Gila River Basin Native Fish Monitoring

2018 Final Annual Report

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Introduction

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

The primary objectives of this monitoring program is to detect the presence of each focus species in each stream and determine its distributional extent within occupied streams. Secondarily, evaluate fish community structure to determine abundance of the focus species relative to co-occurring fishes. This report summarizes monitoring activities conducted by Marsh & Associates, LLC (M&A) during calendar year 2018 for the Gila River Basin Native Fish Monitoring project (GRBMP). Here, detailed trip summaries with catch data are reported, results are summarized across sub-basins, species distribution maps were constructed, sampling gears were qualitatively evaluated, and a preliminary multivariate analysis of fish community composition was completed.

Surveys were conducted in selected streams of major drainages throughout Gila River basin that were not being surveyed by other entities (i.e., agencies, institutions, and private contractors). The focus species in each stream is one or more of five native species: Gila Chub *Gila intermedia*, Roundtail Chub *Gila robusta*, Spikedace *Meda fulgida*, Loach Minnow *Tiaroga cobitis*, and Gila Topminnow *Poeciliopsis occidentalis*. Gila Chub, Spikedace, Loach Minnow, and Gila Topminnow are currently listed as endangered. Roundtail Chub and Headwater Chub *Gila nigra* were historically recognized as separate species but were recently reclassified and combined as a single species referred to as Roundtail Chub (Page et al. 2017). Here, we refer to both chub as Roundtail Chub, and note streams where they formerly were recognized as Headwater Chub. Gila Chub also was merged with Roundtail Chub, but they are reported separately because they still are listed as an endangered species.

Methods

Sampling

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

Monitoring protocol followed Clarkson et al. (2011) and any deviations were reported in the trip summaries section. For clarification, definitions of terms are discussed below that are commonly used throughout this report. Stream reach refers to a specific stretch of river denoted by watershed position (i.e., lower, middle, upper), and station refers to a location within a stream reach where sampling occurred. The number of reaches for each stream system was determined based on length of the stream. Streams that were less than five miles had one stream reach, streams that were greater than five miles, but less than 10 miles were assigned two stream reaches, and lastly, streams greater than 10 miles were assigned three stream reaches. In most cases, streams longer than 10 miles had three stream reaches (i.e., lower, middle, upper) that were approximately equidistant and representative of their position within the watershed. However, accessibility, need of sampling, and perennial streamflow also were considered in determining stream reaches.

First priority upon arrival at a stream reach was to determine presence of the focus species at a station. Sampling all available habitat was conducted through a 500-meter (m) station. All fishes encountered during this initial station were identified to species (Table 1) and enumerated. Large-bodied individuals were also sorted by age class (Age-0 and Age-1+). If the focus species was not detected, the effort was repeated at a location within the same reach, but not immediately adjacent to the initial station, and preferably at a different access point. If the target species still was not detected, a third and final station was surveyed following the same protocol. However, if the focus species was detected, a 100 m station was established at the point of detection and continued upstream. During this survey, mesohabitats (i.e., riffle, run, and pool) and dry sections were delineated, and species were counted within each mesohabitat. Generally, there was one station performed within a stream reach if the focus species was detected and adequate numbers were captured (≥25 individuals), and a maximum of three stations if the focus species was not detected or was recorded in low numbers. Fixed stations that were established from previous years were revisited at the same lower boundary of detection to replicate sampling effort. Fixed stations are established when ≥25 individuals (focus species) are captured from previous surveys.

Station lengths were measured 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 station, as well as specimen photos of any species of interest. At stations where the focus species was detected and ≥25 individuals were captured, photographs were taken at upper and lower boundaries of the station in both upstream and downstream directions for future reference of fixed stations.

Table 1. List of species encountered during surveys throughout Gila River Basin in 2018.

Common name	Code	Scientific name
Rainbow Trout	ONMY	*Oncorhynchus mykiss*
Brown Trout	SATR	*Salmo trutta*
Longfin Dace	AGCH	*Agosia chrysogaster*
Gila Chub	GIIN	*Gila intermedia*
Roundtail Chub	GIRO	*Gila robusta*
Speckled Dace	RHOS	*Rhinichthys osculus*
Loach Minnow	TICO	*Tiaroga cobitis*
Red Shiner	CYLU	*Cyprinella lutrensis*
Common Carp	CYCA	*Cyprinus carpio*
Fathead Minnow	PIPR	*Pimephales promelas*
Sonora Sucker	CAIN	*Catostomus insignis*
Desert Sucker	PACL	*Pantosteus clarki*
Yellow Bullhead	AMNA	*Ameiurus natalis*
Channel Catfish	ICPU	*Ictalurus punctatus*
Flathead Catfish	PYOL	*Pylodictis olivaris*
Gila Topminnow	POOC	*Poeciliopsis occidentalis*
Western Mosquitofish	GAAF	*Gambusia affinis*
Green Sunfish	LECY	*Lepomis cyanellus*
Smallmouth Bass	MIDO	*Micropterus dolomieui*
Largemouth Bass	MISA	*Micropterus salmoides*
Bluegill	LEMA	*Lepomis macrochirus*
American Bullfrog	RACA	*Rana catesbeiana*
Arizona Toad	ANMI	*Anaxyrus microscaphus*
Lowland Leopard Frog	RAYA	*Rana yavapaiensis*
Northern Crayfish	ORVI	*Orconectes virilis*
Sonora Mud Turtle	KISO	*Kinosternon sonoriense*
Spiny Softshell Turtle	TRSP	*Apalone spinifera*

Data summary and analyses

Fish capture data were summarized and compiled in tabular form by stream that provided numerical, catch-per-unit effort (CPUE), and relative abundance for each species and age class. Also, a narrative text summarized trip details and fish community composition. Status of the focus species was assessed in contexts of physical habitat conditions, the local fish community, proximate or perceived threats, and other relevant conservation concerns. Solutions implemented (or recommended) to remedy any problems were described, and additional recommendations were offered that might contribute to program improvement. Species distribution maps were constructed for each focus species in QGIS (QGIS Development Team 2017).

Incorporating multivariate analysis of fish communities may provide important insight into understanding factors that promote establishment of non-native fishes and play a role in stability and persistence of native fishes. Ultimately, understanding fish community structure at different spatial and temporal scales may allow fisheries practitioners to identify and prioritize stream systems for conservation and restoration efforts. One difficulty associated with examining fish community structure for this program is that sampling gears were not always standardized within or among streams for several reasons. For instance, sampling gears were selected based on the focus species in addition to local physical habitat characteristics (e.g., depth, clarity, substrate, vegetation, etc.) which resulted in myriad gears being used among or within stream systems. Additionally, spatial grain (i.e., length of stream sampled) of each station generally varied from 100 m to 500 m, and species richness increases with a larger spatial grain. However, fish communities are depauperate in Gila River basin and longitudinal turnover in fish community composition is minimal at the reach-scale. Therefore, bias due to differences in spatial grain is negligible, but spatial autocorrelation is likely high among stations within a stream reach. Fish community data were standardized to account for sampling methods and biases by using presence-absence and pooled across stations within each stream reach to account for spatial autocorrelation. Non-metric multidimensional scaling (NMDS) was used to plot fish communities in multivariate space with Bray-Curtis distance to examine similarity of fish community composition at the reach-scale (i.e., points closer in space are more similar). Non-metric multidimensional scaling was used because there are no linear assumptions and it provides an accurate representation of fish community composition in multivariate space (McCune and Grace 2002). Additionally, NMDS is commonly used to assess spatial and temporal patterns in fish community structure (Kiernan and Moyle 2012, Matthews et al. 2013, Matthews and Marsh-Matthews 2016). Rare species that occurred at <5% of stations were removed to reduce noise (McCune and Grace 2002). All analyses were performed in R 3.4.3 (R Development Core Team 2017). Non-metric multidimensional scaling was performed using the "metMDS" function and selected variables (e.g., catchment area and non-native species richness) were fit as smoothed surfaces onto NMDS plots to visualize non-linear relationships using the "ordisurf" function in the vegan package (Oksanen et al. 2017).

Results

Planned work in 2018 was to sample 24 streams, of which 19 were fully completed. Three streams (lower Wet Beaver Creek, Salome Creek, and O'Donnell Canyon) were visited but will require additional sampling in 2019. Lower Salt River was sampled in January 2019 and is not included in this report. Whitewater Creek was not visited due to logistical constraints and will be sampled in 2019.

Sampling was conducted in five of the eight Gila River sub-basins (i.e., Agua Fria, Verde, Salt, Upper Gila, and San Pedro) across 20 streams, with a total of 63 stations sampled (Figure 2). Four of the five focus species (i.e., Roundtail Chub, Loach Minnow, and Gila Topminnow) were targeted. Gila Chub, Roundtail Chub, Loach Minnow, and Gila Topminnow were detected at 55%, 30%, 33%, and 100% of stations where they were targeted, respectively (Appendix A, Figures A1-A5).

Fish Community Structure

Across all streams, a total of 6,017 individuals and 21 fish species (8 native and 13 non-native) was captured (Table 2; Appendix A, Figures A6-A7). No new taxa were detected, but Smallmouth Bass was recorded for the first time in Rock Creek (see page 49). Native taxa accounted for 44% of total catch, while non-native taxa accounted for 56%. Backpack electrofishing was the primary sampling gear, which accounted for 55% (n=3,328) of total catch (Appendix A, Figure A8). Backpack electrofishing was effective at capturing both age classes (i.e., Age-0 and Age-1+) and small-bodied fishes. However, BPEF was not effective in stream reaches with deep pools or high turbidity. Seining was employed when other gears were not effective, such as in the upper Salt River and lower Verde River, and accounted for 33% (n=1,969) of total catch (Appendix A, Figure A9). Small-bodied fishes were effectively captured with seines. Large-bodied fishes were also captured in seines, but their abundance was likely underrepresented. Promar hoop nets were employed at 30% of stations and accounted for only 5% (n=304) of total catch (Appendix A, Figure A10). Also, Age-0 individuals were rarely detected. Promar hoop nets were generally used to sample chub when BPEF was not feasible, or sampling stations were in remote locations. Minnow traps were used to target Gila Topminnow and were employed at two stations, which accounted for 5% (n=296) of total catch (Appendix A, Figure A11). All other gears (e.g., dip-nets, large hoop nets, and fly angling) accounted for <2% of total catch (not shown).

The NMDS plot of fish communities at the stream reach-scale indicated most sub-basins had similar fish community composition, except Agua Fria River basin was distinct (Appendix A, Figure A12). This pattern was driven by presence of Gila Topminnow and paucity of non-native taxa (Appendix A, Figure A12). It also was apparent stream reaches were grouped based on the gradient of native and non-native species richness (Appendix A, Figures A13-A14). This pattern was related to catchment area, where larger catchments had a higher richness of non-native taxa (Appendix A, Figure A15).

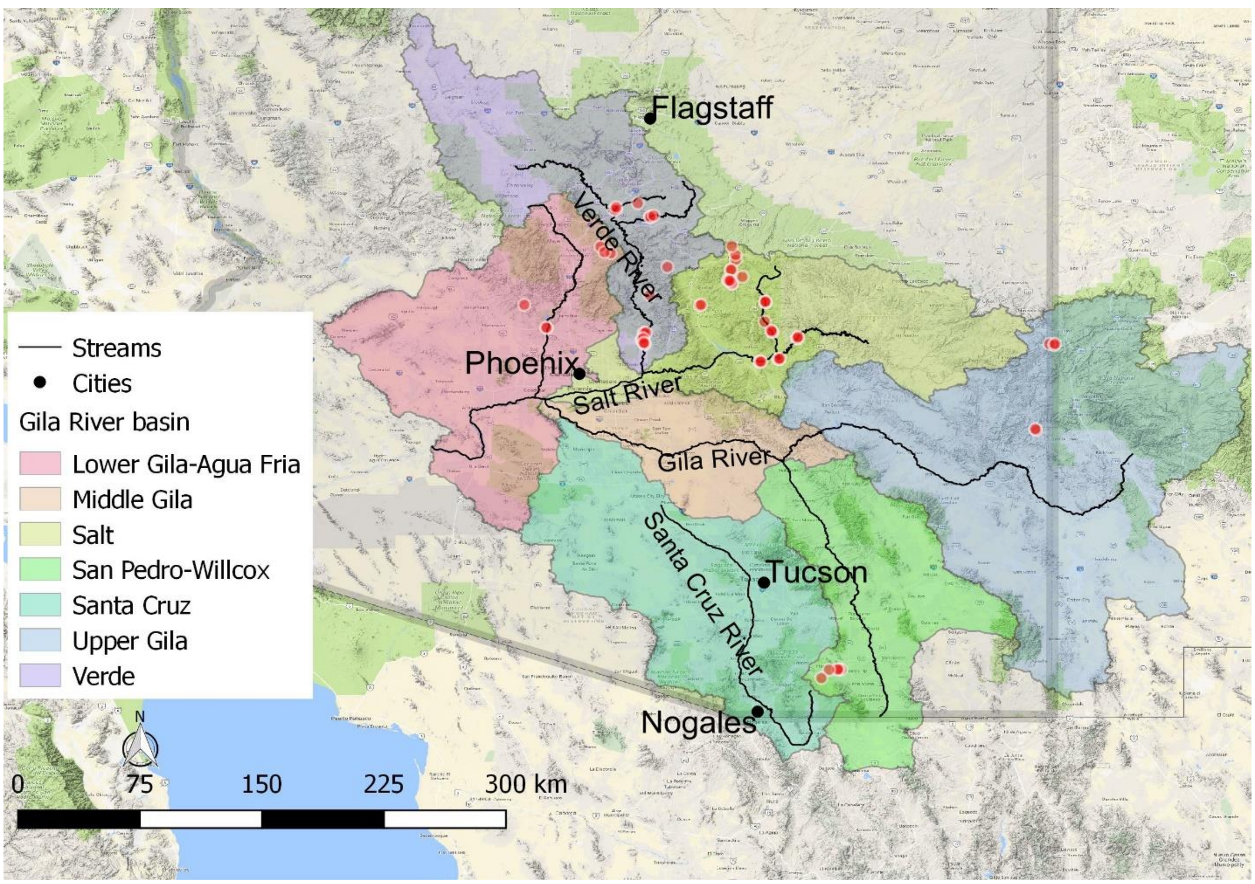

Figure 1. Distribution of sampling stations in selected streams of Gila River basin, 2018.

Table 2. Summary of species detected (+) and not detected (-) by stream reach. Non-native species are denoted (*) and species codes are listed in Table 1.

Stream and reach	ONMY*	SATR*	AGCH	GIIN	GIRO	RHOS	TICO	CYLU*	CYCA*	PIPR*	CAIN	PACL	AMNA*	ICPU*	PYOL*	POOC	GAAF*	LECY*	MIDO*	MISA*	LEMA*
AD Wash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Little Sycamore Creek	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Upper Sycamore Creek	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lower Sycamore Creek	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Morgan City Wash	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-
Cherry Creek (upper)	-	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Cherry Creek (middle)	-	-	+	-	+	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Cherry Creek (lower)	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-
Lower Spring Creek (upper)	-	-	-	-	+	-	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-
Lower Spring Creek (middle)	-	-	+	-	+	-	-	-	-	-	-	+	+	-	-	-	-	+	-	-	-
Lower Spring Creek (lower)	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-
Tonto Creek (upper)	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tonto Creek (middle)	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-
Tonto Creek (lower)	-	-	-	-	-	-	-	+	+	-	-	-	+	+	-	-	-	+	+	+	-
Marsh Creek	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Upper Salt River (upper)	-	-	-	-	-	-	-	+	+	+	-	-	-	+	+	-	-	-	-	-	-
Upper Salt River (middle)	-	-	-	-	-	-	-	+	-	+	-	-	-	+	-	-	+	+	-	-	-
Upper Salt River (lower)	-	-	-	-	-	-	-	+	-	+	-	-	-	+	+	-	+	+	-	-	-
Lower Babocomari River	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	+	-	+	-
Post/Freeman Canyon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Campbell Blue Creek	-	+	+	-	-	+	+	-	-	-	+	+	-	-	-	-	-	-	-	-	-
Dix Creek - Left Prong	-	-	-	+	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
Dix Creek - Right Prong	-	-	+	+	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Dry Blue Creek	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deadman Creek	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Lower Verde River (middle)	-	-	-	-	-	-	-	+	+	-	+	+	-	-	-	-	+	-	+	-	-
Lower Verde River (lower)	-	-	-	-	-	-	-	+	+	-	+	+	+	-	-	-	+	-	+	-	-
Rock Creek	-	-	+	-	+	+	-	-	-	+	-	+	-	-	-	-	-	+	-	-	-
Walker Creek	-	-	-	+	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
West Clear Creek	+	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	-
Wet Beaver Creek	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	+	+	+	-	+

*Non-native species
(+) detected
(-) not detected

Trip Summaries

Morgan City Wash January 30, 2018

12S NAD83 Lower boundary 1: 381557E, 3744935N Upper boundary 1: 381285E, 3745252N

Lower boundary 2: 381228E, 3745307N Upper boundary 2: 381129E, 3745328N

Morgan City Wash is tributary to the Agua Fria River and is located ~1 km SW of Lake Pleasant (Figure 2). Gila Topminnow (Sharp Spring lineage) were stocked in July 2009, with supplemental stockings in October 2009 and November 2010 (Timmons et al. 2016). Desert Pupfish also were stocked in 2009 and 2010 but were not successfully established (Pearson et al. 2013).

On January 30, 2018, Morgan City Wash was surveyed above the fish barrier. The station was accessed via the Agua Fria Trailhead. Based on detection of Gila Topminnow in previous surveys, a 500 m station was established at the lower end of the first pool. Gila Topminnow were not visually observed in this pool or for 500 m upstream; however, 12 baited minnow traps were set throughout and left to fish for approximately two hours. Longfin Dace were observed in high abundance, and several Green Sunfish of various sizes were observed in larger pools throughout the reach. Topminnow were eventually captured via dip-net in shallow water ~100 m upstream, after which a 100 m reach was established and sampled. A total of 51 Gila Topminnow and one longfin dace was captured in 32 dipnet sweeps (Table 3). Water quality parameters were not measured. Photographs of upper and lower boundaries of the 100 m sample station are provided in Appendix B (Figures B1-B4).

Upon retrieving minnow traps from the initial station, Gila Topminnow were found in one pool, though in low numbers (Table 4). The barrier is not preventing movement of Green Sunfish upstream in upper reaches of Morgan City Wash and will require repair and maintenance prior to any attempt to remove Green Sunfish and restore Gila Topminnow.

Table 3. Summary of catch in Morgan City Wash by 1 m dip net sweeps. Total effort was 32 dipnet sweeps.

Species	Age	Count	% of total catch	CPUE (fish/1 m sweep)
AGCH	N/A	1	1.9	0.03
POOC	N/A	51	98.1	1.59
TOTAL		**52**	**100**	**1.63**

Table 4. Summary of catch in Morgan City Wash by minnow traps. Total effort was 24 net hours

Species	Age	Count	% of total catch	CPUE (fish/net hr)
AGCH	N/A	36	42.9	1.50
LECY	0	1	1.2	0.04
LECY	1+	2	2.4	0.08
POOC	N/A	45	53.6	1.88
TOTAL		**84**	**100**	**3.50**

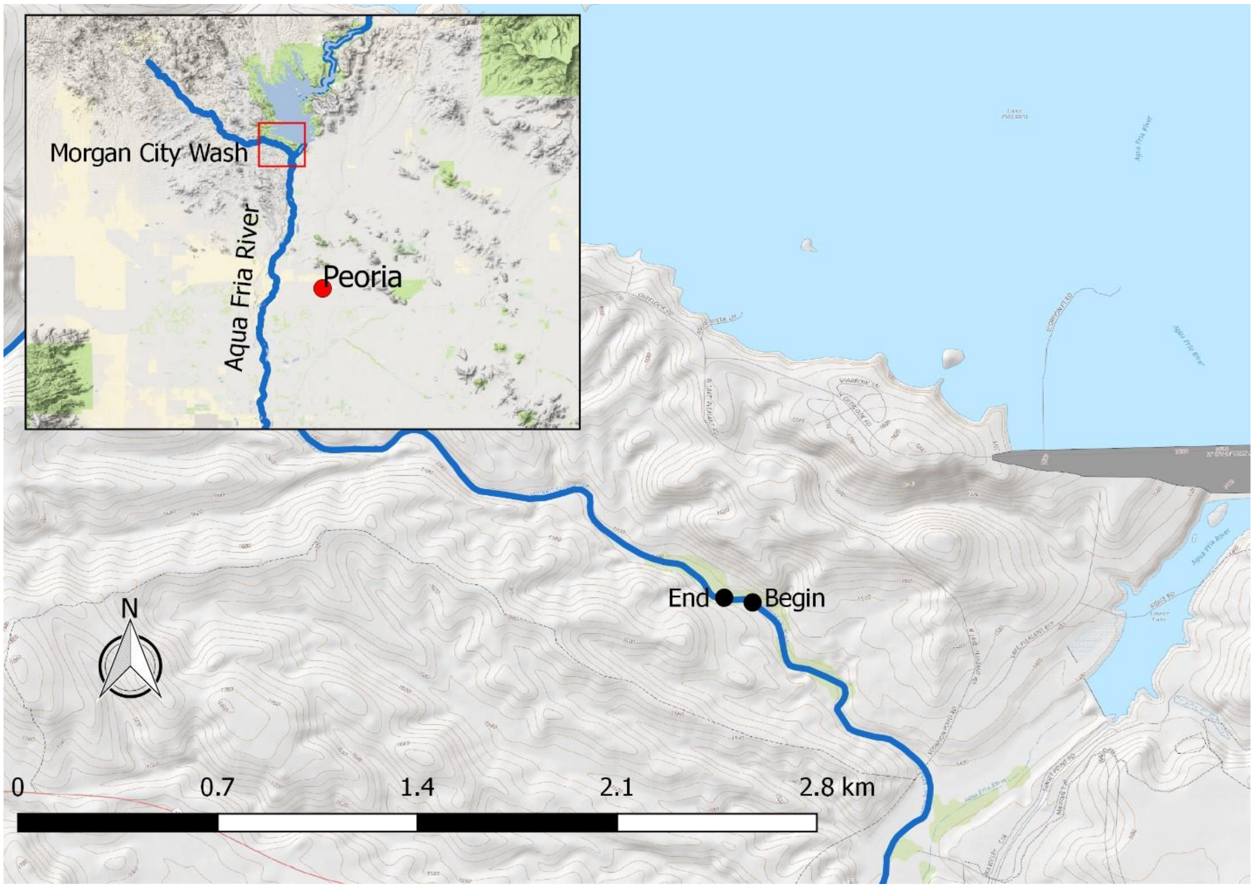

Figure 2. Location of 100 m sampling station in Morgan City Wash, sampled January 30, 2018.

AD Wash January 31, 2018

12S NAD83 Lower boundary: 368447E, 3761698N Upper boundary: 368436E, 3761630N

AD Wash (Figure 3) is tributary to Castle Creek upstream of Lake Pleasant and holds water perennially in a 1.2 km stretch of steep canyon which contains deep bedrock pools with shallow surface water connection. Gila Topminnow (Sharp Spring lineage) and desert pupfish were initially stocked into AD Wash in March 1993. By May 1993, topminnow had dispersed and were abundant throughout the stream reach; however, Desert Pupfish did not become established (Weedman and Young 1997). Sampling in 2016 performed by AZGFD found Gila Topminnow were persisting and abundant (n=1,716; Timmons and Paulus 2016).

On January 31, 2018, AD Wash was accessed via Castle Hot Springs Road, which intersects the lower, dry section of the wash. Gila Topminnow were observed visually in the lowest pool and ten baited minnow traps were set in habitat throughout a 100 m station. Habitat varied from shallow, densely vegetated pools, to bedrock pools up to 3 m deep. Traps were left to fish for two hours. A total of 212 Gila Topminnow was captured across all habitats (Table 5). No non-native species were captured or observed. Water quality parameters were not recorded. Photographs of upper and lower boundaries of the 100 m sample station are provided in Appendix B (Figures B5-B8).

Standing water was found lower in the drainage and a Lowland Leopard Frog was captured in a small pool, displaying symptoms of the fungal disease Chytridiomycosis.

Table 5. Summary of catch in AD Wash by minnow traps. Total effort was 20 net hours.

Species	Age	Count	% of total catch	CPUE (Fish/net hr)
POOC	N/A	212	100	10.6
TOTAL		**212**	**100**	**10.6**

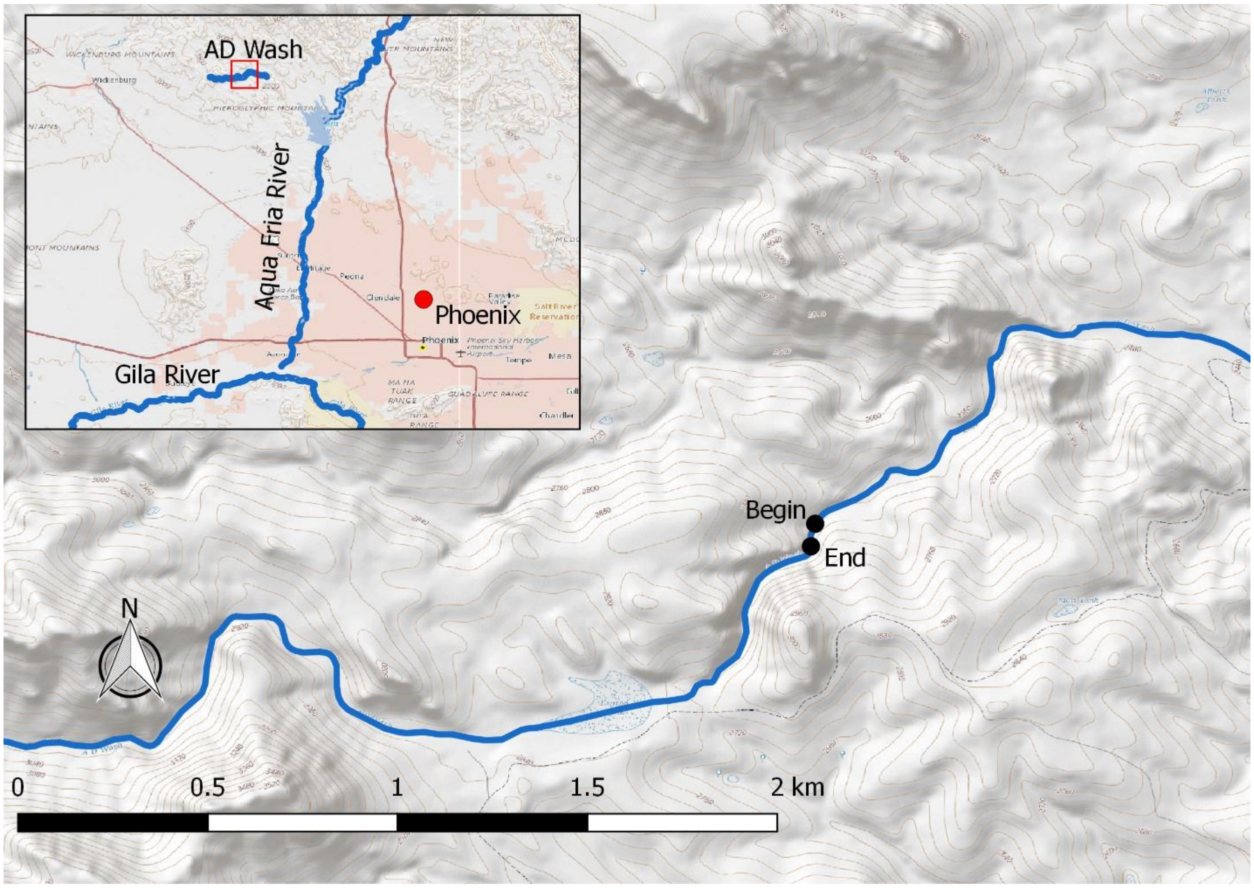

Figure 3. Location of 100 m sampling station in AD Wash, sampled January 31, 2018.

Babocomari River

Draining portions of Mustang Mountain and Canelo Hills watersheds, Babocomari River travels northeast through Elgin, Arizona, to its confluence with San Pedro River. Historically, the river flowed through continuous ciénegas and marshes to the San Pedro confluence; however, arroyo cutting diminished flows in all but one area on Babocomari Ranch, which was protected by a dam constructed in the 1930s. Perennial water now only exists downstream of the ciénega and dam at Babocomari Ranch headquarters. Gila Chub were first collected from Babocomari River in 1892 near Fort Huachuca, and subsequently documented in 1950 below Babocomari Ranch (Weedman et al. 1996). Non-native species first appeared in museum collections in the late 1960s, and surveys in 1988 did not detect Gila Chub. Surveys by

AZGFD in 2013 and 2015, at various locations downstream of the dam, did not detect Gila Chub, nor any other native species (Timmons et al. 2014; Timmons and Paulus 2016).

Upper Babocomari River February 21, 2018

Upper portions of Babocomari River were accessed at two locations on November 21, 2018, at the Elgin Canelo Road Bridge in Elgin, Arizona and south of T4 Spring. The river channel was dry in both locations, with terrestrial vegetation well established. Due to lack of water in the upper section of Babocomari River, no sampling stations were established.

Lower Babocomari River February 21 – 22, 2018

12R NAD83	Lower boundary 1: 557076E, 3500150N	Upper boundary 1: 556737E, 3499793N
	Lower boundary 2: 555512E, 3500291N	Upper boundary 2: 555000E, 3500048N
	Lower boundary 3: 554924E, 3500291N	Upper boundary3: 554504E, 3500208N

On February 21, 2018, Babocomari River was accessed via Babocomari Ranch near the eastern-most extent of private property. A 500 m survey station was established downstream of the road crossing (Figure 4). The station was electrofished for 1,736 seconds and no chub were captured or observed. The majority of habitat in this station consisted of long, deep runs and few deep pools with overhanging root masses. Only one native species, Sonora Sucker, was captured. Smallmouth Bass and Green Sunfish comprised 97% of total catch. A second station was established upstream, beginning 500 m downstream of another road crossing. Much of the habitat throughout this station was shallow pools with a deep, silty substrate with almost 100% submerged vegetation cover. The station was electrofished for 754 seconds and no Gila Chub were captured or observed. Smallmouth Bass and Western Mosquitofish were the only species captured. In addition to electrofishing, three Promar hoop nets were set in the deepest pools at the upstream end and fished for two hours. However, no fish were captured in hoop nets. A third station was established about 11 m upstream of the road crossing. Habitat was similar to the second reach, albeit with noticeably less submerged vegetation. The station was electrofished for 828 seconds and only Smallmouth Bass was captured. For reporting purposes, catch data were combined across stations (Table 6). Water quality parameters were not recorded at all stations. Photographs of available habitat are provided in Appendix B (Figures B9-B12).

The greatest threat to survival of Gila Chub in Babocomari River seems to be presence of non-native piscivorous fishes.

Table 6. Summary of catch in lower Babocomari River by BPEF. Total effort was 3,318 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
CAIN	1+	1	1.92	0.00030
GAAF	N/A	3	5.77	0.00090
LECY	0	6	11.54	0.00181
LECY	1+	6	11.54	0.00181
MISA	0	18	34.62	0.00542
MISA	1+	18	34.62	0.00542
TOTAL		**52**	**100**	**0.01567**

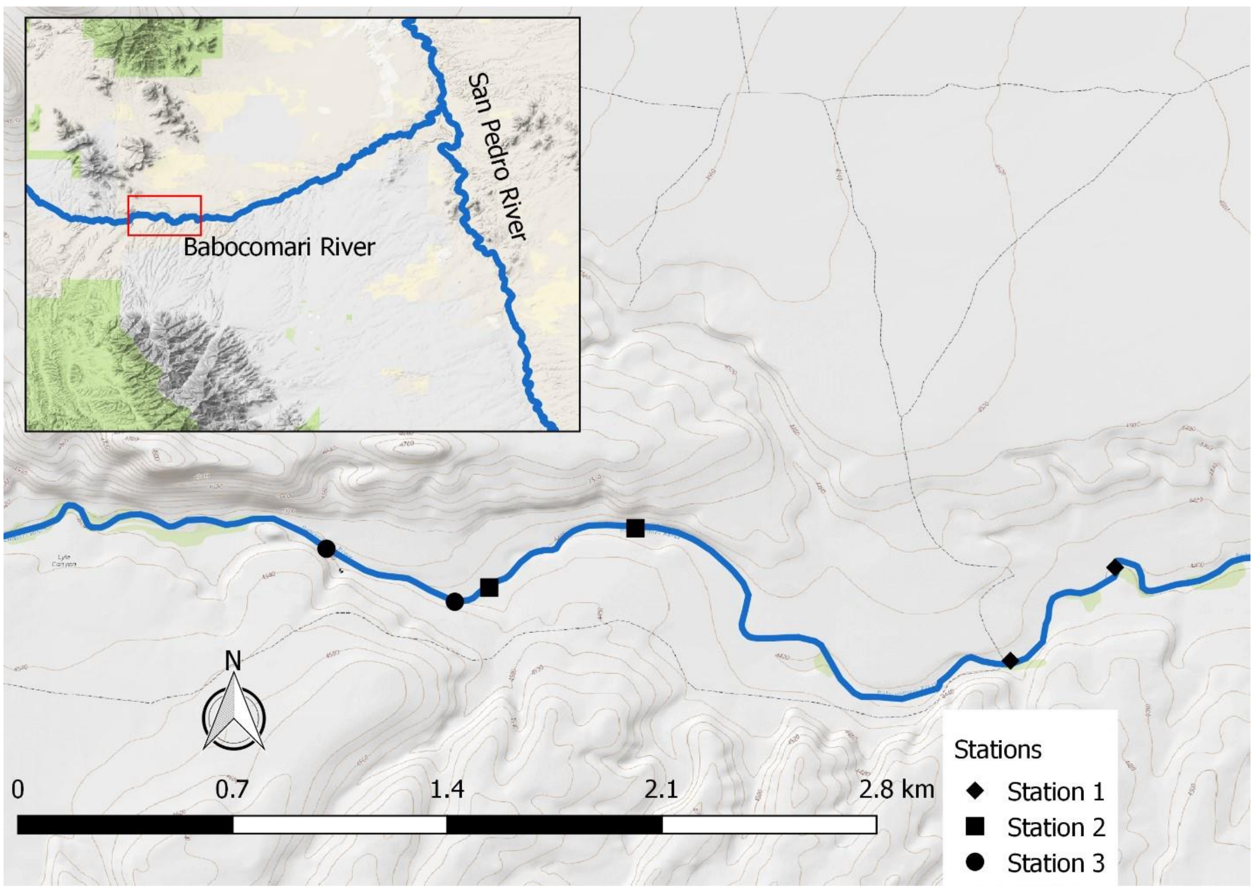

Figure 4. Location of three 500 m sampling stations in lower Babocomari River, sampled February 21–22, 2018.

T4 Spring February 21, 2018

T4 spring is located north of the Babocomari River channel, west of Babocomari Ranch. It is comprised of a 10 m x 10 m earthen cattle tank that is filled by a series of shallow, disconnected pools that disperse about 250 m downstream from the spring. Gila Chub and Longfin Dace were detected in spring 1988 (Weedman et al. 1996). In 2009, the last remaining Gila Chub (n=4) were removed from the spring and relocated to the International Wildlife Museum in Tucson (T. Robinson, AZGFD, pers. comm.). During surveys by AZGFD in 2013 and 2015, the tank was full, and water persisted upstream (Timmons et al. 2014; Timmons and Paulus 2016). The only species detected during these surveys were Western Mosquitofish, American Bullfrog and Sonora Mud Turtle.

T4 Spring was accessed via Babocomari Ranch Road on February 21, 2018 and was found to be dry. There was no surface water from the tank upstream to the spring. There are currently no plans for this site to be restored; however, if it were to be recharged and native fish re-stocked, it would be beneficial to provide a cattle exclusion over some portion of the tank, extending upstream to the spring to prevent habitat degradation. Photographs of T4 Spring are available in Appendix B (Figures B13-B14).

Post Canyon/Freeman Spring Canyon February 22, 2018

12R NAD83 Lower boundary: 545083E, 3494032N Upper boundary: 544766E, 3493902N

Post Canyon (Figure 5) is tributary to O'Donnell Canyon and maintains perennial water (except during periods of extreme drought) in short reaches of connected pools above and below a small dam. The site is commonly referred to as Post Canyon; however, the majority of habitat and perennial waters are sampled in a drainage referred to as Freeman Spring Canyon within 90 m of the Post Canyon confluence. Perennial portions of the stream are on land owned or managed by the Appleton-Whittell Research Ranch of the National Audubon Society (NAS). A survey in 1989 captured one Gila Chub and seven Largemouth Bass; however, they were not detected in subsequent surveys in 1991, 1992 and 1995, and it was deemed that they no longer remained in Post Canyon (Weedman et al. 1996). Previous surveys for the GRBMP, in 2012 and 2016, detected only Western Mosquitofish and Green Sunfish (Timmons and Upton 2013; Timmons et al. 2017). Native Sonora Mud Turtles also are found consistently at this site.

Freeman Spring Canyon was accessed on February 22, 2018 with assistance from personnel at the Appleton-Whittell Research Ranch. Surface water above the dam was only a recent occurrence from some winter rain (C. Francois, NAS, pers. comm). It was shallow and appeared fishless, so nets were not set here. Bedrock pools below the dam were full and deep, and ten Promar hoop nets were set throughout this stretch. There was no water present in Post Canyon. Traps were left to fish for 5.5 hours and retrieved in the afternoon. Green Sunfish was the only fish species captured (n=32) and the majority of these were Age-1+ (n=31; Table 7). Juvenile and adult Sonora Mud Turtles also were captured. Western Mosquitofish were absent from this survey, potentially due to large mesh size of traps deployed, although none were observed otherwise. Water quality parameters were not recorded. Photograph of available habitat in Freeman Spring Canyon is provided in Appendix B (Figure B15).

Due to presence of non-native species in O'Donnell Canyon and elsewhere in the watershed, eradicating Green Sunfish from this site is not feasible currently. Non-native removal and maintenance of barrier system downstream of Post Canyon will need to occur before Gila Chub are considered for re-introduction at this site.

Table 7. Summary of catch in Post/Freeman Canyon by Promar hoop nets. Total effort was 54 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
KISO	0	1	2.56	0.0185
KISO	1+	6	15.38	0.1111
LECY	0	1	2.56	0.0185
LECY	1+	31	79.49	0.5741
TOTAL		**39**	**100**	**0.7222**

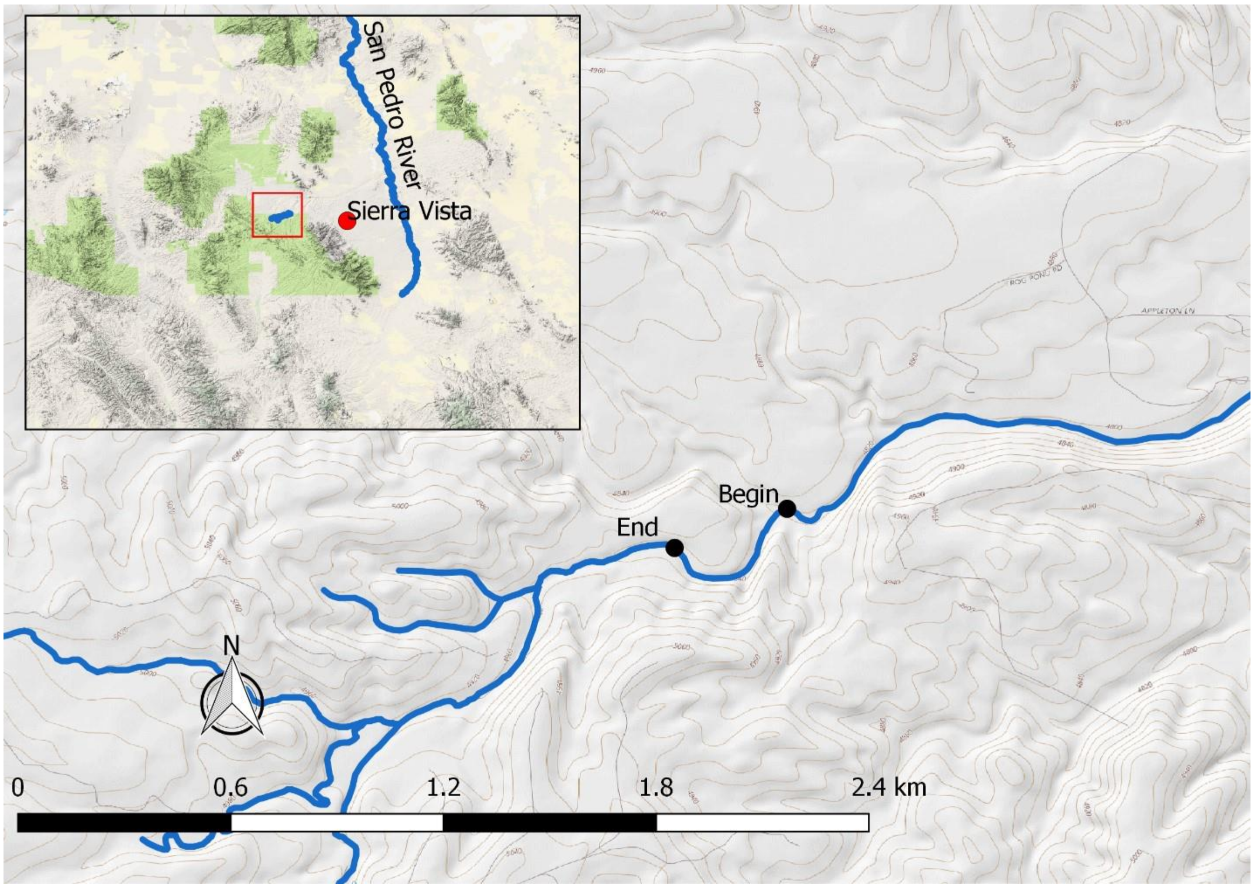

Figure 5. Location of one sampling station in Post Canyon, sampled February 22, 2018.

Cherry Creek

Cherry Creek is tributary to the Salt River that drains the eastern slope of Sierra Anchas. It is bounded in the north by the Naegelin Rim, northwest of Young, Arizona. Earliest collection of Roundtail Chub from Cherry Creek was in 1950 by R. R. Miller and H. E. Winn (Voeltz 2002). Roundtail Chub have been regularly collected and surveyed throughout the creek since then (Voeltz 2002); although their distribution appears to have been reduced. In a 1998 survey by AZGFD, Roundtail Chub were sampled as far downstream as Devils Chasm, about 3.2 km upstream of Ellison Ranch, but were not detected in subsequent surveys in 2012 and 2015. In fact, Roundtail Chub were not detected across all three reaches sampled in 2012 and were only detected in the middle reach in 2015 (Timmons and Upton 2013; Timmons and Paulus 2016). The middle reach (commonly referred to as "below the falls") has become the only established fixed station on Cherry Creek. Roundtail Chub have been detected here in surveys in 2014 and 2015 (Bonar et al. 2014; Timmons and Paulus 2016), as well as the current survey. Non-native species have been reported in Cherry Creek since the 1990s and have continued to be collected throughout the creek in the subsequent years.

Upper Cherry Creek March 7, 2018

12S NAD83	Lower boundary 1: 510705E, 3762578N	Upper boundary 1: 510700E, 3762776N
	Lower boundary 2: 510844E, 3762798N	Upper boundary 2: 510840E, 3763083N
	Lower boundary 3: 510828E, 3763142N	Upper boundary 3: 510713E, 3763606N

The upper reach of Cherry Creek was accessed on March 7, 2018 from Forest Service Road (FSR) 329 ~11.3 km south of Cherry Creek Lodge. A 500 m station was established (Figure 6) and surveyed by BPEF for 666 seconds. While only native species were captured, no chub were observed. Due to limited access to this section of creek, a second station was established about 150 m upstream of the end of the first station. Appropriate habitat throughout this reach was electrofished for 602 seconds, and again no chub was observed. A third and final station was established ~120 m upstream and electrofished for 400 seconds. No chub were captured or observed. Catch in all three stations was exclusively native species totaling 67 individuals, with Speckled Dace being most abundant (n=35; 52.24%), followed by Age-1+ Desert Sucker (n=19; 28.36%) and Longfin Dace (n=13; 19.4%; Table 8). Water quality parameters were not recorded. Photographs of available habitat are provided in Appendix B (Figures B16-B17).

Consistent with surveys in 2012 and 2015, native species continue to dominate the fish community of this reach. Green Sunfish were found in low abundance in 2012 and 2015 and do not appear to have persisted, perhaps due to flash flooding in the system since 2015. Natural barriers in the stream may prevent their re-invasion but will also prevent natural establishment of chub, which do not appear to persist in this reach. A translocation of Roundtail Chub from the middle reach may be required to re-establish their population in upper Cherry Creek.

Table 8. Summary of catch in upper Cherry Creek by BPEF. Total effort was 1,668 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	N/A	13	19.40	0.0078
PACL	1+	19	28.36	0.0114
RHOS	N/A	35	52.24	0.0210
TOTAL		**67**	**100**	**0.0402**

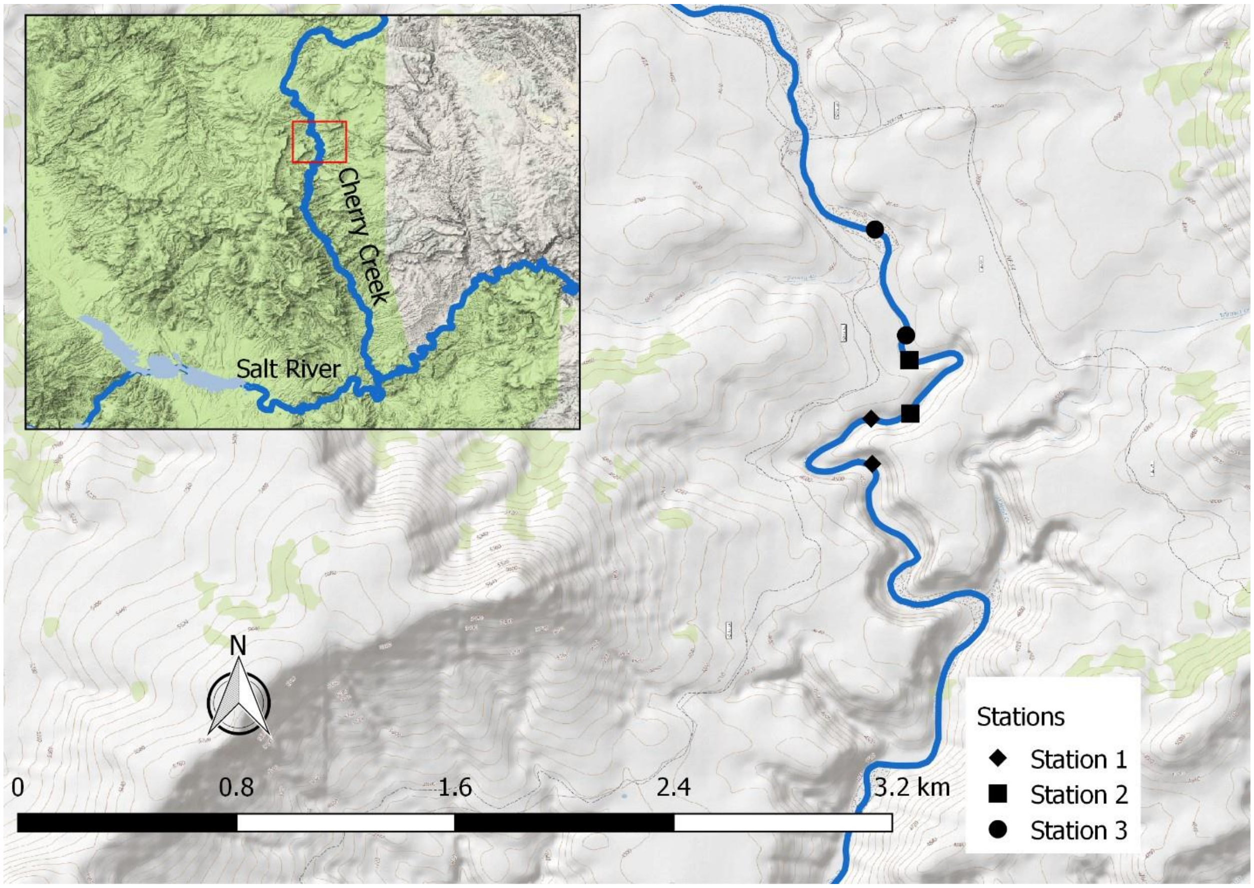

Figure 6. Location of three 500 m sampling stations in upper Cherry Creek, sampled March 7, 2018

Middle Cherry Creek April 4, 2018

12S NAD83 Lower boundary: 510445E, 3748733N Upper boundary 510399E, 3748838N

After the first attempt to survey, this reach was abandoned due to road conditions. However, it was accessed successfully on April 4, 2018 via Cherry Creek road by hiking down the Gold Creek drainage. As Roundtail Chub were detected at this station in the 2015 survey by AZGFD it is now a fixed survey station. Roundtail Chub were detected immediately after electrofishing, so a 100 m station was established (Figure 7). Riffle, run, and pool habitat were surveyed separately, and number of species and individuals were recorded for each mesohabitat. For reporting purposes, catch was combined. A total of 131 fish was caught. Catch was exclusively native species (Table 9), with Age-0 Roundtail Chub accounting for the majority of catch at 38.2% (n=50). Age-1+ Roundtail Chub accounted for 12.2% (n=16). Both age classes of Desert Sucker, Longfin Dace, and Speckled Dace comprised the remainder of the catch. Water temperature and conductivity recorded at 14:10 were 21.5 °C and 543 µS, respectively. Photographs of upper and lower boundaries of the 100 m sample station are provided in Appendix B (Figures B18-B21).

Longfin Dace and Speckled Dace were not recorded in the previous survey in 2015; however, Sonora Sucker and Desert Sucker were found on that occasion. All fish captured in 2015 were Age-1+ individuals. A notable difference to the 2015 survey is absence of Green Sunfish, which comprised 49%

of total catch in that year, and may have accounted for lack of small-bodied fishes sampled. Flash flooding in the system since then may have resulted in displacement of Green Sunfish, which is not adapted to such flow conditions. If there is no barrier to upstream dispersal, it is possible that they will reinvade from lower reaches where they have consistently been found. In absence of non-native species, natives in this reach appear to be persistent. On the hike upstream to the road a deep pool was found that contained approximately one dozen Age-1+ chub (12S 509952E, 3749367N). In future surveys, it is recommended to set nets here while the fixed station is surveyed downstream.

Table 9. Summary of catch in middle Cherry Creek by BPEF. Total effort was 608 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	N/A	21	16.03	0.035
PACL	0	20	15.27	0.033
PACL	1+	17	12.98	0.028
RHOS	N/A	7	5.34	0.012
GIRO	0	50	38.17	0.082
GIRO	1+	16	12.21	0.026
Total		**131**	**100**	**0.215**

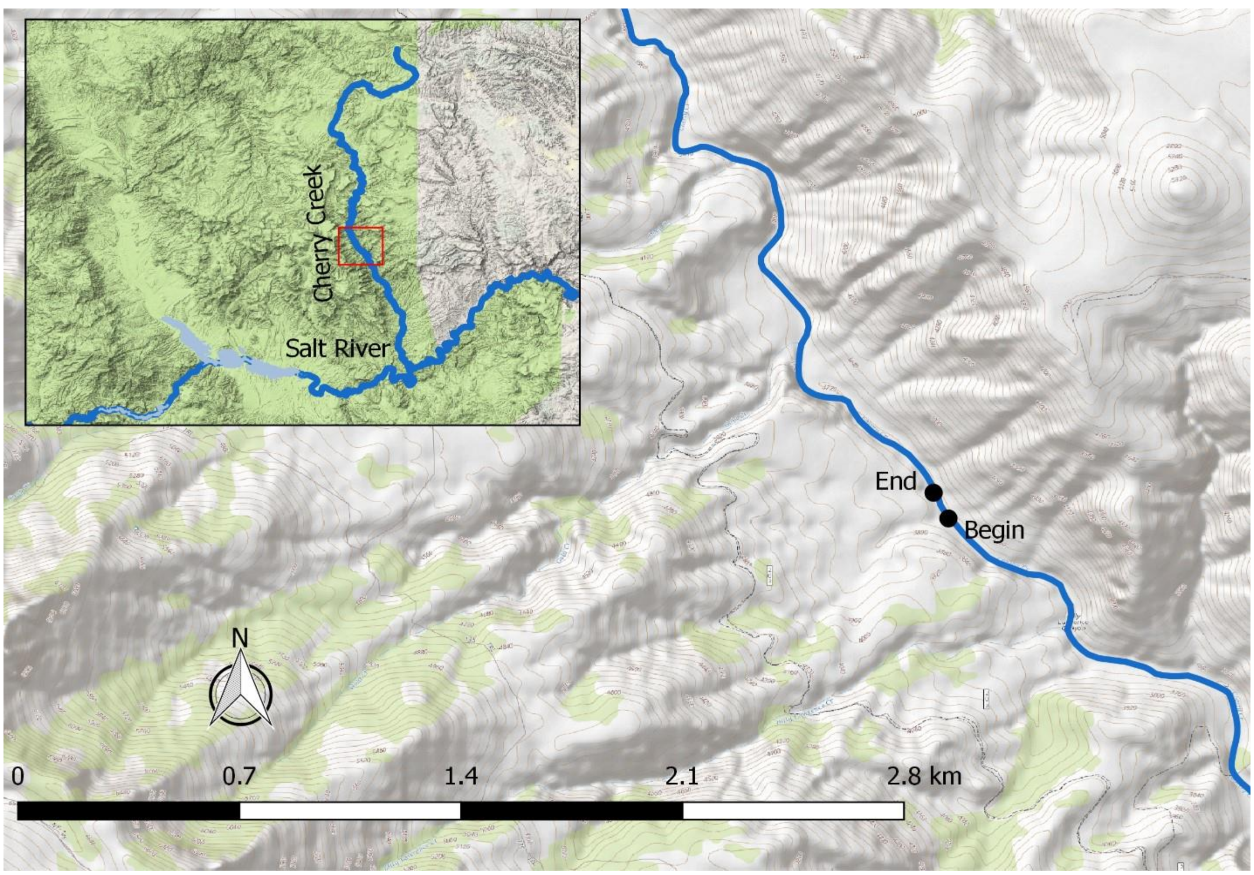

Figure 7. Location of 100 m sampling station in middle Cherry Creek, sampled April 4, 2018.

Lower Cherry Creek March 6, 2018

12S NAD83 Lower boundary 1: 514987E, 3741123N Upper boundary 1: 514833E, 3741631N

Lower boundary 2: 514807E, 3741751N Upper boundary 2: 514421E, 3742038N

Lower boundary 3: 514356E, 3742256N Upper boundary 3: 514026E, 3742448N

Lower Cherry Creek (Figure 8) was accessed via Cherry Creek road near Ellison Ranch. A 500 m station was established and electrofished for 422 seconds, targeting Roundtail Chub habitat that comprised about 60% of total available habitat. Low numbers of Green Sunfish (n=3; Age-1+) and Fathead Minnow (n=8) were captured, but no chub were detected (Table 10). A second station was established ~120 m upstream due to limited access to the stream. This station was electrofished for 954 seconds and appeared to contain more suitable chub habitat. Again, Age-1+ Green Sunfish (n=16) and Fathead Minnow (n=27) were the only species encountered. A final 500 m station was established ~300 m upstream at a different access point and was electrofished for 661 seconds. Potential chub habitat comprised about 70% of the total reach. Again, Age-0 Green Sunfish (n=2), Age-1+ Green Sunfish (n=3) and Fathead Minnow (n=14) were the only species encountered. Water quality parameters were not recorded. Photographs of available habitat are provided in Appendix B (Figures B22-B23).

During surveys in 2012 and 2015, a higher diversity of non-native species was detected: Yellow Bullhead, Flathead Catfish, Red Shiner, Green Sunfish, and Fathead Minnow. The only native fishes detected in 2012 were Sonora Sucker and Desert Sucker and the only native species detected in 2015 was Longfin Dace at one station. Abundance and persistence of non-native piscivorous fish species in this reach likely inhibits recruitment of Roundtail Chub and would need to be removed prior to any chub translocation efforts.

Table 10. Summary of catch in lower Cherry Creek by BPEF. Total effort was 2,037 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
LECY	0	2	2.74	0.0010
LECY	1+	22	30.14	0.0108
PIPR	N/A	49	67.12	0.0241
TOTAL		**73**	**100**	**0.0358**

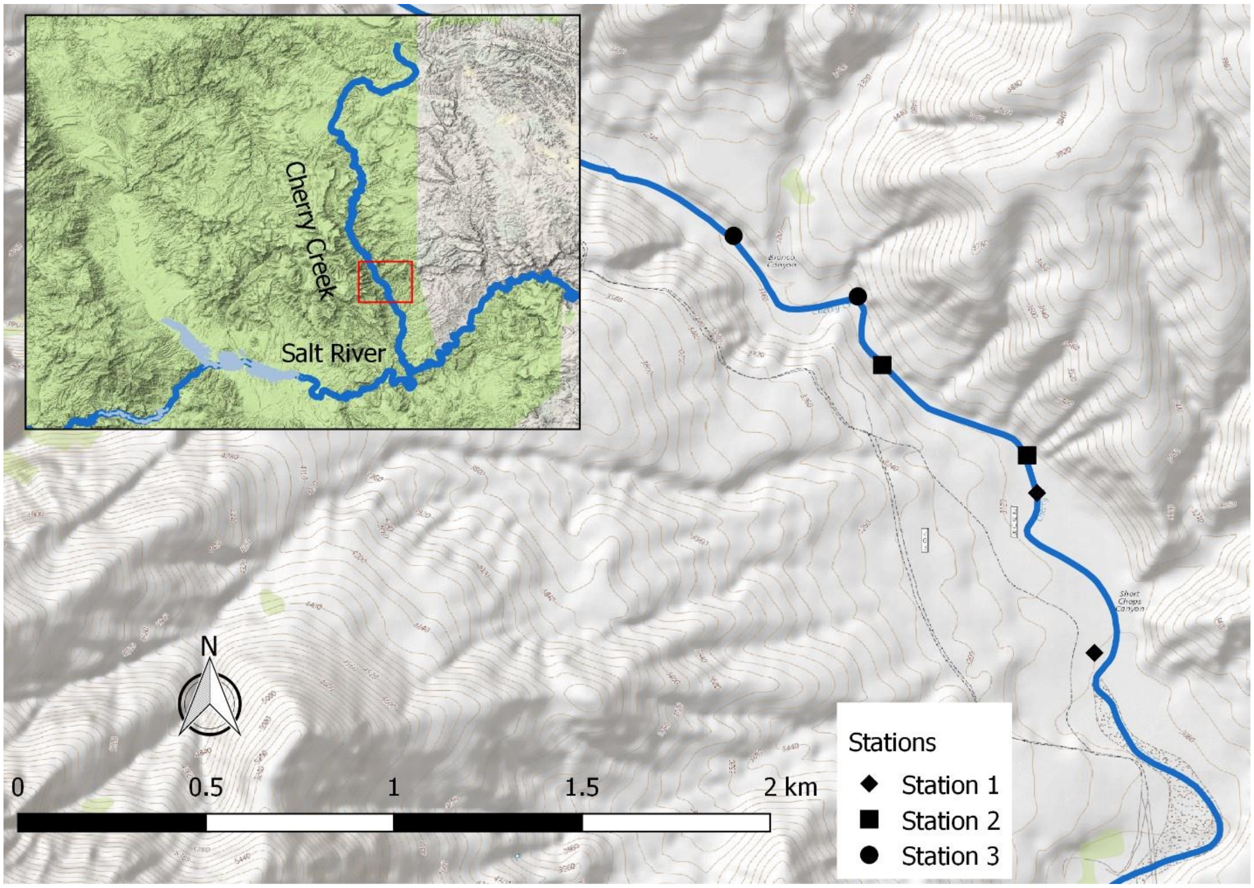

Figure 8. Location of three 500 m sampling stations in lower Cherry Creek, sampled March 6, 2018.

Sycamore Creek

Sycamore Creek originates at Pine Springs in Black Hills and runs ~32 km southwest to its confluence with Agua Fria River. Streamflow is primarily intermittent with deep perennial pools that persist during dry periods. The focus species in Sycamore Creek was Gila Chub and the earliest recorded collection of this species from Sycamore Creek was in 1930 (Weedman et al. 1996). Based on previous surveys, Gila Chub continue to persist at the site (Timmons and Upton 2013; Timmons and Paulus 2016), but populations are isolated and never locally abundant. Cooler stream temperatures allow non-native Rainbow Trout to persist.

Little Sycamore Creek March 28, 2018

12S NAD83 Lower boundary: 413791E, 3802742N Upper boundary: 413879E, 3802803N

Little Sycamore Creek flows west to its confluence with Sycamore Creek, a tributary to Agua Fria River (Figure 9). Little Sycamore Creek was accessed on FSR 68 and Horner Mountain Road. Site access was gained by contacting the Ranch Manager (Horner Mountain Ranch) because the road crosses private property and is gated. Vehicles were parked near the creek on U.S. Forest Service (USFS) land. A 100 m station was established and electrofished for 607 seconds, and a total of 21 Age-1+ Gila Chub were caught (Table 11). There was also one Sonora Mud Turtle observed. The station was not extended upstream because the channel was dry. Water temperature and conductivity recorded at 10:26 were 14.0 °C and 600 µS, respectively. Photographs of upper and lower boundaries of the 100 m station are provided in Appendix B (Figures B24-B27).

Little Sycamore Creek habitat consisted of a series of isolated pools with dense filamentous algae. A ranch employee noted they have never seen Little Sycamore Creek completely dry over the last 10 years, but several pools go dry in late summer.

Despite prescribed fire within the watershed, multi-year drought, and high sediment loads (Timmons and Upton 2013), Gila Chub continue to persist in Little Sycamore Creek. However, surveys in 2012 and 2015 performed by AZGFD (Timmons and Upton 2013; Timmons and Paulus 2016) found higher abundance of Gila Chub. Also, Longfin Dace was detected in 2012 (Timmons and Upton 2013), but not in 2015 (Timmons and Paulus 2016) or during this 2018 survey. Future monitoring of Little Sycamore Creek will be required to determine persistence and abundance patterns of Gila Chub and Longfin Dace.

Table 11. Summary of catch in Little Sycamore Creek by BPEF. Total effort was 607 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
KISO	1+	1	4.55	0.00165
GIIN	1+	21	95.45	0.03460
TOTAL		**22**	**100**	**0.03624**

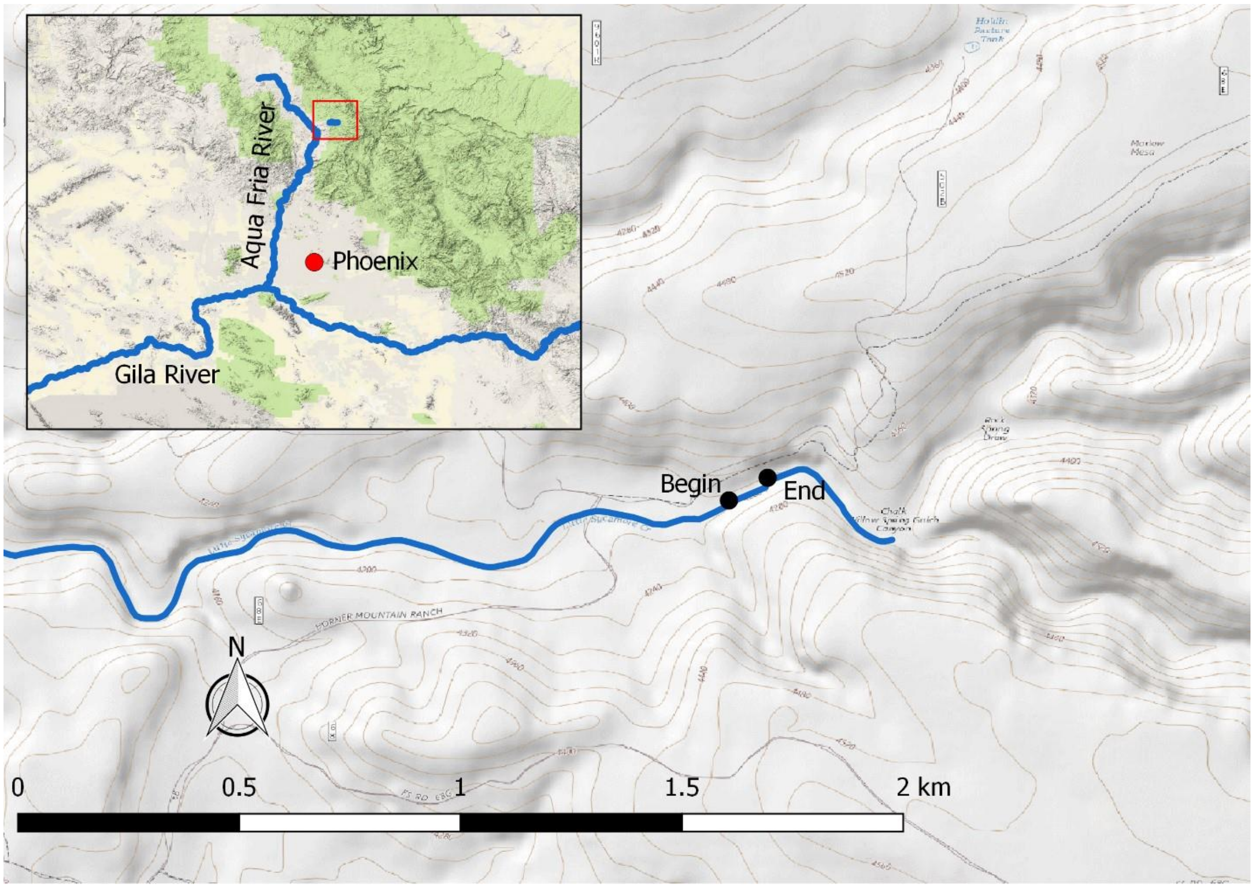

Figure 9. Location of 100 m sampling station in Little Sycamore Creek, sampled March 28, 2018.

Upper Sycamore Creek March 28, 2018

12S NAD83 Lower boundary: 419846E, 3798031N Upper boundary: 420058E, 3798182N

Upper Sycamore Creek (west of Double T Ranch) was accessed on FSR 68. Previous sampling detected Gila Chub below "Double T Falls" and confirmed they have persisted through time (Timmons and Upton 2013; Timmons and Paulus 2016). Double T Falls is a large waterfall that serves as an effective fish barrier; however, there is not much water immediately upstream. A sampling station was established downstream of the falls and once Gila Chub were detected, a 100 m station was established and electrofished for 572 seconds (Figure 10). Less than 25 Gila Chub were collected within the 100 m station, so the sampling station was extended upstream, but ended short of 500 m below the falls (~300 m station). A total of 15 fish was caught, which consisted of Gila Chub and Rainbow Trout (Table 12). All Gila Chub were Age-1+ and accounted for 80.0% (n=12) of catch. Rainbow Trout accounted for 20.0% (n=3) of the remaining catch and all were Age-1+. Most fish were collected directly below the falls in a large pool. Despite Gila Chub being found in low abundance, a subsequent sampling station not established upstream of the falls after a cursory examination revealed no fish. Water quality parameters were not recorded. Stream habitat consisted of plunge pools with short riffles composed of cobble and boulder substrate. Photographs of upper and lower boundaries of the 100 m station are provided in Appendix B (Figures B28-B31).

Gila Chub persisted in upper Sycamore Creek despite presence of Rainbow Trout. Monitoring should continue at upper Sycamore Creek to determine persistence and population dynamics of Gila Chub.

Table 12. Summary of catch in upper Sycamore Creek by BPEF. Total effort was 572 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
GIIN	1+	12	85.71	0.0210
ONMY	1+	2	14.29	0.0035
TOTAL		**14**	**100**	**0.0245**

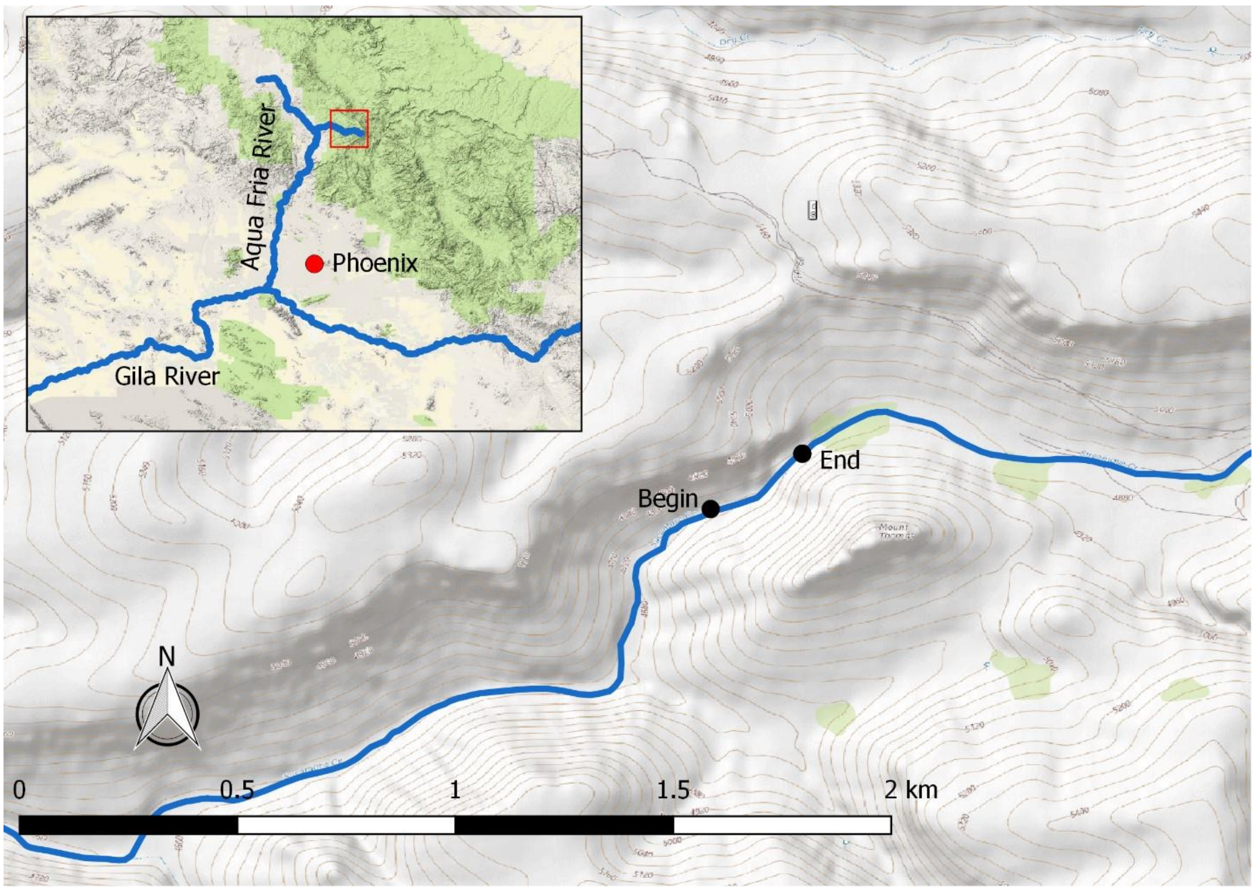

Figure 10. Location of 300 m sampling station in upper Sycamore Creek, sampled March 28, 2018.

Lower Sycamore Creek March 28–29, 2018

12S NAD83 Lower boundary: 416144E, 3798802N Upper boundary: 416221E, 3798745N

Lower Sycamore Creek (also known as Middle Box) was accessed on FSR 68. A 100 m sampling station was established (Figure 11) and electrofished for 369 seconds. Additionally, 10 Promar hoop nets were deployed. Deep pools prevented effective BPEF and Gila Chub were collected only with Promar hoop nets. A total of 22 fish was caught, all of which were native (Table 13). Age-1+ Gila Chub accounted for 95.5% (n=21) of total catch, followed by one Longfin Dace (4.5%, n=1). No fish were detected above the falls, which is consistent with previous sampling at this location (Timmons and Upton 2013; Timmons and Paulus 2016). A second 500 m station was not established upstream due to a fishless stream reach. Water temperature recorded at 08:30 was 14.0 °C; conductivity was measured but not recorded. Photographs of upper and lower boundaries of the 100 m station and Gila Chub are provided in Appendix B (Figures B32-B36).

Heavy cattle grazing adjacent to the most downstream pool resulted in eroded stream banks and high turbidity during the sampling effort. Previous sampling of Lower Sycamore Creek has found other native species present in high abundance, including Longfin Dace and Sonora Sucker (Timmons and Paulus 2016), while another survey only detected Gila Chub (Timmons and Upton 2013). Compared to the previous survey (Timmons and Paulus 2016), catch rates for Gila Chub in 2018 were considerably less robust; however, this could be a result of seasonal water fluctuations. Therefore, future monitoring efforts should utilize the most appropriate sampling gear depending on water levels.

Ultimately, no non-native fishes have been detected at this site through time and a suite of native fishes has been reported. It appears persistence of native fishes at this site will depend on perennial stream flows and continued absence of non-native fishes.

Table 13. Summary of catch in lower Sycamore Creek by Promar hoop nets. Total effort was 160 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
GIIN	1+	21	95.45	0.13130
AGCH	N/A	1	4.55	0.00625
TOTAL		**22**	**100.00**	**0.13755**

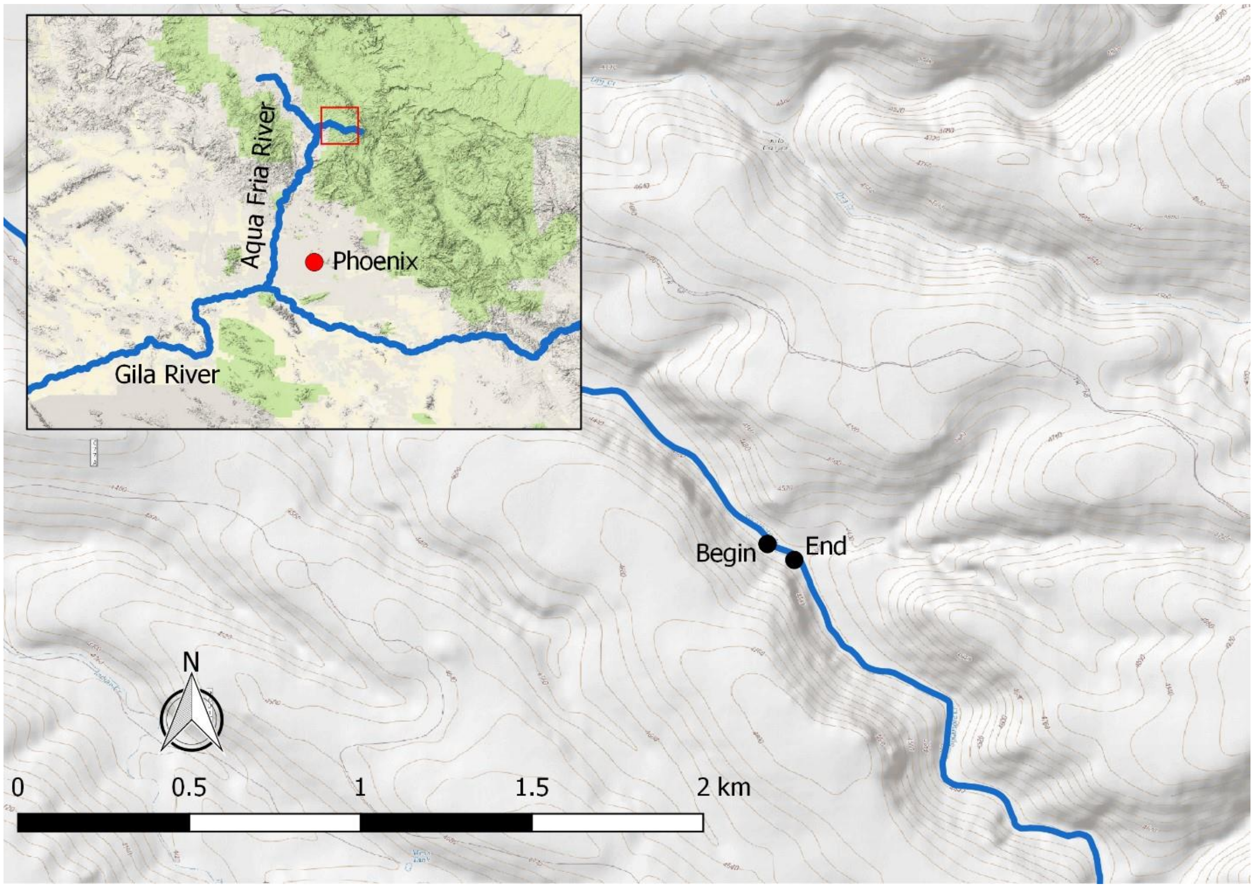

Figure 11. Location of 100 m sampling station in lower Sycamore Creek, sampled March 28–29, 2018.

Deadman Creek April 17–19, 2018

12S NAD83 Lower boundary: 442530E, 3767887N Upper boundary: 450722E, 3772940N

Deadman Creek (Figure 12) originates in Maverick Basin and is formed by North and South Forks of Deadman Creek, which flows into Verde River. The stream system is within Mazatzal Wilderness in Tonto National Forest National Forest; thus, access is both restricted and difficult. Roundtail Chub were first detected in South Fork Deadman Creek in 1991, and a subsequent survey of Deadman Creek in 1993 confirmed presence of Roundtail Chub (Voeltz 2002). A later survey determined Roundtail Chub persisted for nearly a decade, with abundance increasing towards the confluence of South Fork (Bagley 2002). However, none were detected in 2014 near the confluence of Deadman Creek and South Fork Deadman Creek (Timmons et al. 2015). Chub from this stream were formerly referred to as Headwater Chub.

An initial attempt to sample Deadman Creek with assistance of horses was made on October 2017. The vehicle was parked near the wilderness boundary (12S 437675E, 3761062N) and a crew hiked cross country to the Deadman Creek drainage. Unfortunately, horses were not able to deliver gear due to thick underbrush, which resulted in an early departure of the field team with no sampling conducted. Furthermore, the hike was very strenuous, and it is not recommended to access Deadman Creek using the same strategy. In 2018, an alternative plan was proposed with assistance from a landowner with private property within Mazatzal Wilderness.

On April 17, 2018, Deadman Creek was accessed. On the first night, the crew stayed at J's Ranch (12S 439612E, 3768019N), and the next morning the vehicle was parked (12S 439910E, 3767139N) and a crew hiked adjacent to Mullen Wash (~500 m north) into the Deadman Creek drainage. Once in the Deadman Creek drainage (12S 442530E, 3767887N), Roundtail Chub were actively searched for with visual observation and BPEF. Instead of beginning a 500 m station, sampling continued from the point of entry upstream to 100 m within the South Fork confluence (~9.7 km Euclidean distance) to cover as much ground as possible. Hiking was slow due to large boulders, thick vegetation, and stretches of pool habitat confined to a narrow channel. Despite large pools and good chub habitat, none were detected visually or with a BPEF effort of 594 seconds. The only fish species detected was Fathead Minnow, with the last point of occurrence recorded at 12S 449231E, 3771743N. Abundance of Fathead Minnow was not recorded and neither were water quality parameters. Photographs of available habitat are provided in Appendix B (Figures B37-B40).

Chub were not found during the 2014 survey of South Fork and Deadman Creek, and together with these results, it appears they have not persisted in Deadman Creek. It is likely that ash and/or toxic run-off from the 2004 Willow Fire is a contributing factor; however, additional surveys should be conducted within Deadman Creek and South Fork Deadman Creek to confirm these results.

Other notable occurrences of wildlife include two Gila Monster *Heloderma suspectum* along the stream a few kilometers upstream of the access point and an unidentified juvenile rattlesnake.

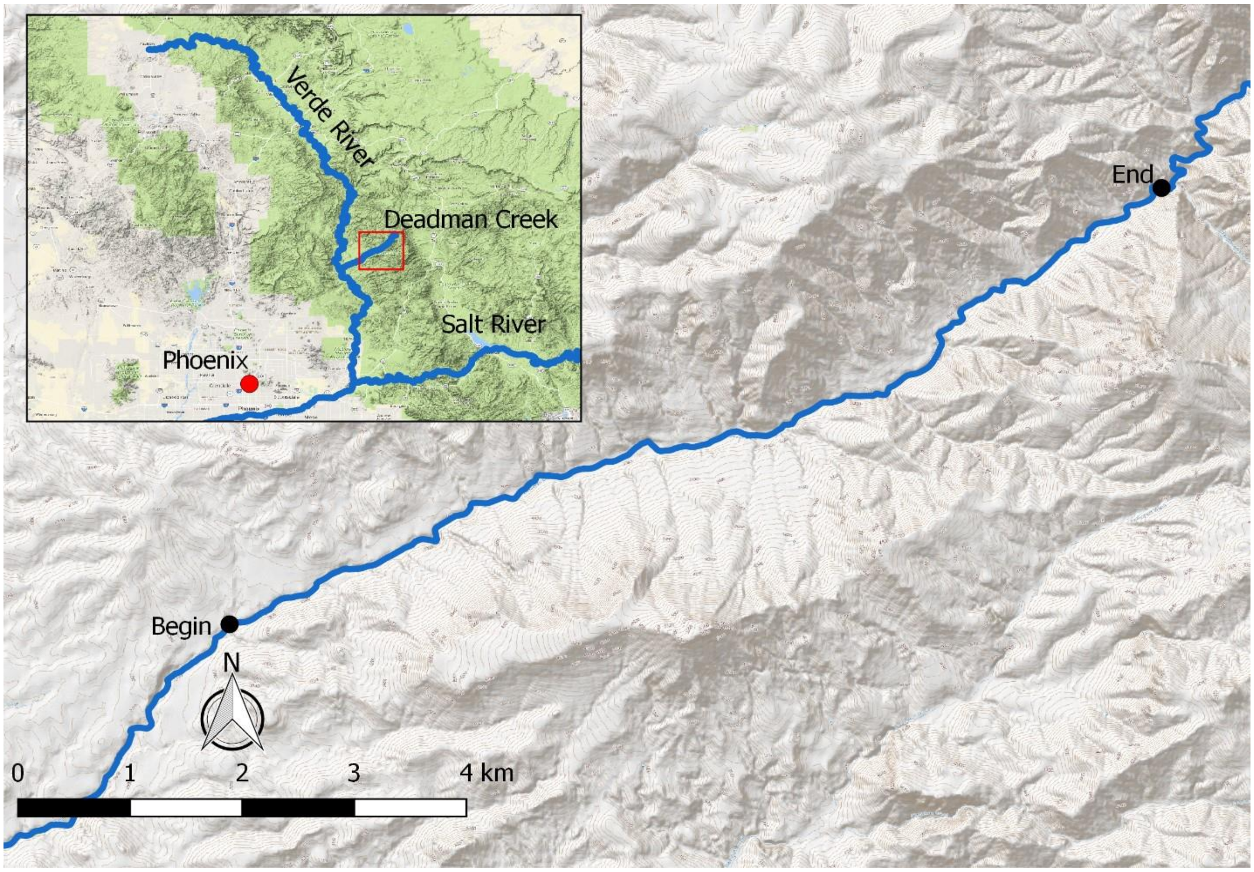

Figure 12. Location of stream surveyed in Deadman Creek, April 17–19, 2018.

Tonto Creek

Tonto Creek originates at the base of Mogollon Rim in Tonto National Forest and flows south ~80 km to Roosevelt Lake. Downstream of Gun Creek, stream discharge is intermittent as it enters a broad alluvial basin. Previous surveys found the focus species, Roundtail Chub, were not present in the upper and lower reaches, but a population persists in the middle reach within Hellsgate Wilderness Area (Timmons et al. 2014). Chub from this stream were formerly referred to as Headwater Chub. The current fish community of Tonto Creek is predominately non-native taxa, which may explain the sparse distribution of native fishes.

Upper Tonto Creek May 22, 2018

12S NAD83	Lower boundary 1: 493374E, 3793057N	Upper boundary 1: 493479E, 3793579N
	Lower boundary 2: 493220E, 3796482N	Upper boundary 2: 492950E, 3796807N
	Lower boundary 3: 490992E, 3802644N	Upper boundary 3: 490870E, 3803133N

On May 22, 2018, the upper reach of Tonto Creek was sampled with assistance from USFS personnel. A sampling station was established downstream of Bear Flat Campground in Tonto National Forest, ~29 km east of Payson, Arizona (Figure 13). The station was accessed from FSR 405A and the vehicle was parked at Bear Flat Campground. A 500 m station was established and sampled with BPEF; nets were not deployed because USFS was closing that section of forest the next day and there would not have been adequate time to complete all stations. Also, water quality parameters (i.e., temperature and conductivity) were not measured due to equipment failures. Backpack electrofishing was effective throughout the station, except within several large pools where only the margins could be sampled. Timmons et al. (2017) deployed 20 hoop nets and captured six fish, whereas a previous survey used only BPEF and had better results (Timmons et al. 2015). Therefore, deploying nets at this station likely would not have provided a more representative sample. A total effort of 519 seconds was employed, which resulted in capture of 28 fish. Brown Trout accounted for 57% (n=16) of catch, while Rainbow Trout (n=7; 25%) and Desert Sucker (n=5; 18%) comprised the remaining catch. For reporting purposes, catch was tabulated for each sampling gear across all stations within the upper reach (Table 14). Stream velocity was low to moderate with riffle, run, and pool habitat present with large cobble and boulder substrate. Northern Crayfish were abundant throughout the stream reach. There was minimal overhanging vegetation or undercut banks. Stream turbidity was high and made BPEF difficult. Photographs of available habitat are provided in Appendix B (Figures B41-B44). The focus species (Roundtail Chub) was not detected, so sampling protocol was followed, and another station was established upstream.

The second station (Figure 13) was established ~3.9 km upstream of the first station near the Christopher Creek confluence. Site access was gained by parking near US Highway 260 (12 S 493850E, 3797660N) and hiking downhill into the Christopher Creek drainage. A 500 m station was established just downstream of the confluence and BPEF was employed for 583 seconds. A total of 78 fish was captured. Salmonids dominated the sample with Brown Trout being most abundant (n=68; 87%) followed by Rainbow Trout (n=9; 12%), and Desert Sucker (n=1; <1%). Water clarity was much higher than the first station and BPEF was the most effective method. There were some deeper pools where nets could have been set, but these pools comprised only a small proportion of habitat. All major mesohabitats (i.e., riffle, run, pool) were present and this station was high gradient with moderate streamflow. Northern crayfish were present, but less abundant than at the first station. Again, the focus species was not detected, and a subsequent station was established upstream.

The third station (Figure 13) was established ~7 km upstream of the second station and ~1.9 km downstream of Tonto Creek Fish Hatchery. Station access was gained by parking adjacent to the stream in a paved pull off. A 500 m station was established, and BPEF was employed for 428 seconds. A total of 11 fish were captured, all of which were Rainbow Trout. All fish were collected within the first ~200 m of sampling. The stream was comprised of large cobble and boulder substrate with numerous step pools and high gradient channels that appeared to be poor habitat for Roundtail Chub. There were very few areas with overhanging vegetation or undercut banks. No crayfish were detected at this station.

Ultimately, our survey results were congruent with previous sampling conducted by AZGFD in the upper reach of Tonto Creek. It appears the presence of non-native fishes have restricted the range of Roundtail Chub in Tonto Creek as they have not been detected during the last three monitoring efforts conducted under the GRBMP.

Table 14. Summary of catch in upper Tonto Creek by BPEF. Total effort was 1,530 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
ONMY	1+	7	10.29	0.005
SATR	0	61	89.71	0.040
Total		**68**	**100**	**0.243**

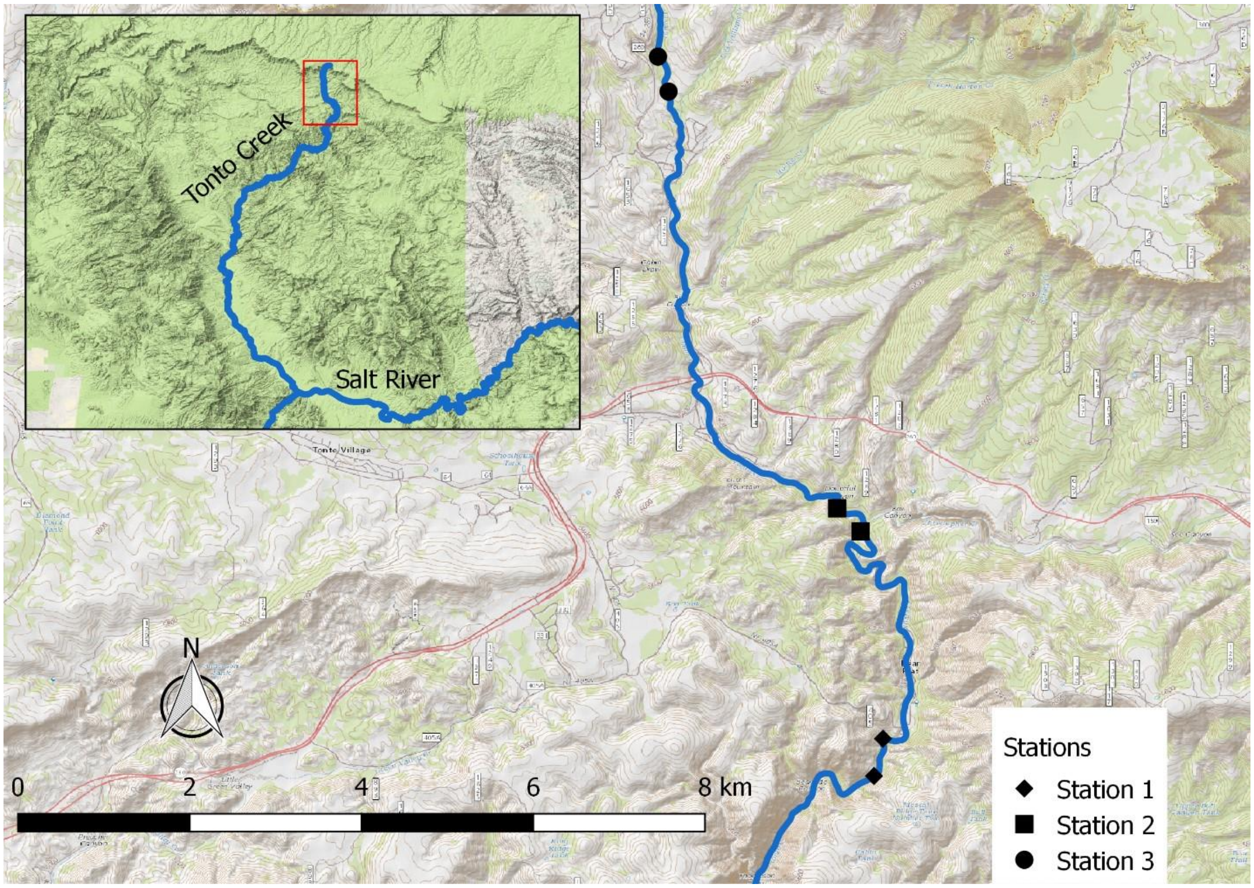

Figure 13. Location of three 500 m sampling stations in upper Tonto Creek, sampled May 22, 2018.

Middle Tonto Creek (Hellsgate Wilderness Area) June 21–23, 2018

12S NAD83 Lower boundary 1: 490258E, 3785650N Upper boundary 1: 490665E, 3785817N

Lower boundary 2: 490741E, 3785923N Upper boundary 2: 491171E, 3786187N

On June 21–23, 2018, the middle reach of Tonto Creek (Hellsgate Wilderness Area) was accessed from the trailhead on the north side of Tonto Creek. On June 21, 15 Promar hoop nets were deployed and fished overnight in the same section of stream sampled by AZGFD in 2013 (Timmons et al. 2014; Figure 14). Water temperature and conductivity at 13:00 were 24.7 °C and 406 µS, respectively. While nets were fishing, Roundtail Chub was targeted via fly rod with a black wooly bugger. Moderate turbidity impaired visual observation of Roundtail Chub in deep pools, but angling resulted in capture of 14 Age-

1+ Roundtail Chub and six Green Sunfish. Six of the Roundtail Chub were infected with anchor worm *Lernaea cyprinacea*. Nets were pulled in the morning, which resulted in capture of only non-native Yellow Bullhead and Green Sunfish. Because an insufficient number of Roundtail Chub were captured, the station was extended downstream to encompass a 500 m station. However, it was expected that there would be <25 chub captured downstream of the first station, so an attempt was made to travel downstream as far as possible to establish two additional stations, plus the extended station to meet sampling protocol requirements. There were several large pools encountered downstream that required swimming. Flotation devices were not packed, and heavy packs quickly became waterlogged and negatively buoyant. Therefore, only one additional station was established downstream of the first station.

In the second station, 15 Promar hoop nets were deployed throughout a 500 m station with deep pool habitat and fished for two hours. Promar hoop nets captured Roundtail Chub (n=1; 10%), Green Sunfish (n=3; 30%), Yellow Bullhead (n=4; 40%), and Northern Crayfish (n=2; 20%). For reporting purposes, catch was tabulated for each sampling gear across all stations within the middle reach (Tables 15 and 16). Stream habitat was characterized by deep pools connected by shallow riffles and runs. Pool substrate was predominately silt and gravel; whereas riffles and runs were predominately cobble and boulder substrate. Streamflow was slow, and turbidity was moderate in deep pools and low in riffle and run habitat. Water temperature and conductivity recorded at 07:30 were 19.6 °C and 435 µS, respectively.

Lastly, the remaining 400 m of the first station was sampled by deploying 15 Promar hoop nets throughout the stream. Nets were fished for five hours which resulted in capture of Northern Crayfish (n=26; 76.5%) and Green Sunfish (n=8; 23.5%). Roundtail Chub were visually observed in shallow pool and run habitats despite not being captured. Age-0 Roundtail Chub (not confirmed) were also observed in shallow run habitat. Stream habitat in the downstream portion of this station was markedly different from upstream habitat. For instance, there were shallower pools connected by riffle and run habitat. Photographs of available habitat are provided in Appendix B (Figures B45-B48).

Tonto Creek in Hellsgate Wilderness Area should continue to be monitored on a regular basis to determine persistence and understand population dynamics of Roundtail Chub.

Table 15. Summary of catch in middle Tonto Creek (Hellsgate Wilderness Area) by Promar hoop nets. Total effort was 345 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
AMNA	1+	22	28.21	0.064
GIRO	1+	1	1.28	0.003
LECY	1+	13	16.67	0.038
ORVI	N/A	42	53.85	0.122
Total		**78**	**100**	**0.226**

Table 16. Summary of catch in middle Tonto Creek (Hellsgate Wilderness Area) by fly rod. Total effort was three fishing hours.

Species	Age	Count	% of total catch	CPUE (fish/hr)
GIRO	1+	14	70.00	4.667
LECY	1+	6	30.00	2.000
Total		**20**	**100**	**6.667**

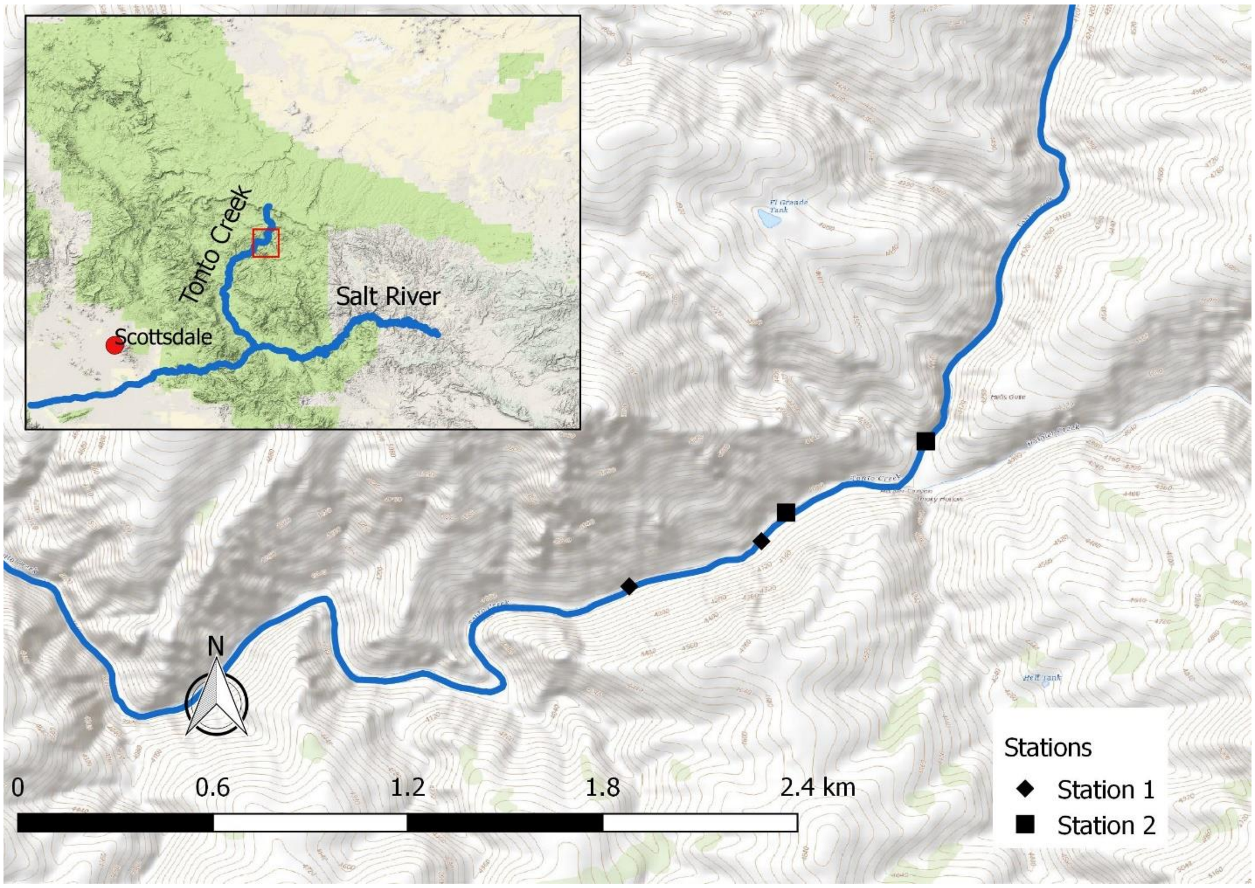

Figure 14. Location of two 500 m sampling stations in middle Tonto Creek (Hellsgate Wilderness Area), sampled June 21–23, 2018.

Lower Tonto Creek May 23, 2018

12S NAD83 Lower boundary 1: 472177E, 3760416N Upper boundary 1: 472566E, 3760691N

Lower boundary 2: 472859E, 3760839N Upper boundary 2: 472967E, 3761042N

On May 23, 2018, the lower reach of Tonto Creek was sampled with assistance from USFS personnel. A sampling station was established upstream of the United States Geological Survey (USGS) gaging station near Gun Creek, ~4 km south of Jakes Corner, Arizona (Figure 15). Stream access was gained by taking

FSR 188 to the stream gauge cable trolley parking (12S 471735E, 3759942N). Water was not found until several hundred meters upstream of the stream gauge. Once water was found, a 500 m sampling station was established. The first isolated pool was shallow and sampled via dip net. The pool was occupied by a suite of large-bodied non-native fishes (Table 17). Once connected surface water was encountered, BPEF was employed for a total of 280 seconds, and three Promar hoop nets were set for three hours. Across all sampling gears, a total of 94 fish representing six species was captured. Backpack electrofishing and dip nets were the most effective sampling gears. No native fishes were captured within the 500 m station. Red Shiner was most abundant (n=49; 52%), followed by Green Sunfish (n=16; 17%) and Yellow Bullhead (n=14; 15%). Streamflow was slow to non-existent and only pool habitat was present with gravel, pebble, cobble, and boulder substrate. There was one large pool that was non-wadable where Promar nets were set for two hours. Stream turbidity was low to moderate. The focus species (Roundtail Chub) was not detected, so sampling protocol was followed, and another station was established upstream.

The second 500 m station (Figure 15) was established ~300 m upstream from the first station due to limited access. Backpack electrofishing was employed for a total of 150 seconds before the stream became canyon bound and impassable with a BPEF, which resulted in the second station being only 260 m in length. Yellow Bullhead was the most abundant fish captured (n=6; 50%), followed by Red Shiner (n=5; 41.7%), and Smallmouth Bass (n=1; 8.3%). Five Promar hoop nets were deployed where the stream became impassable, which resulted in capture of one Green Sunfish. For reporting purposes, catch was tabulated for each sampling gear across all stations within the lower reach (Tables 17-19). A third station was not established because of limited upstream access, and the stream was dry downstream. Photographs of available habitat are provided in Appendix B (Figures B49-B52).

Table 17. Summary of catch in lower Tonto Creek by dip-net. Total effort was 5 sweeps.

Species	Age	Count	% of total catch	CPUE (fish/1m sweep)
AMNA	1+	5	16.13	1.00
CYCA	0	3	9.68	0.60
CYCA	1+	3	9.68	0.60
CYLU	N/A	10	32.26	2.00
ICPU	1+	1	3.23	0.20
LECY	0	5	16.13	1.00
LECY	1+	2	6.45	0.40
MIDO	1+	1	3.23	0.20
MISA	1+	1	3.23	0.20
TOTAL		**31**	**100**	**6.20**

Table 18. Summary of catch in lower Tonto Creek by BPEF. Total effort was 430 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AMNA	1+	15	20.27	0.035
CYLU	N/A	44	59.46	0.102
LECY	0	5	6.76	0.012
LECY	1+	4	5.41	0.009
MIDO	1+	6	8.11	0.014
Total		**74**	**100**	**0.172**

Table 19. Summary of catch in lower Tonto Creek by Promar hoop nets. Total effort was 19 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
LECY	1+	4	100	0.211
Total		**4**	**100**	0.211

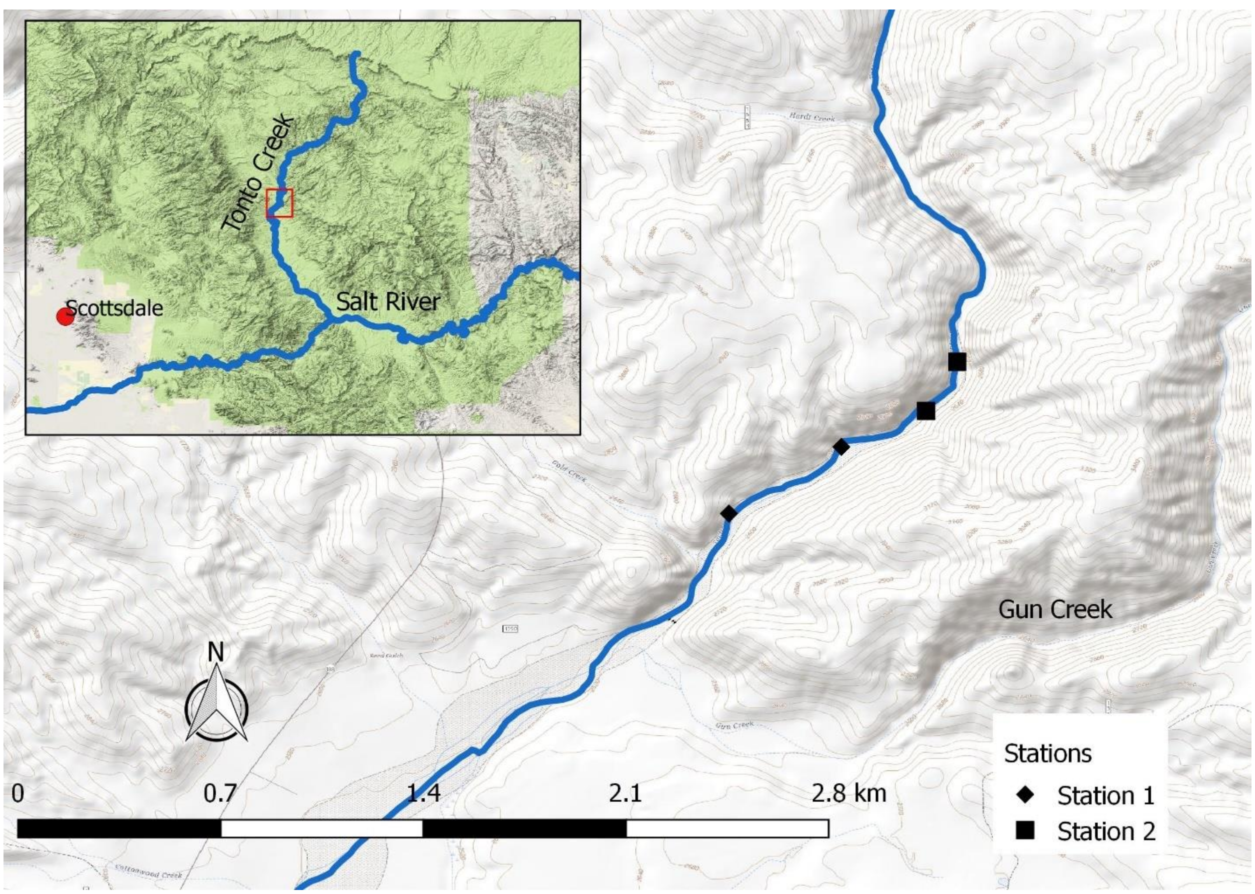

Figure 15. Location of two sampling stations in lower Tonto Creek, sampled May 23, 2018

Lower Spring Creek

Spring Creek is located within Sierra Anchas of central Arizona, flowing northwest to its confluence with Tonto Creek (Salt River drainage). The focus species in Spring Creek is Roundtail Chub. Chub from this stream were formerly referred to as Headwater Chub. Previous sampling has been conducted in easily accessible middle and upper reaches (Timmons et al. 2015; Timmons et al. 2017), but few surveys have sampled downstream of Flying W Ranch due to difficult access (e.g., Hickerson et al. 2014). A suite of native species including Roundtail Chub has been reported within the upper and middle reaches, but Green Sunfish also are abundant (Timmons et al. 2015; Timmons et al. 2017) and pose a threat to persistence of native fishes. Hickerson et al. (2014) sampled Spring Creek via fly fishing near the confluence of Tonto Creek and found Roundtail Chub were present, but upstream distribution in Spring Creek was not determined. The objective of sampling Spring Creek in 2018 was to determine distribution and abundance of Roundtail Chub downstream of Flying W Ranch as requested by AZGFD. Three equidistant stream reaches were established to meet this objective (Figure 16).

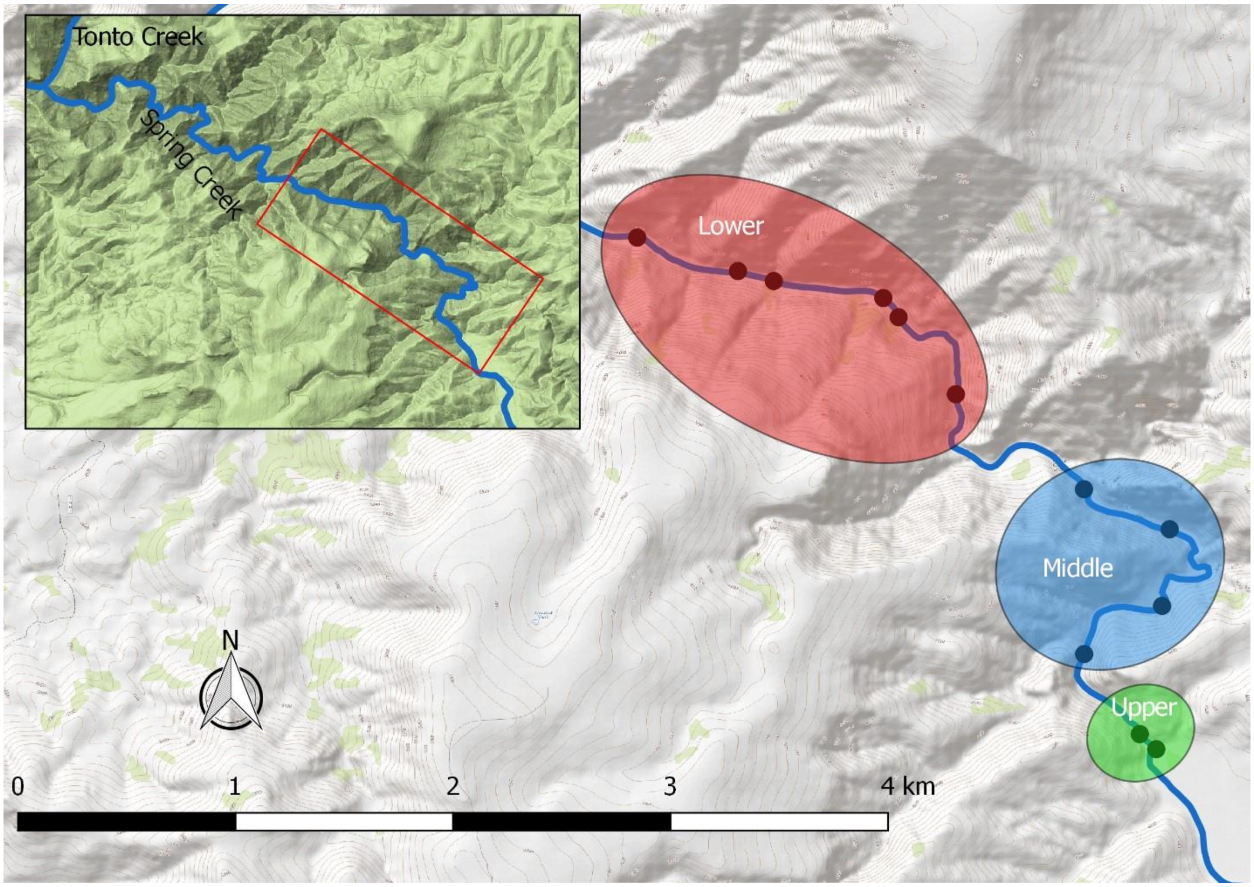

Figure 16. Location of stream reaches (i.e., upper, middle, and lower) and upper and lower boundaries of sampling stations in Spring Creek, sampled June 5–7, 2018.

Spring Creek – Flying W Ranch (Upper Reach) June 5–6, 2018

12S NAD83 Lower boundary 1: 491060E, 3775612N Upper boundary 1: 491136E, 3775528N

Spring Creek was accessed on FSR 134 west of Young, Arizona and the vehicle was parked near the stream crossing. Because of limited access, all sampling stations were accessed by the same route. On the first day a crew hiked ~1.5 km downstream and established a sampling station (upper reach) where the stream became canyon bound, and chub were visually detected, so a 100 m station was established (Figure 17). Prior to sampling, 20 Roundtail Chub were visually counted in the first pool, but few of these were captured (n=2) with BPEF as depth was a limiting factor. Habitat consisted of pools with pebble, cobble, and boulder substrate connected by shallow riffles that appeared to prevent movement of chub between pools. Backpack electrofishing for a total of 510 seconds resulted in capture of Roundtail Chub (n=11; 27.5%), Desert Sucker (n=6; 15.0%), and Green Sunfish (n=23; 57.5%; Table 20). Promar hoop nets were deployed and fished overnight in deep pools where BPEF was not effective. Promar hoop nets resulted in capture of Roundtail Chub (n=5; 10.2%), Desert Sucker (n=4; 8.2%), Green Sunfish (n=34; 69.4%), and Yellow Bullhead (n=6; 12.2%; Table 21). A subsequent 500 m station was not established upstream because there was limited water and unsuitable chub habitat.

Water temperature and conductivity recorded at 07:10 (June 6) were 17.9 °C and 501 µS, respectively. Stream habitat within the upper reach consisted of waist deep pools with abundant submerged vegetation and algae, connected by shallow riffles. Substrate in the upper reach was predominately boulder and cobble. There was heavy cattle grazing upstream of the sampling station where stream banks were void of vegetation and eroded. One Arizona Toad was captured along the stream bank near the upper boundary. Photographs of available habitat and an adult Roundtail Chub in breeding condition are provided in Appendix B (Figures B53-B57).

Table 20. Summary of catch in lower Spring Creek (Flying W Ranch; upper reach) by BPEF. Total effort was 510 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
GIRO	1+	11	27.50	0.022
LECY	1+	23	57.50	0.045
PACL	0	4	10.00	0.008
PACL	1+	2	5.00	0.004
Total		**40**	**100**	**0.078**

Table 21. Summary of catch in lower Spring Creek (Flying W Ranch; upper reach) by Promar hoop nets. Total effort was 95 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
AMNA	1+	6	12.24	0.063
GIRO	1+	5	10.20	0.053
LECY	1+	34	69.39	0.358
PACL	1+	4	8.16	0.042
Total		**49**	**100**	**0.516**

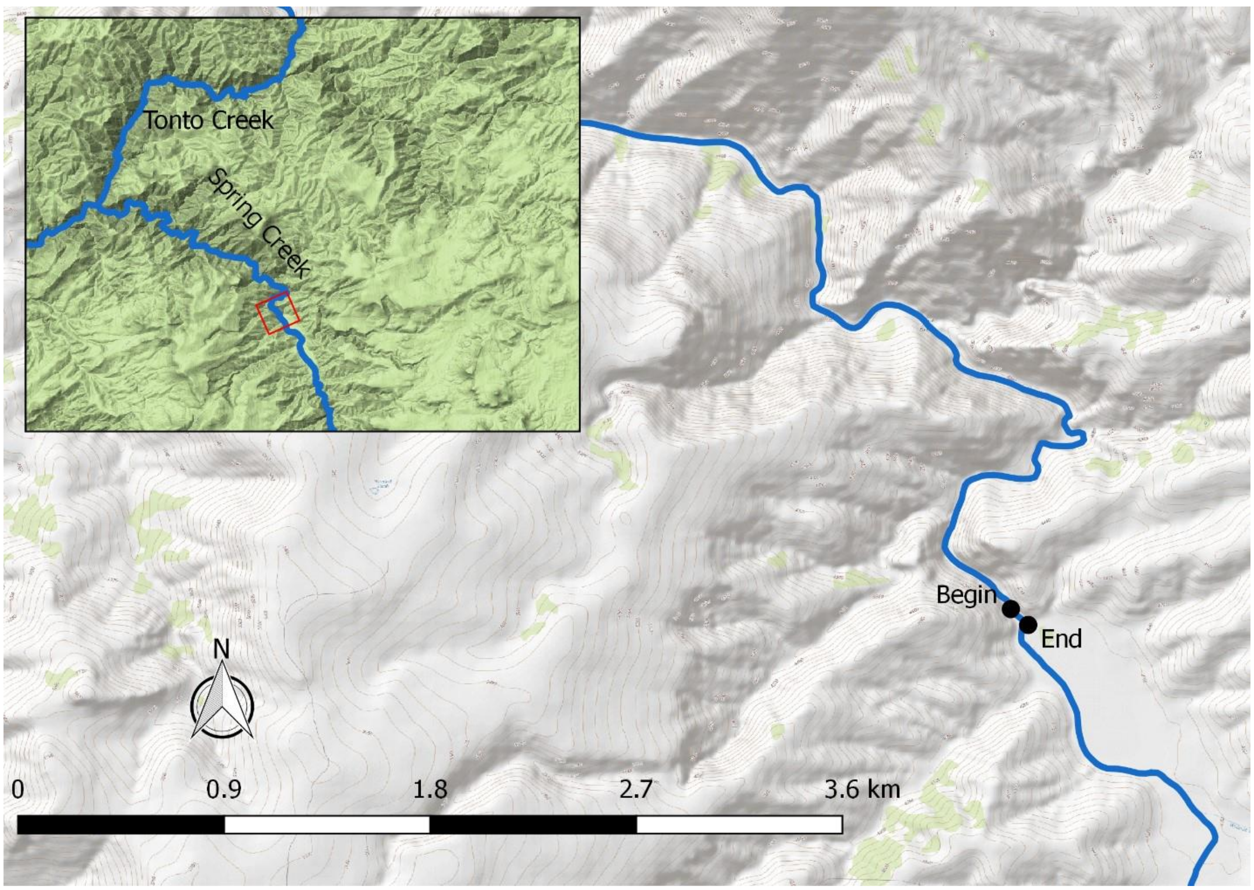

Figure 17. Location of 100 m sampling station in Spring Creek (Flying W Ranch; upper reach), sampled June 5–6, 2018.

Spring Creek – Flying W Ranch (Middle Reach) June 6, 2018

12S NAD83 Lower boundary 1: 490805E, 3776965N Upper boundary 1: 491199E, 3776744N

Lower boundary 2: 491163E, 3776320N Upper boundary 2: 490805E, 3776055N

A total of two stations was sampled within the middle reach (Figure 18). The first station was established ~1 km upstream from the third station sampled in the most downstream reach (discussed below). Backpack electrofishing for 466 seconds resulted in capture of Green Sunfish (n=41; 82.0%), Yellow Bullhead (n=8; 16.0%), and Age-1+ Roundtail Chub (n=1; 2.0%). After this station was completed, there was little time left in the day to complete another station and Promar hoop nets were deployed in a pool upstream where Roundtail Chub were noted as abundant on the hike in. Water temperature recorded at 8:44 was 17.7 °C. The next morning, nets were retrieved, which resulted in capture of Green Sunfish (n=57; 68.7%), Yellow Bullhead (n=13; 15.6%), Roundtail Chub (n=11; 13.3%), Desert Sucker (n=1; 1.2%), and Sonora Mud Turtle (n=1; 1.2%). Since 25 Roundtail Chub were not captured, a 500 m station was established downstream by BPEF upstream to the lower boundary of where nets were set. The 100 m of stream where the nets were deployed was connected by shallow riffle to the downstream habitat, so it was assumed no fish were recaptured. Roundtail Chub were detected within the first five minutes of sampling, but a 500 m station was completed because abundance was <25 individuals within a 100 m station. Backpack electrofishing for 710 seconds resulted in capture of Roundtail Chub (n=34; 37.8%), Green Sunfish (n=45; 50.0%), Yellow Bullhead (n=7; 7.8%), Desert Sucker (n=3; 3.3%), and Longfin Dace (n=1; 1.1%). For reporting purposes, catch data were tabulated across all stations for each sampling gear (Tables 22-23).

This section of stream had suitable chub habitat and was the most efficiently sampled reach. Routine sampling of lower Spring Creek (i.e., middle and upper reaches sampled in 2018) should continue to monitor persistence and population dynamics of Roundtail Chub. Photographs of available habitat are provided in Appendix B (Figures B58-B59).

Black Bear *Ursa americanus* sign was heavy along the riparian zone in the middle reach. Additionally, unidentified tadpoles were abundant throughout the middle reach.

Table 22. Summary of catch in lower Spring Creek (middle reach) by BPEF. Total effort was 1,176 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	N/A	1	0.71	0.001
AMNA	1+	15	10.71	0.013
GIRO	1+	35	25.00	0.030
LECY	1+	86	61.43	0.073
PACL	0	3	2.14	0.003
Total		**140**	**100**	**0.119**

Table 23. Summary of catch in lower Spring Creek (middle reach) by Promar hoop nets. Total effort was 133 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
AMNA	1+	13	15.66	0.098
GIRO	1+	11	13.25	0.083
KISO	1+	1	1.20	0.008
LECY	1+	57	68.67	0.429
PACL	1+	1	1.20	0.008
Total		**83**	**100**	**0.625**

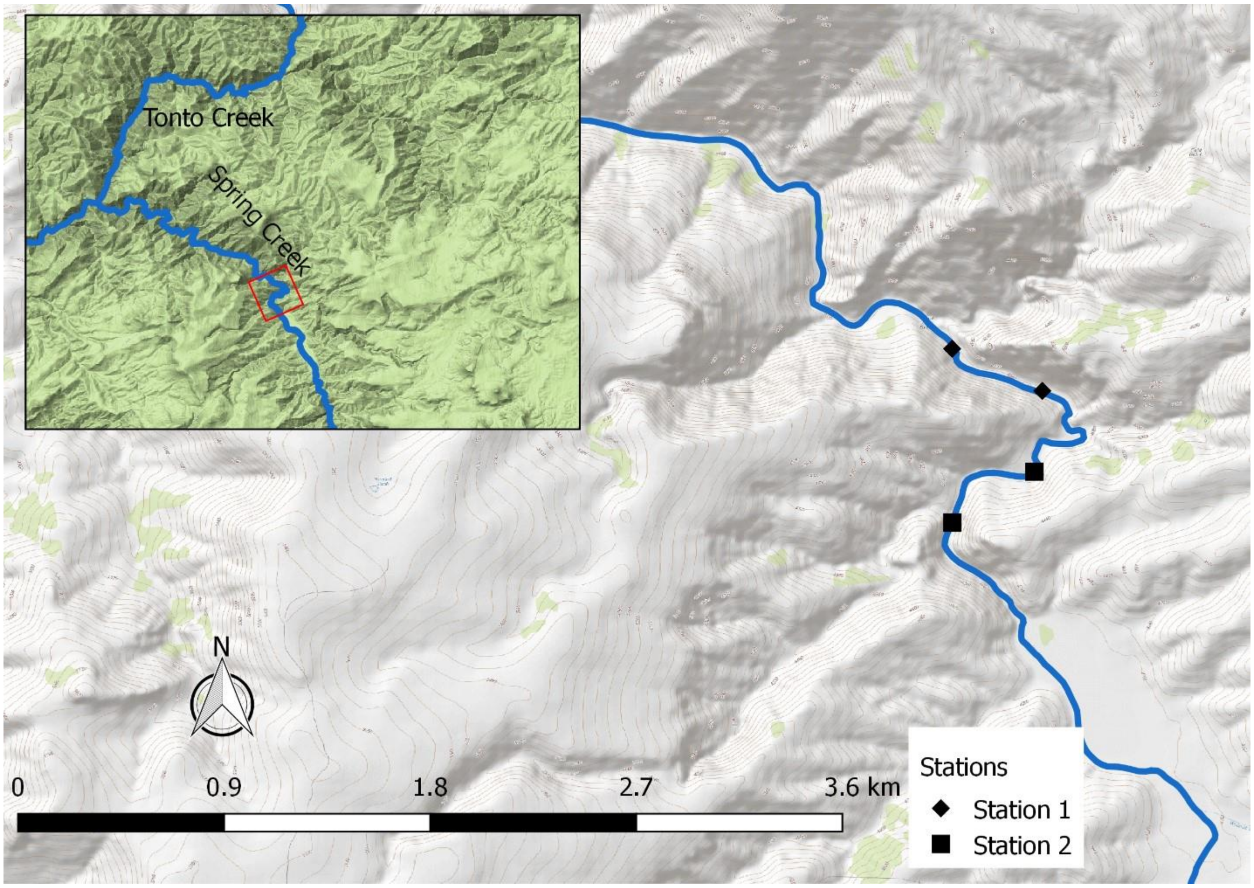

Figure 18. Location of two 500 m sampling stations in Spring Creek (middle reach), sampled on June 6–7, 2018.

Spring Creek – Flying W Ranch (Lower Reach) June 6, 2018

12S NAD83	Lower boundary 1: 488754E, 3778358N	Upper boundary 1: 489217E, 3778172N
	Lower boundary 2: 489381E, 3778117N	Upper boundary 2: 489884E, 3778023N
	Lower boundary 3: 489954E, 3777916N	Upper boundary 3: 490217E, 3777491N

The lower reach of Spring Creek was accessed by hiking as far as reasonable and returning the same day. Staff hiked 7.5 km downstream of Flying W Ranch, which was ~7.5 km from the confluence with Tonto Creek. Initially, the plan was to hike within a few kilometers of the confluence, but there were several obstacles that slowed hiking, such as areas which required climbing on cliffs around pools and shuttling gear (e.g., BPEF) over heads in neck deep water. After hiking for ~4 hours, a 100 m station was established (Figure 19) where Roundtail Chub was observed swimming in the largest pool encountered (12S 488754E, 3778358N). Water temperature and conductivity recorded at 12:50 were 22.5 °C and 325 µS, respectively. Nine Promar hoop nets were set for two hours and BPEF was employed within the 100 m station. No Roundtail Chub or other natives were captured within the 100 m sampling station, so a 500 m station was established upstream. Roundtail Chub were not captured via BPEF because of depth, and nets were full of Green Sunfish, which may have reduced capture likelihood of other species. Unfortunately, angling gear was not packed and would have been a useful sampling gear.

Backpack electrofishing was employed upstream for a total of 434 seconds, which resulted in capture of Age-1+ Roundtail Chub (n=1; 1.2%), Green Sunfish (n=75; 89.3%), and Yellow Bullhead (n=8; 9.5%). Because low numbers of chub were recorded, a second 500 m station was established ~150 m upstream (Figure 19). Water temperature and conductivity recorded at 13:00 were 25.0 °C and 510 µS, respectively. Backpack electrofishing for 468 seconds resulted in capture of Green Sunfish (n=154; 91.1%), Yellow Bullhead (n=12; 7.1%), and Age-1+ Roundtail Chub (n=3; 1.2%). Again, because low numbers of Roundtail Chub were recorded, a third 500 m station was established ~116 m upstream. Backpacking electrofishing for 849 seconds resulted in capture of Age-1+ Roundtail Chub (n=15; 4.8%), Green Sunfish (n=285; 90.8%), and Yellow Bullhead (n=14; 4.4%). Water temperature and conductivity recorded at 14:32 were 27.1 °C and 415 µS, respectively. For reporting purposes, catch data were tabulated across stations for each sampling gear (Tables 24-25).

Stream habitat within the lower reach consisted of stretches with no water or shallow pools connected by riffles with large substrate (i.e., boulder and cobble). There were several pools with waist deep water with bottoms comprised of gravel, pebble, and cobble substrate. Larger pools had abundant submerged vegetation and algae. Heavy cattle grazing appeared to have resulted in nutrient loading and stream bank erosion that had negative downstream effects. Photographs of available habitat are provided in Appendix B (Figures B60-B62).

It was evident abundance of Roundtail Chub increased upstream along with suitable habitat. Another notable observation was failure to detect of Age-0 chub, indicating potential recruitment failure. Roundtail Chub are persistent in lower Spring Creek (Hickerson et al. 2014), but the sheer numbers of Green Sunfish pose a serious threat. Mechanical removal of Green Sunfish in this extensive and rugged stream reach would be challenging and likely be ineffective. However, construction of a fish barrier and a subsequent large flash flood may provide an opportunity to suppress Green Sunfish and conserve a sustainable population of Roundtail Chub.

Future sampling of this reach should strongly consider ability of the field crew to maneuver over rough terrain. If the objective of future sampling is to determine the lower extent of Roundtail Chub, it is recommended that only angling gear and Promar hoop nets are used to allow field crews to swim through deep pools. An extended backpacking trip would be feasible, but there are limited places to camp and swimming through pools with gear would be required.

Table 24. Summary of catch in lower Spring Creek (Flying W Ranch; lower reach) by BPEF. Total effort was 1,946 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
LECY	1+	516	90.53	0.265
AMNA	1+	35	6.14	0.018
GIRO	1+	19	3.33	0.010
Total		**570**	**100**	**0.293**

Table 25. Summary of catch in Spring Creek (Flying W Ranch; lower reach) by Promar hoop nets. Total effort was 18 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
AMNA	1+	1	1.75	0.056
KISO	1+	1	1.75	0.056
LECY	1+	55	96.49	3.056
Total		**57**	**100**	**3.167**

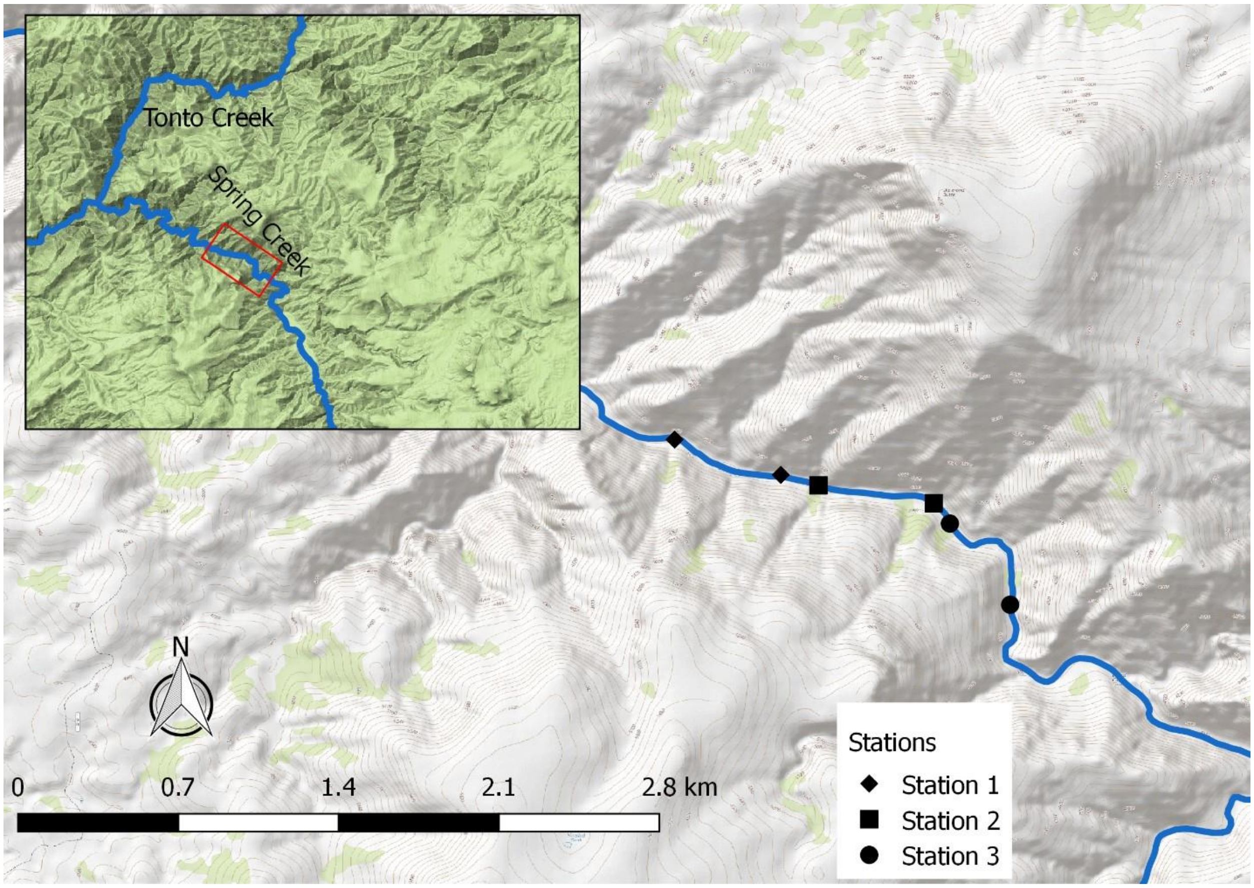

Figure 19. Location of three 500 m sampling stations in Spring Creek (lower reach), sampled on June 6, 2018.

Walker Creek July 3, 2018

12S NAD83 Lower boundary 1: 436014E, 3833687N Upper boundary 1: 436123E, 3833691N

Walker Creek flows west to its confluence with Wet Beaver Creek in Verde River basin within Coconino National Forest (Figure 20). Walker Creek has been sampled for the GRBMP near Rancho Roco Roja, above Lander Spring in 2014 and 2016 (Timmons et al. 2015; Timmons et al. 2017). In both years, the focus species, Gila Chub, was detected in sufficient numbers within the same location in addition to Desert Sucker and Speckled Dace. Non-native fishes are not present within this stream reach potentially due to intermittent streamflow and a small diversion barrier (Timmons et al. 2017).

On July 3, Walker Creek was accessed from Walker Basin Trail on FSR 9201C. The vehicle was parked near the gate (12S 435496E, 3834651N) and a crew hiked along the 4x4 road to a lightly used trail that led to Walker Creek (12S 436267E, 3834507N). The road is only accessible to vehicles with high clearance. Furthermore, there are few areas to park along the narrow road and it is recommended to access on foot. Once the stream was encountered, Gila Chub were visually observed downstream of a diversion barrier near the lower survey boundary in 2016, so a 100 m station was established. Backpack electrofishing for a total of 742 seconds resulted in capture of Speckled Dace (n=65; 56.0%), Gila Chub (n=38; 32.8%), and Desert Sucker (n=13; 11.2%). All species appeared to be in good condition with no parasites. Most Gila Chub were captured near the lower boundary in a pool downstream of the diversion barrier. Favorable water levels allowed effective sampling in this pool unlike sampling performed in 2016 (Timmons et al. 2017). Deviations from sampling protocol include not recording effort for each mesohabitat sampled, so all fish captured were pooled across mesohabitats (Table 26).

Water temperature and conductivity recorded at 11:15 were 21.7 °C and 381 µS, respectively. Stream habitat consisted of shallow pools connected by slow moving riffles and runs comprised of cobble and boulder substrate. Large woody debris was abundant throughout the station and there were undercut banks with root masses. Photographs of upper and lower boundaries of the 100 m sample station are provided in Appendix B (Figures B63-B66).

Routine sampling of Walker Creek should continue to monitor persistence and population dynamics of Gila Chub. Furthermore, additional monitoring should be conducted to determine distribution and abundance of non-native fishes downstream of Rancho Roco Roja. Factors should be identified that prevent upstream movement of non-native fishes to prevent establishment. The diversion barrier appears inadequate to prevent upstream movement of non-native fishes during periods with higher water levels. However, non-native fishes have not reached the diversion barrier yet and movement may be restricted by intermittent flow or a physical barrier downstream (Timmons et al. 2017).

Table 26. Summary of catch in Walker Creek by BPEF. Total effort was 742 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
GIIN	0	20	17.24	0.027
GIIN	1+	18	15.52	0.024
PACL	1+	13	11.21	0.018
RHOS	N/A	65	56.03	0.088
Total		**116**	**100**	**0.156**

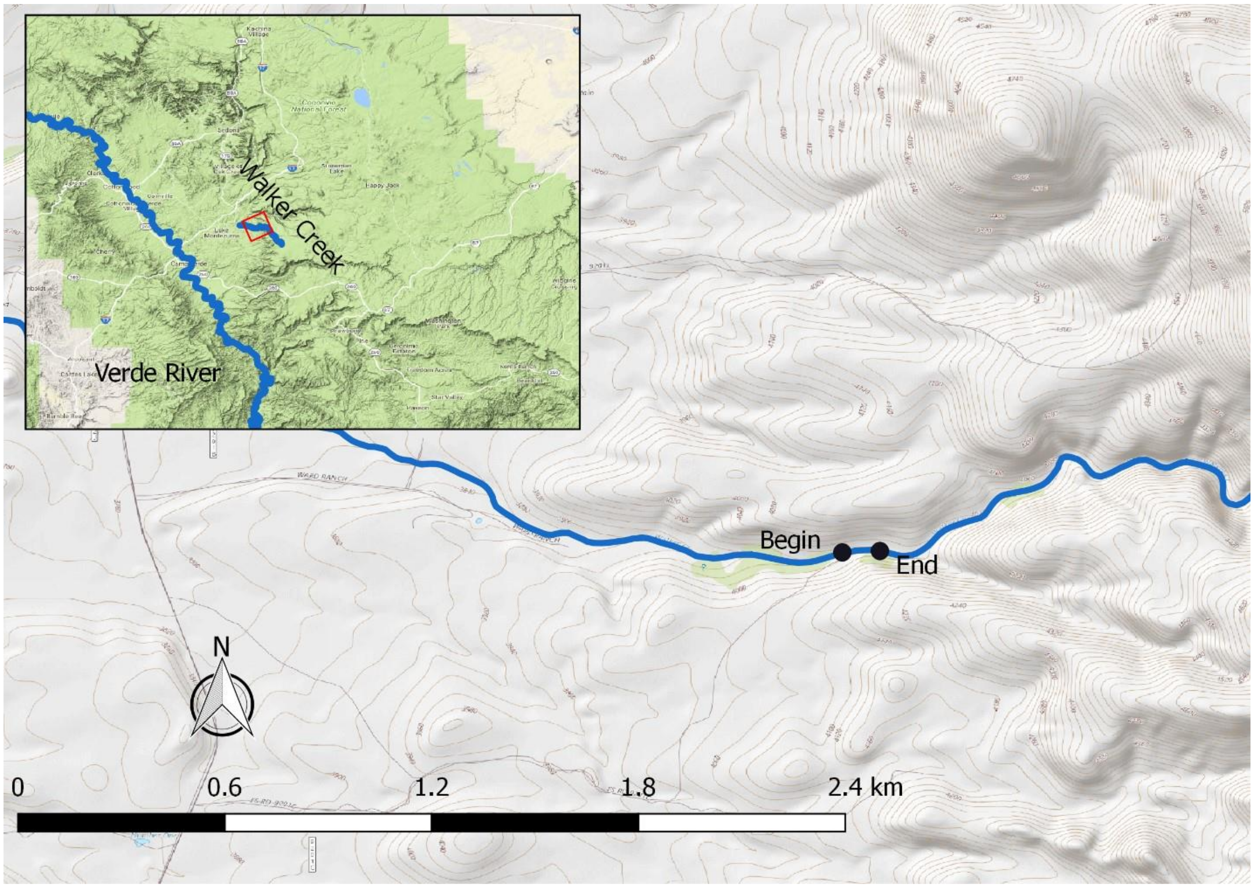

Figure 20. Location of 100 m sampling station in Walker Creek, sampled on July 3, 2018.

Marsh Creek July 4, 2018

12S NAD83 Lower boundary 1: 497247E, 3780740N Upper boundary 1: 497263E, 3780733N

Marsh Creek originates at the base of Naegelin Rim and flows northwest to its confluence with Haigler Creek within Hellsgate Wilderness Area in Tonto National Forest (Figure 21). Previous sampling of Marsh Creek for the GRBMP was conducted in 2013 and 2016 (Timmons et al. 2014; Timmons et al. 2017). In both years, the focus species Roundtail Chub and Green Sunfish were detected. Chub from this stream were formerly referred to as Headwater Chub.

Marsh Creek was accessed by parking near a side drainage (12S 497606E, 3779179N) and hiking into the Marsh Creek drainage. Access in 2013 and 2016 was gained by contacting Marsh Creek Ranch and hiking downstream. Upon arrival, a reconnaissance of the stream was performed to assess habitat and perform visual observations for Roundtail Chub. Chub were visually observed at the first pool encountered (12S 497513E, 3780334N) upstream of sampling stations established in 2013 and 2016. Visual surveys downstream revealed most of the stream was dry with only a few isolated pools. In fact, most of the stream reach sampled in 2013 and 2016 was dry. There was a small isolated pool remaining within the station that was sampled in 2013, and it was visually observed that chub were present. A 20 m station was established (total length of pool) and BPEF for a total of 138 seconds, which resulted in capture of 82 fish. Age-0 Roundtail Chub accounted for 69.5% (n=57) of catch, while Age-1+ fish accounted for 23.2% (n=19) and Green Sunfish accounted for 7.3% (n=6). Reproduction and recruitment of Roundtail Chub was confirmed as indicated by a strong cohort of Age-0 fish. Catch data were tabulated in Table 27. Water temperature and conductivity recorded at 08:24 were 15.6 °C and 485 µS, respectively. Photographs of upper and lower boundaries of the 20 m sampling station are provided in Appendix B (Figures B67-B70).

Based on comparison with previous visits to Marsh Creek, it appears water levels fluctuate drastically. In 2013 and 2016, sampling was conducted in August and September, respectively, after monsoons had replenished stream discharge. Water levels were low in 2018, which poses a threat to persistence of Roundtail Chub in Marsh Creek if normal rainfall does not continue. Furthermore, Green Sunfish were present but in lower abundance compared to previous surveys. Stream desiccation and presence of Green Sunfish are the biggest threats to persistence of Roundtail Chub in Marsh Creek. Routine sampling of Marsh Creek should be continued to monitor persistence and population dynamics of Roundtail Chub.

Table 27. Summary of catch in upper Marsh Creek by BPEF. Total effort was 138 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
GIRO	0	57	69.51	0.413
GIRO	1+	19	23.17	0.138
LECY	1+	6	7.32	0.043
Total		**82**	**100**	**0.594**

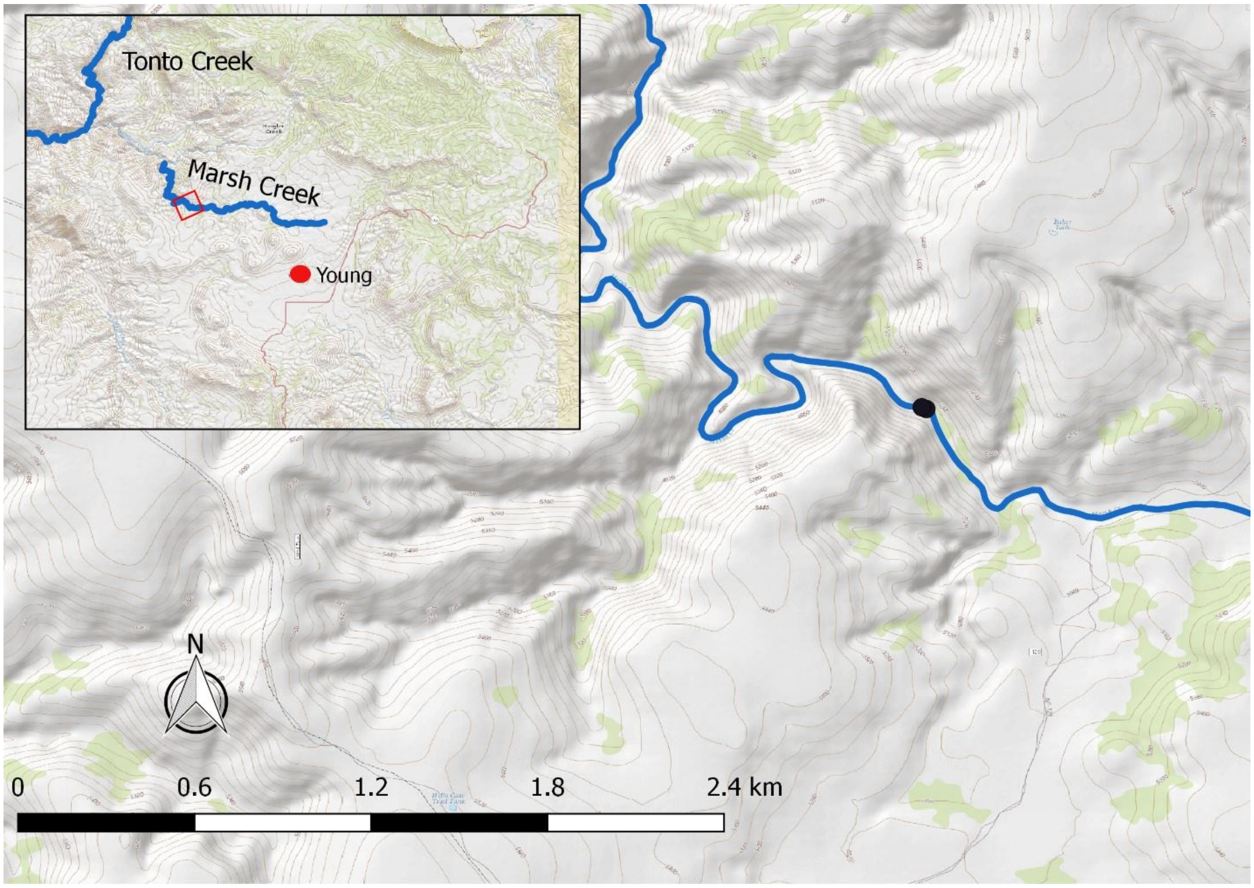

Figure 21. Location of 20 m sampling station in Marsh Creek, sampled on July 4, 2018.

Rock Creek July 11, 2018

12S NAD83 Lower boundary 1: 453108E, 3787995N Upper boundary 1: 453214E, 3788479N

Rock Creek (Verde River basin) is tributary to East Verde River in Tonto National Forest (Figure 22). Most of Rock Creek appears intermittent based on Google Earth, but Polk Spring maintains a perennial stream reach of ~1 km in length. Rock Creek has never been sampled under the GRBMP, but sampling by AZGFD and M&A have previously confirmed the presence of Roundtail Chub and a suite of other native fishes (Cotten and Miller 2014; Marsh and Clarkson 2015; and Wisenall et al. 2015). Chub from this stream were formerly referred to as Headwater Chub.

Rock Creek was accessed by hiking ~7 km on Doll Baby Ranch Road (trailhead to Arizona Trail). A 500 m station was established ~150 m downstream of where Wisenall et al. (2015) first collected Roundtail Chub in a pool using Promar hoop nets. Turbidity was high due to ¼ inch of rain the previous day. Roundtail Chub were detected within the first 50 m of BPEF and a 100 m station was established, but <25 Roundtail Chub were captured and a 500 m station was completed. Backpack electrofishing for a total of 958 seconds resulted capture of Green Sunfish (n=107; 72.3%), Roundtail Chub (n=21; 14.2%), Speckled Dace (n=17; 11.5%), Desert Sucker (n=1; <1%), Fathead Minnow (n=1; <1%), and Longfin Dace (n=1; <1%; Table 28). Age-0 Roundtail Chub accounted for 12.8% (n=19) of catch while Age-1+ Roundtail Chub accounted for 1.4% (n=2). However, some Longfin Dace may have been misidentified and counted as Age-0 Roundtail Chub, but this number is likely low. An additional station was not established upstream of Polk Spring because the creek becomes intermittent and was dry. Multiple small isolated pools were shocked, and chub were last detected at 12S 453221E, 3788886N. Also, one Smallmouth Bass was captured in an isolated pool upstream of the sampling station which represents the first known collection of this species in Rock Creek. The furthest point surveyed upstream was located at 12S 453333E, 3788919N. Water temperature and conductivity recorded at 12:12 were 24.8 °C and 530 µS, respectively.

Stream habitat consisted of shallow pools with bottoms composed of cobble, boulder, and silt. There also were some pools with large woody debris. Pool habitat was connected by shallow runs with cobble and boulder substrate. Riffle habitat was also present but comprised a small portion of available habitat. Most of the stream had a high percent of canopy cover. A photograph of available habitat is provided in Appendix B (Figure B71).

Roundtail Chub have persisted in Rock Creek despite co-occurrence with non-native fishes. Yellow Bullhead was not recorded in this survey, but our failure to detect them may have been due to poor water clarity. East Verde River was completely dry, indicating Rock Creek provides critical refugia for native fishes. Routine sampling of Rock Creek should continue to monitor persistence and population dynamics of Roundtail Chub and other native fishes.

Table 28. Summary of catch in Rock Creek by BPEF. Total effort was 958 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	N/A	1	0.68	0.001
GIRO	0	19	12.84	0.020
GIRO	1+	2	1.35	0.002
LECY	0	75	50.68	0.078
LECY	1+	32	21.62	0.033
PACL	0	1	0.68	0.001
PIPR	N/A	1	0.68	0.001
RHOS	N/A	17	11.49	0.018
Total		**148**	**100**	**0.154**

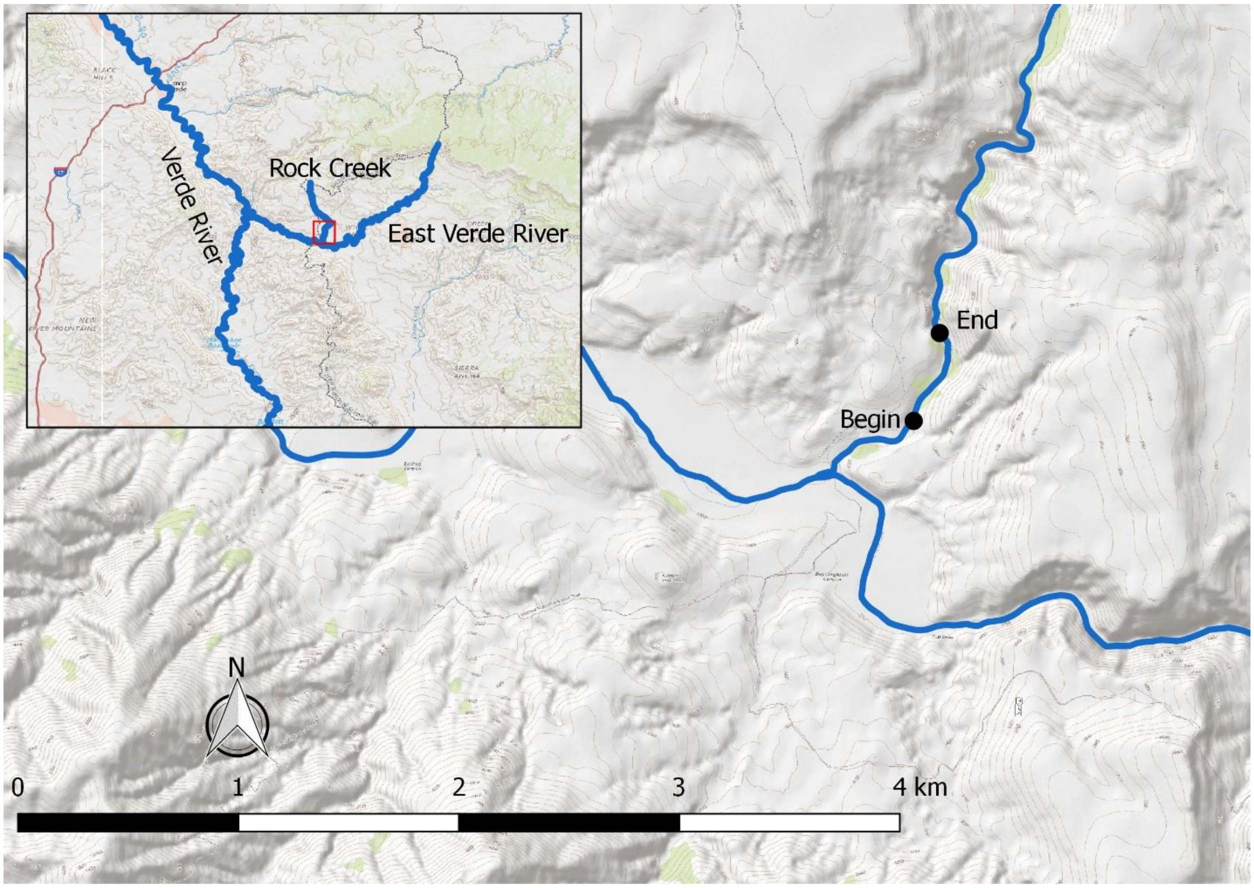

Figure 22. Location of 500 m sampling station in Rock Creek, sampled on July 11, 2018.

Campbell Blue Creek July 17, 2018

12S NAD83 Lower boundary 1: 679023E, 3734486N Upper boundary 1: 679053E, 3734592N

Campbell Blue Creek originates ~11.2 km southwest of Alpine, Arizona within Apache-Sitgreaves National Forest and flows southeast until it converges with Dry Blue Creek and forms Blue River (Figure 23). The focus species in Campbell Blue Creek is Loach Minnow. Loach Minnow are widely distributed throughout Campbell Blue Creek. The species is generally associated with swift riffles over pebble, cobble, or gravel (Barber and Minckley 1966, Turner and Tafanelli 1983, Rinne 1989, Propst and Bestgen 1991). In 2011, the Wallow Fire burned 2,115 km^2 (522,642 acres) of forest in Arizona and fish kills were observed in upper Gila River basin. Immediate post-fire surveys (2011-2012) found Loach Minnow were absent from Campbell Blue Creek (Kesner et al. 2011; Patterson et al. 2012). However, Loach Minnow populations naturally recovered in Campbell Blue Creek three years post-fire and continue to persist (Humphrey et al. 2015; Timmons et al. 2017).

A 500 m station was established ~100 m downstream of where Timmons et al. (2017) established their station (12 S 679047E, 3734570N). Backpack electrofishing while kick-seining was utilized to target Loach Minnow and this method also provided an effective way to provide an accurate representation of fish community composition. Loach Minnow were immediately detected, so a 100 m station was established and shocked for a total of 559 seconds. Backpack electrofishing resulted in capture of

Speckled Dace (n=327; 49.0%), Longfin Dace (n=292; 43.7%), Loach Minnow (n=25; 3.7%), Desert Sucker (n=20; 3.0%), Brown Trout (n=3; <1%), and Sonora Sucker (n=1; <1%; Table 29). Surprisingly, most Loach Minnow were captured outside of preferred habitat in slow moving riffle/runs (predominately runs) with sand, gravel, and pebble substrate. Northern Crayfish and tadpoles also were present. Water temperature and conductivity recorded at 15:03 were 28.1 °C and 316 μS, respectively. Photographs of upper and lower boundaries of the 100 m sampling station are provided in Appendix B (Figures B72-B75).

The fish community in Campbell Blue Creek continues to be predominately native fishes and should be monitored regularly. Loach Minnow recovered following a large forest fire and appear to continue to increase in number despite sub-optimal habitat conditions (e.g., high embeddedness). A previous survey found Loach Minnow may have a greater niche-breadth than previously thought (Humphrey et al. 2015; Marsh et al. 2003). Alternatively, other unidentified factors may have facilitated reestablishment. Population recovery demonstrates resiliency of Loach Minnow in the upper Gila River basin and highlights the importance of maintaining watershed connectivity in regions with intact native fish communities to ensure self-sustaining populations.

Table 29. Summary of catch in Campbell Blue Creek by BPEF. Total effort was 559 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	N/A	292	43.71	0.522
CAIN	1+	1	0.15	0.002
PACL	0	20	2.99	0.036
RHOS	N/A	327	48.95	0.585
SATR	0	3	0.45	0.005
TICO	N/A	25	3.74	0.045
Total		**668**	**100**	**1.195**

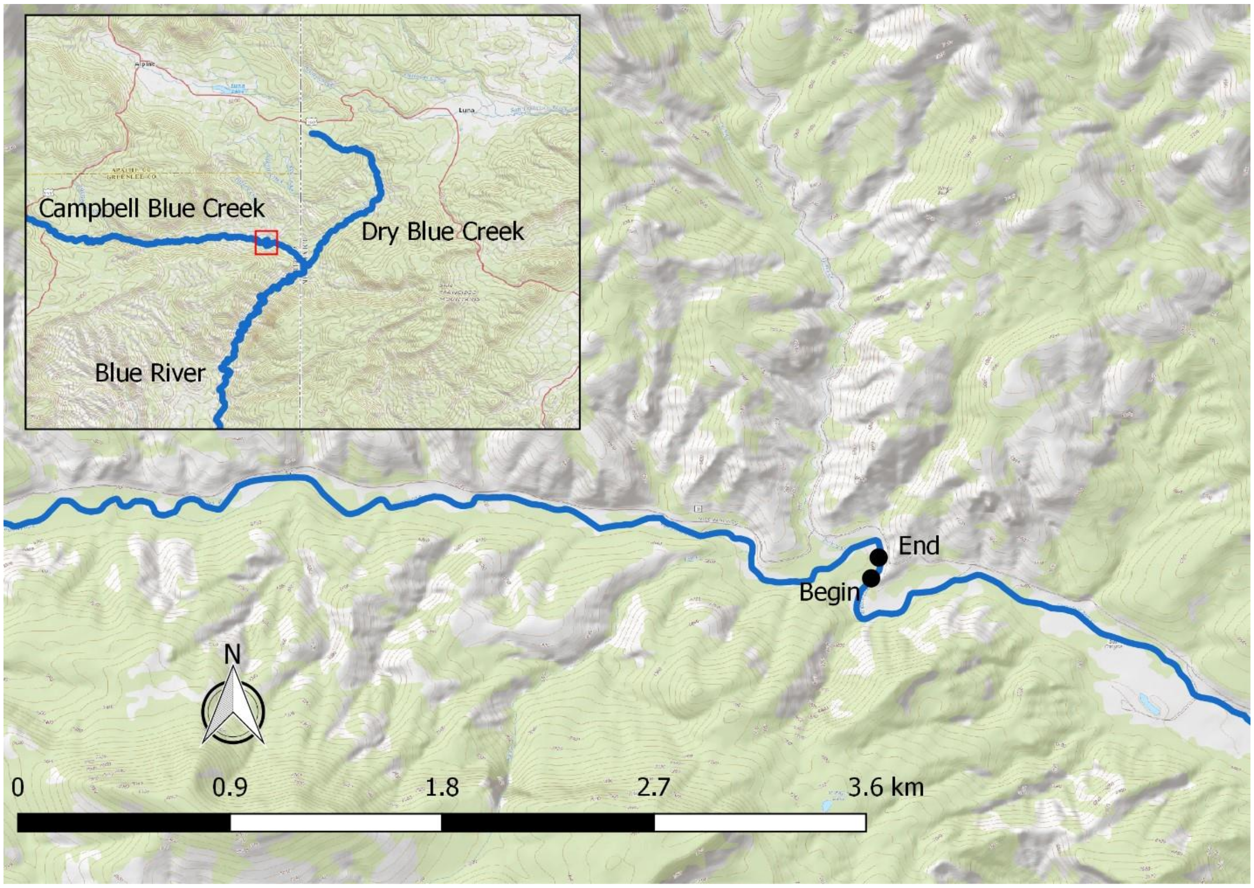

Figure 23. Location of 100 m sampling station in Campbell Blue Creek, sampled on July 17, 2018.

Dry Blue/Pace Creek July 18, 2018

12S NAD83	Lower boundary 1: 681870E, 3733829N	Upper boundary 1: 682018E, 3734349N
	Lower boundary 2: 682319E, 3734588N	Upper boundary 2: 682446E, 3734947N

Dry Blue Creek originates ~16.4 km southeast of Alpine, Arizona within Apache-Sitgreaves National Forest in New Mexico. Dry Blue Creek flows southwest to its confluence with Campbell Blue Creek and forms Blue River (Figure 24). The focus species in Dry Blue Creek is Loach Minnow. Loach Minnow were reported before the 2011 Wallow Fire (Bagley et al. 1998, Karam and Kesner 2007) but have not been detected from Dry Blue Creek post-fire (Massure et al. 2013; Humphrey et al. 2015; Timmons et al. 2017). Habitat drastically changed after the Wallow Fire due to erosion and sediment deposition in interstitial spaces, which is believed to be responsible for loss of Loach Minnow. Despite the disappearance of Loach Minnow, both Speckled Dace and Longfin Dace continue to persist in Dry Blue Creek.

A 500 m station was established at the same location sampled by AZGFD in 2016 (Timmons et al. 2017). Backpack electrofishing was performed for a total of 1,069 seconds which resulted in capture of Longfin Dace (n=319; 52.3%), Speckled Dace (n=288; 47.3%), and Brown Trout (n=2; <1%). Stream habitat sampled that was most suitable for Loach Minnow included long riffles with cobble substrate. Riffles were embedded with silt, and aquatic macrophytes were dense in all habitat types (i.e., riffle, run, pool). Water temperature and conductivity recorded at 08:27 were 14.5 °C and 430 µS, respectively.

Because no Loach Minnow were detected, an additional station was established ~377 m upstream. Stream habitat changed compared to the downstream station with more pools filled with organic matter and shorter riffles with higher embeddedness. The stream became dry after sampling for a total of 250 m. Backpack electrofishing for a total of 211 seconds resulted in capture of Speckled Dace (n=66, 52.4%), Longfin Dace (n=56, 44.4%), and Brown Trout (n=4, 3.2%). Water temperature and conductivity recorded at 09:37 were 15.2 °C and 408 µS, respectively. Because Loach Minnow were not detected, Pace Creek was visited to establish a station. Pace Creek was visually surveyed upstream to 12 S 681401E 3737318N. Most of the creek was dry, except for one small isolated pool (12 S 682775E, 3737138N). This pool was not sampled since it did not contain suitable Loach Minnow habitat. In retrospect, it would have been a good idea to sample the isolated pool. For reporting purposes, catch data were tabulated across all stations (Table 30). Photographs of available habitat are provided in Appendix B (Figures B76- B77).

It remains poorly understood why Loach Minnow populations recovered in Campbell Blue Creek, but not Dry Blue Creek. Both streams suffered from fish kills and habitat change after the Wallow Fire, but the magnitude of change remains unknown. Dry Blue Creek and the surrounding area should continue to be monitored to assess recovery dynamics and long-term fish abundance trends.

Table 30. Summary of catch in Dry Blue Creek by BPEF. Total effort was 1,280 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	N/A	375	51.02	0.293
RHOS	N/A	354	48.16	0.277
SATR	0	3	0.41	0.002
SATR	1+	3	0.41	0.002
Total		**735**	**100**	**0.574**

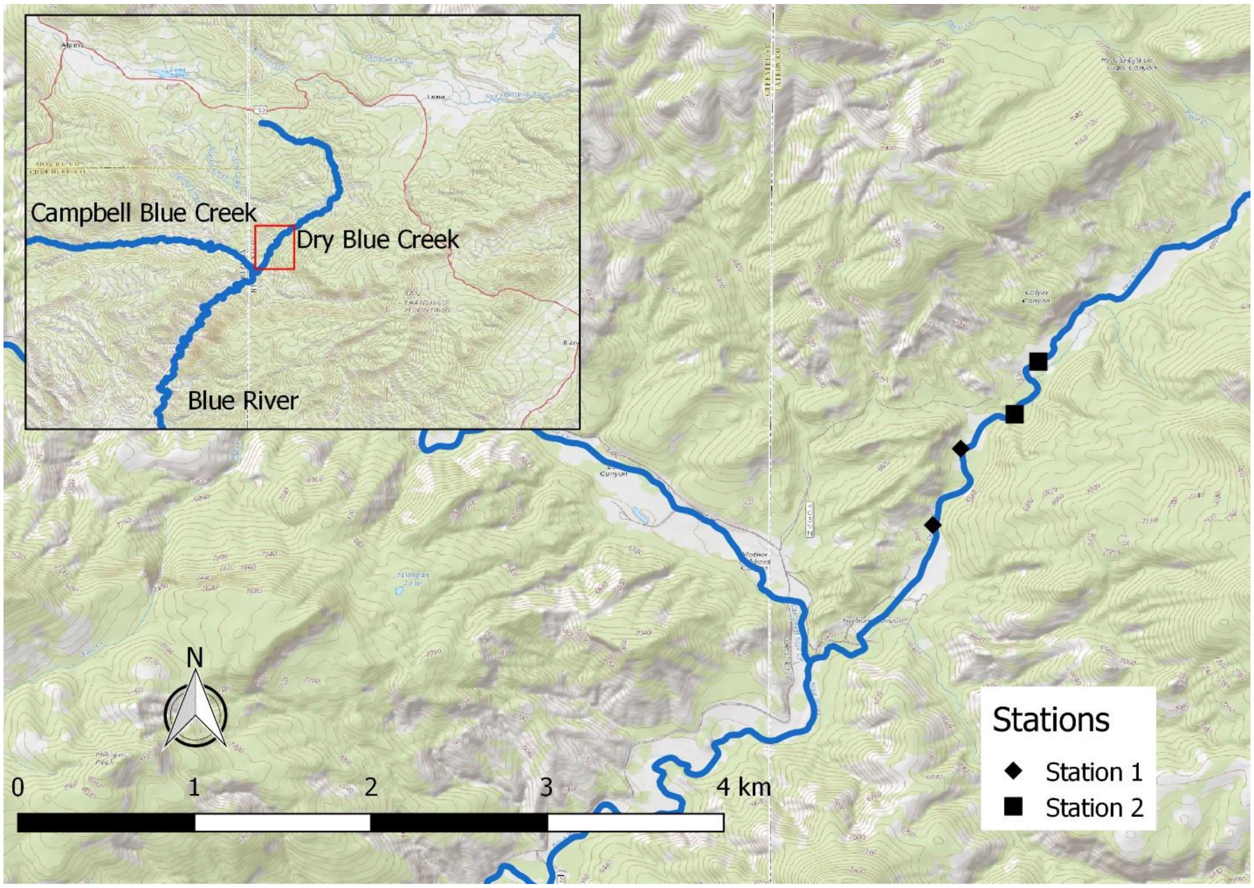

Figure 24. Location of two (500 m and 250 m) sampling stations in Dry Blue Creek, sampled July 18, 2018.

Dix Creek – Left and Right Prong July 19, 2018

12S NAD83	Lower boundary 1: 672367E, 3672740N	Upper boundary 1: 672453E, 3672794N
	Lower boundary 2: 671755E, 3673456N	Upper boundary 2: 671678E, 3673512N

Left Prong Dix Creek and Right Prong Dix Creek (Figure 25) merge to form Dix Creek which flows north to its confluence with the San Francisco River in the upper Gila River basin ~80 km northeast of Safford, Arizona. The focus species in Dix Creek is Gila Chub. Dix Creek is entirely composed of native fish species with Gila Chub having been previously reported as abundant (Timmons et al. 2014; Timmons et al. 2017). Access to Dix Creek was gained from Martinez Ranch Road. The vehicle was parked at 12 S 672329E 3673786N, and then both left and right prong were accessed from FSR 215 crossing. It is advised to walk, unless a 4x4 vehicle with high clearance is used.

A 500 m station was established on Left Prong Dix Creek at the same location sampled by AZGFD in 2016 (Timmons et al. 2017). Gila Chub were immediately detected, so a 100 m station was established and shocked for a total of 647 seconds. Backpack electrofishing resulted in capture of Gila Chub (n=36; 49.3%), Speckled Dace (n=36; 49.3%), and Sonora Sucker (n=1; <1%). Age-0 (n=18) and Age-1+ Gila Chub (n=18) accounted for 24.7% of total catch. Stream habitat was complex with riffle, run, and pool habitat composed predominately of pebble, cobble, and boulder substrate. Undercut banks were present with exposed root wads. Also, canopy cover was almost 100% and large woody debris was abundant. Water temperature and conductivity recorded at 08:39 were 21.0 °C and 404 µS, respectively. Photographs of upper and lower boundaries of the 100 m sample station are provided in Appendix B (Figures B78-B81).

A 500 m station was also established on Right Prong Dix Creek at the same location sampled by AZGFD in 2016 (Timmons et al. 2017). Gila Chub were immediately detected, so a 100 m station was established and shocked for a total of 722 seconds which resulted in capture of Speckled Dace (n=42; 28.6%), Gila Chub (n=39; 26.5%), Desert Sucker (n=39; 26.5%), and Longfin Dace (n=27; 18.4%). Age-0 Gila Chub accounted for 6.1% of catch, while Age-1+ accounted for 20.4%. For reporting purposes, catch data were tabulated across both stations (Table 31). Stream habitat was complex with riffle, run, and pool habitat composed predominately of pebble, cobble, and boulder substrate. Canopy cover was moderate, covering ~50% of the sampling station. Water temperature and conductivity recorded at 10:30 were 26.0 °C and 363 µS, respectively. Photographs of upper and lower boundaries of the 100 m sample station are provided in Appendix B (Figures B82-B85).

Table 31. Summary of catch in Dix Creek (left and right prong) by BPEF. Total effort was 1,369 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AGCH	N/A	27	15.52	0.020
CAIN	1+	1	0.57	0.001
GIIN	0	27	15.52	0.020
GIIN	1+	48	27.59	0.035
PACL	0	28	16.09	0.020
PACL	1+	28	16.09	0.020
RHOS	N/A	42	24.14	0.031
Total		**174**	**100**	**0.127**

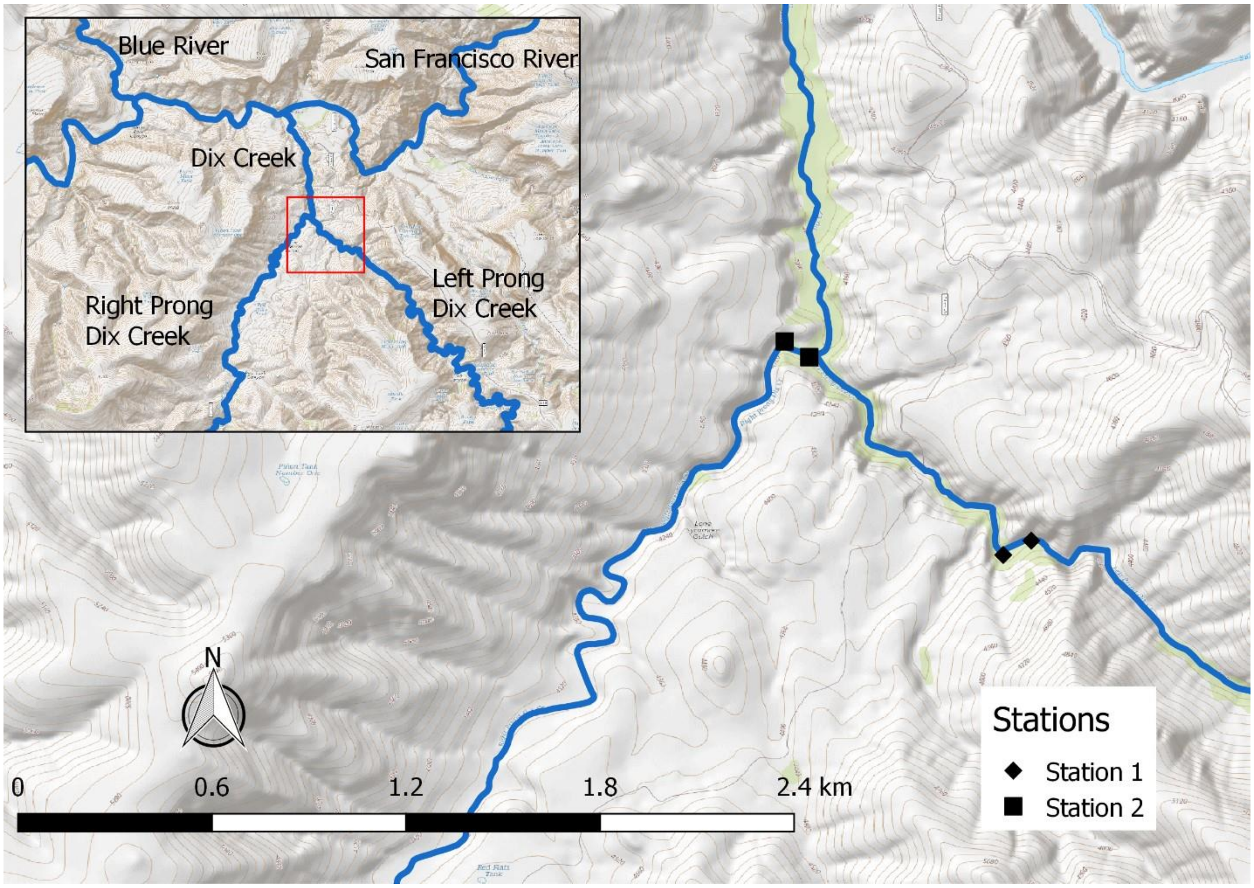

Figure 25. Location of two 100 m sampling stations in Dix Creek, sampled on July 19, 2018.

Lower Wet Beaver Creek July 31–August 1, 2018

12S NAD83	Lower boundary 1: 422127E, 3829105N	Upper boundary 1: 422579E, 3828850N
	Lower boundary 2: 423065E, 3829194N	Upper boundary 2: 422686E, 3829515N
	Lower boundary 3: 423254E, 3830869N	Upper boundary 3: 423703E, 3831038N

Wet Beaver Creek is tributary to Verde River in Coconino National Forest (Figure 26). The focus species in Wet Beaver Creek is Roundtail Chub; however, recent surveys have found Roundtail Chub absent from lower Wet Beaver Creek and a fish community predominately composed of non-native taxa (Timmons et al. 2015; Timmons et al. 2017).

A 500 m station was established ~370 m downstream of where Timmons et al. (2017) established their most downstream station in 2016 (downstream of Montezuma Castle National Monument [NMn]). Habitat consisted of slow moving wide deep pools with silt substrate. Only the first 30 m allowed sampling via BPEF due to depth, and the stream became dry after 200 m. Backpack electrofishing for a total of 386 seconds resulted in no catch. Eight Promar hoop nets were set and fished for two hours, which also resulted in no catch. Water temperature and conductivity recorded at 10:40 were 29.7 °C and 257 µS, respectively.

Next, a 500 m station was established ~700 m upstream at the same point where Timmons et al. (2017) established a station downstream of Montezuma Castle NMn in 2016. Backpack electrofishing for a total of 1,100 seconds resulted in the capture of Western Mosquitofish (n=7; 46.7%), Yellow Bullhead (n=4; 26.7%), Smallmouth Bass (n=3; 20%), and Bluegill (n=1; 6.7%). High turbidity impaired effective BPEF. Nets were not set because they were ineffective at the first station. Stream habitat consisted of slow moving channels and pools ~1 m deep on average with grassy banks. Water temperature and conductivity recorded at 13:55 were 33.8 °C and 273 µS, respectively.

Because no Roundtail Chub were detected at the previous two stations, a third and final station was established ~3.5 km upstream from the second station, which was on the north side of Montezuma Castle NMn. The third station was ~800 km downstream of where Timmons et al. (2017) sampled in 2016. Stream habitat appeared to be more suitable for Roundtail Chub with riffle, run, and pool habitat composed of pebble, cobble, and boulder substrate. Backpack electrofishing for a total of 764 seconds resulted in capture of Red Shiner (n=24; 51.1%), Smallmouth Bass (n=20; 42.5%), Green Sunfish (n=2; 4.3%), and Bluegill (n=1; 2.1%). For reporting purposes, catch data were tabulated across all stations (Table 32). The first 200-300 m was shockable before it returned to wide deep pools. High turbidity also impaired BPEF. Water temperature and conductivity recorded at 10:30 were 27.7 °C and 603 µS, respectively. Photographs of available habitat are provided in Appendix B (Figures B86-B90).

Non-native fishes continue to be dominant in lower Wet Beaver Creek, which may explain lack of detection of native fish in this survey. However, BPEF was not effective and other gears such as seines and large hoop nets may be more effective. The total number of required stations for lower Wet Beaver Creek was not met in 2018, therefore additional stations will be sampled further upstream in 2019.

Table 32. Summary of catch in lower Wet Beaver Creek by BPEF. Total effort was 2,250 seconds.

Species	Age	Count	% of total catch	CPUE (fish/sec)
AMNA	1+	4	6.56	0.002
CYLU	N/A	24	39.34	0.011
GAAF	N/A	7	11.48	0.003
LECY	1+	2	3.28	0.001
LEMA	0	1	1.64	0.001
MIDO	0	15	24.59	0.007
MIDO	1+	8	13.11	0.004
Total		**61**	**100**	**0.029**

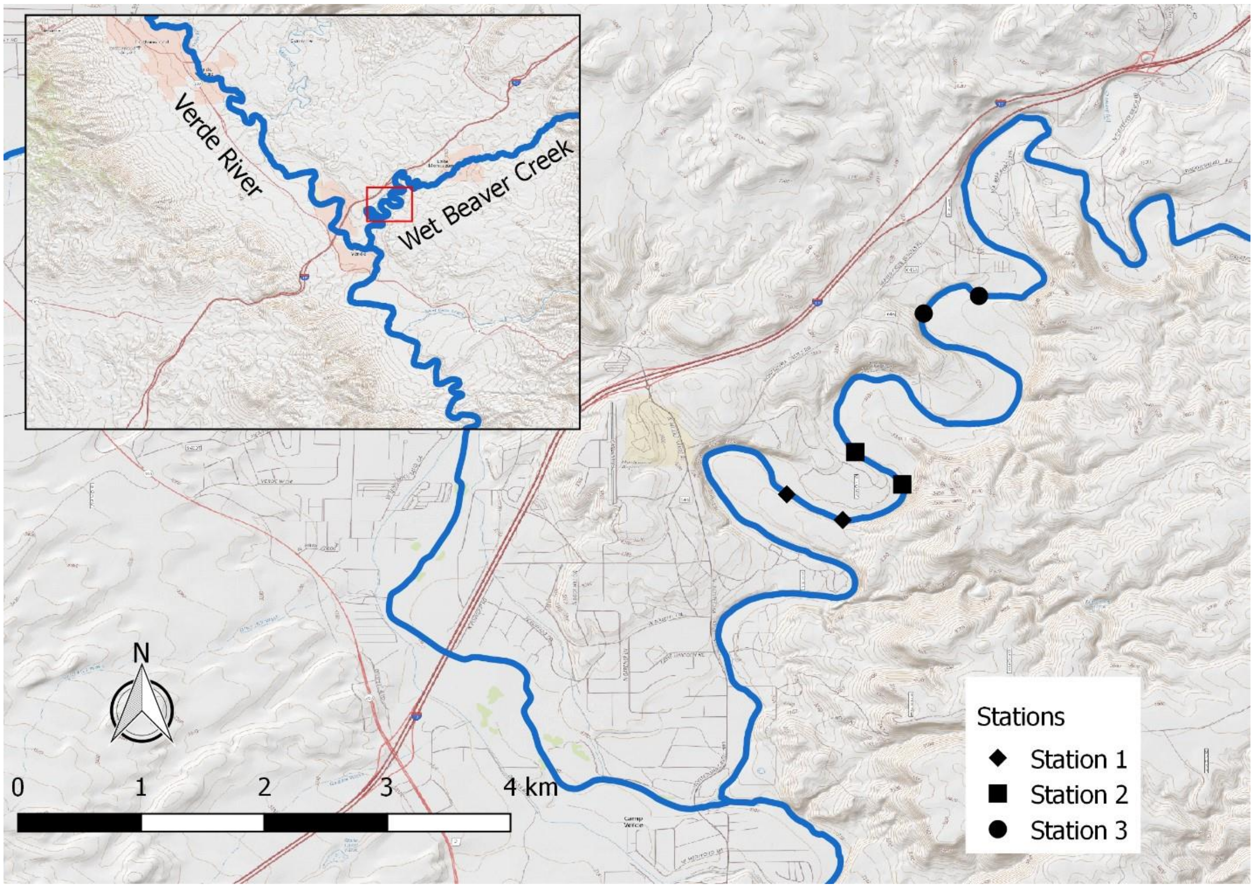

Figure 26. Location of three 500 m sampling stations in lower Wet Beaver Creek sampled on July 31–August 1, 2018.

Upper Salt River

Salt River is formed by confluence of White River and Black River and flows southwest ~322 km, making it the longest tributary of Gila River. Salt River basin drains portions of Mogollon Rim, Natanes Mountains, and Natanes Plateau. The historical fish community consisted of 15 native fishes (Gilbert and Scofield 1898), but by 1926 it had been reduced to eight native and two introduced species (Miller 1961; Minckley and Deacon 1968). Over the next three decades, non-native fish diversity increased while the number of native fishes was reduced to seven in the Phoenix Metropolitan Area (Marsh and Minckley 1982). In 1963 to 1967, surveys near Phoenix in Salt River recorded 29 fish species, five of which were native and widely distributed (Marsh and Minckley 1982). In 1981, fish community composition showed an abrupt shift, with distribution and abundance of native fishes showing little resemblance to historical structure (Marsh and Minckley 1982). Historical patterns of fish community structure in Salt River above Roosevelt Lake (i.e., upper Salt River) remain poorly understood, but native fishes there likely responded in a similar fashion to those downstream. Recent surveys of upper Salt River found non-native fishes were dominant with Desert Sucker being the only native fish detected in low abundance at one location (Timmons and Paulus 2016).

Upper Salt River – Gleason Flats (Upper Reach) August 28, 2018

12S NAD83 Lower boundary 1: 529488E, 3736854N Upper boundary 1: 529874E, 3737024N

Lower boundary 2: 529965E, 3737155N Upper boundary 2: 530093E, 3737441N

Lower boundary 3: 530153E, 3737775N Upper boundary 3: 530324E, 3738221N

On August 28, upper Salt River at Gleason Flats was accessed on Haystack Butte Road. The road became rough at 12S 530277E 3735556N and impassable with a 4x4 truck at 12S 529645E 3736295N, so the vehicle was parked at 12S 529612E 3736205N in a small turnout and the river was accessed on foot. All sampling stations overlapped with stations sampled by AZGFD in 2015 (Timmons and Paulus 2016). Because Roundtail Chub, the focus species, was not detected, a total of three stations (Figure 27) were sampled with a seine (20 ft x 6 ft, 0.236 in mesh). Backpack electrofishing was not employed due to high turbidity. Catch is summarized and tabulated across all stations because fish community composition showed no turnover from upstream to downstream and habitat was consistent across all stations. Across three stations, 35 seine hauls resulted in capture of Red Shiner (n=53; 50.0%), Channel Catfish (n=29; 27.4%), Fathead Minnow (n=11; 10.4%), Flathead Catfish (n=8; 7.5%), and Common Carp (n=5; 4.7%; Table 33). Seining was impaired by high turbidity and large substrate. Substrate was predominately boulder and cobble intermixed with silt. Water temperature and conductivity recorded at 09:38 were 23.7 °C and 3,094 µS, respectively. Stream discharge at time of sampling was 250 cubic feet per second (cfs) at the USGS stream gage 09498500 near Roosevelt, Arizona. Photographs of available habitat were lost.

The road to Gleason Flats was well maintained until Haystack Ranch, beyond which the road became better suited for ATVs or UTVs due to large rocks and erosion. The stream was easily accessible from the road except for thick vegetation along river banks. River depth generally ranged from 0.46 m to 0.91 m, but there were some deeper pools, with the deepest reach being the most downstream station. Seining was performed along silt/gravel bars and banks with a gradual slope. Seining was difficult but proved effective at capturing a representative sample of fish community composition. There is no ideal method to sample fishes at this location, but future sampling should be conducted with BPEF before monsoon season when stream discharge and velocity are minimal, and turbidity is low. Hoop nets should be deployed at the most downstream station below the rapids in a deep pool.

Table 33. Summary of catch in upper Salt River at Gleason Flats by seine. Total effort was 35 seine hauls.

Species	**Age**	**Count**	**% of total catch**	**CPUE (fish/seine haul)**
CYCA	0	5	4.72	0.143
CYLU	N/A	53	50.00	1.514
ICPU	0	29	27.36	0.829
PIPR	N/A	11	10.38	0.314
PYOL	0	8	7.55	0.229
Total		**106**	**100**	**3.029**

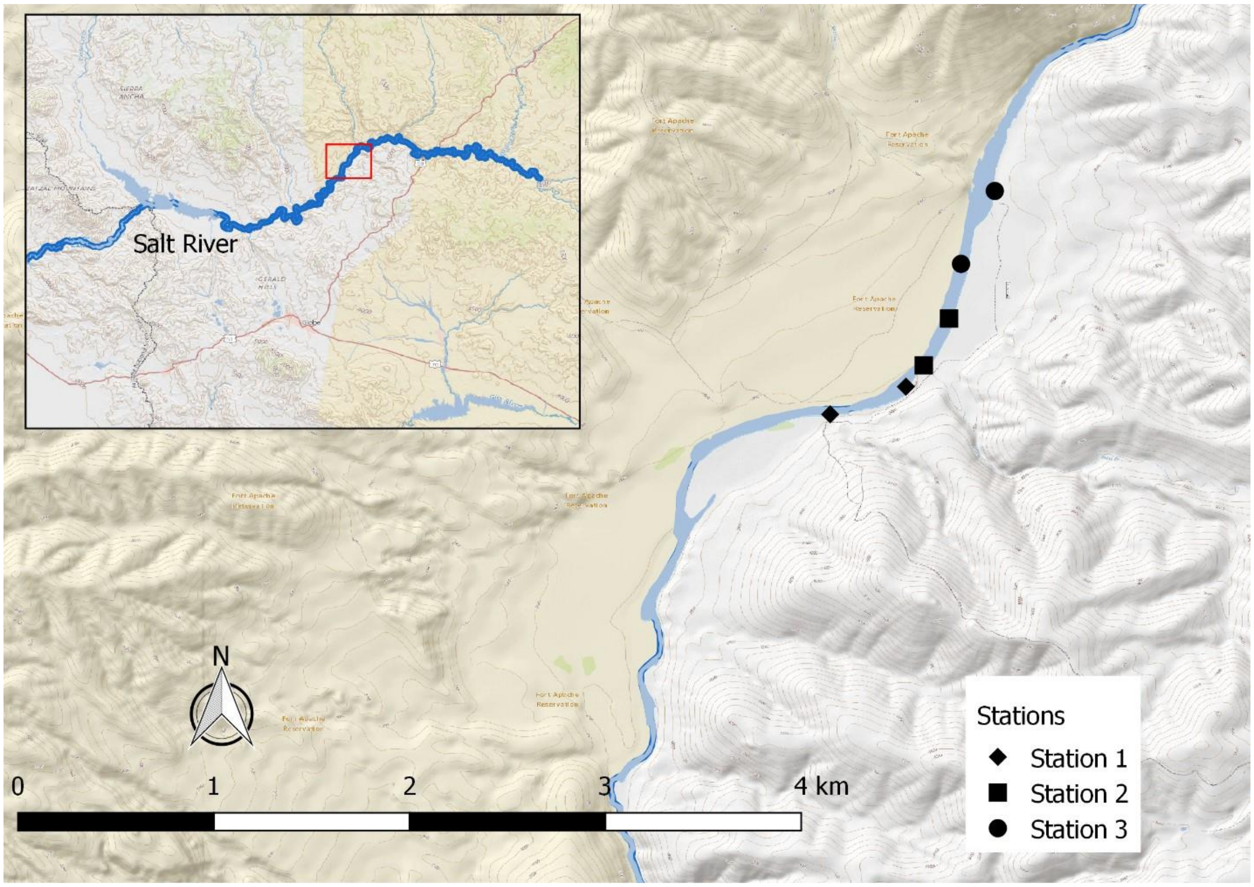

Figure 27. Location of three 500 m sampling stations in upper Salt River at Gleason Flats sampled on August 28, 2018.

Upper Salt River – Horseshoe Bend (Middle Reach) August 27, 2018

12S NAD83	Lower boundary 1: 518347E, 3722036N	Upper boundary 1: 518649E, 3721732N
	Lower boundary 2: 518901E, 3721869N	Upper boundary 2: 519167E, 3722173N
	Lower boundary 3: 519286E, 3722335N	Upper boundary 3: 519327E, 3722808N

On August 27, upper Salt River at Horseshoe Bend was accessed on Hicks Road and an unnamed road. All sampling stations overlapped with stations sampled by AZGFD in 2015 (Timmons and Paulus 2016). A total of three stations (Figure 28) was sampled using seines (20 ft x 6 ft, 0.236 in mesh; and 13 ft x 4 ft, 0.078 in mesh) and Promar hoop nets due to high turbidity. Catch is summarized and tabulated across all stations because fish community composition showed no turnover from upstream to downstream and habitat was consistent across all stations. Across three stations, 37 seine hauls resulted in capture of Red Shiner (n=413; 85.3%), Channel Catfish (n=47; 9.7%), Western Mosquitofish (n=15; 3.1%), Fathead Minnow (n=4; <1%), Common Carp (n=3; <1%), and Green Sunfish (n=2; <1%; Table 34). Only adult Red Shiner were counted as thousands of Age-0 fish were captured in the fine mesh seine. Seining was impaired by high turbidity and large substrate, and eight Promar hoop nets only captured one Channel Catfish and three Sonora Mud Turtles (Table 35). Northern Crayfish also were present. Substrate was predominately boulder and cobble intermixed with silt. Water temperature and conductivity recorded at 10:49 were 27.4 °C and 2,547 µS, respectively. Stream discharge at time of sampling was 250 cfs at the USGS stream gage 09498500 near Roosevelt, Arizona. Photographs of available habitat were lost.

The road to Horseshoe Bend was well maintained; however, river access (e.g., wading) was difficult due to high turbidity, large substrate, and high stream velocity. There were only a few places to cross that were less than waist deep and vegetation along stream banks was heavy, making stream crossings particularly difficult. The most upstream station was deepest and hoop nets should be used at this station in the future. Seining was difficult, but proved effective at capturing a representative sample of fish community composition. There is no ideal method to sample fishes at this location, but future sampling should be conducted with BPEF before monsoon season when stream discharge and velocity are minimal, and turbidity is low.

Table 34. Summary of catch in upper Salt River at Horseshoe Bend by seine. Total effort was 37 seine hauls.

Species	**Age**	**Count**	**% of total catch**	**CPUE (fish/seine haul)**
CYLU	N/A	413	85.86	11.162
GAAF	N/A	15	3.12	0.405
ICPU	0	47	9.77	1.270
LECY	0	2	0.42	0.054
PIPR	N/A	4	0.83	0.108
Total		**481**	**100**	**13.000**

Table 35. Summary of catch in upper Salt River at Horseshoe Bend by Promar hoop nets. Total effort was 16 net hours.

Species	**Age**	**Count**	**% of total catch**	**CPUE (fish/net hr)**
ICPU	1+	1	25.00	0.063
KISO	N/A	3	75.00	0.188
Total		**4**	**100**	**0.250**

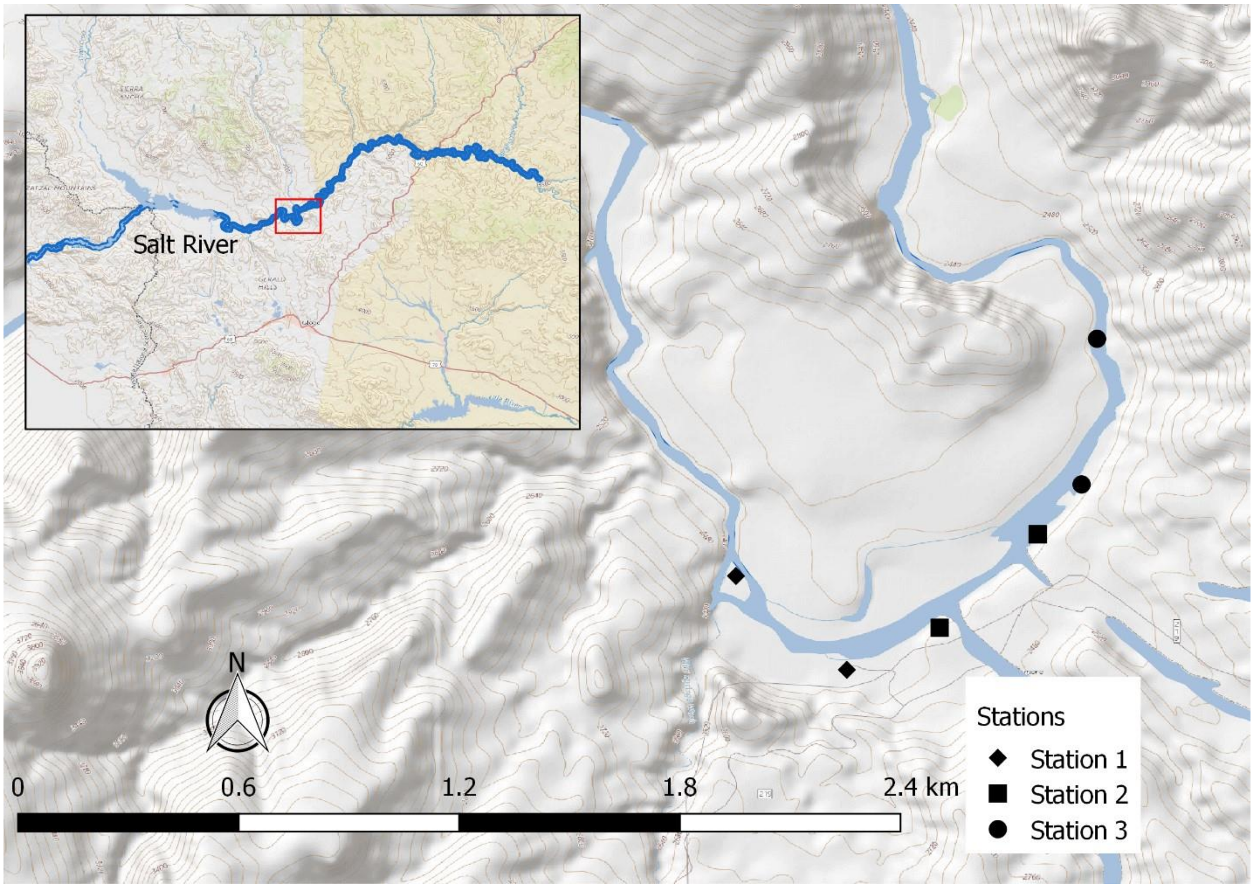

Figure 28. Location of three 500 m sampling stations in upper Salt River at Horseshoe Bend sampled on August 27, 2018.

Upper Salt River – Highway 288 Bridge (Lower Reach) September 27, 2018

12S NAD83	Lower boundary 1: 507231E, 3719961N	Upper boundary 1: 507737E, 3720051N
	Lower boundary 2: 507906E, 3720258N	Upper boundary 2: 508277E, 3720298N
	Lower boundary 3: 508182E, 3720119N	Upper boundary 3: 508357E, 3719736N

On September 27, upper Salt River at Highway 288 bridge was accessed by parking at the bridge and hiking/swimming upstream. The first 500 m station (Figure 29) was established under the bridge and a combination of Promar hoop nets, large hoop nets, and seines were used. Five large hoop nets were set near the bridge and four were set at the second pool upstream (12S 507554E, 3719981N). Promar hoop nets and large hoop nets captured Spiny Softshell Turtles (n=6; 33.3%), Sonora Mud Turtles (n=6; 33.3%), Channel Catfish (n=4; 22.2%), and Northern Crayfish (n=2; 11.1%). There were few suitable places to seine; however, 11 seine hauls resulted in capture of Red Shiner (n=51). Stream habitat consisted of two large riffles, several runs, and two large pools. Riffle habitat was predominately cobble intermixed with boulder, pebble, gravel, and silt. Pool substrate was predominately silt. Riparian vegetation was thick, and it was near impossible to find access points to the river. It is recommended to travel upstream via the river channel with inner tubes or other flotation devices (e.g., kayak or inflatable canoe).

The second 500 m station (Figure 29) was established ~250 m upstream of the first station due to limited access and was sampled with Promar hoop nets and seining. Eleven Promar hoop nets resulted in capture of one Age-1+ Green Sunfish. Seining resulted in capture of Red Shiner (n=133; 96.0%), Western Mosquitofish (n=5; 3.6%), and Fathead Minnow (n=1; <1%). The second sampling station had more run habitat compared to the first station, but substrate was similar across stations. Water temperature recorded at 10:04 was 25 °C.

The third 500 m station (Figure 29) was established ~200 m upstream of the second station due to limited access and was sampled with a seine (12 ft x 4 ft, 0.118 in mesh). Seining resulted in capture of Red Shiner (n=579; 95.7%), Western Mosquitofish (n=21; 3.5%), Fathead Minnow (n=4; 1.3%), and Flathead Catfish (n=1; <1%). For reporting purposes, catch data were tabulated across all stations for each sampling gear (Tables 36-38). Stream habitat at the third station was predominately riffles and runs composed of boulder, cobble, gravel, and silt substrate. Most seining was conducted near the upstream boundary as there were few other places to effectively seine. Stream discharge at time of sampling was 100 cfs at the USGS stream gage 09498500 near Roosevelt, Arizona. Photographs of available habitat are provided in Appendix B (Figures B91-B94).

Overall, there were no native fishes detected across all stations and a suite of non-native species were captured. Desert Sucker are presumably still present in upper Salt River, but in low abundance, which resulted in our failure to detect them. Future sampling should take place before monsoon season when stream discharge and turbidity are minimal.

Table 36. Summary of catch in upper Salt River at highway 288 bridge by Promar hoop nets. Total effort was 36 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
LECY	1+	1	100.00	0.028
Total		**1**	**100**	**0.028**

Table 37. Summary of catch in upper Salt River at highway 288 bridge by large hoop net. Total effort was 45 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
ICPU	0	4	22.22	0.089
KISO	N/A	6	33.33	0.133
ORVI	N/A	2	11.11	0.044
TRSP	N/A	6	33.33	0.133
Total		**18**	**100**	**0.400**

Table 38. Summary of catch in upper Salt River at highway 288 bridge by seine. Total effort was 11 seine hauls.

Species	Age	Count	% of total catch	CPUE (fish/seine haul)
CYLU	N/A	763	95.97	69.364
GAAF	N/A	26	3.27	2.364
PIPR	N/A	5	0.63	0.455
PYOL	0	1	0.13	0.091
Total		**795**	**100**	**72.273**

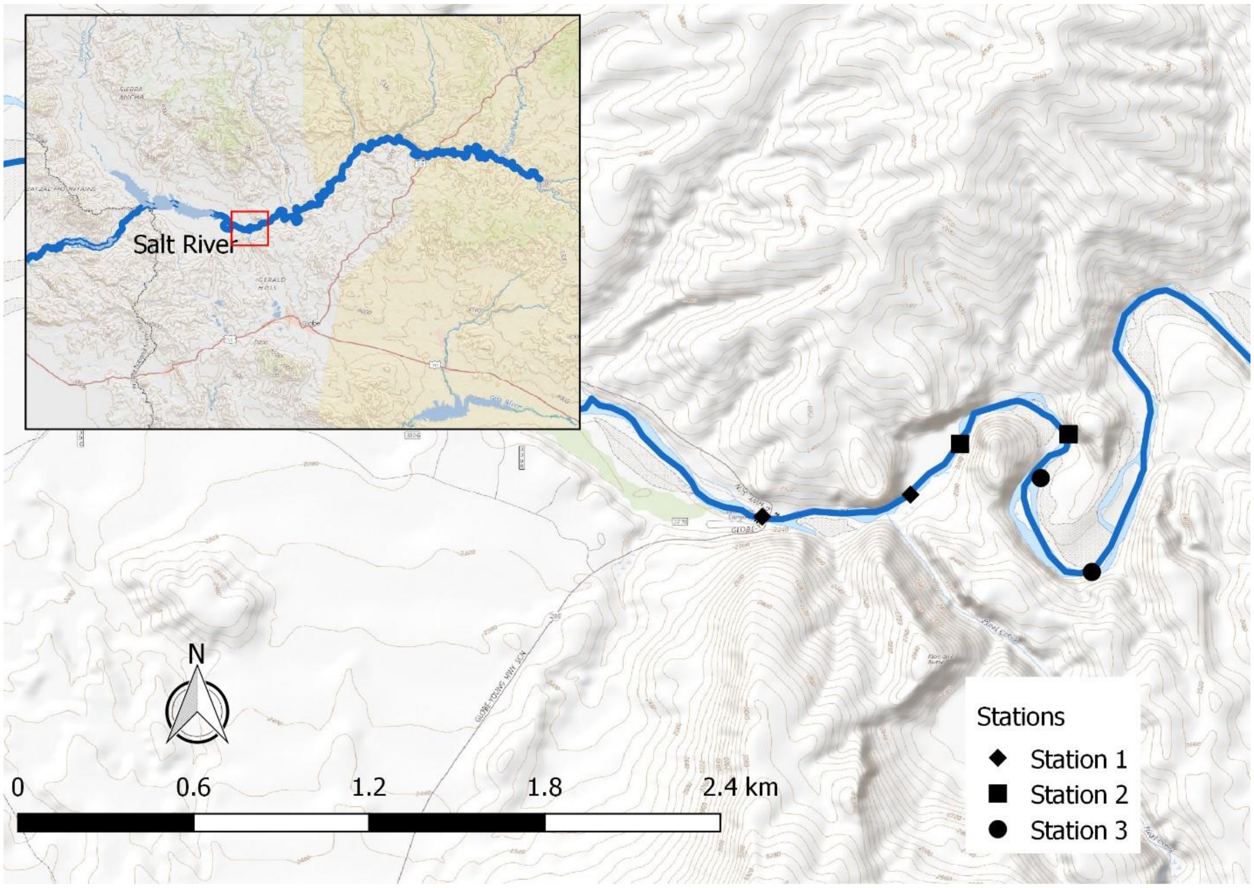

Figure 29. Location of three 500 m sampling stations in upper Salt River at highway 288 bridge sampled on September 27, 2018.

Lower Verde River

Verde River flows ~300 km from its headwaters in Big Chino Wash to its confluence with Salt River. Lower Verde River is considered downstream of Bartlett Dam, which was constructed to produce hydroelectric power and supply water for the Phoenix metropolitan area. In addition to streamflow alteration, non-native fishes were introduced throughout Verde River in the early 1930s for sportfishing (Rinne et al. 1998). From 1974 to 1997, relative abundance of non-native fishes from Horseshoe Dam to the Salt River confluence exceeded 80% (Rinne et al. 1998). However, in 1994 native fishes comprised ~50% of the fish community catch after flooding in 1993, but non-natives quickly recovered (Rinne et al. 1998) and current fish community composition is predominately non-native taxa. The focus species in lower Verde River is Roundtail Chub. The species was last detected in 2010 at two stations ~1.75 km and ~5.75 km downstream of Bartlett Dam (Gill 2010); however, they have not been detected in recent surveys (Timmons and Paulus 2016).

Verde River – Bartlett Dam (Upper Reach) September 11, 2018

12S NAD83	Lower boundary 1: 438817E, 3741061N	Upper boundary 1: 439215E, 3740744N
	Lower boundary 2: 439426E, 3740744N	Upper boundary 2: 439964E, 3741092N
	Lower boundary 3: 440146E, 3741173N	Upper boundary 3: 440550E, 3741473N

On September 11, 2018 lower Verde River was accessed via Riverside Campground on N Bartlett Dam Road downstream of Bartlett Dam. The river was easily accessible from the campground and required a Tonto National Forest Day pass to camp or park in the area. Three 500 m sampling stations were established (Figure 30) because Roundtail Chub were not detected. The two upstream stations were sampled with Promar hoop nets, angling, and large hoop nets, whereas the most downstream station was sampled with a seine (12 ft x 4 ft, 0.118 in mesh); despite considerable effort, no fish species were captured at this last station. The two upstream stations consisted of a wide (~50 m) slow moving river and the most downstream station was channelized with high velocity. Habitat in this reach varied greatly across stations. The upper two stations consisted of a wide (~75 m) and deep (>2 m) section of river with slow-moving current. Substrate here was primarily silt mixed with cobble along shore. The downstream station was more channelized and had a fast-moving current. Substrate was cobble with a few interspersed boulders. Some fish were observed surfacing in the upper two sites around sunset. Water temperature and conductivity recorded at the first station at 10:48 were 25.1 °C and 606 µS, respectively. Stream discharge at time of sampling was 130 cfs at the USGS stream gage 09510000 below Bartlett Dam, Arizona. A photograph of available habitat is provided in Appendix B (Figure B95).

Setting Promar hoop nets and large hoop nets may be more effective if set overnight in the wide section of river.

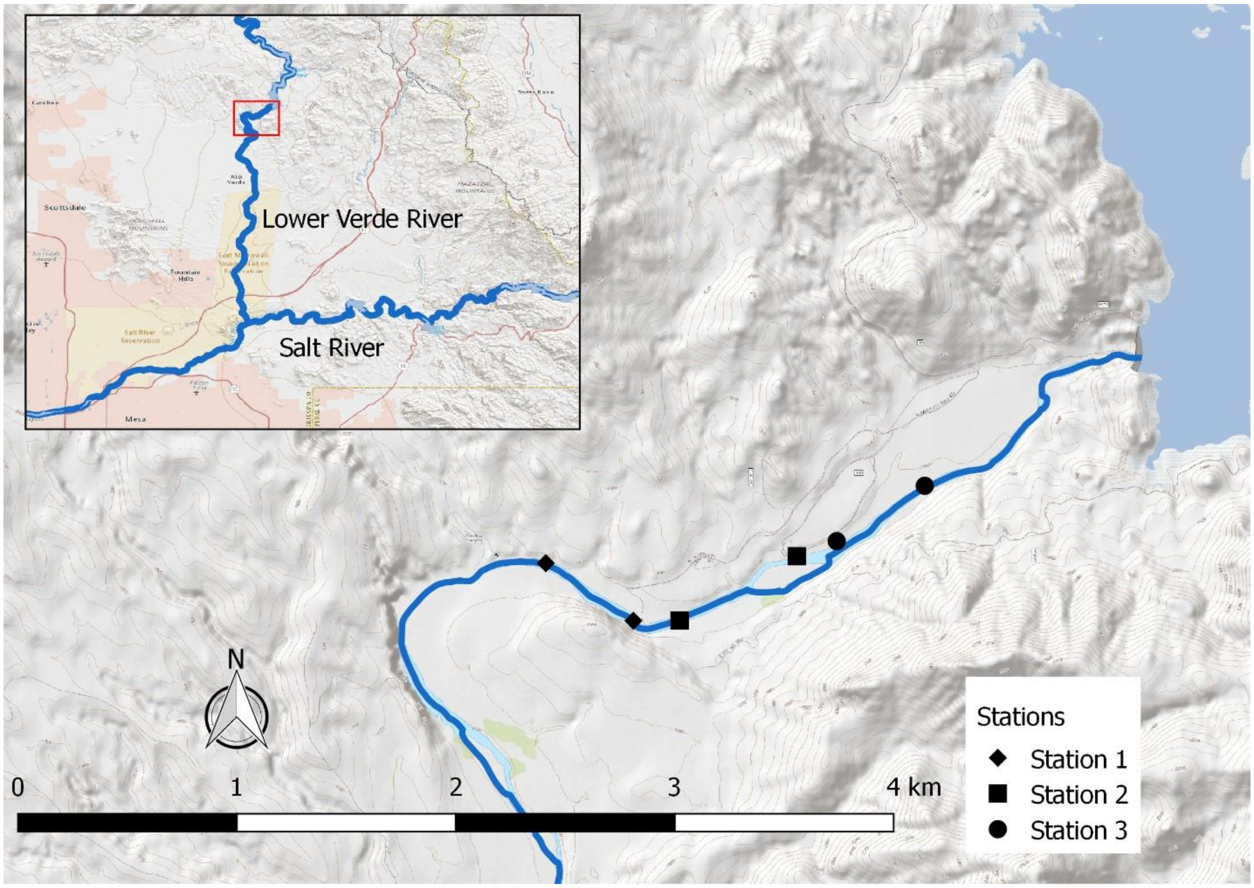

Figure 30. Location of three 500 m sampling stations in lower Verde River below Bartlett Dam sampled on September 11, 2018.

Verde River – Needle Rock (Middle Reach) September 10, 2018

12S NAD83	Lower boundary 1: 437699E, 3735486N	Upper boundary 1: 437814E, 3735979N
	Lower boundary 2: 437991E, 3736462N	Upper boundary 2: 438341E, 3736836N
	Lower boundary 3: 438529E, 3737111N	Upper boundary 3: 438818E, 3737567N

On September 10, 2018 lower Verde River at Needle rock was accessed via Needle Rock Road off E Rio Verde Drive. Sampling stations were easily accessible from two FS Recreation Area parking lots (12S 437985E, 3736567N and 12S 437642E, 3736099N). Three 500 m sampling stations (Figure 31) were established because Roundtail Chub were not detected. The two upstream stations were sampled with angling, Promar hoop nets, and large hoop nets. Neither of these methods captured fish, although fish were observed in the river. This area was heavily trafficked by the public and some nets were tampered with. Nets were not set overnight due to high public use. The most downstream station was sampled with a seine (12 ft x 4 ft, 0.118 in mesh), which proved more effective than passive gears. A total of 12 seine hauls resulted in capture of Western Mosquitofish (n=283; 95.0%), Desert Sucker (n=5; 1.7%), Smallmouth Bass (n=5; 1.7%), Common Carp (n=2; <1%), Sonora Sucker (n=2; <1%), and Red Shiner (n=1; <1%; Table 39). River habitat varied with channelized sections ranging from 1.5 to 3+ m in depth to sections with rapids, riffles, and slower moving wider (~20 m) pools. Substrate was predominately cobble and silt. Water temperature and conductivity recorded at 08:50 were 21°C and 634 µS, respectively. Stream discharge at time of sampling was 130 cfs at the USGS stream gage 09510000 below Bartlett Dam, Arizona. A photograph of available habitat is provided in Appendix B (Figure B96).

Setting Promar hoop nets and large hoop nets may be more effective if set overnight during times public use is minimal. Seining was more effective than setting nets where habitat allowed.

Table 39. Summary of catch in lower Verde River at Needle Rock by seine. Total effort was nine seine hauls.

Species	Age	Count	% of total catch	CPUE (fish/seine haul)
CAIN	1+	2	0.67	0.222
CYCA	0	2	0.67	0.222
CYLU	N/A	1	0.34	0.111
GAFF	N/A	283	94.97	31.444
MIDO	0	2	0.67	0.222
MIDO	1+	3	1.01	0.333
PACL	0	5	1.68	0.556
Total		**298**	**100**	**33.111**

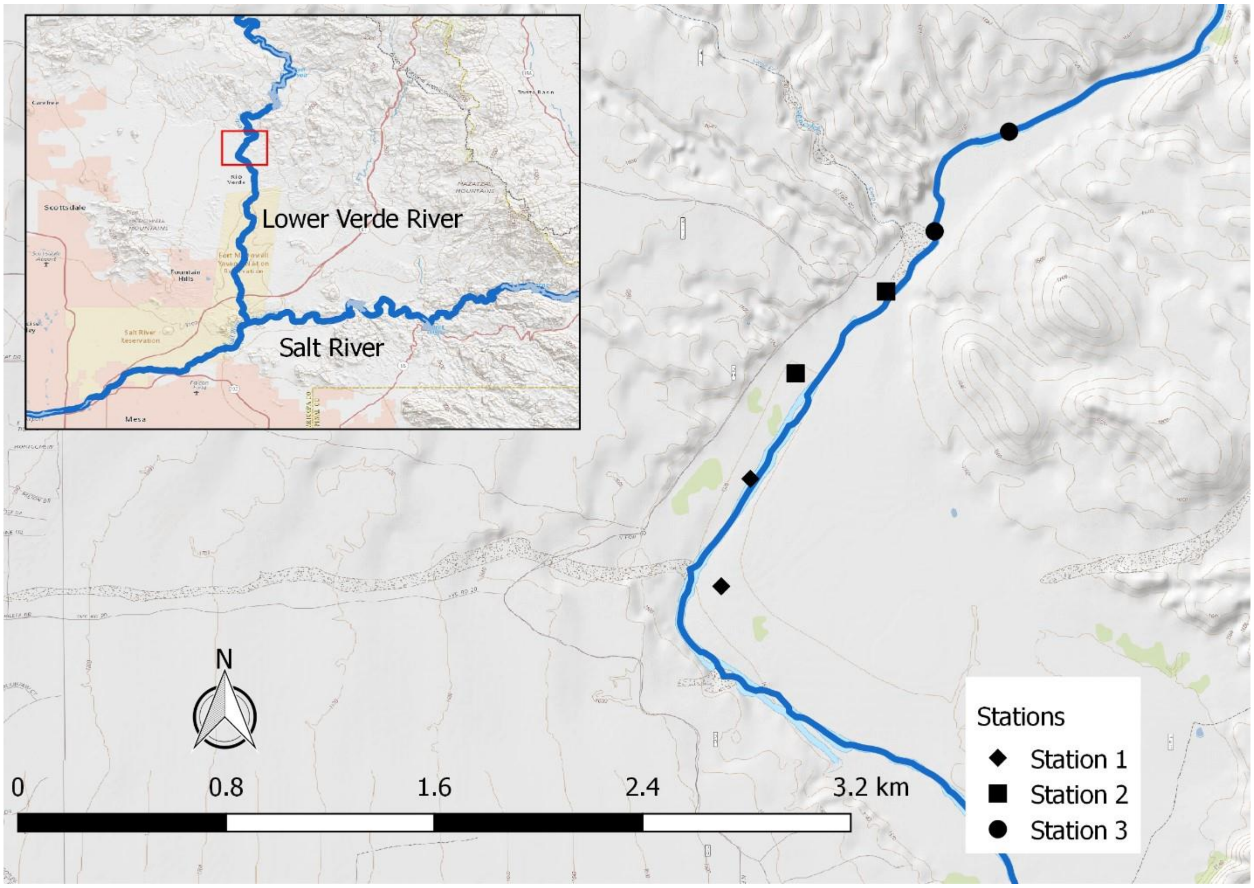

Figure 31. Location of three 500 m sampling stations in lower Verde River at Needle Rock sampled on September 10, 2018.

Verde River – Box Bar (Lower Reach) September 11, 2018

12S NAD83	Lower boundary 1: 439503E, 3732908N	Upper boundary 1: 438990E, 3733215N
	Lower boundary 2: 438966E, 3733326N	Upper boundary 2: 438974E, 3733824N
	Lower boundary 3: 438903E, 3733936N	Upper boundary 3: 438596E, 3734338N

On September 11, 2018 lower Verde River was accessed at Box Bar Recreation area on Box Bar Road off Needle Rock Road. Three 500 m stations were sampled with a seine (12 ft x 4 ft, 0.118 in mesh). The most upstream station (station 3; Figure 32) was accessed by hiking upstream of the recreation area. Across all stations, 36 seine hauls resulted in capture of Western Mosquitofish (n=563; 53.5%), Red Shiner (n=435; 41.3%), Smallmouth Bass (n=25; 2.4%), Desert Sucker (n=22; 2.1%), Sonora Sucker (n=5; <1%), Yellow Bullhead (n=2; <1%), and Common Carp (n=1; <1%; Table 40). Stream habitat consisted of a shallow (<1 m) stretch with intermittent riffles, runs, small pools, and areas with deep (>2 m) slow moving water. Substrate was predominately cobble with silt patches where water was slow moving. A few shallow runs had gravel substrate. Most of the river could be seined; however, there were a few stretches that either required swimming or hiking along the bank until a deep run was passed. Water temperature and conductivity recorded at 16:50 were 24.4°C and 591 µS, respectively. Stream discharge at time of sampling was 130 cfs at the USGS stream gage 09510000 below Bartlett Dam, Arizona. Photographs of available habitat and Sonora Sucker are provided in Appendix B (Figures B97-B98).

Table 40. Summary of catch in lower Verde River at Box Bar by seine. Total effort was 36 seine hauls.

Species	Age	Count	% of total catch	CPUE (fish/seine haul)
AMNA	0	2	0.19	0.056
CAIN	0	5	0.47	0.139
CYCA	1+	1	0.09	0.028
CYLU	N/A	435	41.31	12.083
GAAF	N/A	563	53.47	15.639
MIDO	0	23	2.18	0.639
MIDO	1+	2	0.19	0.056
PACL	0	22	2.09	0.611
Total		**1,053**	**100**	**29.194**

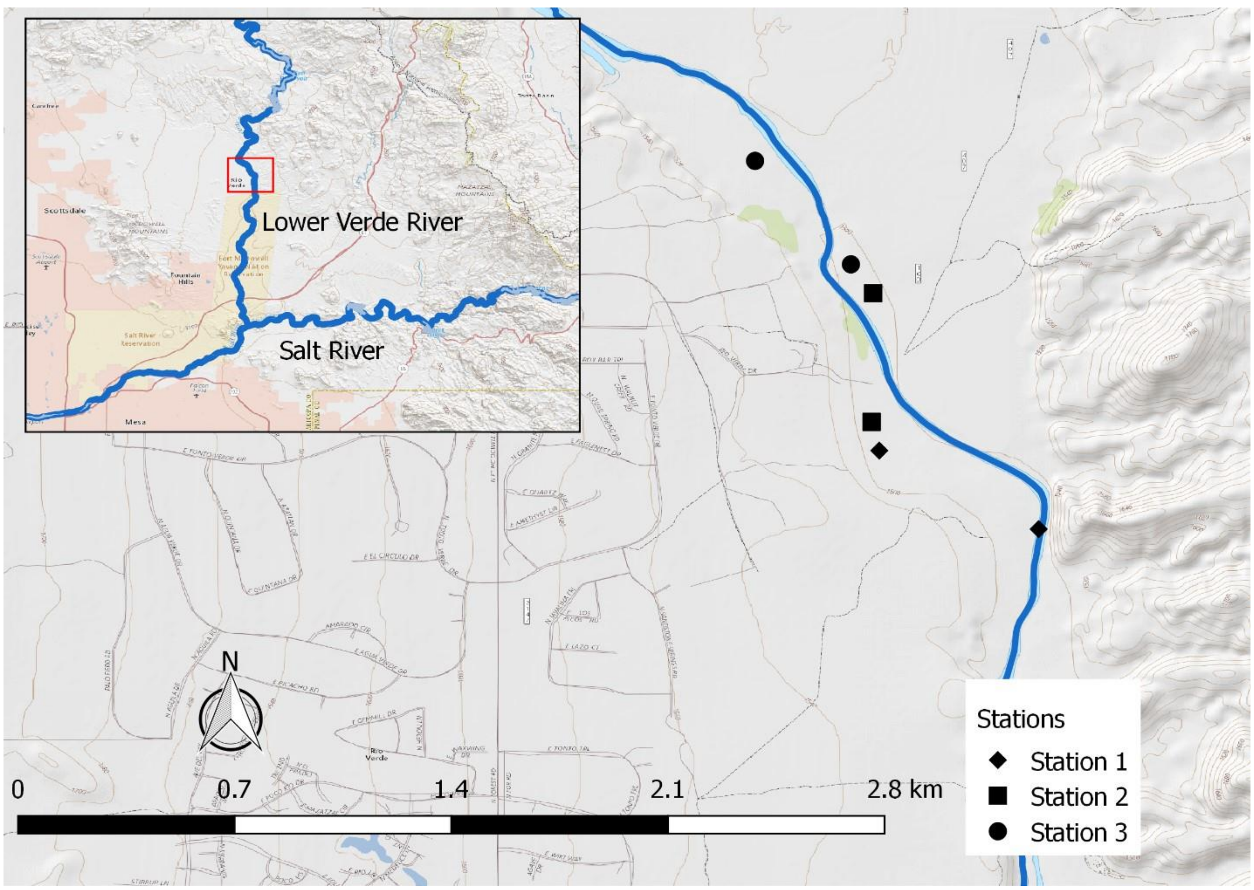

Figure 32. Location of three 500 m sampling stations in lower Verde River at Box Bar sampled on September 11, 2018.

West Clear Creek

West Clear Creek flows southwest ~60 km to its confluence with Verde River near Camp Verde, Arizona. The focus species in West Clear Creek is Roundtail Chub. The species first was reported in 1937 by Tarzwell ~3 km upstream of the Verde River confluence (Voeltz 2002). Roundtail Chub were confirmed persistent this far downstream in 2000 (Bagley 2002); however, recent surveys did not detect them (Timmons et al. 2014). Roundtail Chub continue to persist further upstream between Home Tank Draw and 3.2 km downstream of Maiden Falls with multiple age classes detected in surveys in 2014 and 2015 (Timmons et al. 2014, Matt Rinker, AZGFD, pers. comm.). AZGFD requested M&A sample below Maiden Falls, which is considered the lower reach. Surveys were not conducted downstream at Bull Pen day use area because Roundtail Chub have not been detected there in recent surveys (Timmons et al. 2014). West Clear Creek was initially sampled under this agreement in 2017, but due to field conditions and limited success it was scheduled for resampling in 2018 (McCall and Marsh 2017).

Lower West Clear Creek September 19–20, 2018

12S NAD83	Lower boundary 1: 443054E, 3823488N	Upper boundary 1: 443163E, 3823943N
	Lower boundary 2: 443329E, 3824058N	Upper boundary 2: 443793E, 3824276N
	Lower boundary 3: 445193E, 3824786N	Upper boundary 3: 445687E, 3824933N

On September 19, the lower reach of West Clear Creek was accessed via Blodgett Basin Trail from FSR 214A. The vehicle was parked (12S 440020E, 3824421N) before reaching the trailhead because of low vehicle clearance and large boulders in the road restricting access. The trail is ~2.2 km to reach the stream, with a -549 m (-1,800 ft) change in elevation. Access to the stream riparian area was gained by following the trail down a steep hill side, but an alternative route was found (12S 443090E, 3823716N) that provided easier access upstream of the pool that hindered sampling in 2017 (McCall and Marsh 2017). The first 500 m station (Figure 33) was established ~175 m upstream (12S 443054E, 3823488N) of a 500 m station sampled by M&A under this agreement in 2017. Six Promar hoop nets were deployed evenly across the sampling station in suitable habitat and fished for 23 hours, which resulted in capture of Northern Crayfish (n=4; 57.1%), Smallmouth Bass (n=2; 28.6%), and Roundtail Chub (n=1; 14.3%). Stream gradient was moderate with all major mesohabitats (i.e., riffle, run, pool) present. Plunge pools were common, turbidity was low, and canopy cover was high. Roundtail Chub were not visually observed swimming in pools. Stream discharge at time of sampling was 16.5 cfs at the USGS stream gage 09505800 near Camp Verde, Arizona.

The second 500 m station (Figure 33) was established ~200 m upstream and was sampled via angling and Promar hoop nets (six nets deployed and fished for 17 hours). Fly fishing with a black wooly bugger for 30 minutes resulted in capture of Roundtail Chub (n=2; 50.0%), Smallmouth Bass (n=1; 25.0%), and Rainbow Trout (n=1; 25.0%). Stream habitat was similar to the first station and Roundtail Chub were not visually observed swimming in pools. Water temperature and conductivity recorded at 15:03 were 19.5°C and 340 µS, respectively.

The third 500 m station (Figure 33) was established ~1.5 km upstream of the second station, which was ~500 m downstream of Maiden Falls. To access this site, inner tubes were used to float gear across large pools. Sampling was performed by deploying six Promar hoop nets and angling with a fly rod for 2.5

hours. Promar hoop nets were evenly distributed across the station in pool habitat where Roundtail Chub was visually observed. Fly fishing with a black wooly bugger resulted in capture of Roundtail Chub (n=8; 66.7%) and Rainbow Trout (n=4; 33.3%). Promar hoop nets resulted in capture of Roundtail Chub (n=14; 100.0%). For reporting purposes, catch data were tabulated across all stations for each sampling gear (Tables 41-42). Roundtail Chub that were captured represented only a small fraction of fish observed swimming in pools. Most Roundtail Chub were observed directly below Maiden Falls and ~230 m downstream. Stream habitat was notably different from the first two stations, with deeper pools and less plunge pool habitat. There was a waterfall ~500 m downstream of Maiden Falls that appeared to act as a barrier to upstream dispersal of non-native fishes. Rainbow Trout were detected above the falls, but Smallmouth Bass were not detected between Maiden Falls and the downstream falls. No fish were observed or captured immediately above Maiden Falls, and effort was not expanded upstream. Previous surveys have found non-native fishes occur above Maiden Falls (Timmons et al. 2014). Photographs of available habitat and Roundtail Chub are provided in Appendix B (Figures B99-B105).

Overall, Roundtail Chub abundance increased upstream and most were observed/captured at the third station. Future surveys should focus directly downstream of Maiden Falls with a combination of passive and active (e.g., fly rod) gears. Routine monitoring of West Clear Creek at Maiden Falls should continue to monitor community dynamics and long-term abundance trends.

Table 41. Summary of catch in lower West Clear Creek by Promar hoop nets. Total effort was 255 net hours.

Species	Age	Count	% of total catch	CPUE (fish/net hr)
GIRO	1+	16	61.54	0.063
MIDO	1+	5	19.23	0.020
ORVI	N/A	4	15.38	0.016
PACL	1+	1	3.85	0.004
Total		**26**	**100**	**0.102**

Table 42. Summary of catch in lower West Clear Creek by fly rod. Total effort was three fishing hours.

Species	Age	Count	% of total catch	CPUE (fish/hr)
GIRO	1+	10	62.50	0.333
MIDO	1+	1	6.25	0.033
ONMY	1+	5	31.25	0.167
Total		**16**	**100**	**0.533**

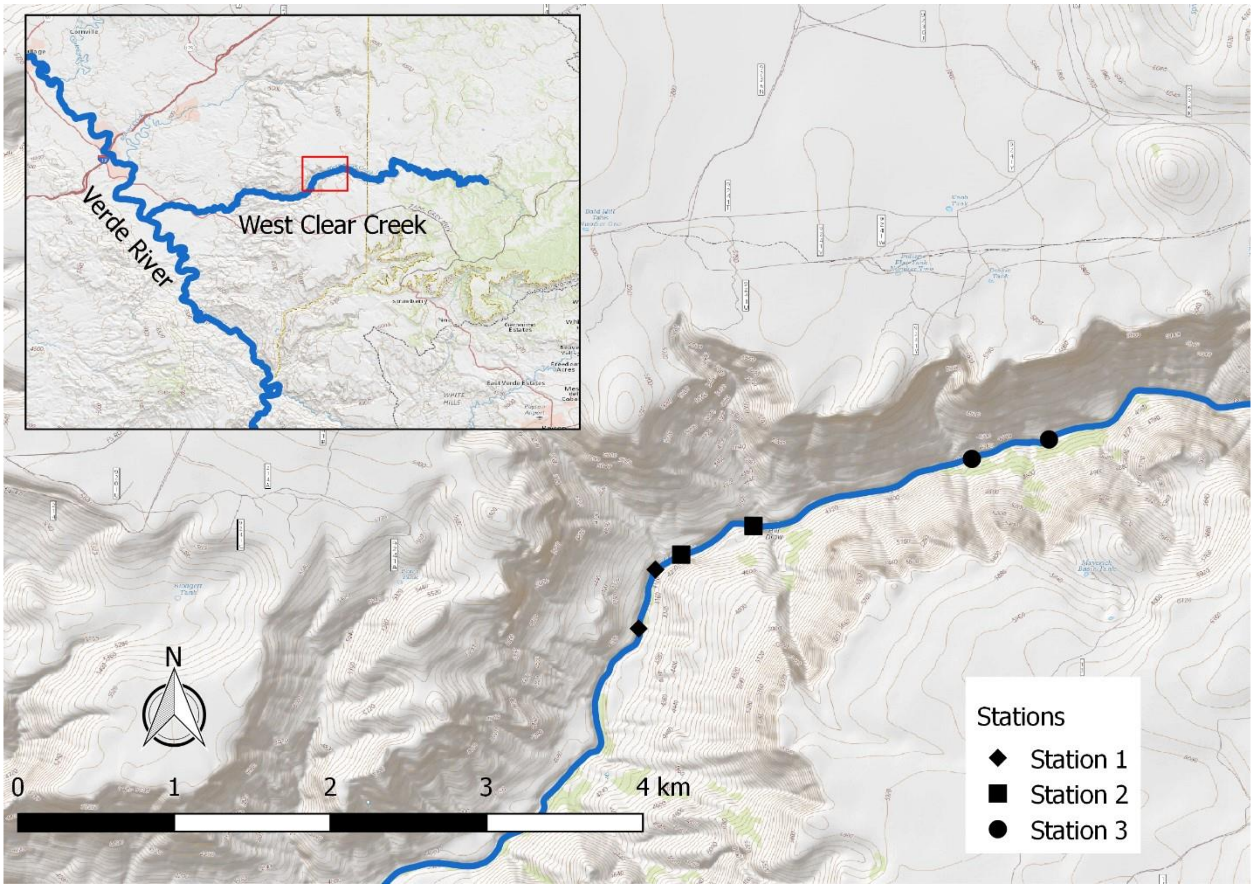

Figure 33. Location of three 500 m sampling stations in lower West Clear Creek sampled on September 19–20, 2018.

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Appendix A – Supplementary Graphs

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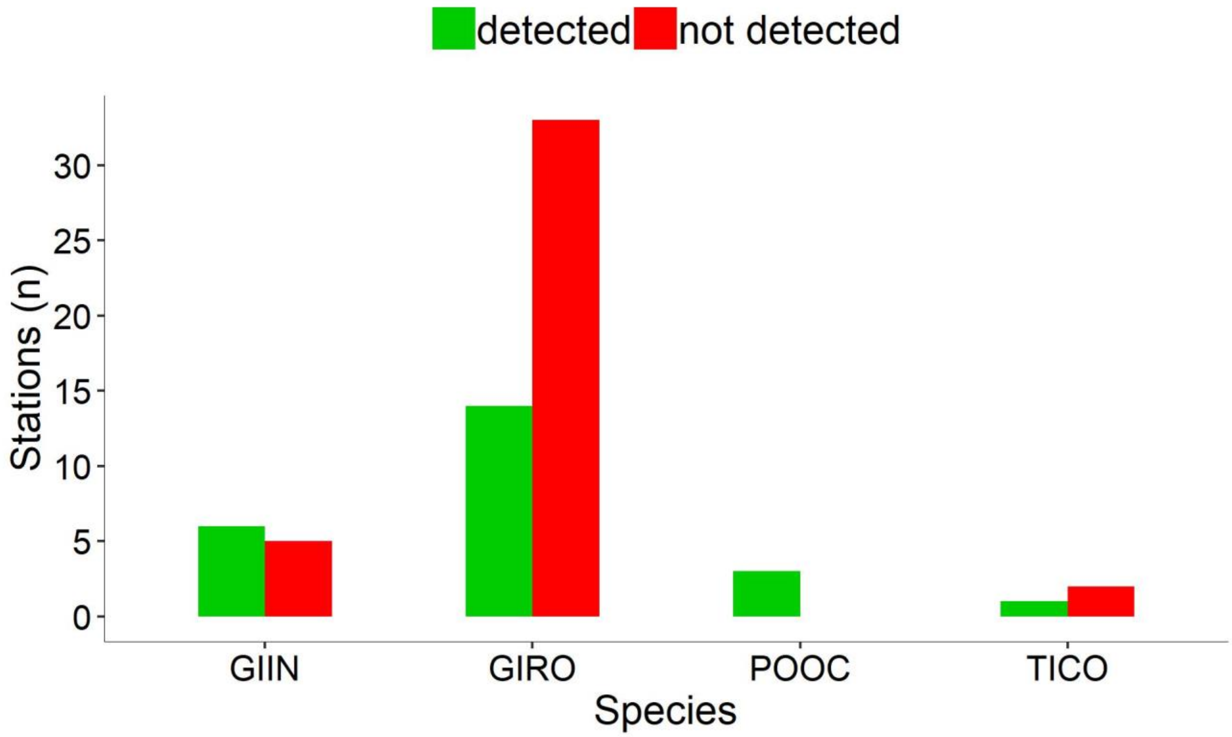
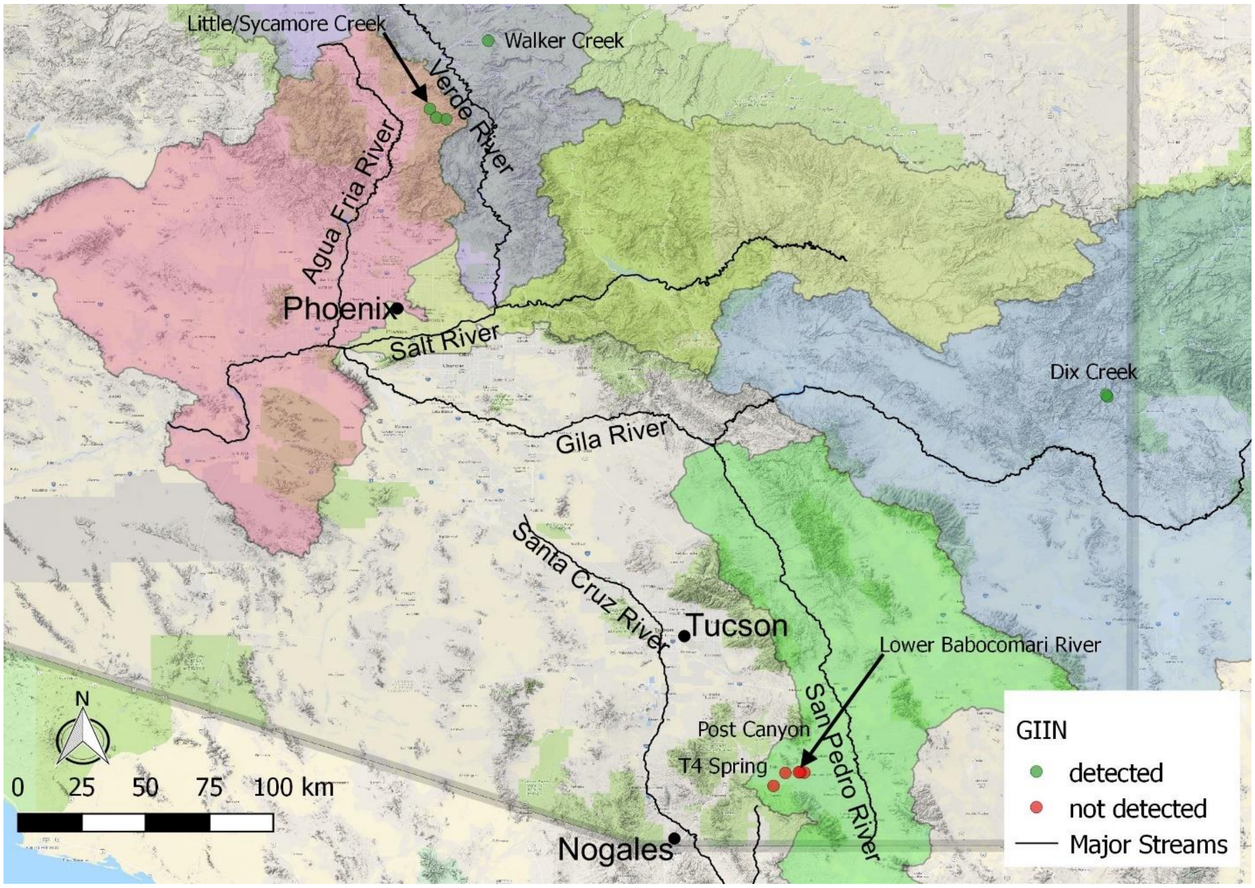


Figure A1. Number of stations where focus species were detected or not detected in selected streams of Gila River basin, 2018.



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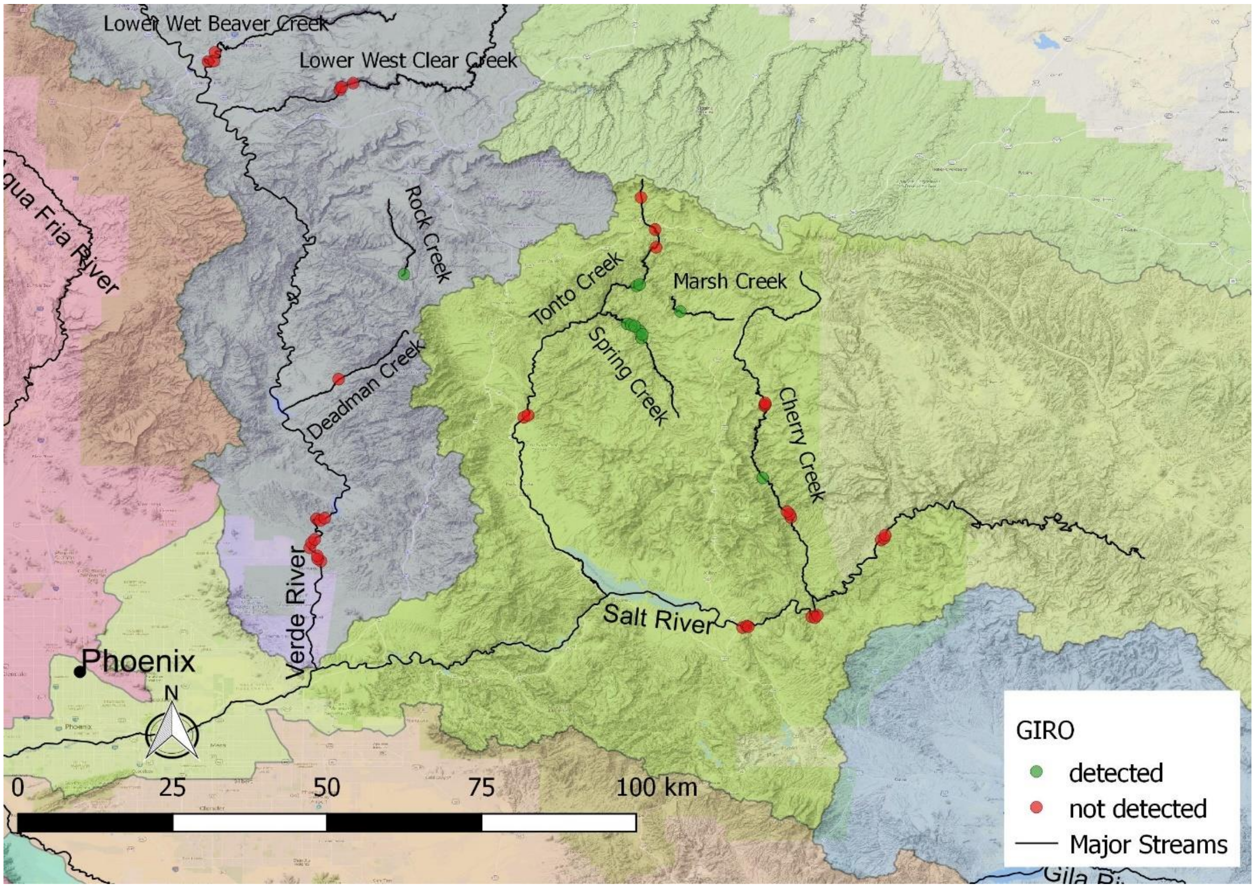

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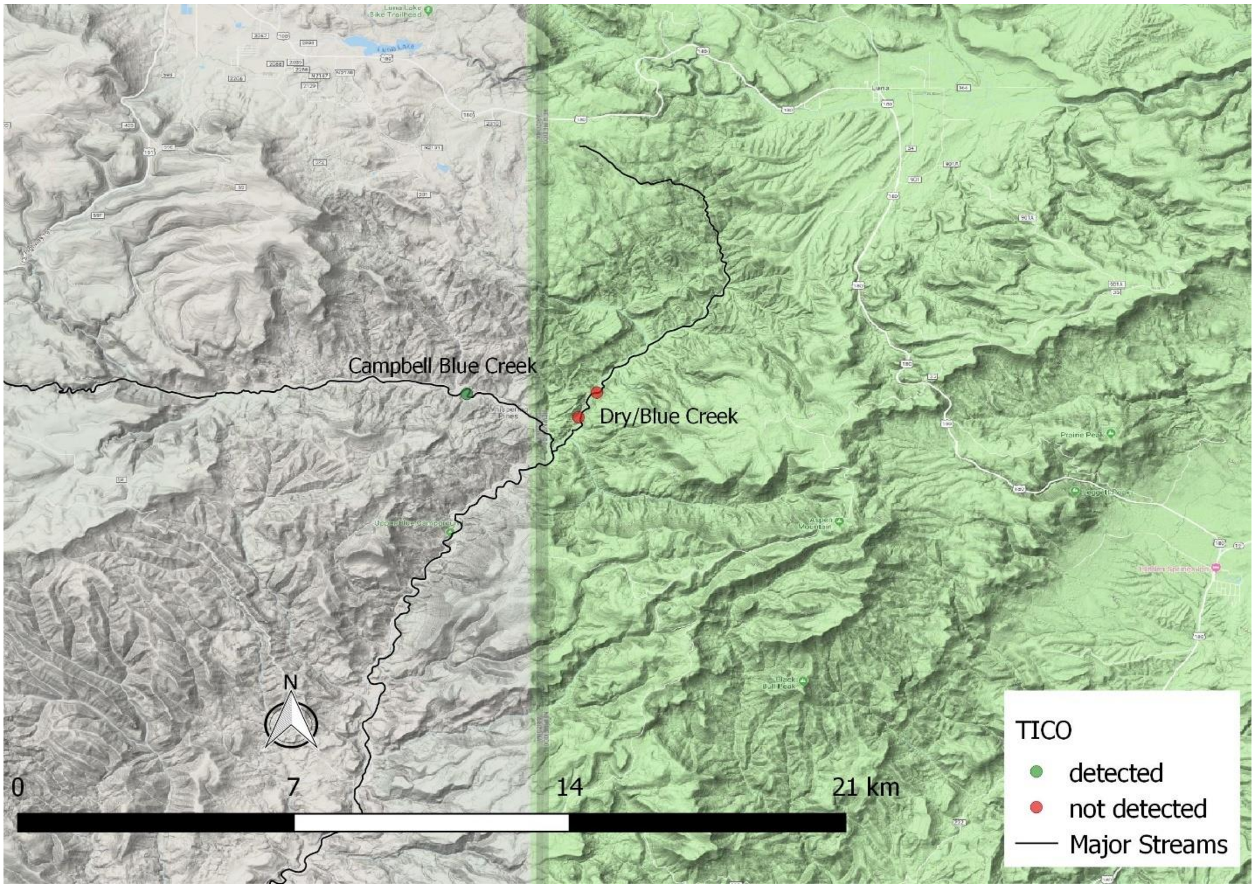

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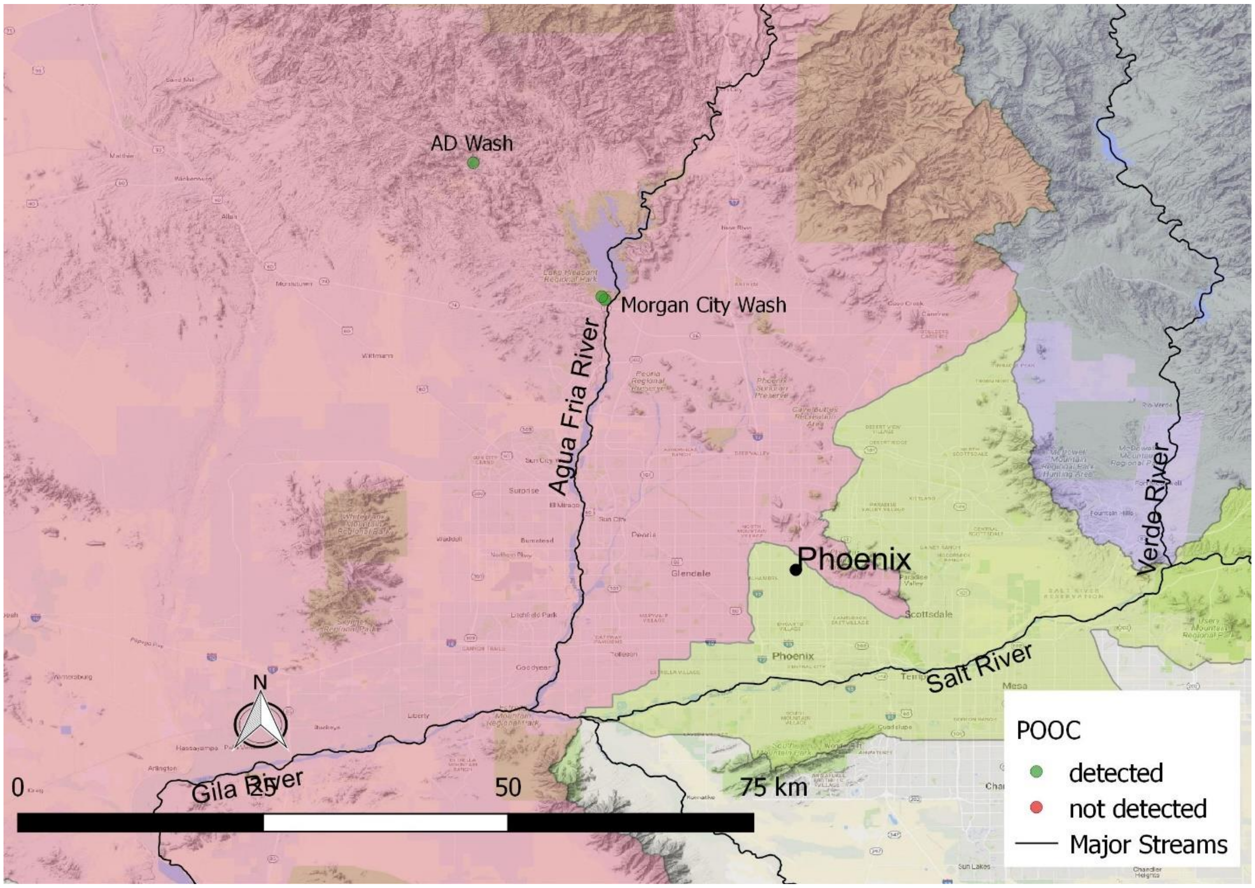

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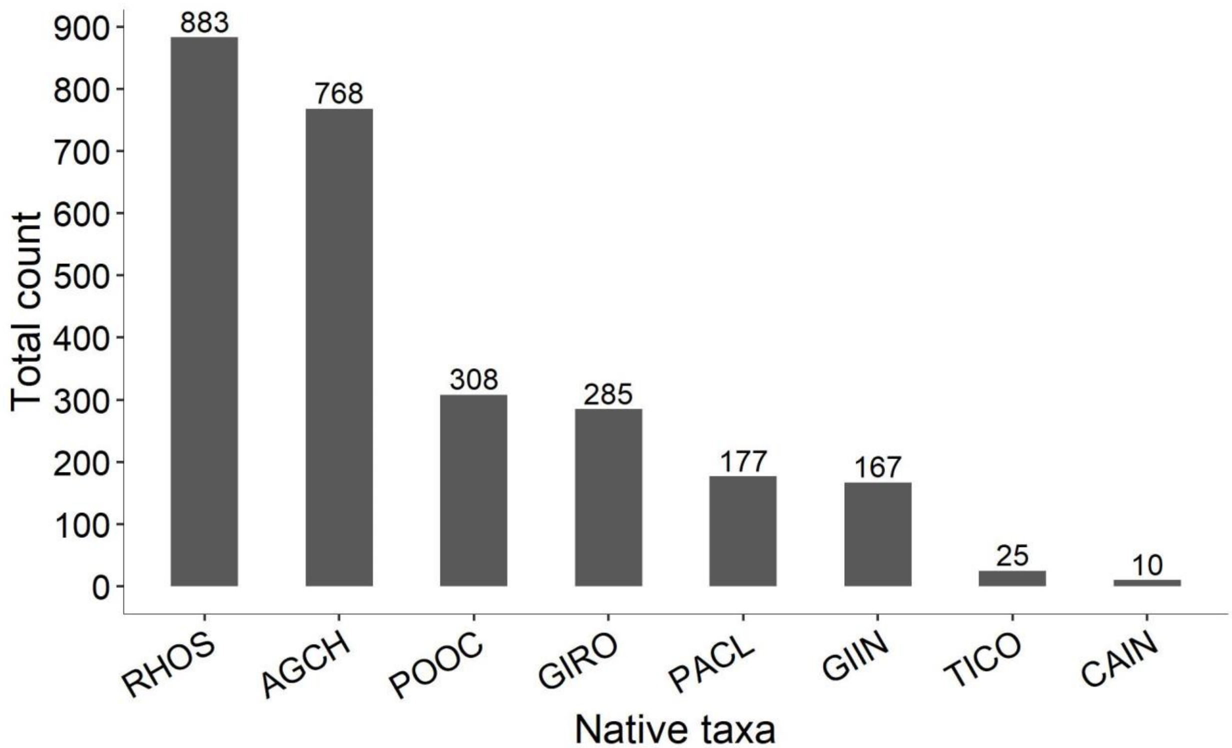

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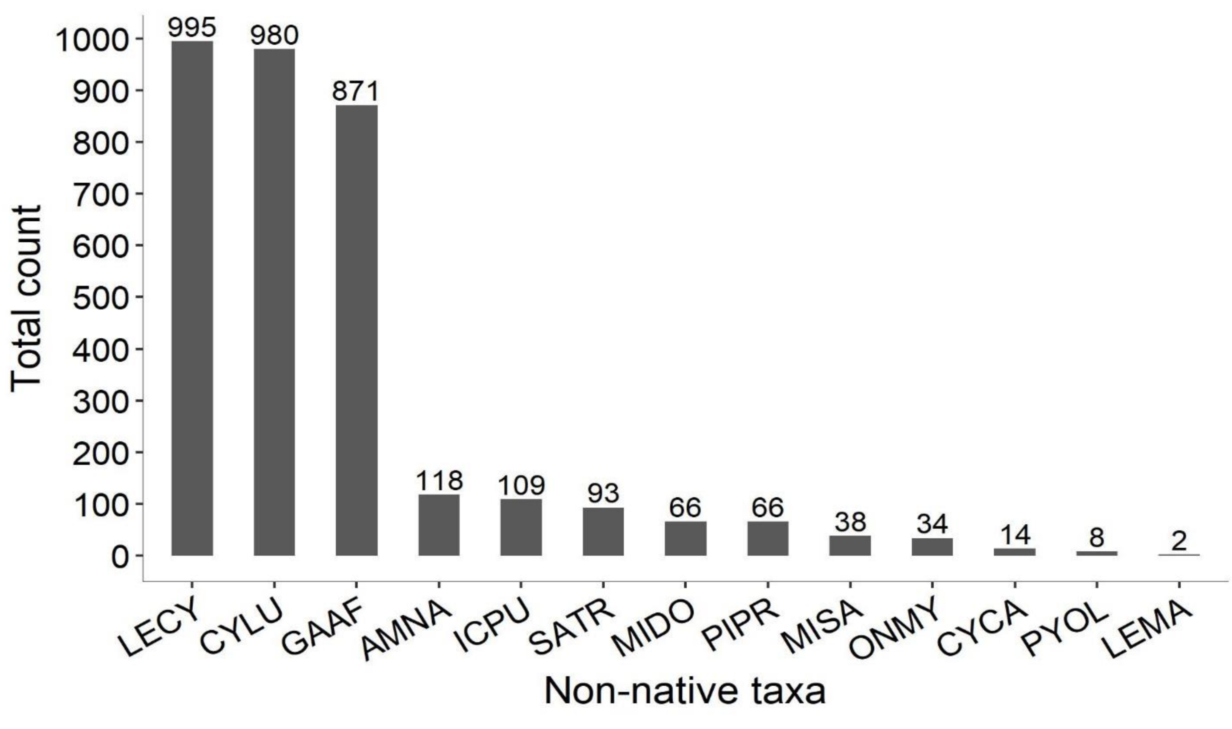

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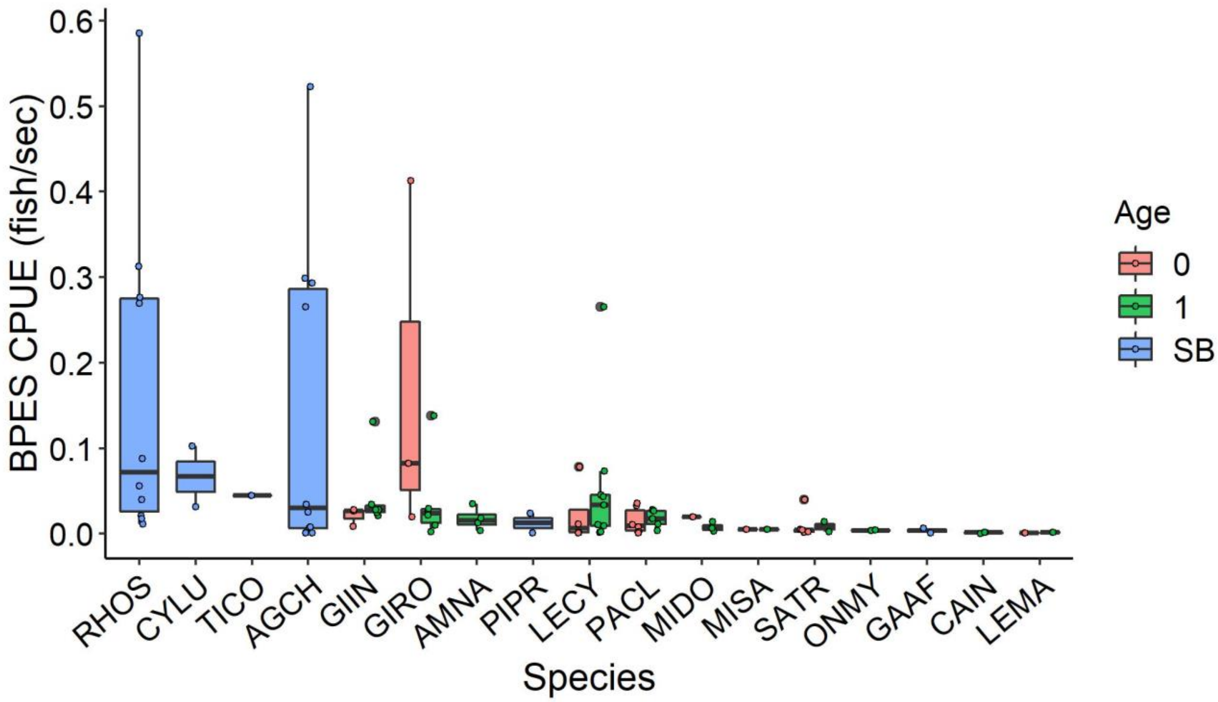

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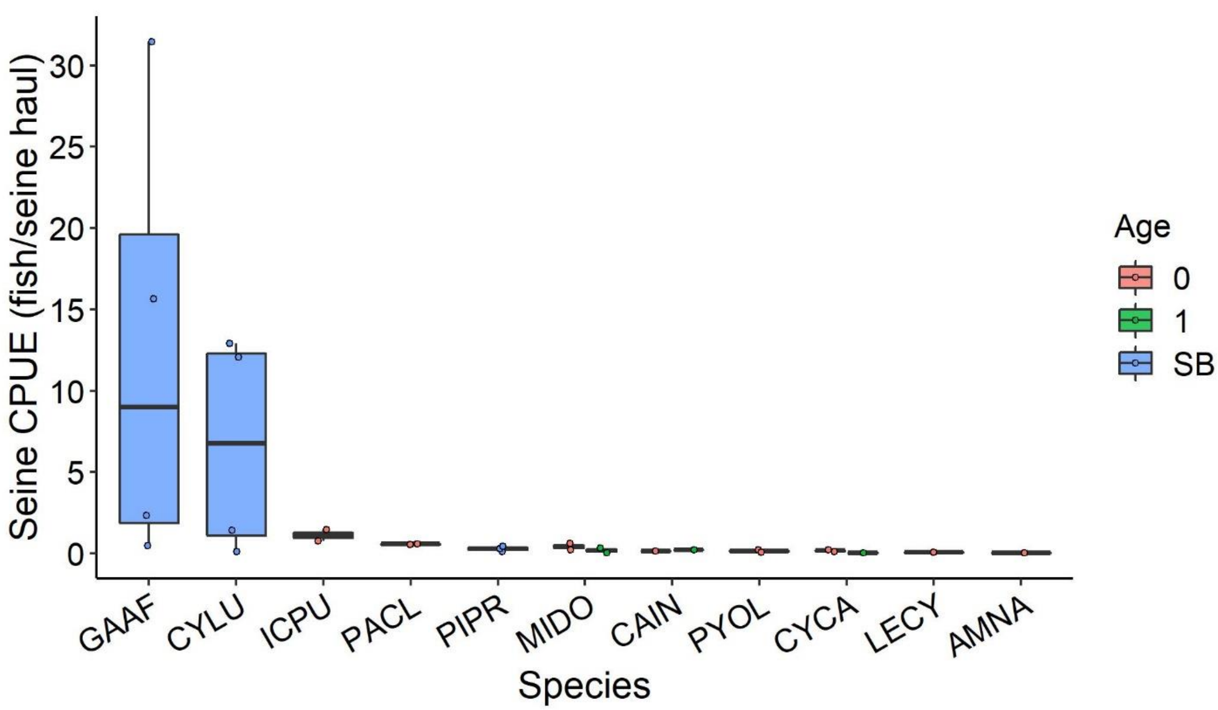

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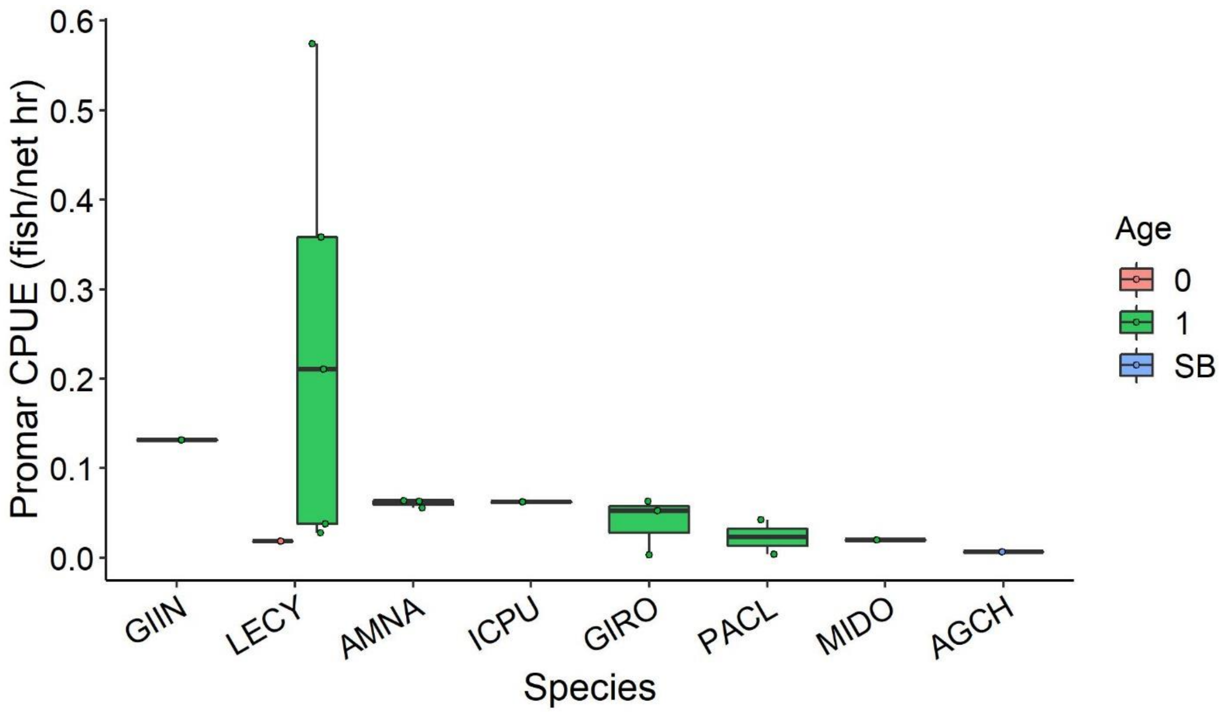

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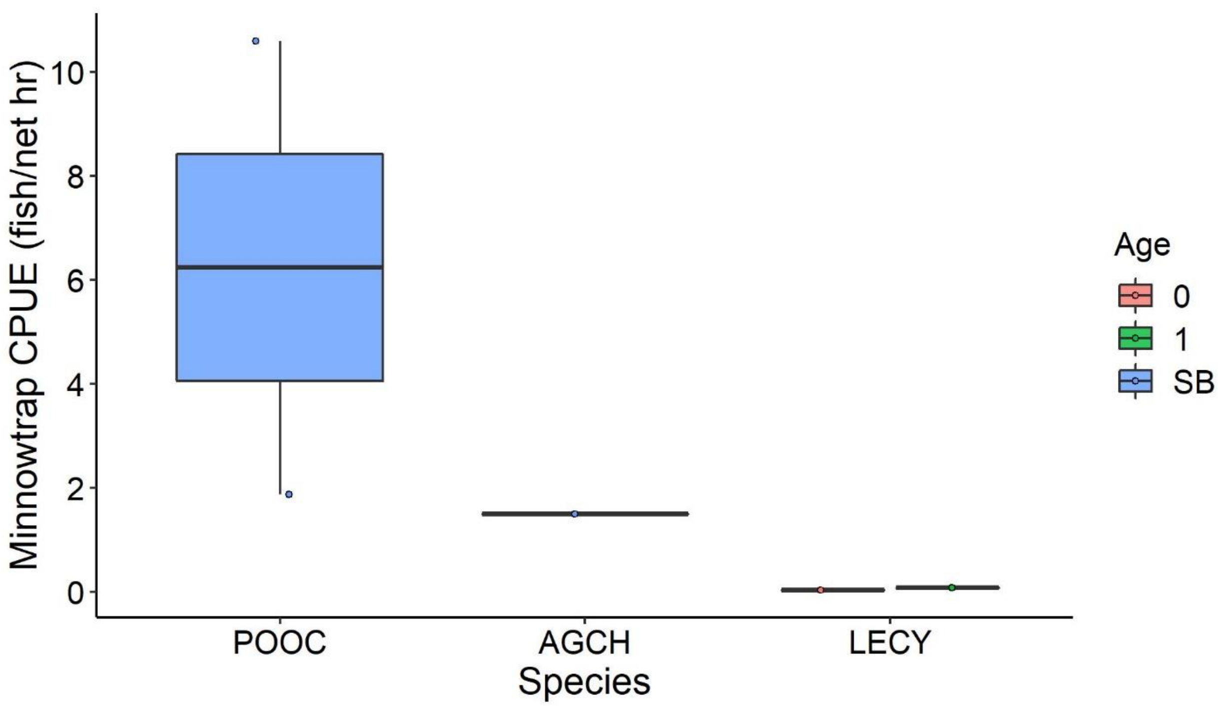

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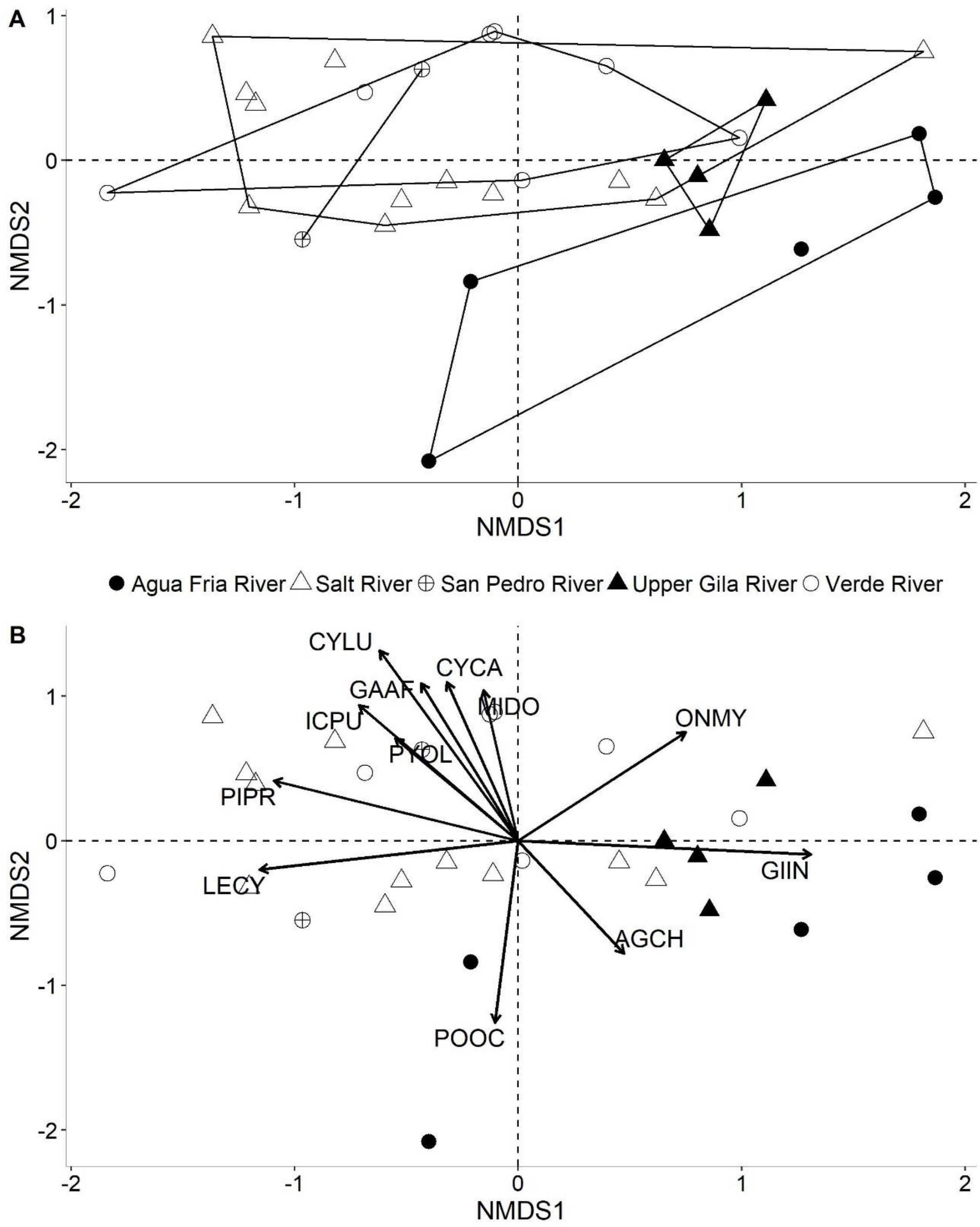

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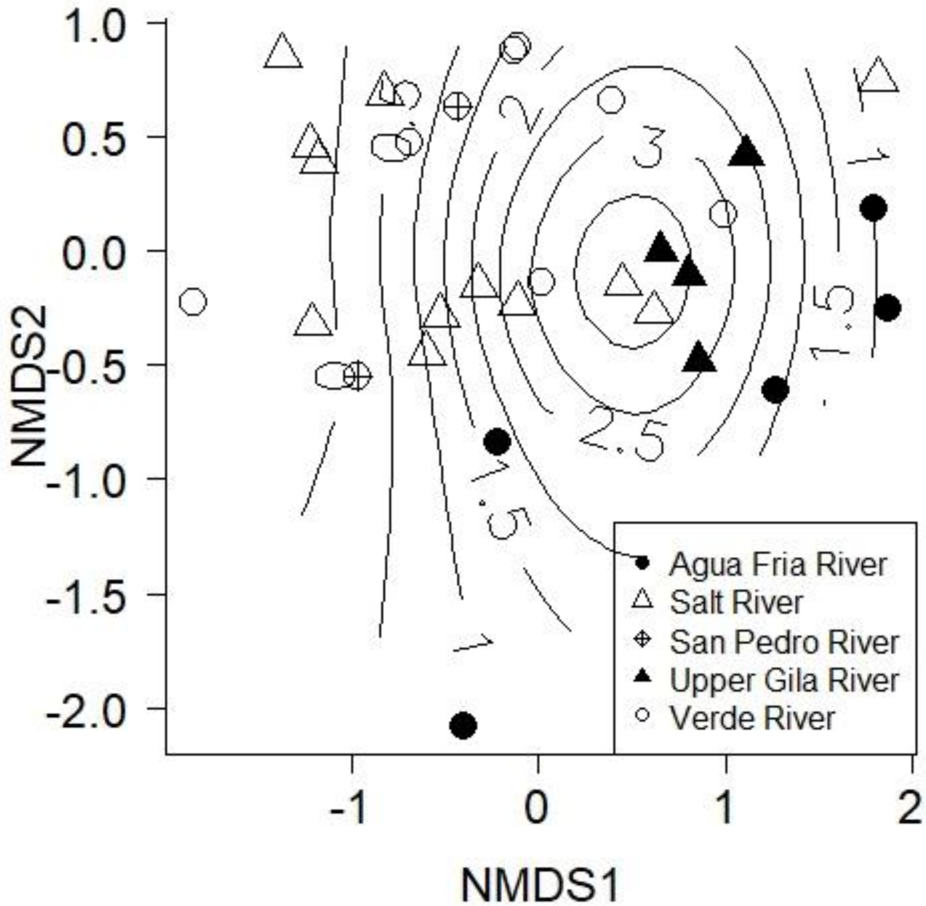

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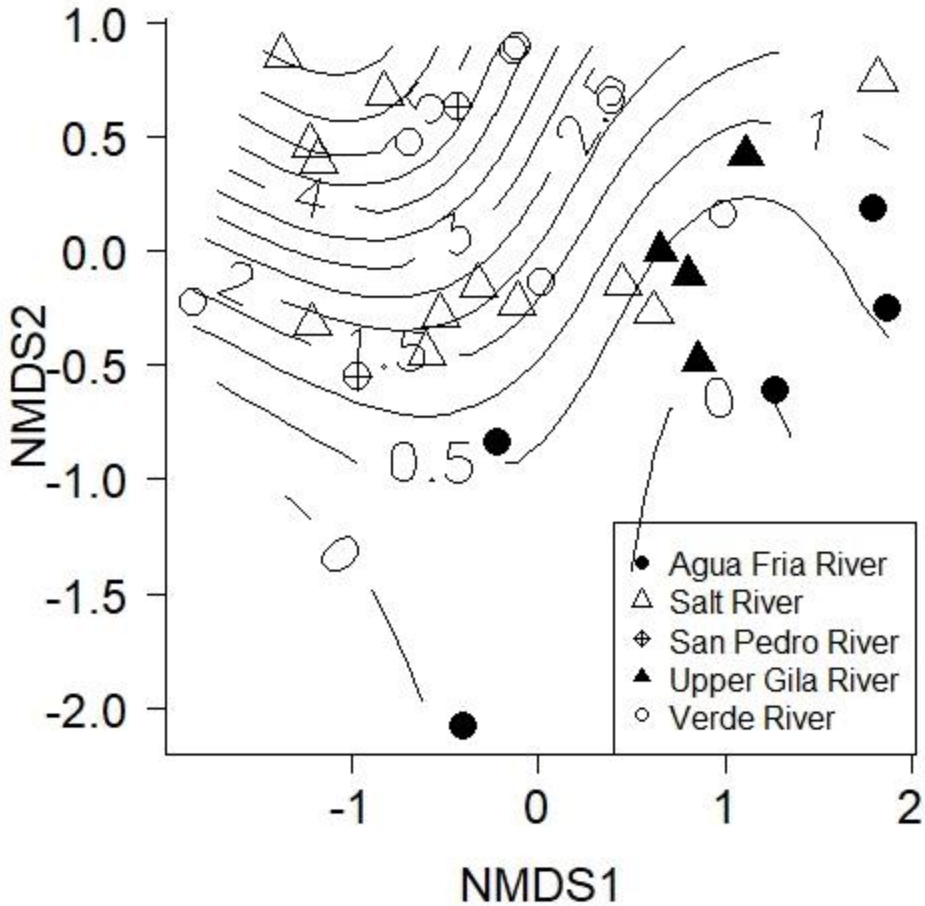

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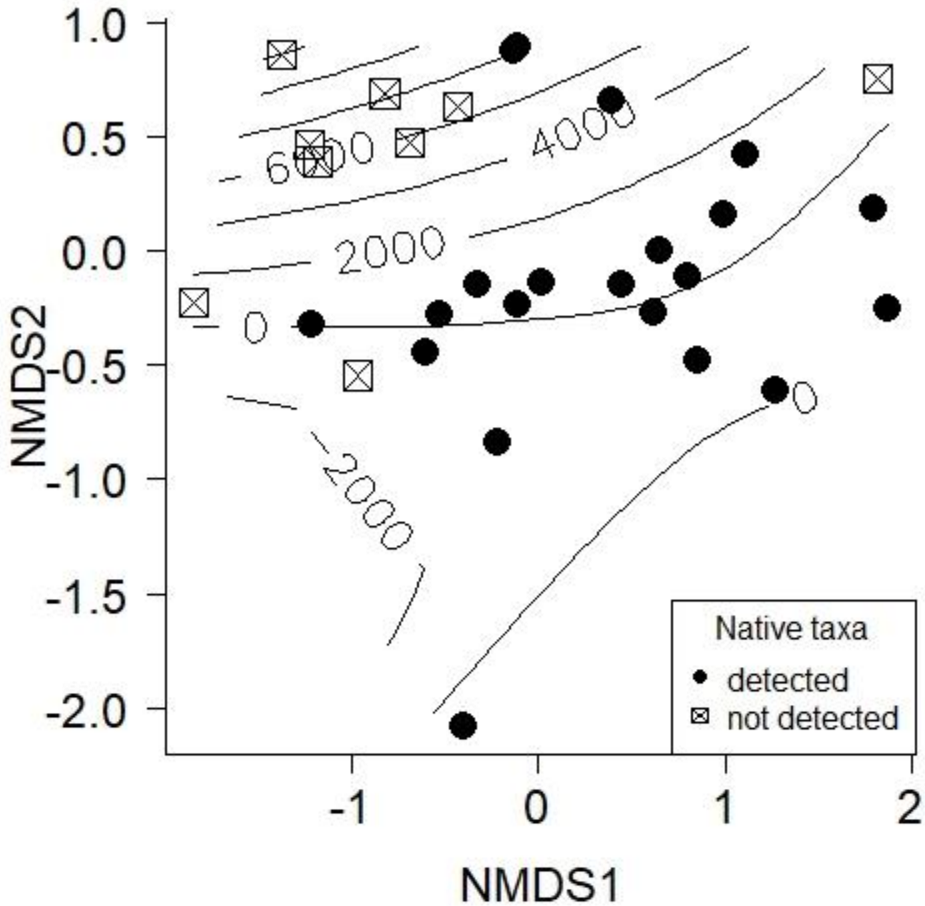

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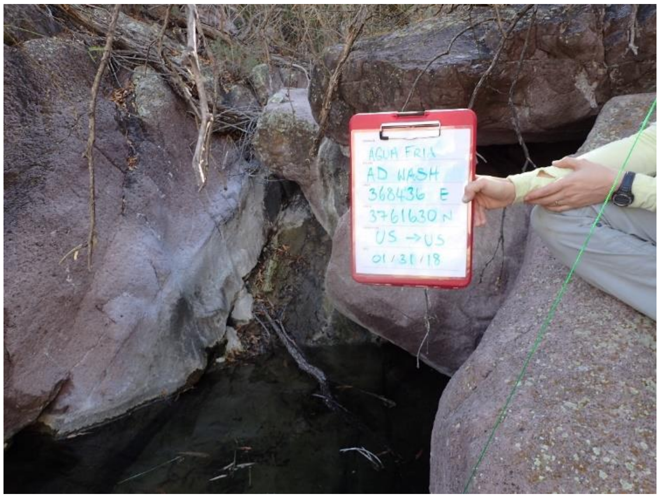

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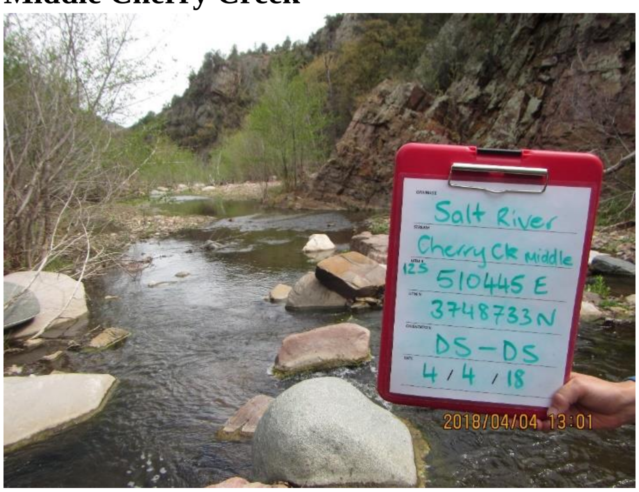

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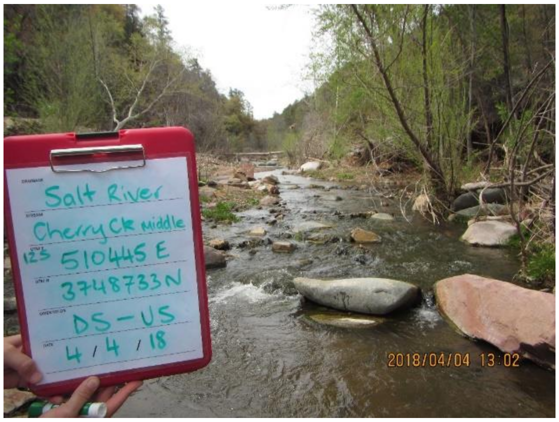

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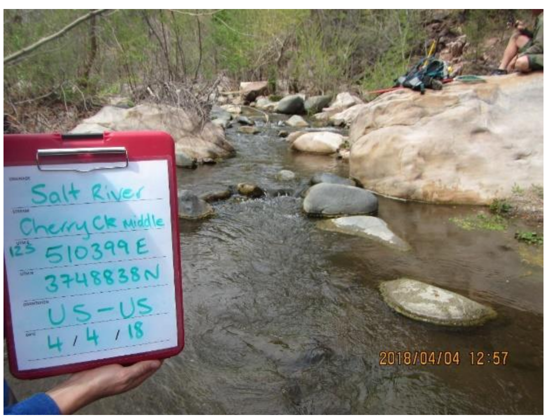

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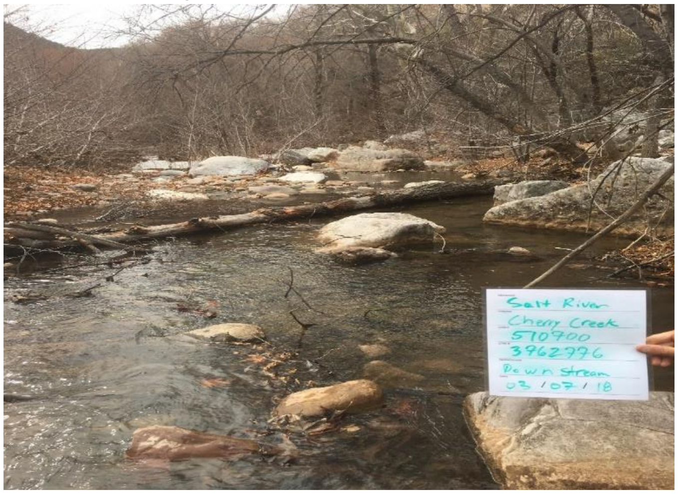

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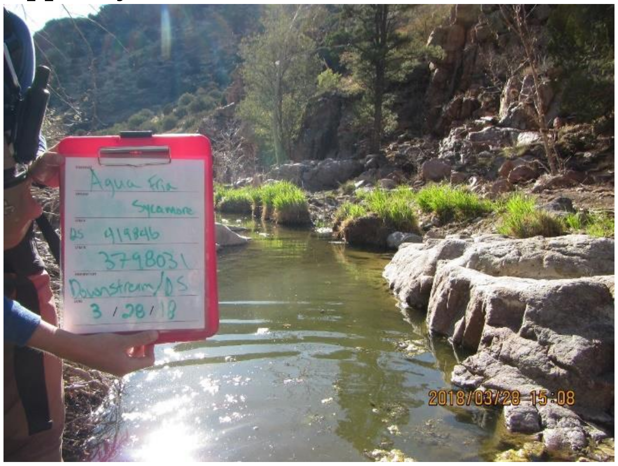

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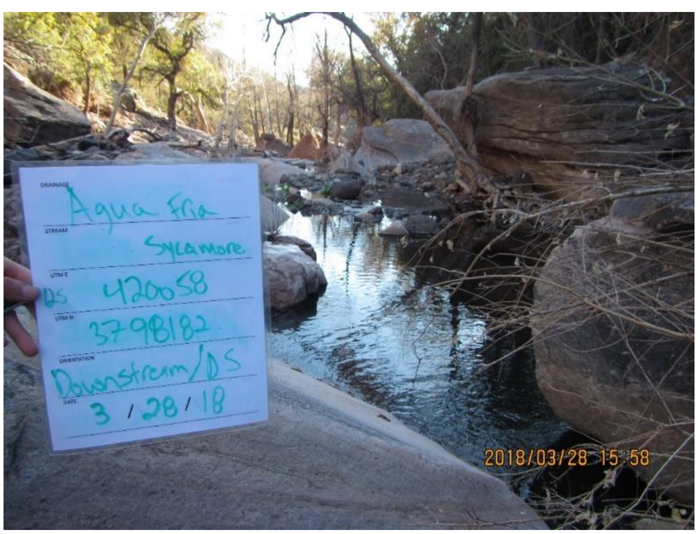

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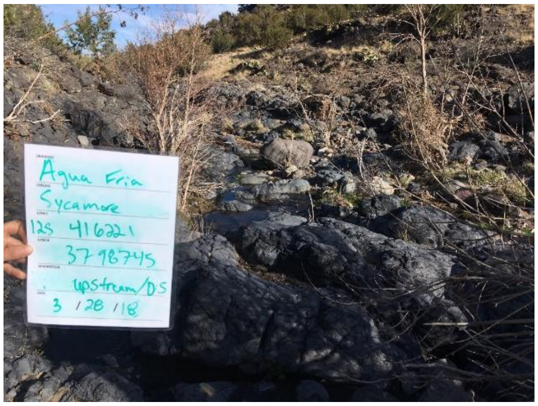

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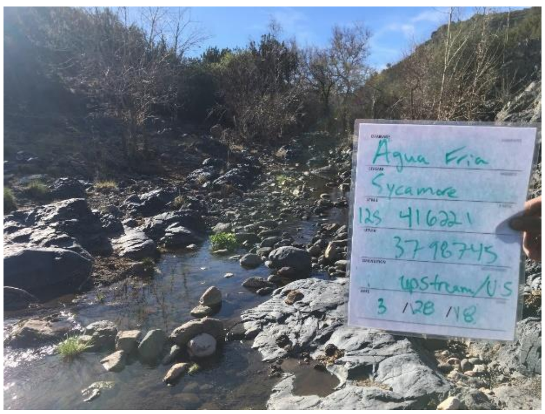

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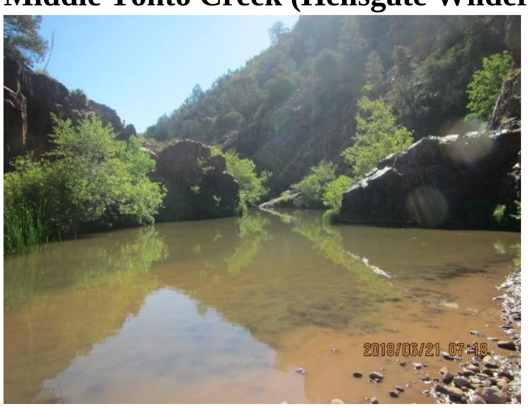

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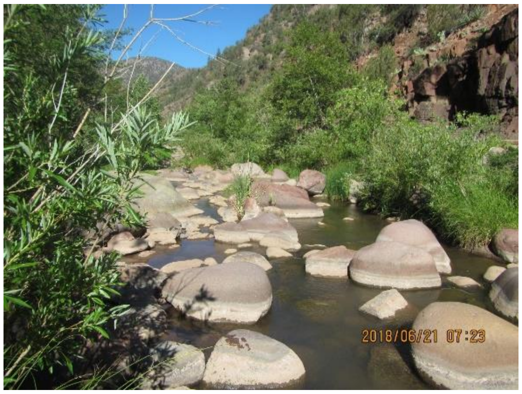

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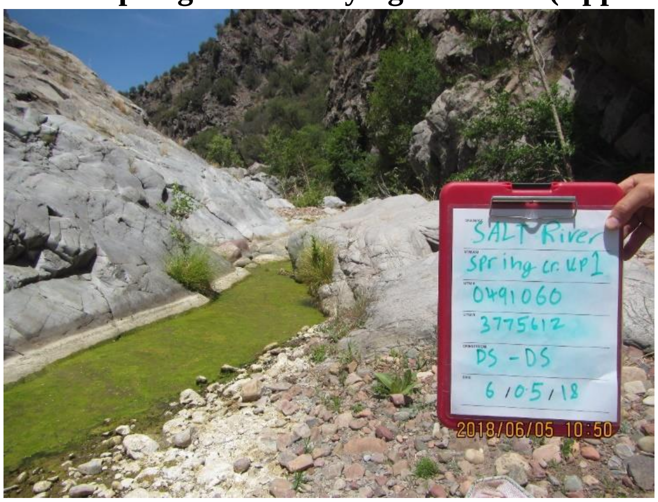

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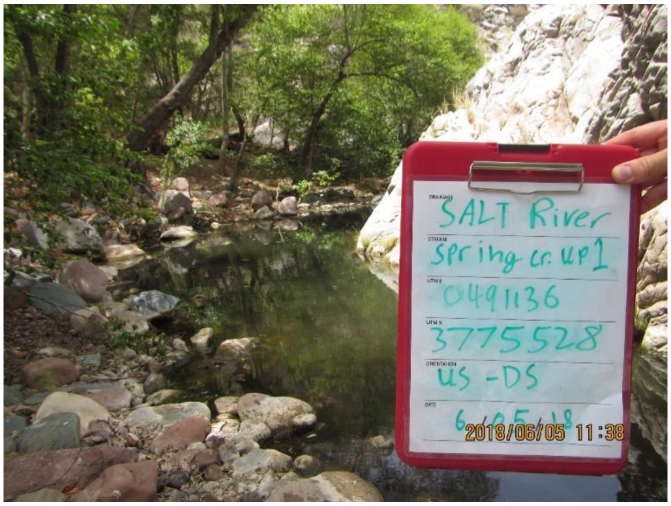

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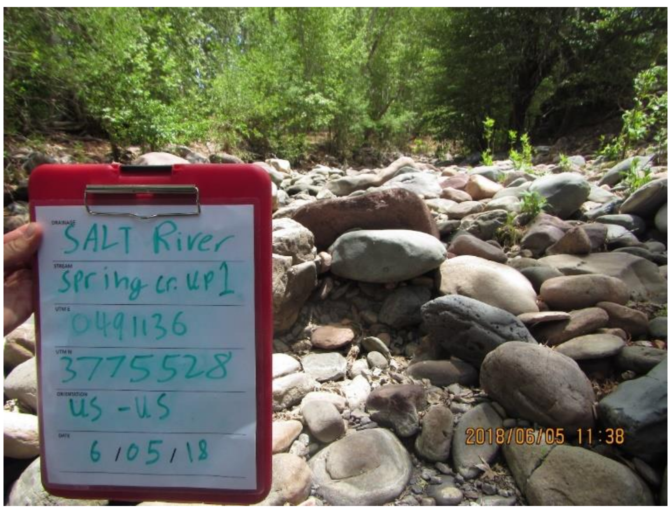

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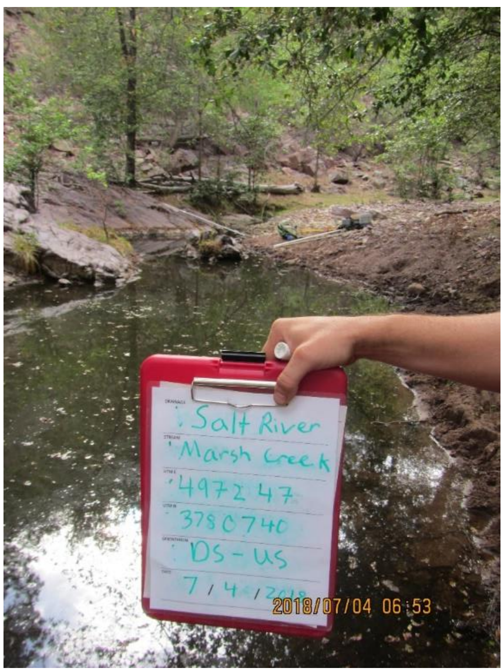

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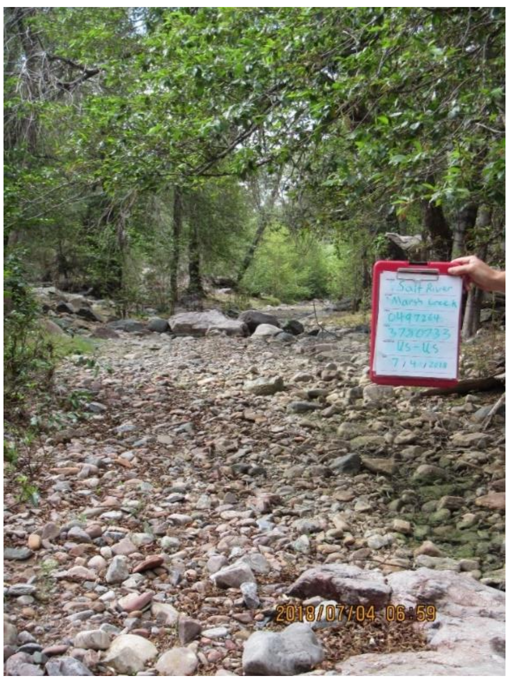

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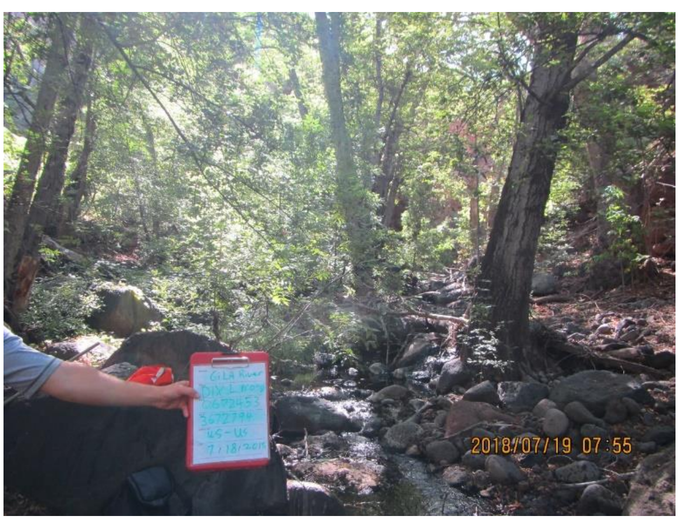

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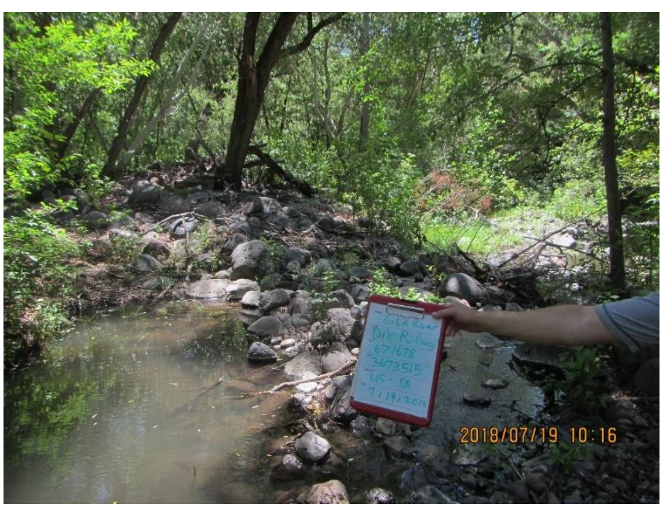

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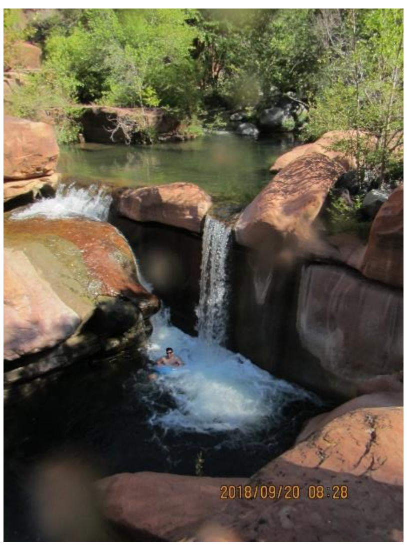

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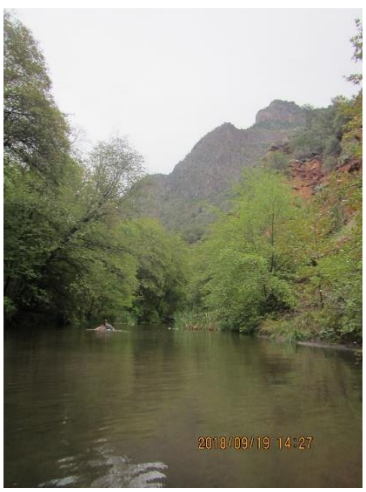

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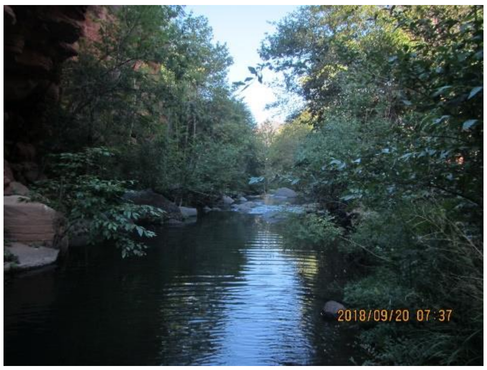

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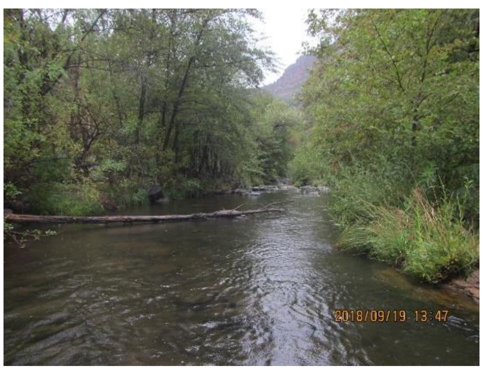

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