow was the focal species for this survey. Cienega Creek was last surveyed for GRBMP in 2015, but it has been more recently surveyed as part of CAP non-native fish monitoring efforts in 2020 and resulted in capture of 1,103 Gila Topminnow (Shollenberger et al. 2021).

M&A and Pima County personnel completed monitoring of Cienega Creek on September 9, 2021. One fixed and two random stations were surveyed in the vicinity of the "Horseshoe Bend/Head Cut" section of the creek (Figure 99). This reach of Cienega Creek was accessed via dirt roads off East Marsh Station Road. A total of 10 seine hauls were conducted throughout each random station and minnow traps were used throughout the fixed station. Across all stations, 26 Gila Topminnow and 102 Longfin Dace were captured.

The first random station, CC02, was located 200-m upstream from the fixed station. Longfin Dace (n=69; 100%) were captured, with the majority coming from a medium-sized pool in the middle of the station. The second random station, CC07, was located 400-m downstream from the fixed station. Mesohabitat throughout this station was entirely shallow riffle and no fish were observed visually or captured via seine hauls.

Fixed station CC04 consisted of a large pool at the start of the station followed by shallow run and riffle mesohabitats. Few fishes were observed outside of the large pool. Five minnow traps were set within the pool and five more traps were set throughout the remainder of the station. All traps were set near surface with an air pocket and fished for approximately two hours. Minnow traps were mostly ineffective at capturing fish. Gila Topminnow (n=2; 3.39%) were captured via traps, however a visual assessment identified a higher abundance of fish. It appeared that fishes present were concentrated in deeper portions of the pool. Much of the pool was too deep to effectively seine, but three seine hauls were conducted where possible to confirm the species present. Longfin Dace (n=33; 55.93%) and Gila Topminnow (n=24; 40.67%) were captured via seine. Catch and effort totals for all surveyed stations are summarized in Tables 18 & 19.

In addition, we visually assessed Cienega Creek at Three Bridges. Recent flooding events shifted sediment and filled in the pools below the bridges. Low numbers of Longfin Dace were observed near the stream margins and were confirmed via dip net sweeps.

Overall lower numbers of Longfin Dace and Gila Topminnow this year could be a result of a few factors. Flood events due to the active monsoon season could have impacted numbers. Additionally, there was more surface water present this year which could lead to the same number of fishes being distributed over a larger extent or concentrated in different locations entirely. Pima County personnel returned to Cienega

Creek on September 10 for wet-dry mapping and observed higher numbers of fish further downstream from our survey reach in a section that is typically dry (I. Murray, personal communication, September 15, 2021).

Stream discharge was measured near the middle of CC04 and was calculated to be 0.07 m^3/s. Water temperature, dissolved oxygen, pH, and conductivity at the fixed station were recorded at 21.6 °C, 9.1 mg/L, 7.7, and 1,775 µS, respectively. Photographs of upper and lower extents of the fixed station are provided below (Figures 100-103).

Table 18. Summary of catch at three stations at Cienega Creek by seine. Total effort was 23, 1-m seine hauls.

Station	Statistic	POOC (<20)	POOC (≥20)	AGCH	Total
CC02 (36.58 m^2)	Count	0	0	69	69
	% total catch	0.00%	0.00%	100.00%	100.00%
	CPUE (ind/m^2)	0.00	0.00	1.89	1.89
CC04* (10.97 m^2)	Count	9	15	33	57
	% total catch	15.79%	26.32%	57.89%	100.00%
	CPUE (ind/m^2)	0.82	1.37	3.01	5.19
CC07 (36.58 m^2)	Count	0	0	0	0
	% total catch	0.00%	0.00%	0.00%	0.00%
	CPUE (ind/m^2)	0.00	0.00	0.00	0.00
Total	Count	9	15	102	126
	% total catch	7.14%	11.90%	80.95%	100.00%
	CPUE (ind/m^2)	0.11	0.18	1.21	1.50

*Denotes fixed station

Table 19. Summary of catch at fixed station CC04 at Cienega Creek by minnow trap. Total effort was 21.32 net hours.

Station	Statistic	POOC (≥20)	Total
CC04* (5.73 hrs)	Count	2	2
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	0.09	0.09

*Denotes fixed station

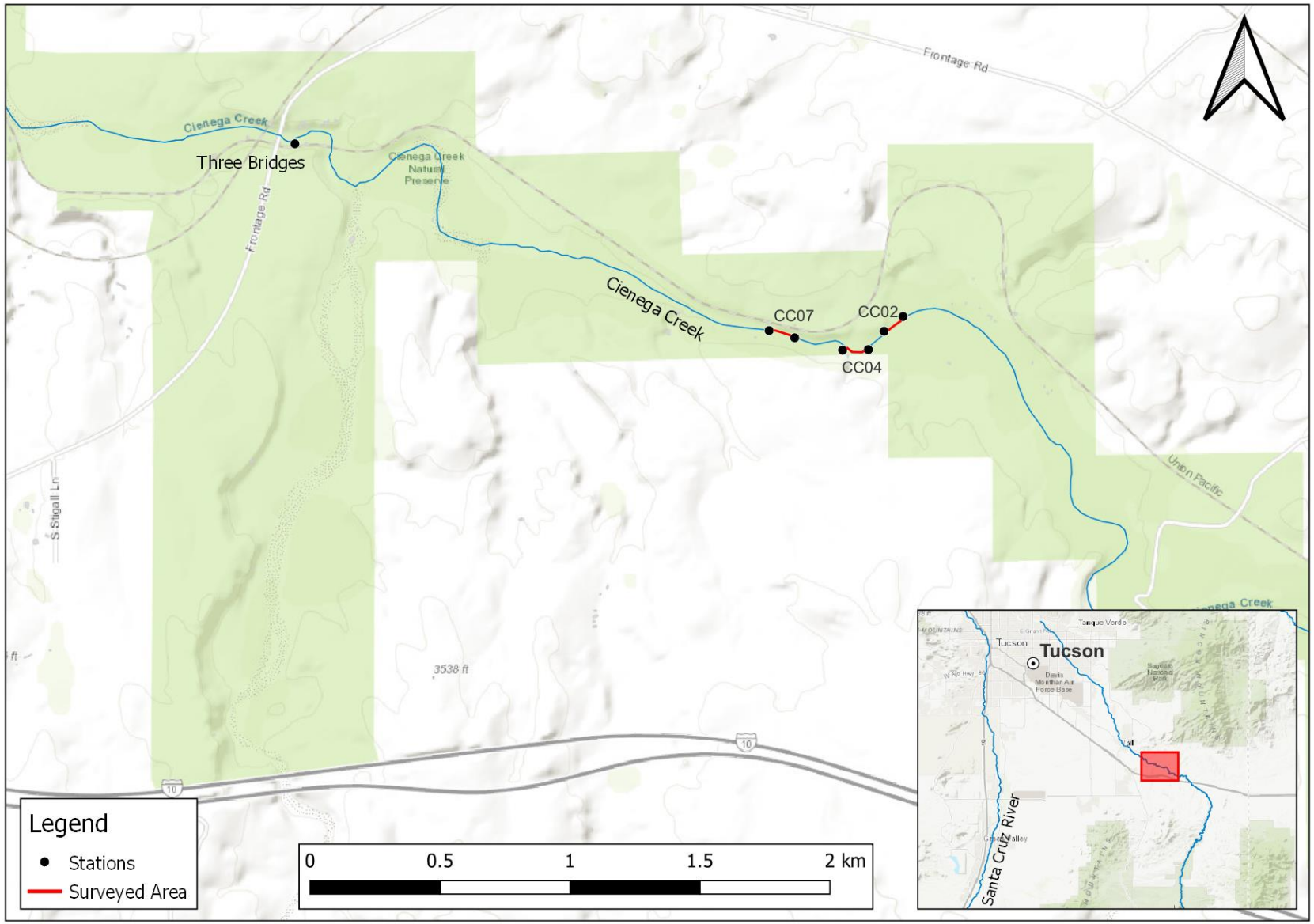

Figure 103. Location of sampling stations at Cienega Creek, surveyed on September 9, 2021.

Figure 104. Downstream to downstream view of fixed station CC04 at Cienega Creek.

Figure 105. Downstream to upstream view of fixed station CC04 at Cienega Creek.

Figure 106. Upstream to downstream view of fixed station CC04 at Cienega Creek.

Figure 107. Upstream to upstream view of fixed station CC04 at Cienega Creek.

Romero Canyon November 9, 2021

Station		Lower Boundary	Upper Boundary
RC06 (Fixed)	12S NAD83	511540E, 3586859N	511573E, 3586783N
RC12		511311E, 3587363N	511343E, 3587267N
RC17		511132E, 3587324N	511064E, 3587257N
RC20		511135E, 3587612N	511144E, 3587531N

Romero Canyon (Pima County, AZ) is within the Santa Catalina Mountains north of Tucson, AZ in the Santa Cruz sub-basin. Romero Canyon has approximately 2.4 km of perennial water that begins 3.7 km upstream from its confluence with Sutherland Wash. Gila Chub was the focal species for this survey. Gila Chub were first stocked into Romero Canyon in 2005 with fish salvaged from Sabino Canyon (FWS, 2015). This population was augmented with 148 individuals in 2019 to expand their range further upstream (Hickerson et al. 2020). Romero Canyon was last surveyed for GRBMP in 2019, prior to augmentation, and resulted in capture of 50 Gila Chub (Shollenberger et al. 2020).

M&A personnel completed sampling Romero Canyon on November 9, 2021. The survey reach was accessed via Romero Canyon Trailhead within Catalina State Park. Four stations (1 fixed, 3 random) were surveyed at Romero Canyon with the lowest station located 1.8 km downstream of Romero Canyon trail crossing and the most upstream site located 400-m downstream of the trail crossing (Figure 109). There was little trappable habitat outside of the fixed station, dip net sweeps were used to supplement sampling where possible. A total of 41 Gila Chub were captured across all surveyed stations.

Ten traps were set throughout the fixed station, RC06. This station consisted of deep slick rock pools. Five mini-hoop nets were deployed, and these captured eight Gila Chub (100%). Five minnow traps were deployed to target young-of-year chub and did not capture any fish. All Gila Chub captured were from a single mini-hoop net set.

Dip net sweeps were the primary sampling method at the three random stations. Zero fish were detected at stations RC20 and RC12 with effort totaling seven and eight dip net sweeps, respectively. No traps could be set in RC20 and RC12. Three minnow traps set at station RC17 captured Gila Chub (n=5; 15.15%) and additional Gila Chub (n=28; 84.85%) were captured via 27 dip net sweeps. All 33 Gila Chub were captured in one pool below a 3-m high waterfall. Canyon Tree Frogs *Hyla arenicolor* were abundant throughout the survey reach. A fourth random station 300-m upstream of RC06 was not completed due to time constraints. Catch and effort totals for all surveyed stations are summarized in Tables 20-22.

Gila Chub were less abundant and widespread compared to previous GRRBMP surveys. There was evidence of impacts from the 2019 Bighorn Fire within the drainage, which may have had adverse effects on the Gila Chub population. Water temperature, dissolved oxygen, pH, and conductivity at the fixed station were recorded at 15.8 °C, 6.9 mg/L, 8.22, and 157 µS, respectively. A length-frequency histogram for all Gila Chub captured at Romero Canyon is included below (Figure 108). Photographs of upper and lower extents of the fixed station are provided below (Figures 110-113).

Table 20. Summary of catch at fixed station RC06 at Romero Canyon by mini-hoop net, surveyed on November 9, 2021. Total effort was 8.88 hours.

Station	Statistic	GIIN	Total
RC06* (8.88 hrs)	Count	8	8
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	0.90	0.90

*Denotes fixed station

Table 21. Summary of catch at stations RC06 and RC17 at Romero Canyon by minnow trap, surveyed on November 9, 2021. Total effort was 15.59 hours.

Station	Statistic	GIIN	Total
RC06* (8.77 hrs)	Count	0	0
	% total catch	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00
RC17 (6.82 hrs)	Count	5	5
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	0.73	0.73
Total	Count	5	5
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	0.32	0.32

*Denotes fixed station

Table 22. Summary of catch at stations RC12, RC17, and RC20 at Romero Canyon by dip net, surveyed on November 9, 2021. Total effort was 42, 1-m dip net sweeps.

Station	Statistic	GIIN	HYAR	Total
RC12 (2.83 m^2)	Count	0	0	0
	% total catch	0.00%	0.00%	0.00%
	CPUE (ind/m^2)	0.00	0.00	0.00
RC17 (9.55 m^2)	Count	28	1	29
	% total catch	96.55%	3.45%	100.00%
	CPUE (ind/m^2)	2.93	0.10	3.04
RC20 (2.47 m^2)	Count	0	0	0
	% total catch	0.00%	0.00%	0.00%
	CPUE (ind/m^2)	0.00	0.00	0.00
Total	Count	28	1	29
	% total catch	96.55%	3.45%	100.00%
	CPUE (ind/m^2)	1.89	0.07	1.95

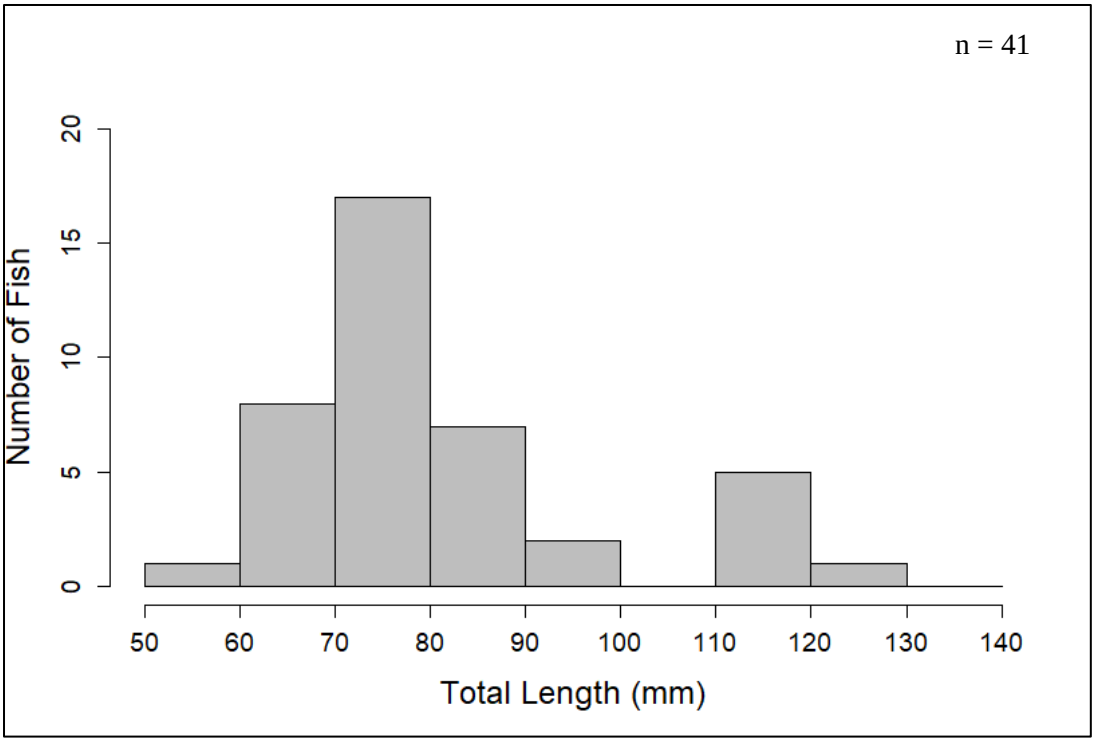

Figure 108. Length-frequency distribution for Gila Chub captured at Romero Canyon, sampled on November 9, 2021.

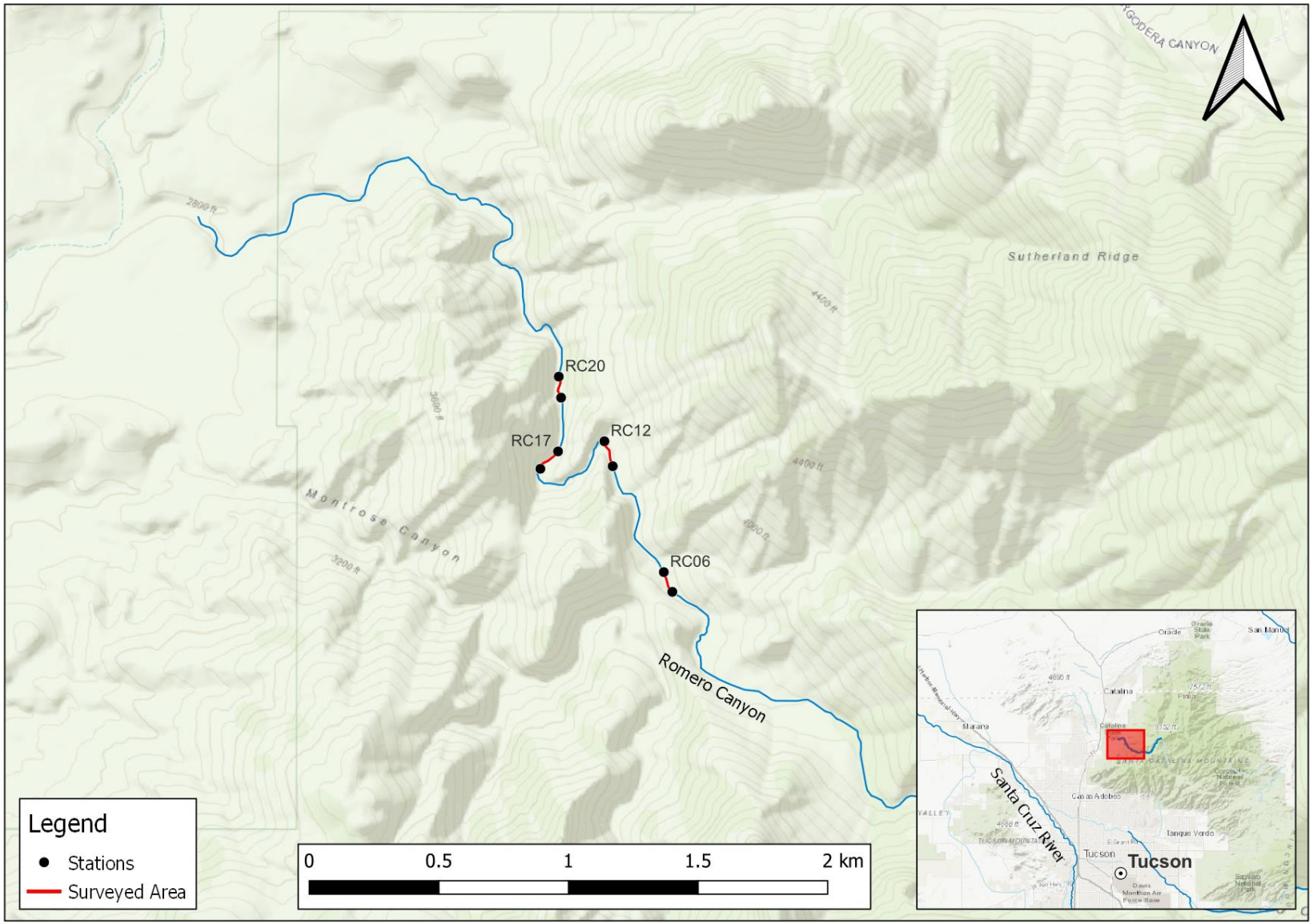

Figure 109. Location of sampling stations at Romero Canyon, surveyed on November 9, 2021.

Figure 110. Downstream to downstream view of fixed station RC06 at Romero Canyon.

Figure 111. Downstream to upstream view of fixed station RC06 at Romero Canyon.

Figure 112. Upstream to downstream view of fixed station RC06 at Romero Canyon.

Figure 113. Upstream to upstream view of fixed station RC06 at Romero Canyon.

Sabino Canyon November 10 & 12, 2021

Station		Lower Boundary	Upper Boundary
SC04	12S NAD83	520468E, 3578335N	520470E, 3578423N
SC06 (Fixed)		520304E, 3578226N	520397E, 3578251N
SC09		520162E, 3578016N	520172E, 3578099N
SC10		520106E, 3577940N	520160E, 3578010N
SC17		519725E, 3577362N	519780E, 3577445N
SC21		519464E, 3577129N	519546E, 3577144N
SC31		518624E, 3576764N	518699E, 3576818N
SC40		517971E, 3576262N	518059E, 3576305N
SC48		517770E, 3575633N	517781E, 3575735N
SC53 (Fixed)		517730E, 3575216N	517752E, 3575327N
SC54		517764E, 3575142N	517747E, 3575192N

Sabino Canyon (Pima County, AZ) is located within Coronado National Forest northeast of Tucson, AZ. Sabino Canyon flows for approximately 28 km before it empties into the Rillito River, although the lower portion of the canyon is primarily ephemeral. Sabino Canyon was chemically treated in 1999 to remove Green Sunfish. Salvaged Gila Chub were stocked into Sabino Canyon following treatment. Gila Topminnow (Cienega Creek lineage) were initially stocked in Sabino Canyon in 2015 (Hickerson et al. 2020). Gila Chub and Gila Topminnow were the focal species for this survey. Sabino Canyon was last surveyed for Gila Chub as part of GRBMP in 2015, resulting in capture of 252 Gila Chub (Timmons and Paulus 2016). Sabino Canyon has not been previously surveyed for Gila Topminnow as part of this contract.

M&A personnel completed monitoring of Sabino Canyon on November 10 & 12, 2021. The survey reach was accessed along Upper Sabin Canyon Road. This road typically is restricted to hikers and trams, however permission was granted by the Forest Service to access it by vehicle. Past surveys consisted of a single 100-m site, however for 2021, 11 stations (2 fixed, 9 random) were surveyed spanning 5 km of stream (Figure 115). The lowest station was located 200-m below Sabino Creek Dam and the upper most station was located 200-m upstream of Sabino Waterfall. Five minnow traps and five mini mini-hoop nets were set at all 11 stations and supplemental dip net sweeps were performed at SC04, SC40, SC53, and SC54. Across all surveyed stations, totals of 217 Gila Topminnow and 143 Gila Chub were captured. Gila Chub were detected at stations SC04, SC06, SC09, SC17, SC21, SC40, SC53, and SC54 and Gila Topminnow were detected at stations SC10, SC21, SC53, and SC54.

Fixed station SC06 was located at the past GRBMP monitoring location. Traps were set for an average of 2.76 hours each. Gila Chub (n=39; 100%) were the only species detected. Mini-hoop nets were most successful and captured all but one chub at this station. Fixed station SC53 was located immediately below Sabino Creek Dam. Traps were set for an average of 2.65 hours each. Five mini-hoop net sets did not capture any fish. Minnow traps captured Gila Chub (n=2; 2.53%) and Gila Topminnow (n=7; 8.86%). Gila Topminnow were visually abundant, so two dip net sweeps were performed in addition to the traps to confirm the species present. These two efforts captured an additional 70 Gila Topminnow (88.61%) at this station. Catch and effort totals for all surveyed stations are summarized in Tables 23-25.

Gila Chub were not widespread throughout the survey reach. They seemed to occur in discrete pockets, with the majority of chub at each site coming from one or two traps. Visual observations of chub in pools were uncommon within and between survey stations. The majority of Gila Topminnow were captured in the two stations below the dam, although Gila Topminnow were found as far up as station SC10. Canyon Tree Frogs and Sonora Mud Turtles were observed throughout the survey reach.

Average water temperature, dissolved oxygen, pH, and conductivity across the two fixed stations were 14.1 °C, 9.0 mg/L, 8.31, and 134 µS, respectively. A length-frequency histogram for all Gila Chub captured at Sabino Canyon is included below (Figure 114). Photographs of upper and lower extents of each fixed station are provided below (Figures 116-123).

Table 23. Summary of catch at stations SC04, SC40, SC53, and SC54 at Sabino Canyon by dip net. Total effort was 9, 1-m dip net sweeps.

Station	Statistic	POOC (<20)	POOC (≥20)	GIIN	Total
SC04 (0.71 m^2)	Count	6	1	0	7
	% total catch	85.71%	14.29%	0.00%	100.00%
	CPUE (ind/m^2)	8.48	1.41	0.00	9.90
SC40 (0.35 m^2)	Count	0	0	3	3
	% total catch	0.00%	0.00%	100.00%	100.00%
	CPUE (ind/m^2)	0.00	0.00	8.48	8.48
SC53* (0.71 m^2)	Count	36	34	0	70
	% total catch	51.43%	48.57%	0.00%	100.00%
	CPUE (ind/m^2)	50.91	48.08	0.00	98.99
SC54 (1.41 m^2)	Count	1	23	1	25
	% total catch	4.00%	92.00%	4.00%	100.00%
	CPUE (ind/m^2)	0.71	16.26	0.71	17.68
Total	Count	43	58	4	105
	% total catch	40.95%	55.24%	3.81%	100.00%
	CPUE (ind/m^2)	4.32	5.83	0.40	10.55

*Denotes fixed station

Table 24. Summary of catch at all stations at Sabino Canyon by minnow trap. Total effort was 126.17 hours.

Station	Statistic	POOC (<20)	POOC (≥20)	GIIN	KISO	Total
SC04 (14.48 hrs)	Count	0	0	4	0	4
	% total catch	0.00%	0.00%	100.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	0.00	0.28	0.00	0.28
SC06* (13.87 hrs)	Count	0	0	1	0	1
	% total catch	0.00%	0.00%	100.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	0.00	0.07	0.00	0.07
SC09 (12.12 hrs)	Count	0	0	7	1	8
	% total catch	0.00%	0.00%	87.50%	12.50%	100.00%
	CPUE (ind/net hr)	0.00	0.00	0.58	0.08	0.66
SC10 (11.72 hrs)	Count	7	6	0	0	13
	% total catch	53.85%	46.15%	0.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.60	0.51	0.00	0.00	1.11
SC17 (9.95 hrs)	Count	0	0	0	0	0
	% total catch	0.00%	0.00%	0.00%	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00	0.00	0.00	0.00
SC21 (9.92 hrs)	Count	3	0	7	0	10
	% total catch	30.00%	0.00%	70.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.30	0.00	0.71	0.00	1.01
SC31 (10 hrs)	Count	0	0	0	0	0
	% total catch	0.00%	0.00%	0.00%	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00	0.00	0.00	0.00
SC40 (10.15 hrs)	Count	0	0	2	0	2
	% total catch	0.00%	0.00%	100.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	0.00	0.20	0.00	0.20
SC48 (10.05 hrs)	Count	0	0	0	0	0
	% total catch	0.00%	0.00%	0.00%	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00	0.00	0.00	0.00
SC53* (13.03 hrs)	Count	0	7	2	0	9
	% total catch	0.00%	77.78%	22.22%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	0.54	0.15	0.00	0.69
SC54 (10.88 hrs)	Count	4	65	0	0	69
	% total catch	5.80%	94.20%	0.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.37	5.97	0.00	0.00	6.34
Total	Count	14	78	23	1	116
	% total catch	12.07%	67.24%	19.83%	0.86%	100.00%
	CPUE (ind/net hr)	0.11	0.62	0.18	0.01	0.92

*Denotes fixed station

Table 25. Summary of catch at all stations at Sabino Canyon by mini-hoop net. Total effort was 125.79 hours.

Station	Statistic	POOC (≥20)	GIIN	KISO	Total
SC04 (14.46 hrs)	Count	0	7	0	7
	% total catch	0.00%	100.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	0.48	0.00	0.48
SC06* (13.72 hrs)	Count	0	38	0	38
	% total catch	0.00%	100.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	2.77	0.00	2.77
SC09 (11.97 hrs)	Count	0	16	1	17
	% total catch	0.00%	94.12%	5.88%	100.00%
	CPUE (ind/net hr)	0.00	1.34	0.08	1.42
SC10 (11.58 hrs)	Count	0	0	0	0
	% total catch	0.00%	0.00%	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00	0.00	0.00
SC17 (9.95 hrs)	Count	0	4	0	4
	% total catch	0.00%	100.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	0.40	0.00	0.40
SC21 (9.73 hrs)	Count	0	0	0	0
	% total catch	0.00%	0.00%	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00	0.00	0.00
SC31 (10.07 hrs)	Count	0	0	1	1
	% total catch	0.00%	0.00%	100.00%	100.00%
	CPUE (ind/net hr)	0.00	0.00	0.10	0.10
SC40 (10.25 hrs)	Count	0	47	0	47
	% total catch	0.00%	100.00%	0.00%	100.00%
	CPUE (ind/net hr)	0.00	4.59	0.00	4.59
SC48 (9.97 hrs)	Count	0	0	0	0
	% total catch	0.00%	0.00%	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00	0.00	0.00
SC53* (13.41 hrs)	Count	0	0	0	0
	% total catch	0.00%	0.00%	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00	0.00	0.00
SC54 (10.68 hrs)	Count	24	4	0	28
	% total catch	85.71%	14.29%	0.00%	100.00%
	CPUE (ind/net hr)	2.25	0.37	0.00	2.62
Total	Count	24	116	2	142
	% total catch	16.90%	81.69%	1.41%	100.00%
	CPUE (ind/net hr)	0.19	0.92	0.02	1.13

*Denotes fixed station

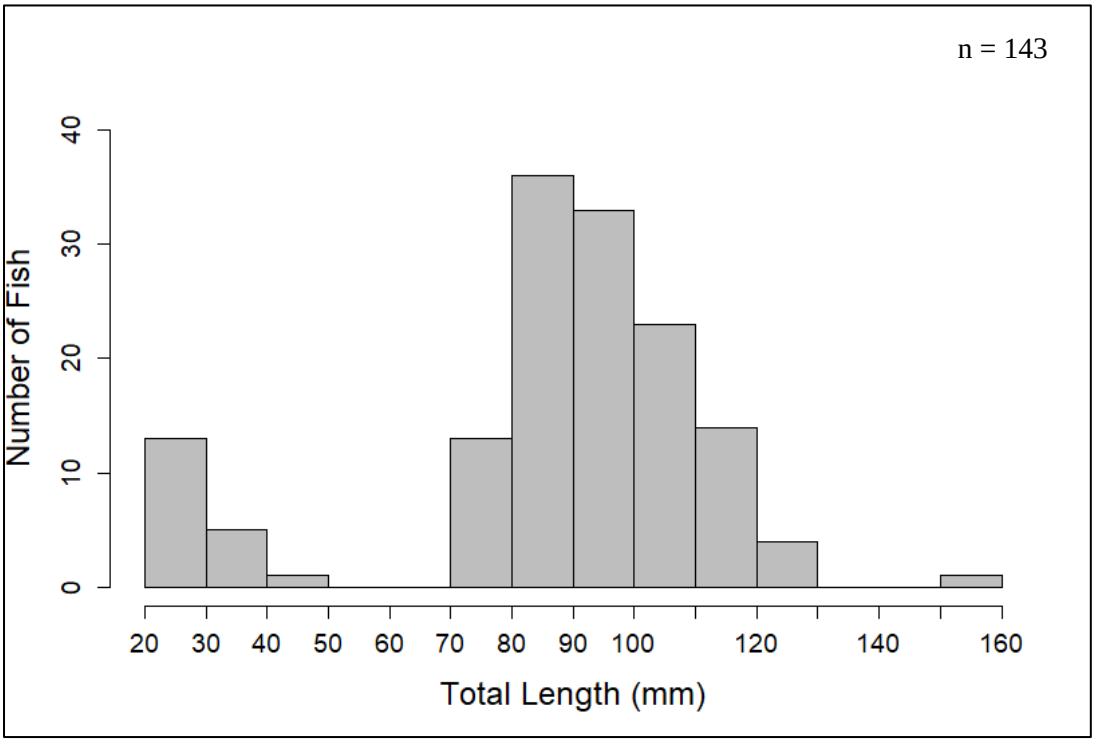

Figure 114. Length-frequency distribution for Gila Chub captured at Sabino Canyon, sampled on November 10 & 12, 2021.

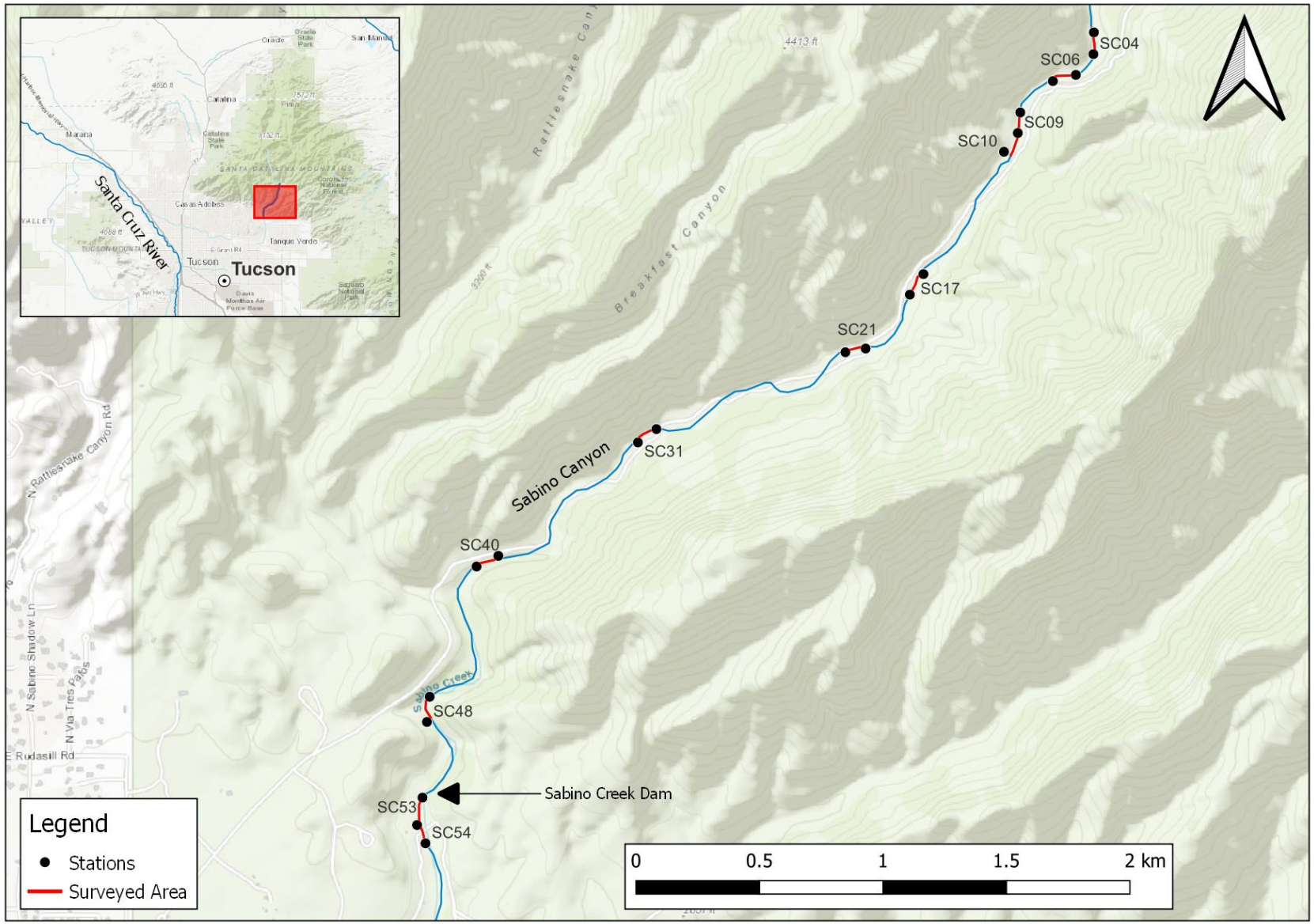

Figure 115. Location of sampling stations at Sabino Canyon, surveyed on November 10 & 12, 2021.

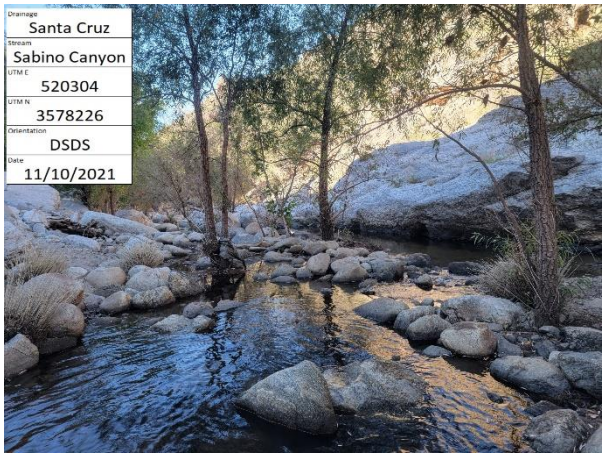

Figure 116. Downstream to downstream view of fixed station SC06 at Sabino Canyon.

Figure 117. Downstream to upstream view of fixed station SC06 at Sabino Canyon.

Figure 118. Upstream to downstream view of fixed station SC06 at Sabino Canyon.

Figure 119. Upstream to upstream view of fixed station SC06 at Sabino Canyon.

Figure 120. Downstream to downstream view of fixed station SC53 at Sabino Canyon.

Figure 121. Downstream to upstream view of fixed station SC53 at Sabino Canyon.

Figure 122. Upstream to downstream view of fixed station SC53 at Sabino Canyon.

Figure 123. Upstream to upstream view of fixed station SC53 at Sabino Canyon.

Bear Canyon November 11, 2021

Station		Lower Boundary	Upper Boundary
BR18	12S NAD83	522482E, 3578390N	522528E, 3578466N
BR21		522281E, 3578238N	522350E, 3578236N
BR33		521811E, 3577374N	521825E, 3577466N
BR37 (Fixed)		521544E, 3577126N	521641E, 3577141N

Bear Canyon (Pima County, AZ) is located adjacent to Sabino Canyon in the Santa Catalina Mountains northeast of Tucson, AZ. Bear Canyon was stocked with Gila Chub in 2005 and the status of the population was unknown until they were detected in 2018 and 2019. Gila Chub was the focal species for this survey. Bear Canyon has not been surveyed previously for GRBMP.

M&A personnel surveyed Bear Canyon on November 11, 2021. Four stations (1 fixed, 3 random) were completed in Bear Canyon between Seven Falls and Sycamore Canyon (Figure 125). Stations were accessed via Bear Canyon Trailhead in Sabino Canyon National Recreation Area. The most downstream station was located just above the top of Seven Falls and the most upstream station was 400-m upstream from the Bear Canyon trail creek crossing. Five minnow traps and five mini mini-hoop nets were set at each station.

No fishes were detected at fixed station BR37 after a total effort of 18.43 combined trap hours. Gila Chub (n=42; 100%) were detected at all three of the random stations. The spatial distribution of Gila Chub was not uniform in Bear Canyon, and the species may be more abundant than catch totals imply. We visually observed more than 100 Gila Chub in a large pool ~75-m downstream from our upper most station. A Black-necked Gartersnake *Thamnophis cyrtopsis* and Canyon Tree Frogs also were observed throughout our survey reach. Catch and effort totals for all surveyed stations are summarized in Tables 26 & 27.

Water temperature, dissolved oxygen, pH, and conductivity at the fixed station were 15.4 °C, 7.5 mg/L, 7.74, and 137 µS, respectively. A length-frequency histogram for all Gila Chub captured at Bear Canyon is included below (Figure 124). Photographs of upper and lower extents of the fixed station are provided below (Figures 126-129).

Table 26. Summary of catch at all stations at Bear Canyon by minnow trap. Total effort was 34.37 hours.

Station	Statistic	GIIN	Total
BR18 (8.97 hrs)	Count	1	1
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	0.11	0.11
BR21 (9.27 hrs)	Count	0	0
	% total catch	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00
BR33 (8.18 hrs)	Count	20	20
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	2.44	2.44
BR37* (7.95 hrs)	Count	0	0
	% total catch	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00
Total	Count	21	21
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	0.61	0.61

*Denotes fixed station

Table 27. Summary of catch at all stations at Bear Canyon by mini-hoop net. Total effort was 41.19 hours.

Station	Statistic	GIIN	Total
BR18 (8.88 hrs)	Count	10	10
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	1.13	1.13
BR21 (11.68 hrs)	Count	3	3
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	0.26	0.26
BR33 (10.15 hrs)	Count	8	8
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	0.79	0.79
BR37* (10.48 hrs)	Count	0	0
	% total catch	0.00%	0.00%
	CPUE (ind/net hr)	0.00	0.00
Total	Count	21	21
	% total catch	100.00%	100.00%
	CPUE (ind/net hr)	0.51	0.51

*Denotes fixed station

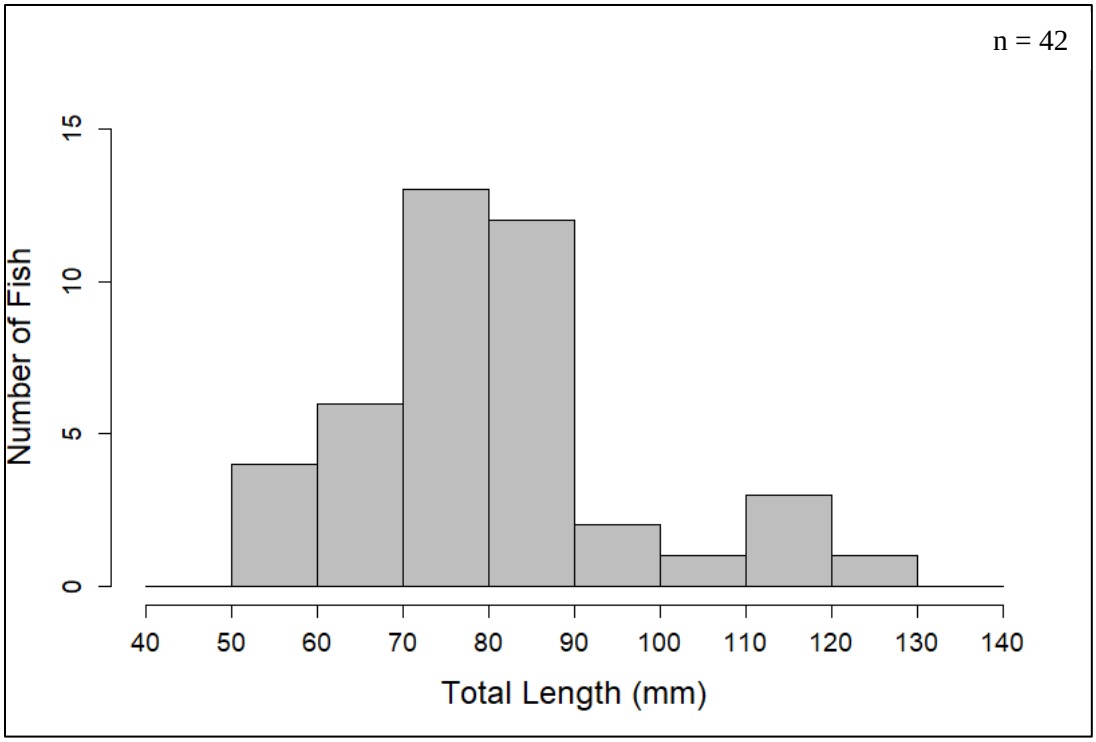

Figure 124. Length-frequency distribution for Gila Chub captured at Bear Canyon, sampled on November 11, 2021.

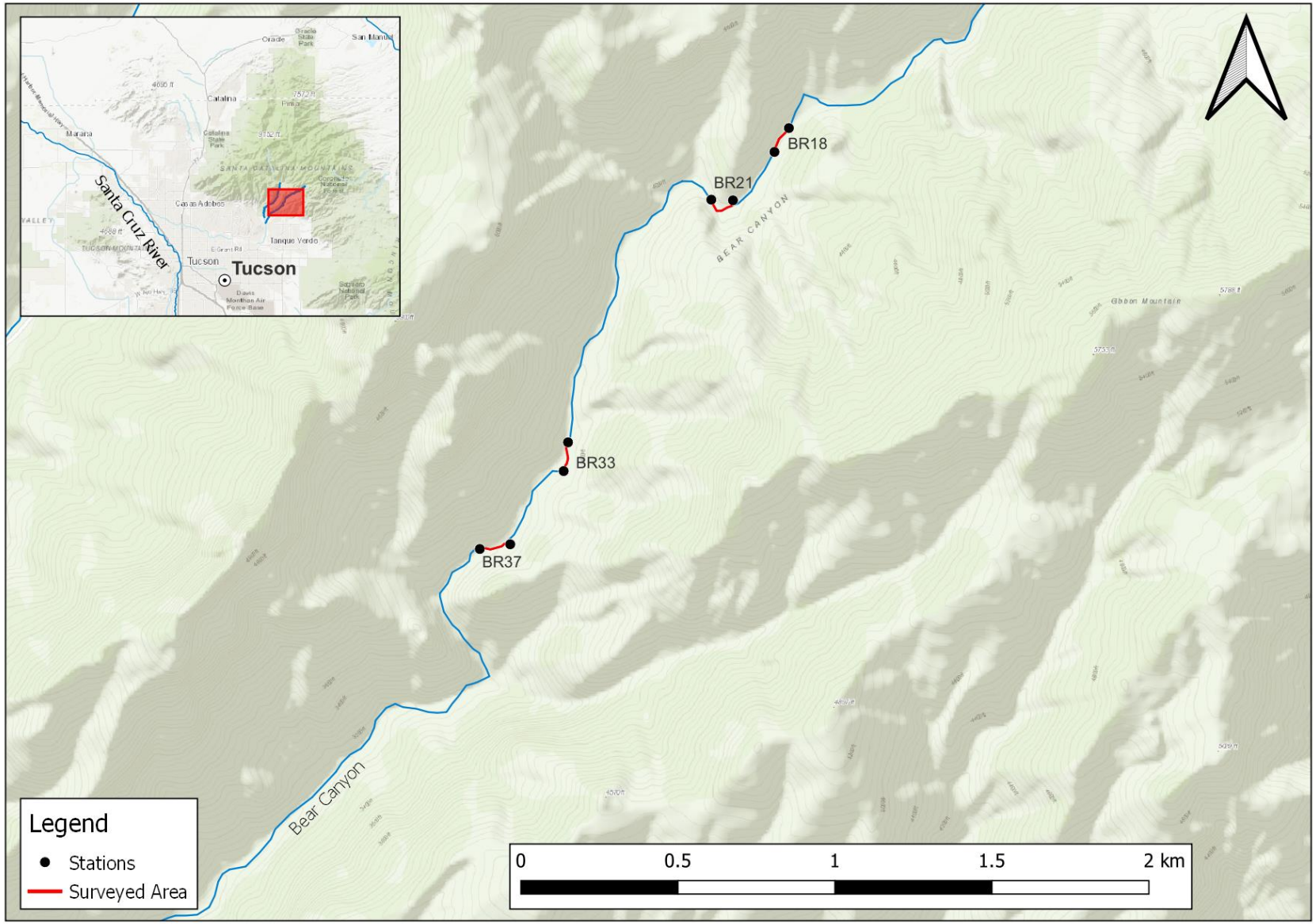

Figure 125. Location of sampling stations at Bear Canyon, surveyed November 11, 2021.

Figure 126. Downstream to downstream view of fixed station BR37 at Bear Canyon.

Figure 127. Downstream to upstream view of fixed station BR37 at Bear Canyon.

Figure 128. Upstream to downstream view of fixed station BR37 at Bear Canyon.

Figure 129. Upstream to upstream view of fixed station BR37 at Bear Canyon.

Upper Gila River Basin

Dix Creek October 12-14, 2021

Station		Lower Boundary	Upper Boundary
DC01 (Fixed)	12S NAD83	671791E, 3673548N	671766E, 3673461N
DC08		671710E, 3674204N	671733E, 3674139N
DC14		671688E, 3674793N	671712E, 3674675N
LPDC21		672157E, 3672983N	672234E, 3672908N
LPDC25		671940E, 3673238N	671938E, 3673144N
LPDC26		671894E, 3673321N	671943E, 3673238N
RPDC06		671612E, 3673329N	671577E, 3673274N
RPDC08		671672E, 3673509N	671626E, 3673434N

Dix Creek (Greenlee County, AZ) is located in Apache-Sitgreaves National Forest approximately 80 km northeast of Safford, AZ in the Upper Gila sub-basin. Dix Creek originates at the confluence of Left Prong Dix Creek and Right Prong Dix Creek and flows north to its confluence with the San Francisco River. The fish assemblage in Dix Creek is entirely native and the stream supports a natural Gila Chub population. Gila Chub was the focal species for this survey. Dix Creek was last surveyed for GRBMP in 2018, resulting in the capture of 75 Gila Chub.

M&A personnel completed sampling at Dix Creek on October 12-14, 2021. Sampling was completed by BPEF. A total of eight 100-m stations were surveyed (Figure 131). The three most downstream stations were accessed by hiking upstream from Martinez Ranch Road. Remaining stations were accessed by parking along NF-215 and hiking down into Left Prong Dix Creek. Across all surveyed stations 83 Gila Chub, 168 Speckled Dace, 95 Longfin Dace, 34 Desert Sucker, and 15 Sonora Sucker were captured. Gila Chub were detected at all but the most downstream station.

Fixed station DC01 was located immediately below the confluence of the left and right prongs. Electrofishing effort at DC01 totaled 641 seconds. Species captured were Gila Chub (n=13; 26%), Speckled Dace (n=19; 38%), Longfin Dace (n=12; 24%), Sonora Sucker (n=4; 8%), and Desert Sucker (n=2; 4%).

Random stations DC08 and DC14 were located downstream from DC01 in Dix Creek. Electrofishing effort totaled 1,832 seconds across these two stations. Species captured were Gila Chub (n=12; 12.77%), Speckled Dace (n=43; 45.74%), Longfin Dace (n=22; 23.4%), Desert Sucker (n=15; 15.96%), and Sonora Sucker (n=2; 2.12%).

Random stations RPDC06 and RPDC08 were surveyed in Right Prong Dix Creek. Electrofishing effort totaled 1,432 seconds across these two stations. Species captured were Gila Chub (n=36; 28.8%), Speckled Dace (n=45; 36%), Longfin Dace (n=22; 17.6%), Desert Sucker (n=13; 10.4%), and Sonora Sucker (n=9; 7.2%).

Random stations LPDC21, LPDC25, and LPDC26 were surveyed in Left Prong Dix Creek. Electrofishing effort totaled 1,565 seconds across these three stations. Species captured were Gila Chub (n=22; 17.46), Speckled Dace (n=61; 48.41%), Longfin Dace (n=39; 30.95%), and Desert Sucker (n=4;

3.17%). Fishes were noticeably less abundant further upstream in Left Prong Dix Creek. Three additional stations were planned further upstream however we were unable to safely access these stations with electrofishing equipment due to a 5-m waterfall and large slot canyon pool located at UTM 12S 672476E, 3672800N. Catch and effort totals for all surveyed stations are summarized in Table 28.

Northern Crayfish were abundant throughout all surveyed stations. Stream discharge was measured at the upstream boundary of DC01 and calculated to be 0.03 m^3/s. Water temperature, dissolved oxygen, pH, and conductivity at the fixed station were 19.2 °C, 6.5 mg/L, 8.50, and 340 µS, respectively. A length-frequency histogram for all Gila Chub captured at Dix Creek is included below (Figure 130). Photographs of upper and lower extents of the fixed station are provided below (Figures 132-135).

Table 28. Summary of catch across all stations at Dix Creek by BPEF, surveyed on October 12-14, 2021. Total effort was 5,470 seconds.

Station	Statistic	AGCH	RHOS	CAIN	PACL	GIIN	Total
DC01 (641 sec)	Count	12	19	4	2	13	50
	% total catch	24.00%	38.00%	8.00%	4.00%	26.00%	100.00%
	CPUE (ind/min)	1.12	1.78	0.37	0.19	1.22	4.68
DC08 (756 sec)	Count	9	13	2	0	12	36
	% total catch	25.00%	36.11%	5.56%	0.00%	33.33%	100.00%
	CPUE (ind/min)	0.71	1.03	0.16	0.00	0.95	2.86
DC14* (1,076 sec)	Count	13	30	0	15	0	58
	% total catch	22.41%	51.72%	0.00%	25.86%	0.00%	100.00%
	CPUE (ind/min)	0.72	1.67	0.00	0.84	0.00	3.23
LPDC21 (460 sec)	Count	2	13	0	0	1	16
	% total catch	12.50%	81.25%	0.00%	0.00%	6.25%	100.00%
	CPUE (ind/min)	0.26	1.70	0.00	0.00	0.13	2.09
LPDC25 (574 sec)	Count	14	20	0	0	9	43
	% total catch	32.56%	46.51%	0.00%	0.00%	20.93%	100.00%
	CPUE (ind/min)	1.46	2.09	0.00	0.00	0.94	4.49
LPDC26 (531 sec)	Count	23	28	0	4	12	67
	% total catch	34.33%	41.79%	0.00%	5.97%	17.91%	100.00%
	CPUE (ind/min)	2.60	3.16	0.00	0.45	1.36	7.57
RPDC06 (524 sec)	Count	7	25	6	6	26	70
	% total catch	10.00%	35.71%	8.57%	8.57%	37.14%	100.00%
	CPUE (ind/min)	0.80	2.86	0.69	0.69	2.98	8.02
RPDC08 (908 sec)	Count	15	20	3	7	10	55
	% total catch	27.27%	36.36%	5.45%	12.73%	18.18%	100.00%
	CPUE (ind/min)	0.99	1.32	0.20	0.46	0.66	3.63
Total	Count	95	168	15	34	83	395
	% total catch	24.05%	42.53%	3.80%	8.61%	21.01%	100.00%
	CPUE (ind/min)	1.04	1.84	0.16	0.37	0.91	4.33

*Denotes fixed station

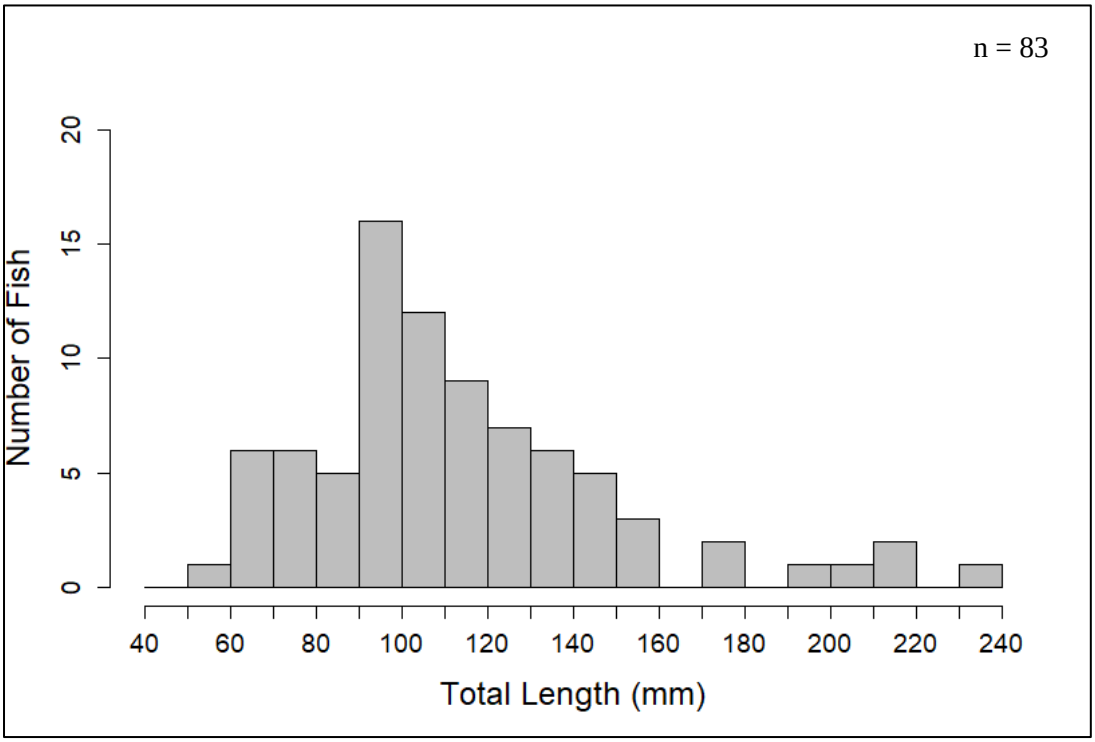

Figure 130. Length-frequency distribution for Gila Chub captured at Dix Creek, sampled on October 12-14, 2021.

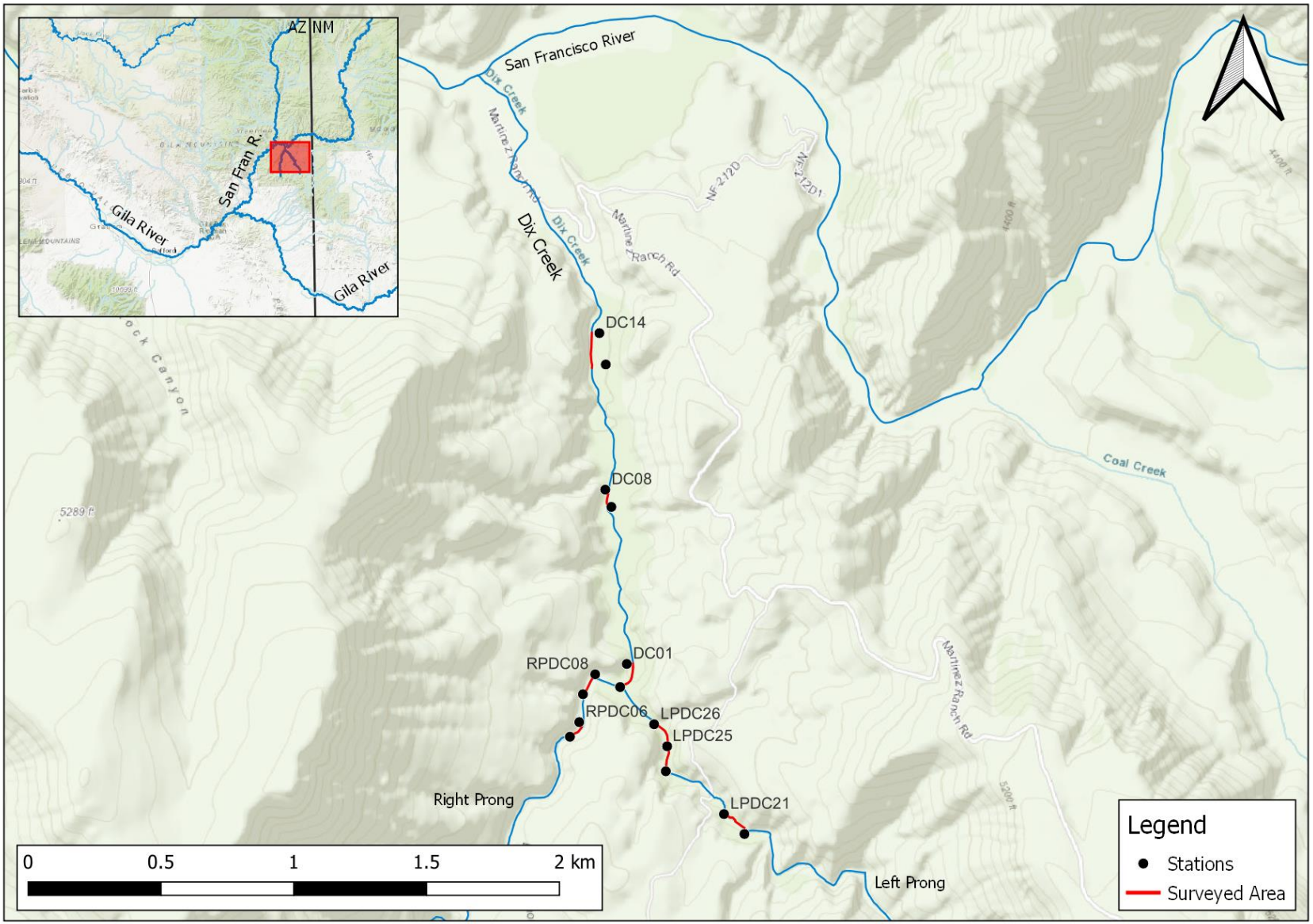

Figure 131. Location of sampling stations at Dix Creek, surveyed on October 12-14, 2021.

Figure 132. Downstream to downstream view of fixed station DC01 at Dix Creek.

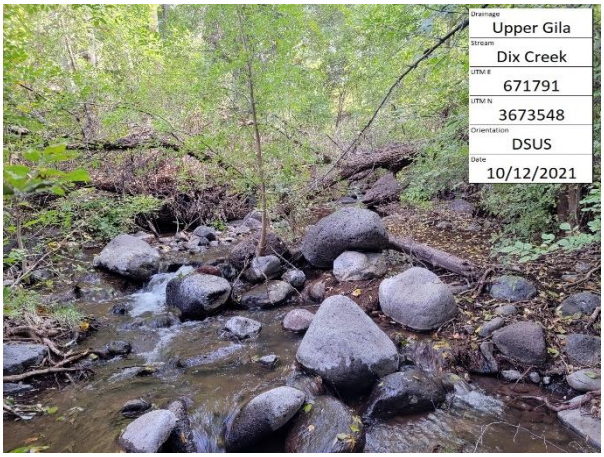

Figure 133. Downstream to upstream view of fixed station DC01 at Dix Creek.

Figure 134. Upstream to downstream view of fixed station DC01 at Dix Creek.

Figure 135. Upstream to upstream view of fixed station DC01 at Dix Creek.

Lower Blue River October 18-20, 2021

Reach	Station		Lower Boundary	Upper Boundary
1	BL09	12S NAD83	667528E, 3677637N	667520E, 3677816N
1	BL15 (Fixed)		668121E, 3678446N	668164E, 3678270N
1	BL17		668309E, 3678169N	668467E, 3678135N
2	BL29		668634E, 3679845N	668742E, 3679942N
2	BL34		668529E, 3680595N	668695E, 3680722N
3	BL42		668011E, 3681461N	667862E, 3681614N
3	BL49		668110E, 3682585N	668144E, 3682781N
4	BL57		668035E, 3684068N	667839E, 3684059N
4	BL60		667945E, 3684327N	667968E, 3684520N
4	BL64 (Fixed)		667968E, 3685061N	668094E, 3685219N
5	BL67		668324E, 3685534N	668333E, 3685721N
5	BL75		668190E, 3686547N	668311E, 3686534N
6	BL77		668375E, 3686825N	668409E, 3686943N
6	BL88		668596E, 3688196N	668497E, 3688374N
6	BL90 (Fixed)		668609E, 3688505N	668624E, 3688698N

The Blue River (Greenlee County, AZ) is a major tributary to the San Francisco River and is located in Apache-Sitgreaves National Forest. Following the 2011 Wallow Fire, Spikedace, Loach Minnow, and Roundtail Chub were stocked into the lower Blue River and have since established self-sustaining populations (Robinson et al. 2017). Non-natives, such as Green Sunfish, Fathead Minnow, Red Shiner, and Channel Catfish, have not been detected since 2017 (Hickerson and Robinson 2019). A fish barrier located 0.8 km upstream from the San Francisco River confluence was constructed in 2012 to prevent movement of non-native fishes upstream. The monitoring reach for this program is located from the barrier to Fritz Ranch (Figure 136). Lower Blue River monitoring efforts have been conducted annually since 2012. Spikedace and Loach Minnow were the focal species for this survey.

M&A and Reclamation personnel completed monitoring of the lower Blue River on October 18-20, 2021. Sampling was completed by backpack electrofishing. Stations BL88 and BL90 were accessed from XXX Ranch Road and remaining stations were accessed by hiking from Juan Miller Road crossing.

We electrofished fifteen 200-m stations (12 random, 3 fixed) in reaches one through six (Barrier to Fritz Ranch) and captured totals of 2 Roundtail Chub, 19 Desert Sucker, 5 Speckled Dace, 6 Longfin Dace, and 1 Sonora Sucker. Combined catch totals for the 15 stations are summarized in Table 29. Roundtail Chub were 110 and 215 mm total length. We did not detect Loach Minnow, Spikedace, or any non-native species. This is a significant decrease from previous monitoring efforts. Lowland Leopard Frogs and Northern Crayfish were observed; crayfish densities were low (0-2 per station).

Visibility was excellent and all but one fish that was visually observed was captured. There appeared to be significant scouring from flooding and substrate in pools was predominately fine sediment. In

addition, embeddedness was high and interstitial space between rocks in riffles and runs was filled with sediment except in swift flowing sections. Most fishes were captured in swift water.

This dramatic reduction in catch is consistent with post-fire flood impacts likely caused by a combination of Bringham and Cow Canyon fires last year and this year's extraordinary monsoon season. The fish assemblage in the lower Blue River experienced a similar impact in 2011 due to runoff from the Wallow Fire (Kesner et al. 2011). The entire assemblage is intact further upstream, and this reach could be repopulated through natural dispersal. Also, larval fish were observed along stream margins indicating fish spawned this year.

Average stream discharge across the three fixed stations was calculated to be 0.33 m^3/s. Average water temperature, dissolved oxygen, pH, and conductivity across the three fixed stations were 18.0 °C, 10.7 mg/L, 8.67, and 820 µS, respectively. Photographs of upper and lower extents of each fixed station are provided below (Figures 137-148).

Table 29. Summary of catch by BPEF for the 15 stations sampled on the lower Blue River on October 18-20, 2021. Total effort was 13,019 seconds.

Reach	Stations	Statistic	AGCH	CAIN	GIRO	PACL	RHOS	Totals
1 (2,717 sec)	BL09 BL15* BL17	Count	2	0	1	7	0	10
		% total catch	20.00%	0.00%	10.00%	70.00%	0.00%	100.00%
		CPUE (ind/min)	0.04	0.00	0.02	0.15	0.00	0.22
2 (1,670 sec)	BL29 BL34	Count	0	0	1	0	0	1
		% total catch	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%
		CPUE (ind/min)	0.00	0.00	0.04	0.00	0.00	0.04
3 (1,609 sec)	BL42 BL49	Count	0	0	0	0	0	0
		% total catch	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		CPUE (ind/min)	0.00	0.00	0.00	0.00	0.00	0.00
4 (2,546 sec)	BL57 BL60 BL64*	Count	0	0	0	2	1	3
		% total catch	0.00%	0.00%	0.00%	66.67%	33.33%	100.00%
		CPUE (ind/min)	0.00	0.00	0.00	0.05	0.02	0.07
5 (1,437 sec)	BL67 BL75	Count	0	1	0	1	0	2
		% total catch	0.00%	50.00%	0.00%	50.00%	0.00%	100.00%
		CPUE (ind/min)	0.00	0.04	0.00	0.04	0.00	0.08
6 (3,040 sec)	BL77 BL88 BL90*	Count	4	0	0	9	4	17
		% total catch	23.53%	0.00%	0.00%	52.94%	23.53%	100.00%
		CPUE (ind/min)	0.08	0.00	0.00	0.18	0.08	0.34
Total		Count	6	1	2	19	5	33
		% total catch	18.18%	3.03%	6.06%	57.58%	15.15%	100.00%
		CPUE (ind/min)	0.03	0.00	0.01	0.09	0.02	0.15

*Denotes fixed station

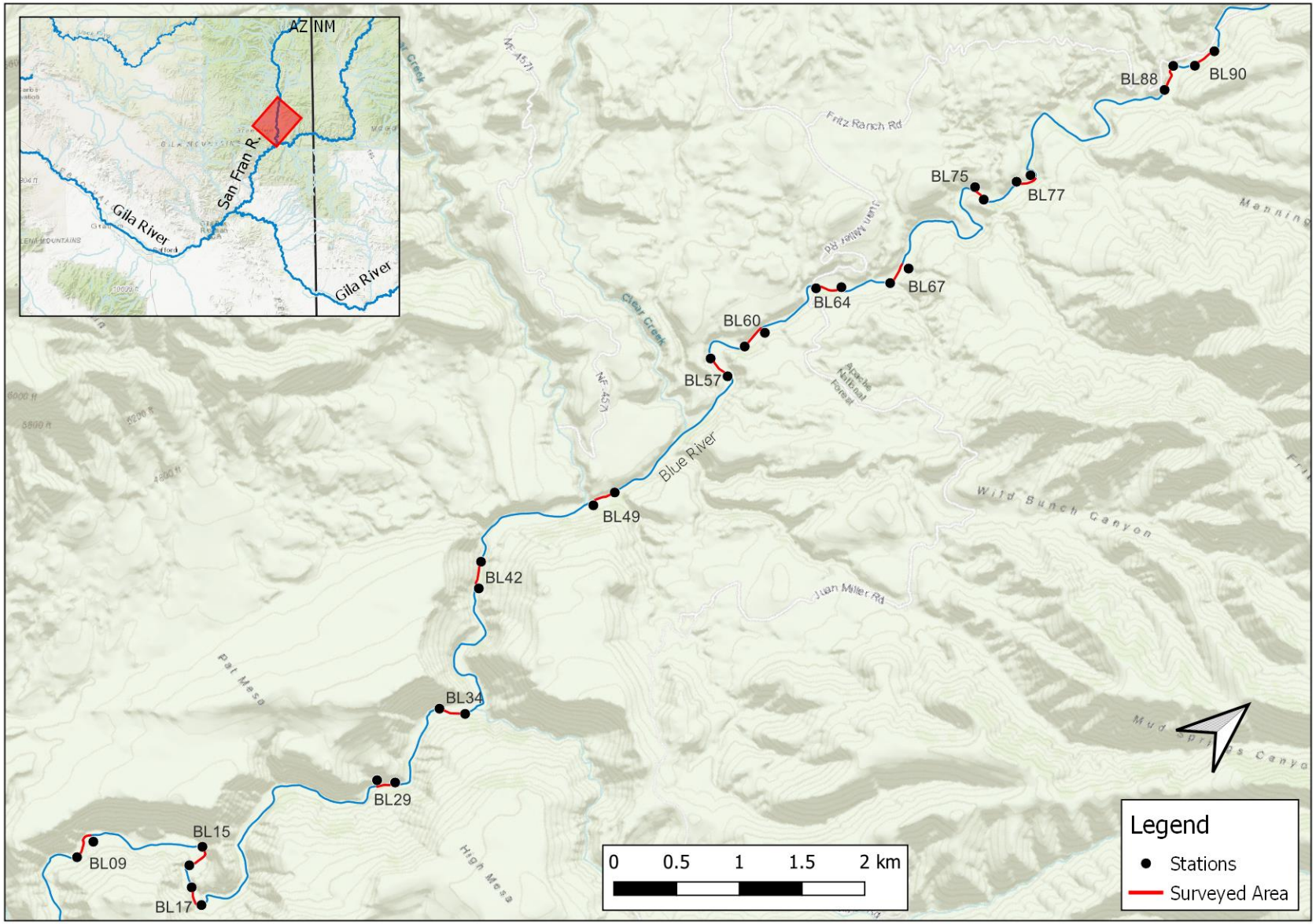

Figure 136. Location of sampling stations at lower Blue River, surveyed on October 18-20, 2021.

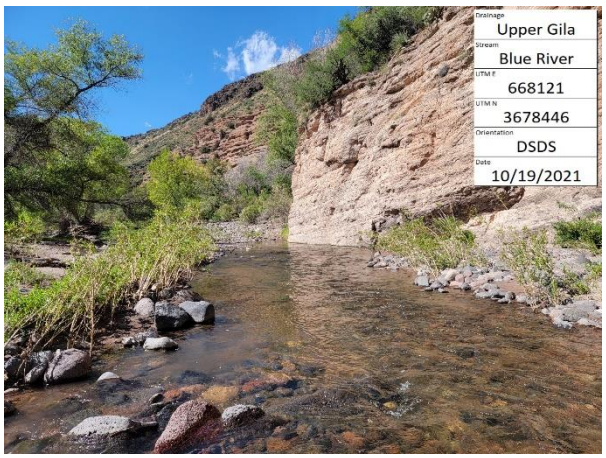

Figure 137. Downstream to downstream view of fixed station BL15 at lower Blue River.

Figure 138. Downstream to upstream view of fixed station BL15 at lower Blue River.

Figure 139. Upstream to downstream view of fixed station BL15 at lower Blue River.

Figure 140. Upstream to upstream view of fixed station BL15 at lower Blue River.

Figure 141. Downstream to downstream view of fixed station BL64 at lower Blue River.

Figure 142. Downstream to upstream view of fixed station BL64 at lower Blue River.

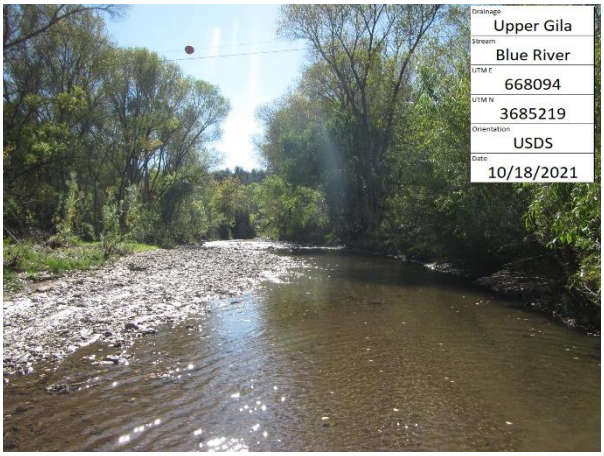

Figure 143. Upstream to downstream view of fixed station BL64 at lower Blue River.

Figure 144. Upstream to upstream view of fixed station BL64 at lower Blue River.

Figure 145. Downstream to downstream view of fixed station BL90 at lower Blue River.

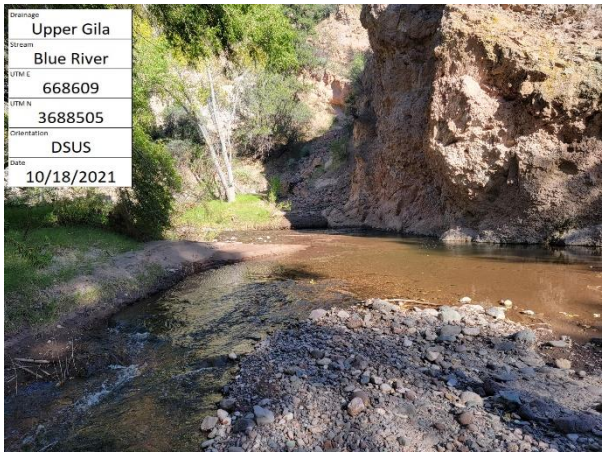

Figure 146. Downstream to upstream view of fixed station BL90 at lower Blue River.

Figure 147. Upstream to downstream view of fixed station BL90 at lower Blue River.

Figure 148. Upstream to upstream view of fixed station BL90 at lower Blue River.

Bear Creek October 26 & 27, 2021

Station		Lower Boundary	Upper Boundary
BC13	12S NAD83	734946E, 3650385N	735057E, 3650415N
BC17		734359E, 3650574N	734558E, 3650575N
BC25		733188E, 3651027N	733331E, 3650942N
BC29 (Fixed)		732497E, 3651253N	732648E, 3651122N

Bear Creek (Grant County, NM) begins in Pinos Altos Mountain Range north of Silver City, NM in the Upper Gila sub-basin. The monitoring reach encompasses a 5.4 km section of stream that begins near Dorsey Spring. Loach Minnow was the focal species for this survey. Loach Minnow were first detected in Bear Creek in 2005 (Menzie and Hopkins 2009). Bear Creek was last surveyed for GRBMP in 2019, resulting in the capture of 83 Loach Minnow (Shollenberger et al. 2020). An initial survey effort in August 2021 was canceled after the completion of two stations due to high flow caused by heavy rain.

M&A personnel completed sampling Bear Creek on October 26 and 27, 2021. Sampling was completed via BPEF. Bear Creek was accessed by parking at the Double E Ranch Management Area and hiking upstream to the survey stations. Coordination with NMGFD is required to access this property. Four 200-m stations were surveyed at Bear Creek with the lowest station beginning at the Double E Ranch Management Area property boundary and the upper-most station located 3.2 km upstream near Stone Canyon (Figure 150). Stations completed in August 2021 were resurveyed in October due to more favorable conditions for BPEF. Results discussed below are from the October survey.

Across all four stations, totals of 158 Loach Minnow, 1,337 Longfin Dace, 635 Desert Sucker, and 131 Sonora Sucker were captured. Specifically for fixed station BC29, electrofishing effort totaled 1,740 seconds. Species captured at BC29 were Loach Minnow (n=65; 11.37%), Longfin Dace (n=353; 61.71%), Desert Sucker (n=127; 22.21%), and Sonora Sucker (n=27; 4.72%). Catch and effort totals for all surveyed stations are summarized in Table 30.

Loach Minnow were detected at all four stations, although in low numbers at station BC13 (n=4). Compared to the previous GRBMP survey, Loach Minnow were less abundant throughout the fixed site with 65 Loach Minnow captured in 200-m this year compared to 83 individuals captured in 100-m in 2019. This could be due to the increase in available habitat and surface water at the time of this survey compared to dryer conditions of June 2019. In addition, post-fire effects from the Tadpole Fire in the upper portion of the drainage could have contributed to lower numbers.

Stream discharge was measured at the upstream boundary of BC29 and calculated to be 0.28 m^3/s on 8/31/2021 and 0.07 m^3/s on 10/27/2021. Water temperature, dissolved oxygen, pH, and conductivity at the fixed station were 15.9 °C, 5.2 mg/L, 8.50, and 469 µS, respectively. A length-frequency histogram for all Loach Minnow captured at Bear Creek is included below (Figure 149). Photographs of upper and lower extents of the fixed station are provided below (Figures 151-154).

Table 30. Summary of catch at four stations within Bear Creek by BPEF, surveyed on October 27 & 28, 2021. Total effort was 5,494 seconds.

Station	Statistic	AGCH	CAIN	PACL	TICO	Total
BC13 (895 sec)	Count	117	0	21	4	142
	% total catch	82.39%	0.00%	14.79%	2.82%	100.00%
	CPUE (ind/min)	7.84	0.00	1.41	0.27	9.52
BC17 (1,388 sec)	Count	515	60	316	45	936
	% total catch	55.02%	6.41%	33.76%	4.81%	100.00%
	CPUE (ind/min)	22.26	2.59	13.66	1.95	40.46
BC25 (1,471 sec)	Count	352	44	171	44	611
	% total catch	57.61%	7.20%	27.99%	7.20%	100.00%
	CPUE (ind/min)	14.36	1.79	6.97	1.79	24.92
BC29* (1,740 sec)	Count	353	27	127	65	572
	% total catch	61.71%	4.72%	22.20%	11.36%	100.00%
	CPUE (ind/min)	12.17	0.93	4.38	2.24	19.72
Total	Count	1337	131	635	158	2261
	% total catch	59.13%	5.79%	28.08%	6.99%	100.00%
	CPUE (ind/min)	14.60	1.43	6.93	1.73	24.69

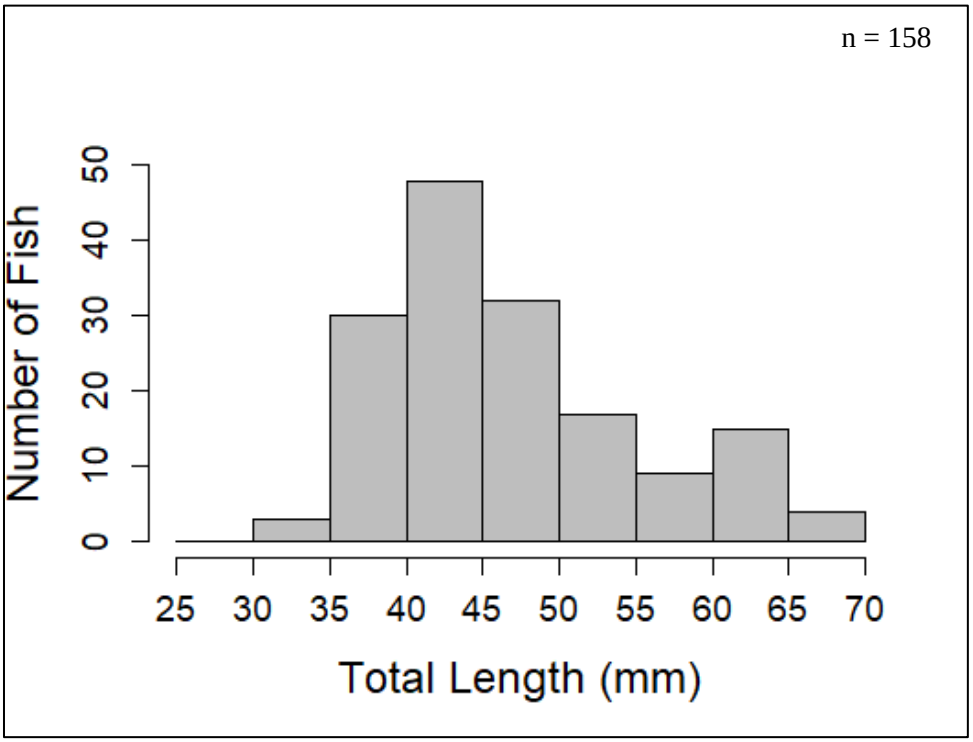

Figure 149. Length-frequency distribution for Loach Minnow captured at Bear Creek, sampled on October 26 & 27, 2021.

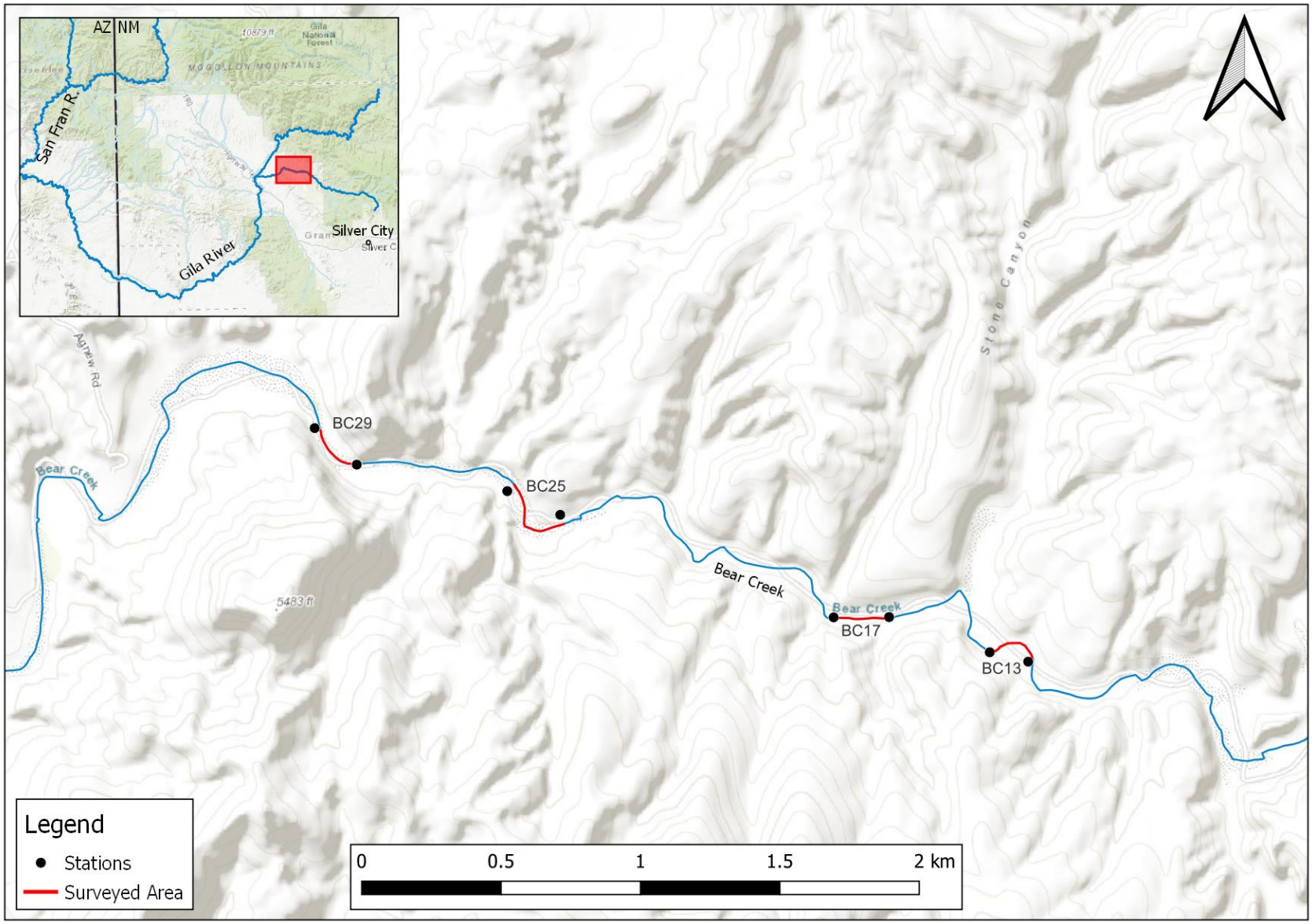

Figure 150. Location of sampling stations at Bear Creek, surveyed on October 26 & 27, 2021.

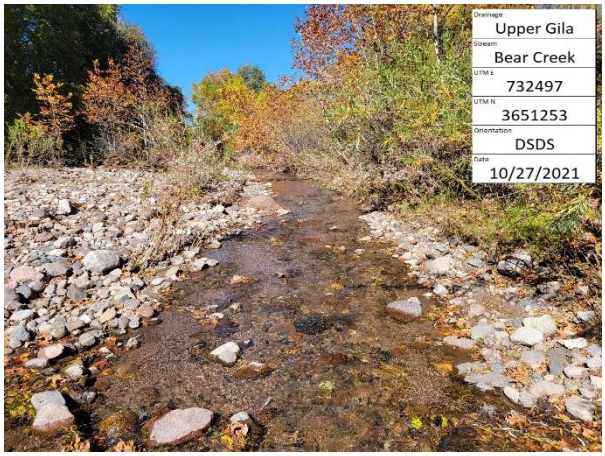

Figure 151. Downstream to downstream view of fixed station BC29 at Bear Creek.

Figure 152. Downstream to upstream view of fixed station BC29 at Bear Creek.

Figure 153. Upstream to downstream view of fixed station BC29 at Bear Creek.

Figure 154. Upstream to upstream view of fixed station BC29 at Bear Creek.

Lower Turkey Creek October 28, 2021

Station		Lower Boundary	Upper Boundary
TC06 (Fixed)	12S NAD83	734892E, 3665796N	734902E, 3665975N
TC10		734727E, 3665052N	734855E, 3665213N
TC16		734567E, 3663889N	734668E, 3664101N
TC22		734304E, 3662868N	734424E, 3662992N

Turkey Creek (Grant County, NM) is located northeast of Gila, NM in Gila National Forest. The lower Turkey Creek monitoring reach begins near Turkey Creek Hot Springs and flows 6 km to its confluence with the Gila River (Figure 156). Gila Chub was the focal species for this survey. Turkey Creek was last surveyed for GRBMP in 2019, resulting in capture of 197 Gila Chub (Shollenberger et al. 2020). An initial effort to survey Turkey Creek in August 2021 was cancelled due to heavy rain and flood conditions (Figure 161).

M&A personnel surveyed Turkey Creek on October 28, 2021. Sampling was completed via BPEF. Lower Turkey Creek was accessed via Turkey Creek Trail at the end of Turkey Creek Road. Four, 200-m stations were completed with the most downstream station located 400-m upstream from the Gila River confluence and the most upstream station above Skeleton Canyon. Across all surveyed stations, totals of 17 Gila Chub, 41 Desert Sucker, 9 Sonora Sucker, 2 Western Mosquitofish, and 1 Yellow Bullhead were captured. In the fixed station, TC06, electrofishing effort totaled 1,011 seconds and resulted in capture of 9 Gila Chub (100%). Gila Chub were detected at all but the most downstream station, although in sparse numbers. Catch and effort totals for all surveyed stations are summarized below (Table 35).

These numbers are dramatically lower compared to the previous GRBMP survey in August 2019 when 187 Gila Chub were captured across two 100-m stations. Also of note was the absence of Longfin Dace and Speckled Dace in this year's survey. It appears the Johnson Fire in May 2021, followed by an extraordinary monsoon season, had a negative impact of the fish assemblage in Turkey Creek. We observed a large amount of burned woody debris within the stream and large amounts of ashy sediment throughout our survey reach. Prior to the Johnson Fire, FWS and USFS personnel salvaged approximately 260 Gila Chub from Turkey Creek and reintroduced them into this reach shortly after monitoring efforts (D. Myers, personal communication, November 12, 2021).

Stream discharge was measured near the upstream boundary of TC06 and calculated to be 0.05 m^3/s. Water temperature, dissolved oxygen, pH, and conductivity at the fixed station were 20.5 °C, 6.0 mg/L, 8.65, and 323 µS, respectively. A length-frequency histogram for all Gila Chub captured at Turkey Creek is included below (Figure 155). Photographs of upper and lower extents of the fixed station are provided below (Figures 157-160).

Table 31. Summary of catch at four stations within Turkey Creek by BPEF, surveyed on October 28, 2021. Total effort was 3,666 seconds.

Station	Statistic	AMNA	CAIN	PACL	GIIN	GAAF	Total
TC06* (1,011 sec)	Count	0	0	0	9	0	9
	% total catch	0.00%	0.00%	0.00%	100.00%	0.00%	100.00%
	CPUE (ind/min)	0.00	0.00	0.00	0.53	0.00	0.53
TC10 (917 sec)	Count	0	3	5	4	0	12
	% total catch	0.00%	25.00%	41.67%	33.33%	0.00%	100.00%
	CPUE (ind/min)	0.00	0.20	0.33	0.26	0.00	0.79
TC16 (1,163 sec)	Count	1	6	36	4	0	47
	% total catch	2.13%	12.77%	76.60%	8.51%	0.00%	100.00%
	CPUE (ind/min)	0.05	0.31	1.86	0.21	0.00	2.42
TC22 (575 sec)	Count	0	0	0	0	2	2
	% total catch	0.00%	0.00%	0.00%	0.00%	100.00%	100.00%
	CPUE (ind/min)	0.00	0.00	0.00	0.00	0.21	0.21
Total	Count	1	9	41	17	2	70
	% total catch	1.43%	12.86%	58.57%	24.29%	2.86%	100.00%
	CPUE (ind/min)	0.02	0.15	0.67	0.28	0.03	1.15

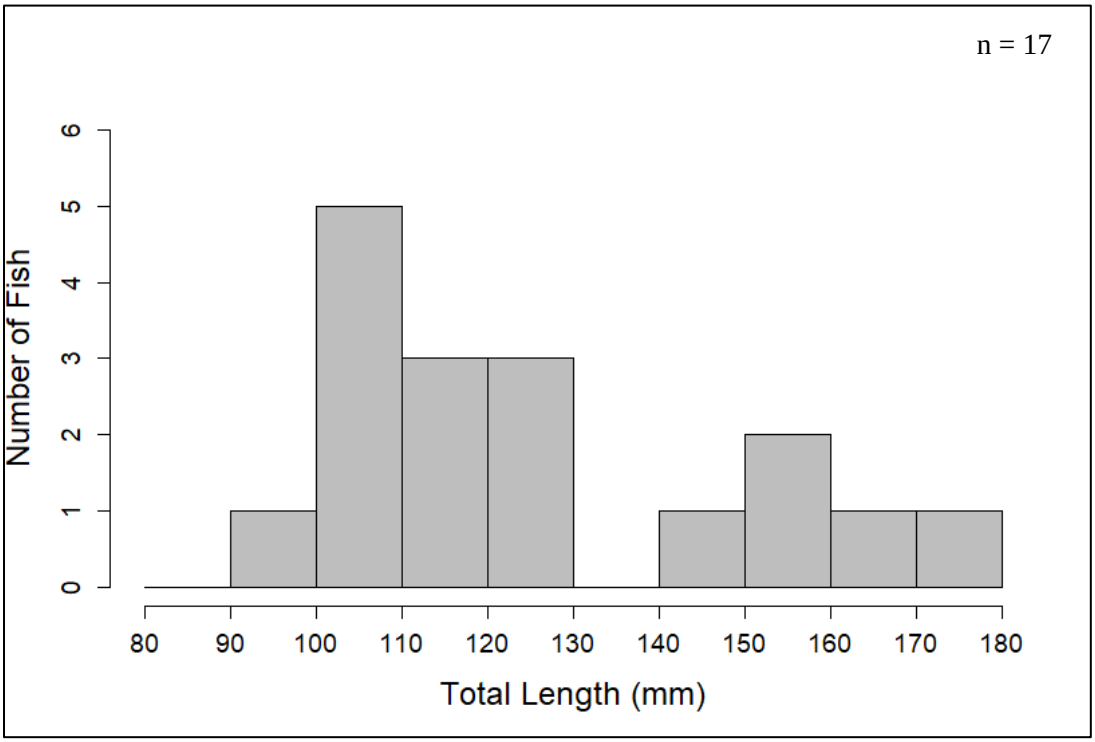

Figure 155. Length-frequency distribution for Gila Chub captured at Turkey Creek, sampled on October 28, 2021.

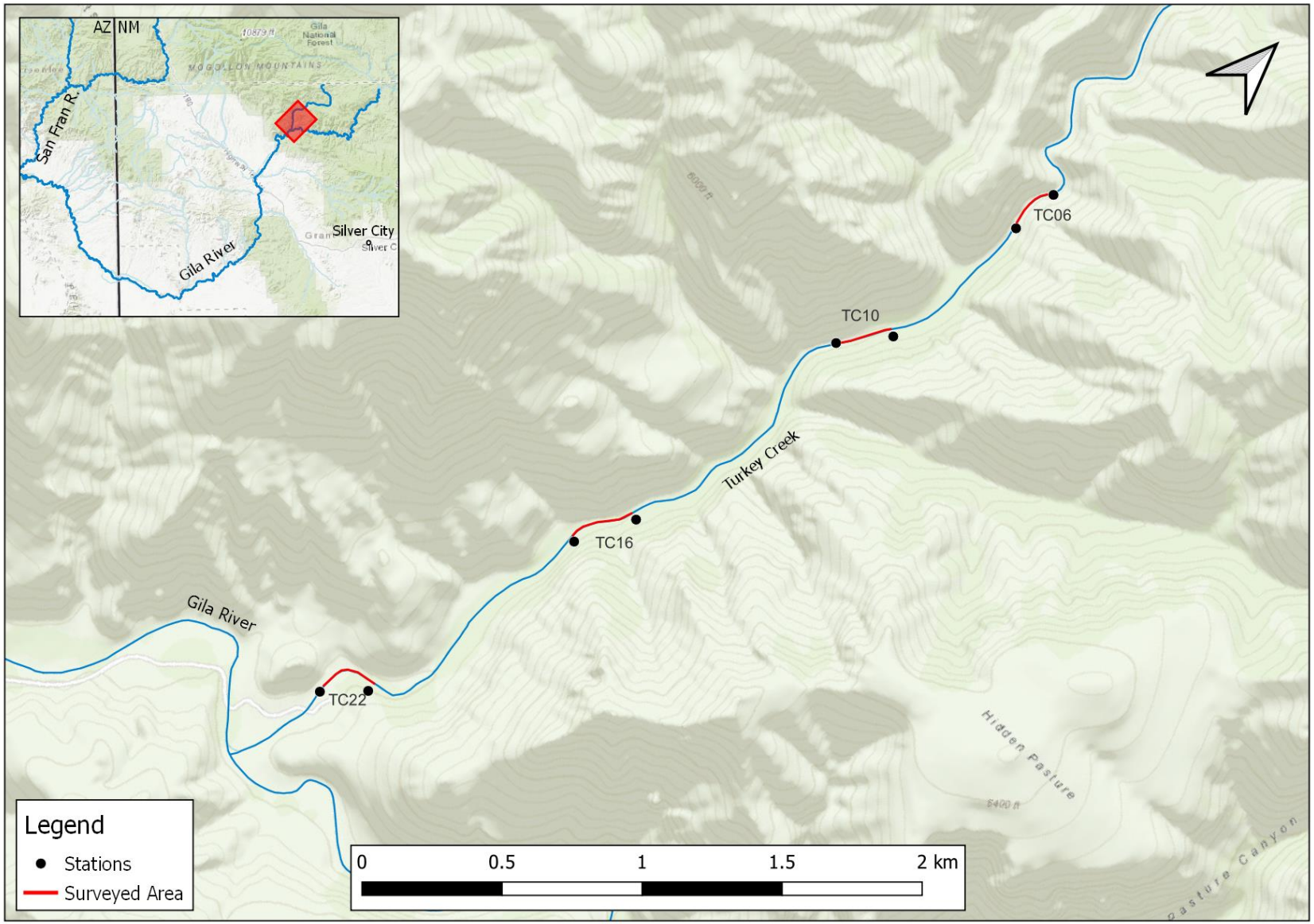

Figure 156. Location of sampling stations at Turkey Creek, surveyed on October 28, 2021.

Figure 157. Downstream to downstream view of fixed station TC06 at Turkey Creek.

Figure 158. Downstream to upstream view of fixed station TC06 at Turkey Creek.

Figure 159. Upstream to downstream view of fixed station TC06 at Turkey Creek.

Figure 160. Upstream to upstream view of fixed station TC06 at Turkey Creek.

Figure 161. Post-fire flooding in Turkey Creek, August 2021.

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Appendix A – supplementary graphs and figures

List of figures

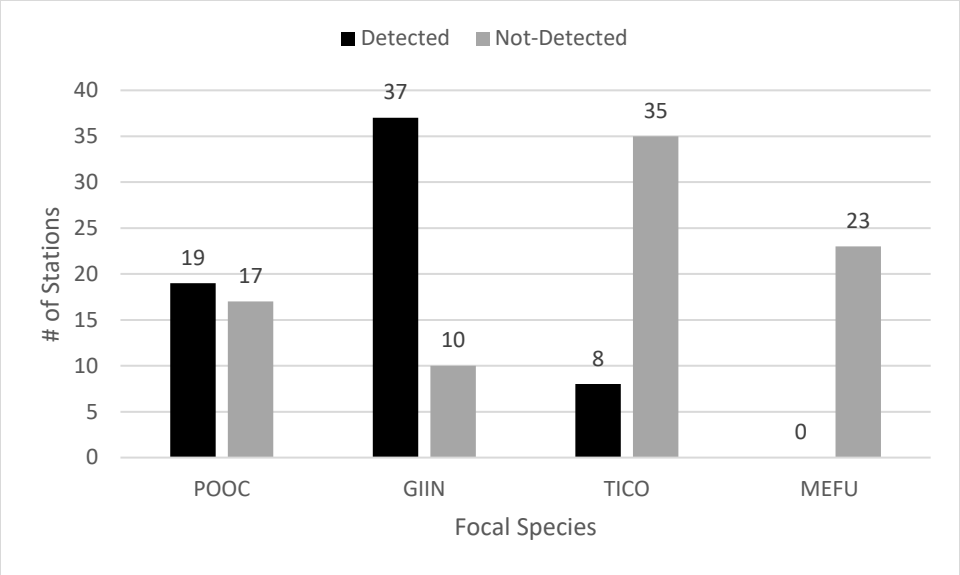

Figure A1. Number of stations where focal species were detected or not detected in selected streams of Gila River basin, 2021; see Table 1 for species codes. (Note: Some stations had multiple focal species)

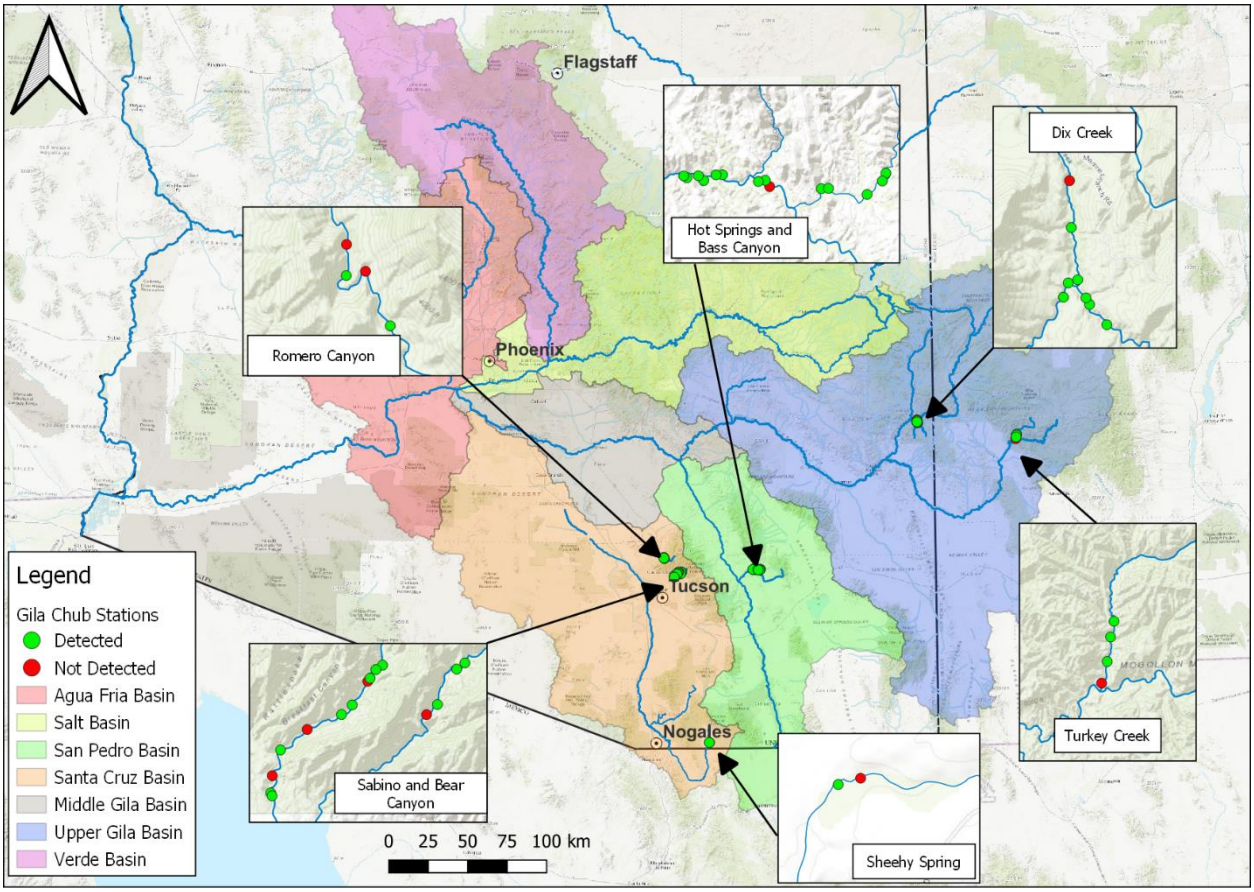

Figure A2. Location of sampling stations where Gila Chub were targeted and detected or not detected in Gila River basin, 2021.

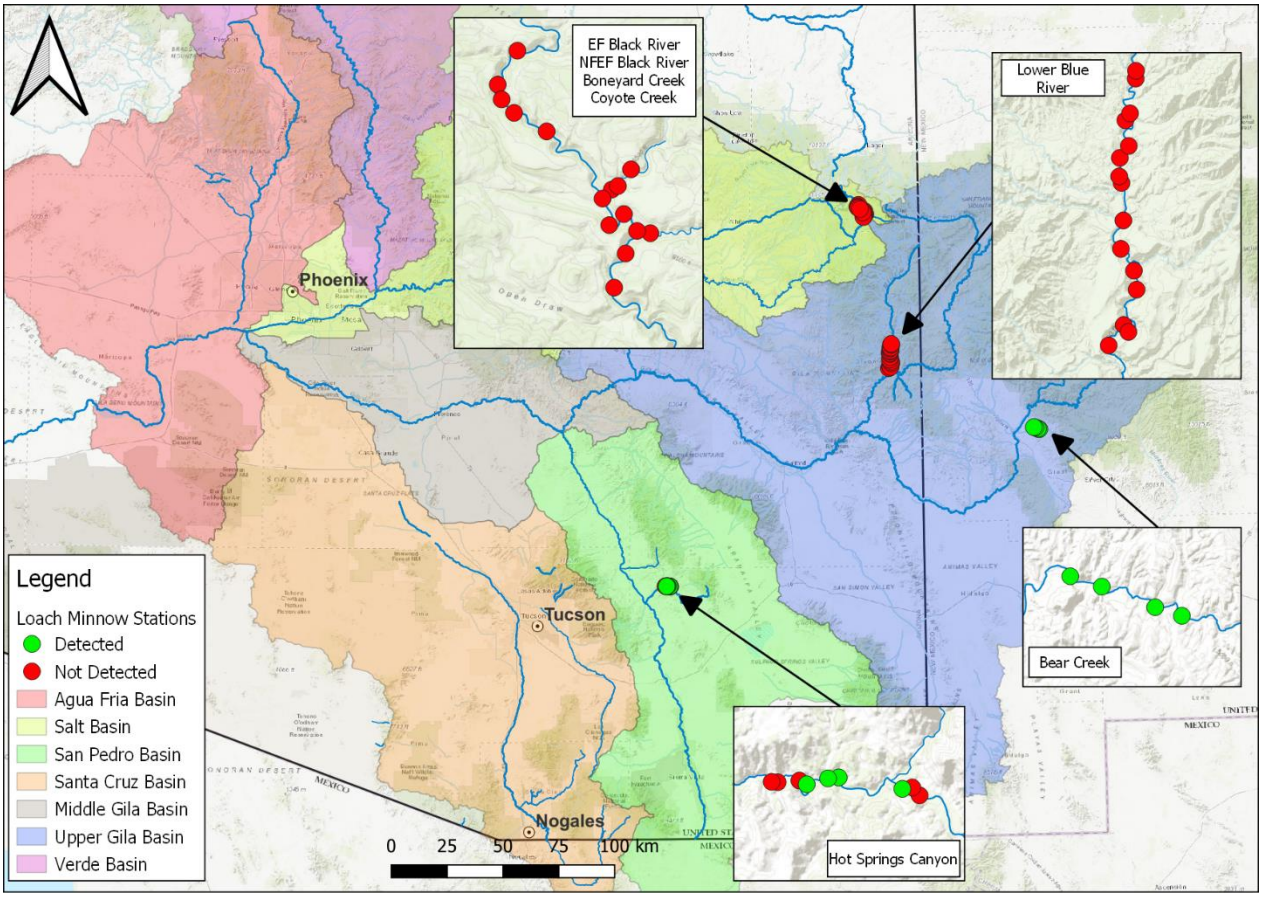

Figure A3. Location of sampling stations where Loach Minnow were targeted and detected or not detected in Gila River basin, 2021.

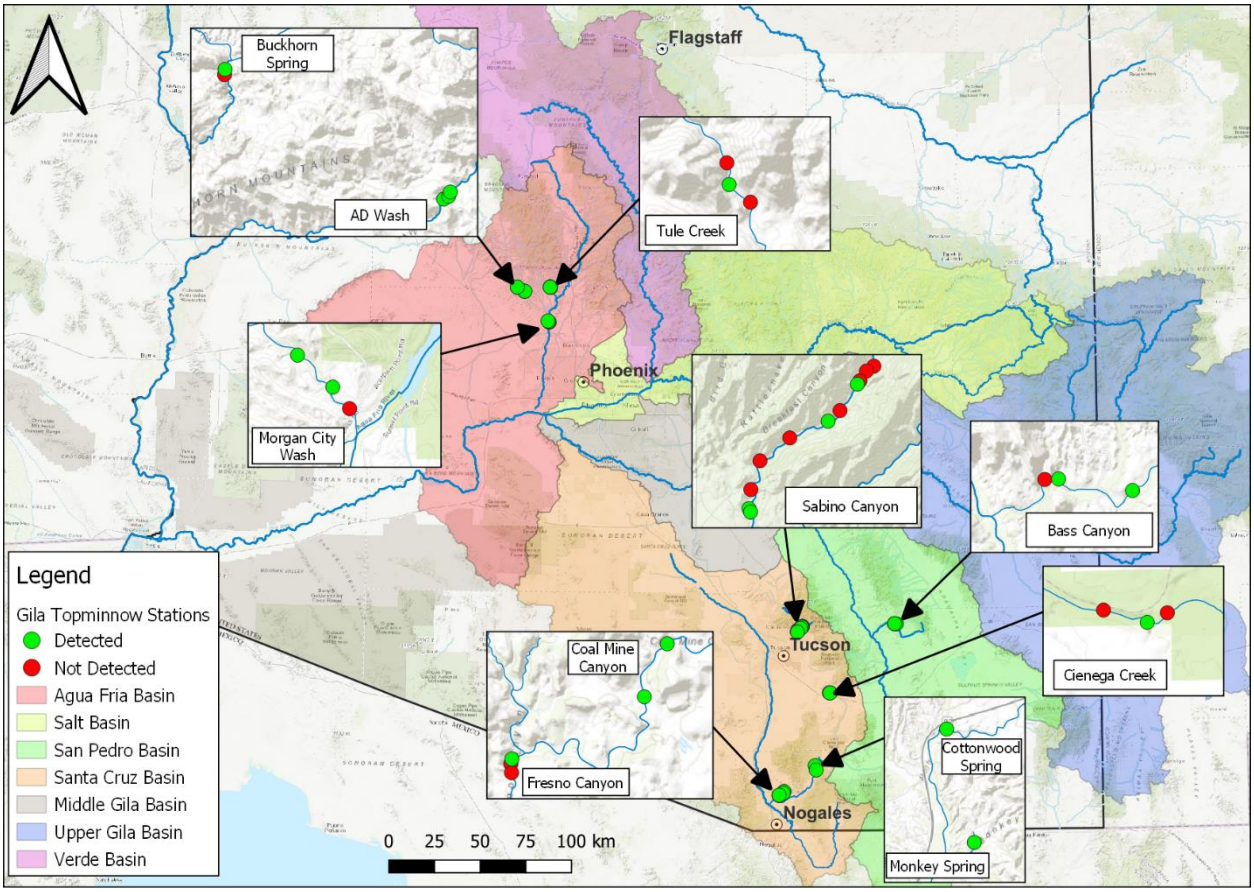

Figure A4. Location of sampling stations where Gila Topminnow were targeted and detected or not detected in Gila River basin, 2021.

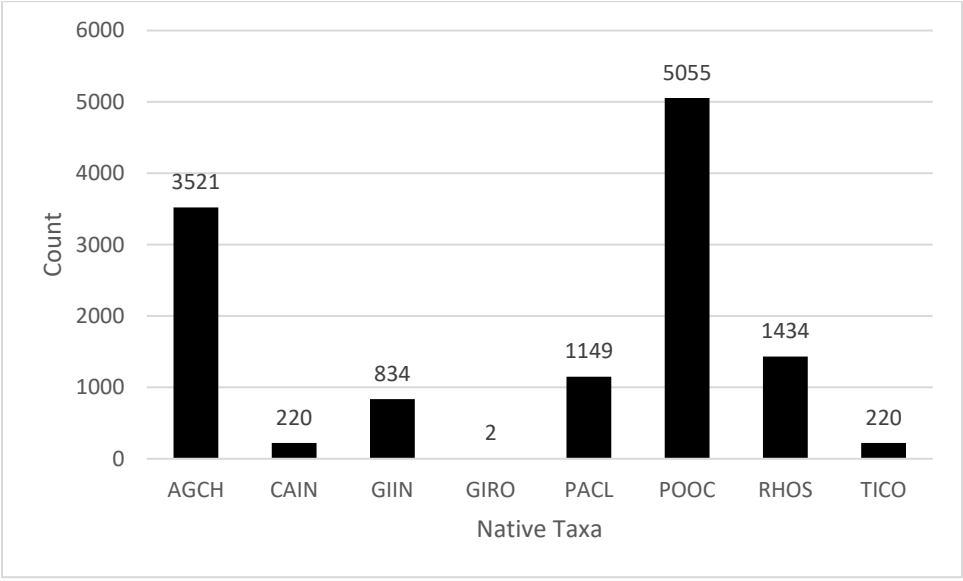

Figure A5. Total number of native taxa captured in selected streams of Gila River basin, 2021; see Table 1 for species codes.

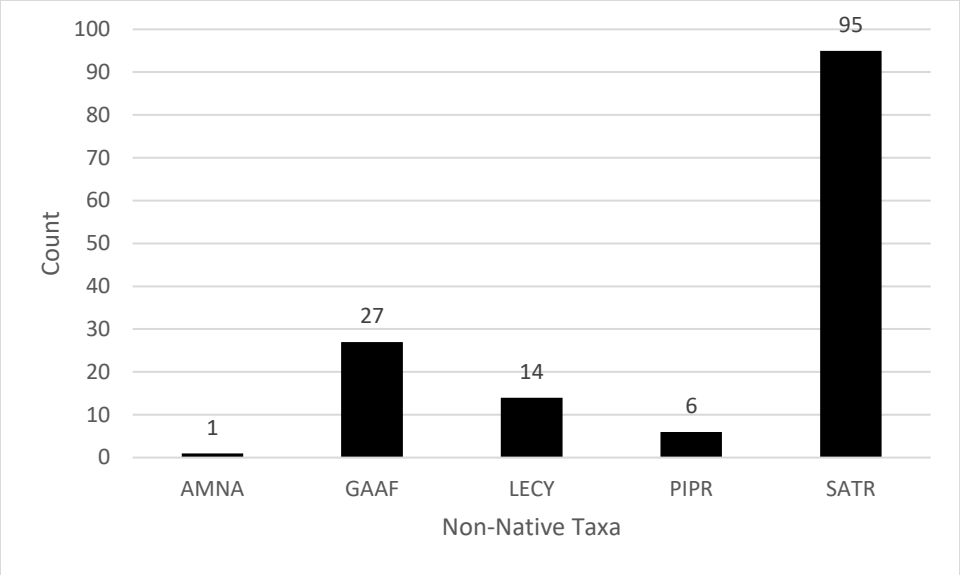

Figure A6. Total number of non-native taxa captured in selected streams of Gila River basin, 2021; see Table 1 for species codes.

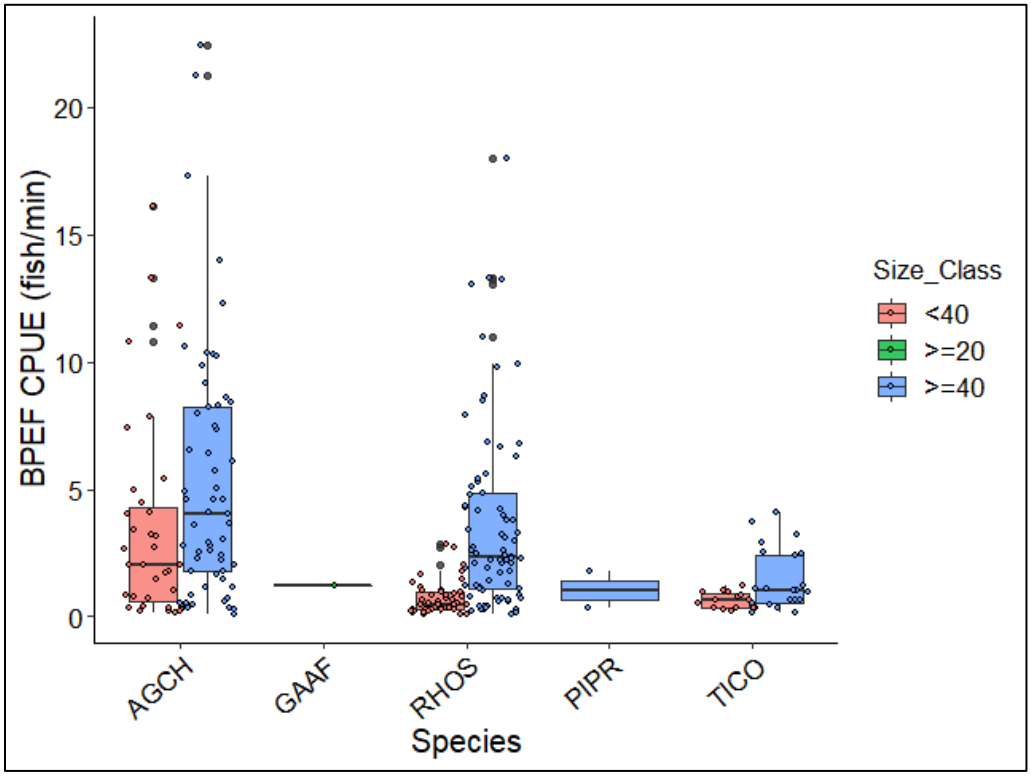

Figure A7. Backpack electrofishing CPUE for small-bodied taxa captured in selected streams of Gila River basin, 2021; see Table 1 for species codes.

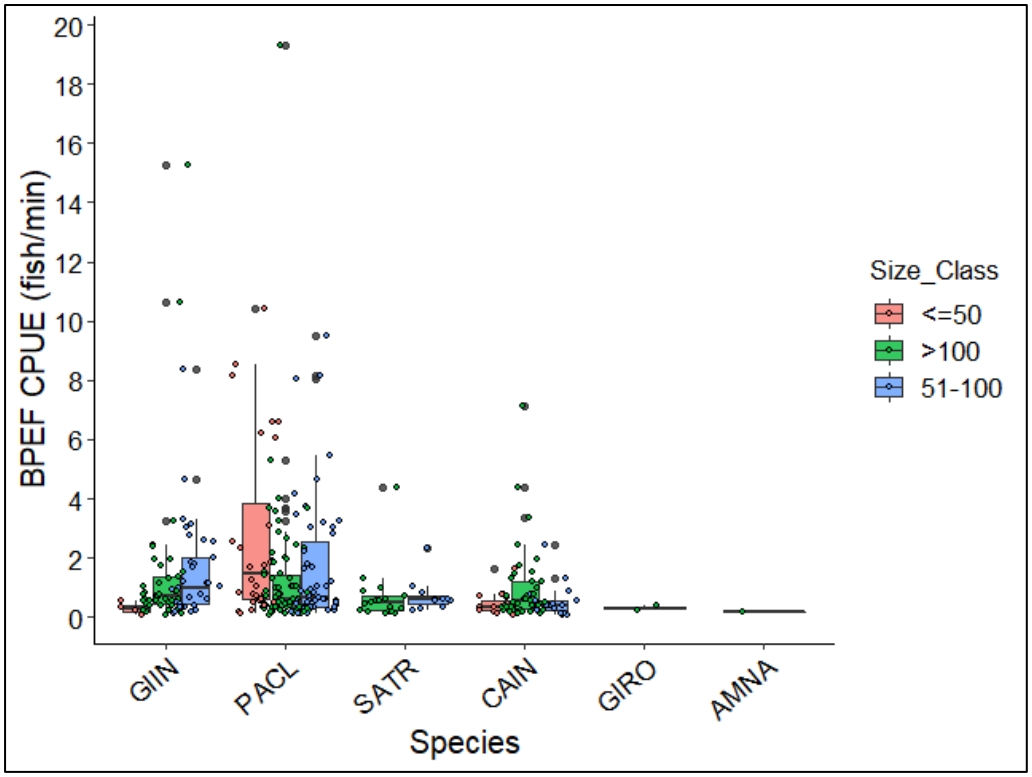

Figure A8. Backpack electrofishing CPUE for large-bodied taxa captured in selected streams of Gila River basin, 2021; see Table 1 for species codes.

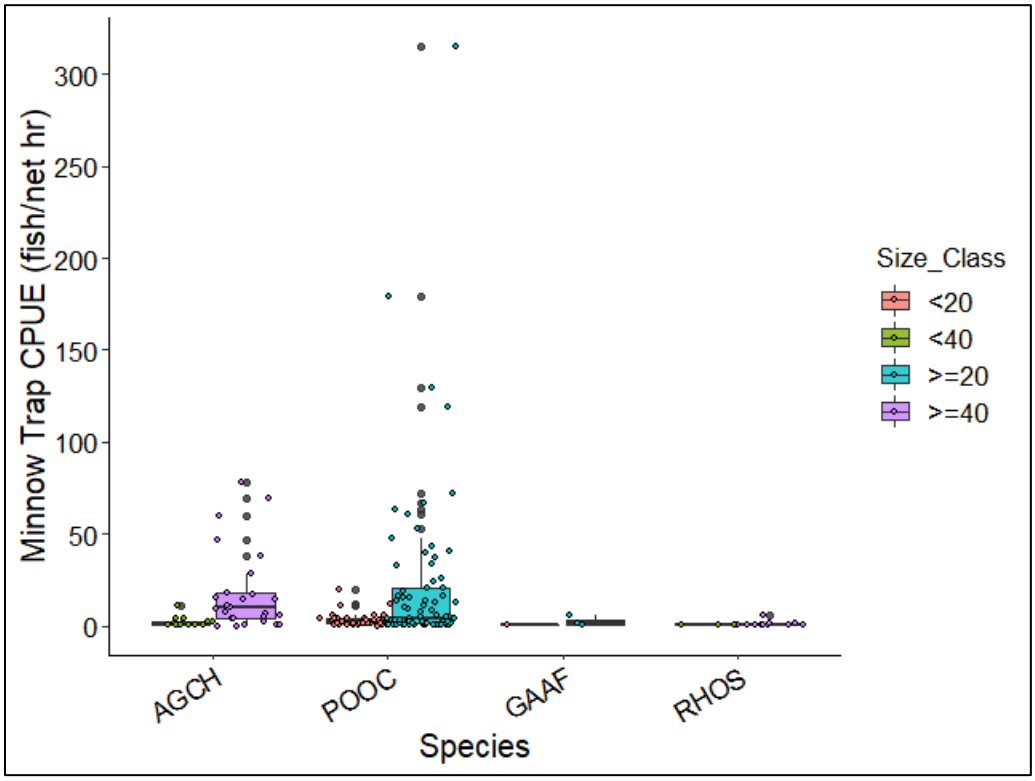

Figure A9. Minnow trap CPUE for all small-bodied taxa captured in selected streams of Gila River basin, 2021; see Table 1 for species codes.

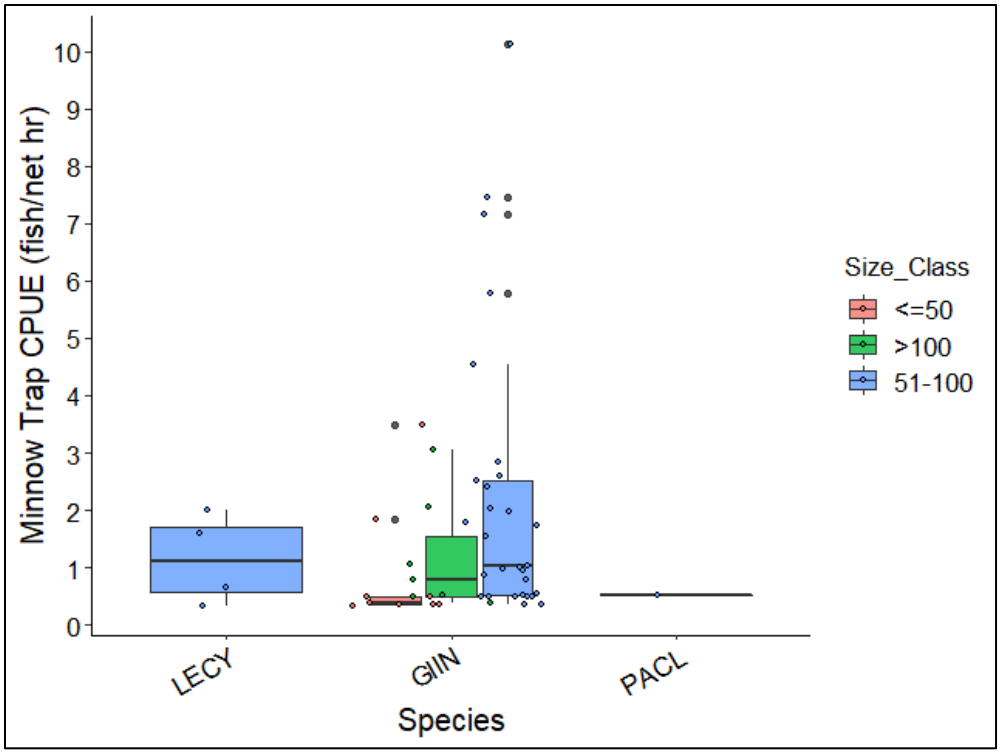

Figure A10. Minnow trap CPUE for all large-bodied taxa captured in selected streams of Gila River basin, 2021; see Table 1 for species codes.

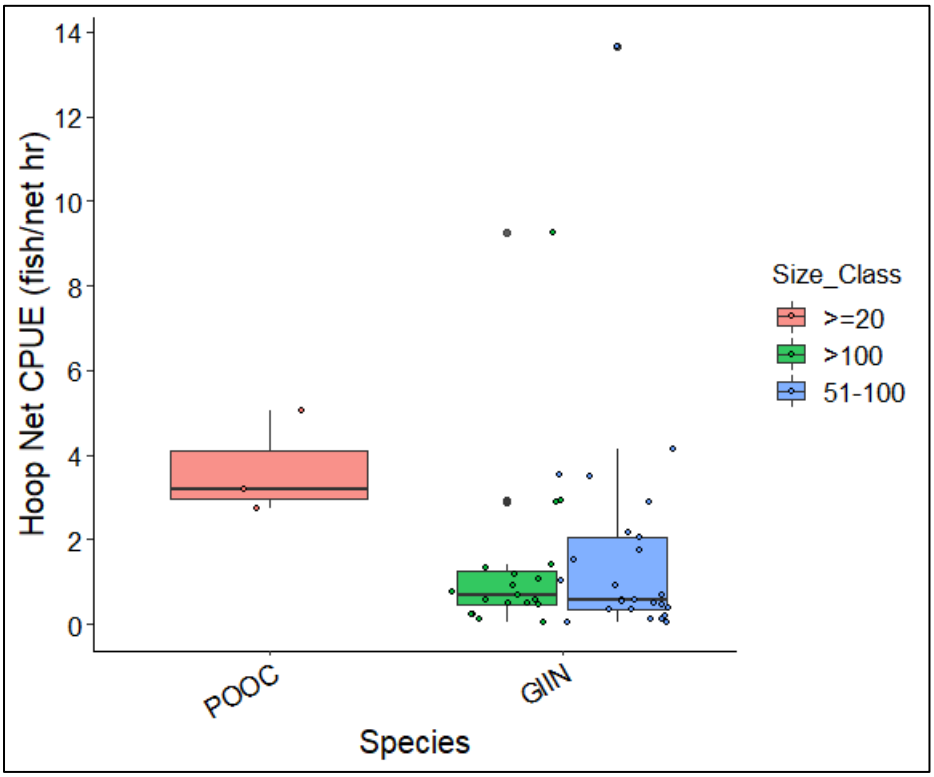

Figure A11. Mini-hoop net CPUE for all taxa captured in selected streams of Gila River basin, 2021; see Table 1 for species codes.

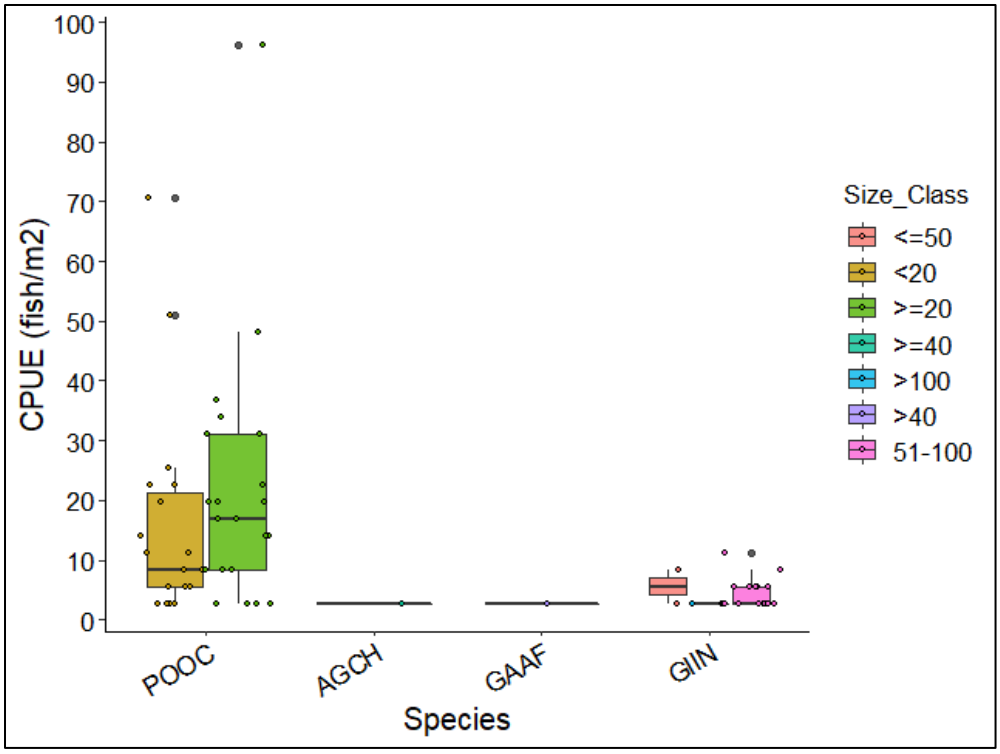

Figure A12. Dip net CPUE for all taxa captured in selected streams of Gila River basin, 2021; see Table 1 for species codes.

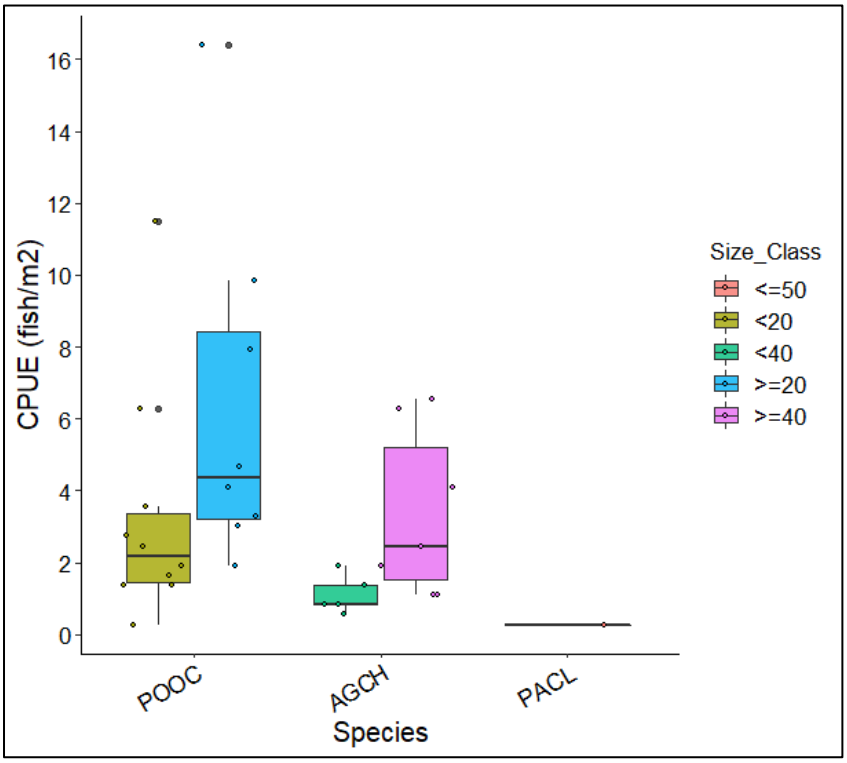

Figure A13. Seine CPUE for all taxa captured in selected streams of Gila River basin, 2021; see Table 1 for species codes.