Gila River Basin Native Fishes Conservation Program:
Bureau of Land Management – New Mexico
2019 Annual Report

Gila River Lower Box ACEC

Interagency Agreement (IAA) (R19PG00076)

between

Bureau of Reclamation and Bureau of Land Management

Submitted by

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February 2020

Introduction

This report summarizes activities by the Bureau of Land Management – New Mexico (BLM-NM) during 2019 under the Interagency Agreement (IAA - R19PG00076) with the Bureau of Reclamation (BOR). Through this agreement, BLM surveyed several streams in the upper Gila River basin in New Mexico under the Gila River Basin Native Fishes Conservation Program (GRBNFCP) formerly known as the CAP Fund Transfer Program. The GRBNFCP was established to minimize impacts on threatened and endangered fishes by the Central Arizona Project (CAP) canal and its subsequent operations which included the introduction of non-native aquatic species from the Colorado River into the Gila River basin. The United States Fish and Wildlife Service (USFWS) biological opinions (BO) in 1994, 2001, and 2008 concluded that operation of the CAP required mitigation for the negative effects on federally listed fish species within the entire Gila River Basin. The GRBNFCP is focused on conservation work for five federally listed fish species including Spikedace (*Meda fulgida*), Loach Minnow (*Tiaroga cobitis*), Gila Chub (*Gila intermedia),* Gila Topminnow (*Poeciliopsis occidentalis*), and Razorback Sucker (*Xyrauchen texanus*). It should be noted that two of the previously described chub species, Gila Chub (*Gila intermedia*) and Headwater Chub (*Gila nigra*) were recently re-described as belonging to the Roundtail Chub (*Gila robusta*) (Page et. al. 2016). Though this change in taxonomy may be warranted, for consistency with regulatory concerns, BLM will continue to recognize the federal ESA listing documents for naming conventions. Though Headwater Chub has not been captured on BLM managed waters in the Gila river basin in southern New Mexico, both the Roundtail and Gila chubs have historically been found there.

A systematic survey of the entire lower Gila River mainstem and its perennial tributaries on BLM managed lands is necessary to determine the presence and extent of target species (Loach Minnow, Spikedace, and Roundtail/Gila Chub) within this area. Initial survey priorities are the BLM's Gila River Lower Box ACEC and permanent sites that are known to or may contain populations of the target species. Tributaries where target species are not known or not present may still have suitable habitat for possible repatriation of target species (e.g. Blue Creek, Apache Creek).

Under this agreement, the Bureau of Land Management Las Cruces District Office (BLM LCDO) surveyed the Gila River mainstem in BLM-NM's Lower Box ACEC and conducted annual surveys at permanent sites within the Gila River basin. Habitat and water quality data were also collected.

The strategic plan and recovery goals these tasks address are:

<u>Strategic Plan Goals:</u>

- Goal 5 - Survey poorly studied stream systems to document existing fish communities.
    - Objective 5 - Investigate fish distributions in the upper Gila River watershed in New Mexico that have not recently been surveyed.

<u>Recovery Goals:</u>

- Spikedace Recovery Plan (1991); Loach Minnow Recovery Plan (1991)

  - Task 2.5 (priority 1): Monitor community composition including range of natural variation
- Gila Chub draft Recovery plan (2014)
  - Task 3.2 (priority 2) Conduct monitoring

<u>Task ID: NM-2014-1</u>

<u>Task 1: Gila River Mainstem and Tributaries: Long-term monitoring and Tributary Fish and Habitat assessment</u>

BLM LCDO staff and contractors continued long-term monitoring surveys of Spikedace, Loach Minnow, and Roundtail Chub (previously classified as Gila Chub) populations within the Gila River mainstem. Fisheries surveys were conducted backpack electro-shockers, dip nets and seine nets and were completed to document status and trend including habitat use and availability. A complete report for these efforts is included at the end of this report (Appendix 1). Additionally, Data from these surveys were combined with the New Mexico Department of Game and Fish survey efforts to continue long-term monitoring efforts by the Department and BLM since the mid-1990's.

<u>Blue Creek</u>
Efforts to assess habitat conditions in Blue Creek were unsuccessful due to lack of water in the BLM portion of the stream. Photo 1 below shows surface water changes within seasons and across years; 2019 was similar to 2015. Efforts to obtain desired data will be attempted again in 2020. Though previous fish surveys have confirmed the presence of at least three native species (i.e. Desert Sucker (*Pantosteus clarkia*), Speckled Dace (*Rhinicthys osculus*) and Longfin Dace (*Agosia chrysogaster*)) in Blue Creek, lack of continuous flow during recent reconnaissance trips begs the question as to their origin. It is hoped that resurveys higher in the watershed will answer that question.

Photo 1 - Blue Creek: Summer 2015 (left), Fall 2016 (right)

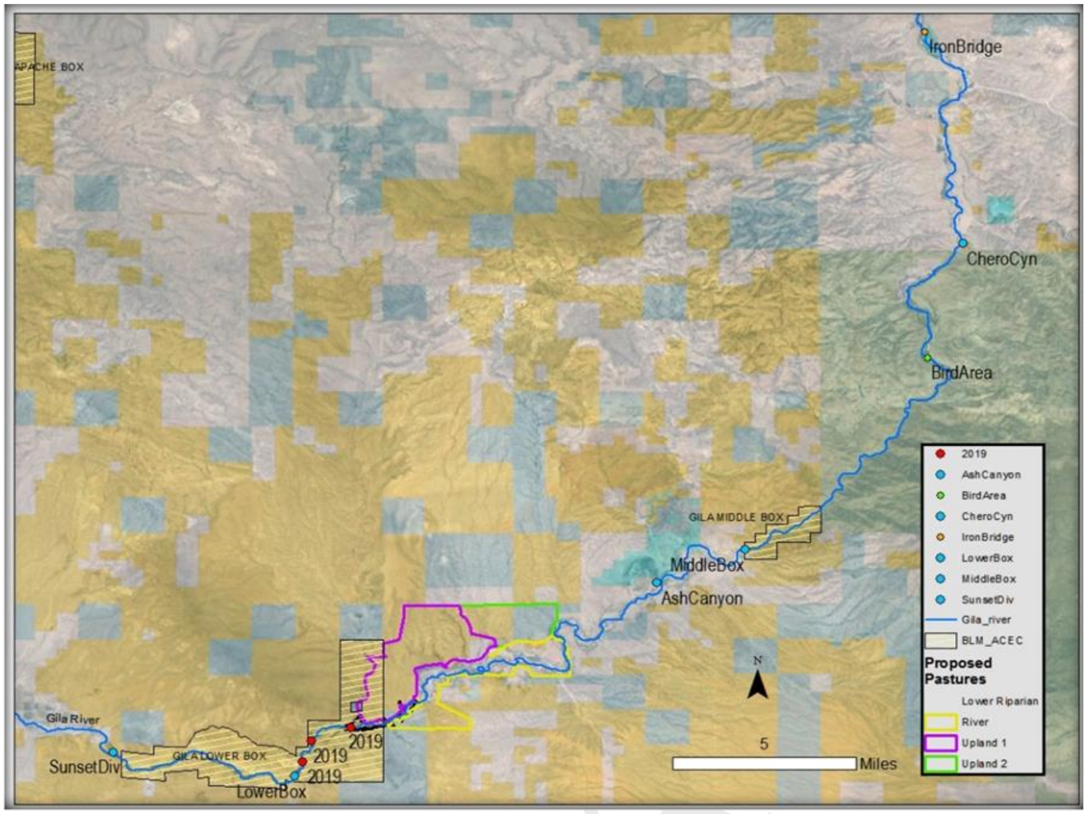
Apache Creek

During the 2019 monsoon season, highly localized and intense rain fall patterns occurred over the Apache Box area (Photo 2) creating flash-flooding in Apache Creek. During these high flow events, previously installed data loggers were either buried too deep for retrieval or washed away and therefore no annual water quality data was obtained. New HOBO data loggers will be re-installed on Apache Creek during the 2020 field season.

Photo 2 – Apache Box and Creek

Task 2: Gila River Mainstem Lower Box Resurvey

Over a four-day period (July 22-25, 2019), BLM LCDO staff surveyed the Gila River mainstem in the BLM-NM's Gila River Lower Box ACEC downstream of Red Rock, NM. To knowledge, this 9-mile reach from Sunset Dam upstream to 1.75 miles above Nichol's Canyon (Figure 1) had not been systematically surveyed prior to this effort. The only previous surveys known in this stretch occurred at Fisherman's Point ("Lower Box" label in Figure 1), but those surveys ceased in the mid-2000's (Propst 2020). The current surveys were scheduled for early summer to increase sampling efficiency due to flows being at there lowest at this time of year. Also, surveys were scheduled to avoid possible delays and safety issues associated with monsoonal moisture and subsequent high flow events (i.e. flash floods). This can be especially hazardous in this stretch of the river since much of the reach is canyon bound.



Map 1 – Map of the Gila Lower Box ACEC and riparian area. 2019 labels show Loach minnow capture sites and are displayed along with other long-term monitoring sites on the Gila River BLM managed lands.

As with Blue Creek and other similar streams in southwest New Mexico, surface flow was sporadic for the first 2 miles of survey reach (Photo 3).

Photo 3 – Gila River upstream of Sunset Dam. July 2019.

Though not unexpected, it was surprising how far upstream the dry channel had migrated. From Sunset Dam upstream approximately 1.5 miles, flow was subsurface with the exception of one small backwater. However, just downstream of the first of three beaver dams found during this survey effort (Photo 4), flow became constant and above ground for the remainder of the sampling area. Average baseflow on the Gila River during this period was less than 2 cubic feet per second (cfs) (USGS 09432000 Gila River below Blue Creek, near Virden, NM).

Photo 4 – First of three beaver dams on the Gila River mainstem, Lower Box ACEC. Summer 2019.

Methods

Fisheries surveys were conducted to ascertain the current status (i.e. presence/absence) of native fish species and overall community composition of the fish fauna in this fairly remote reach. Surveys were conducted using a backpack electro-fisher (Smith-Root LR24 Electrofisher), dip nets and 2m x 3m (0.3cm mesh) seine net. All available mesohabitats were surveyed for targeted species. Habitat types (i.e. pool, run, riffle, etc.), substrate, velocity and water quality were collected. All captured fish were identified and enumerated with fishes >100mm also being measured and weighed. Representative specimens and trap mortalities were accessioned to the Museum of Southwestern Biology at the University of New Mexico. All other fishes were released.

Results

Individuals captured across all habitat types totaled 1588. Ten different fish species were captured during the surveys including four native and six exotic species (Table 1).

Species Code	Status	Common Name	N
PANCLA	N	Desert sucker	4
TIACOB	N	Loach minnow	5
CATINS	N	Sonora sucker	12
AGOCHR	N	Longfin dace	242
PIMPRO	E	Fathead minnow	3
GAMAFF	E	Mosquito fish	534
CYPLUT	E	Red shiner	648
ICTPUN	E	Channel catfish	111
PYLOLI	E	Flathead catfish	28
MICSAL	E	Largemouth bass	1
		N =	1588
		Total Species Captured	10

Table 1 – Fish species captured

Longfin dace (*Agosia chrysogaster*) was the most common native species with red shiner (*Cyprinella lutrensis*) the most common non-native species. Two native catostomids were captured, desert sucker (*Pantosteus clarkii*) and Sonora sucker (*Catostomus insignis*). The target species, loach minnow (*Tiaroga cobitis*) was also captured during the surveys (see Map 1). In addition to red shiner, other non-native species captured included mosquito fish (*Gambusia affinis*), channel catfish (*Ictalurid punctatus*), flathead catfish (*Pylodictis olivaris*) and fathead minnow (*Pimephales promelas*). A single large-mouth bass (*Micropterus salmoides*) specimen was also captured during the inventory (Figure 2). Notably absences across all habitat types and survey reaches was the target native species spikedace *(Meda fulgida*). Also absent from the survey effort - though not necessarily surprising - were both chub species, Gila and Roundtail.

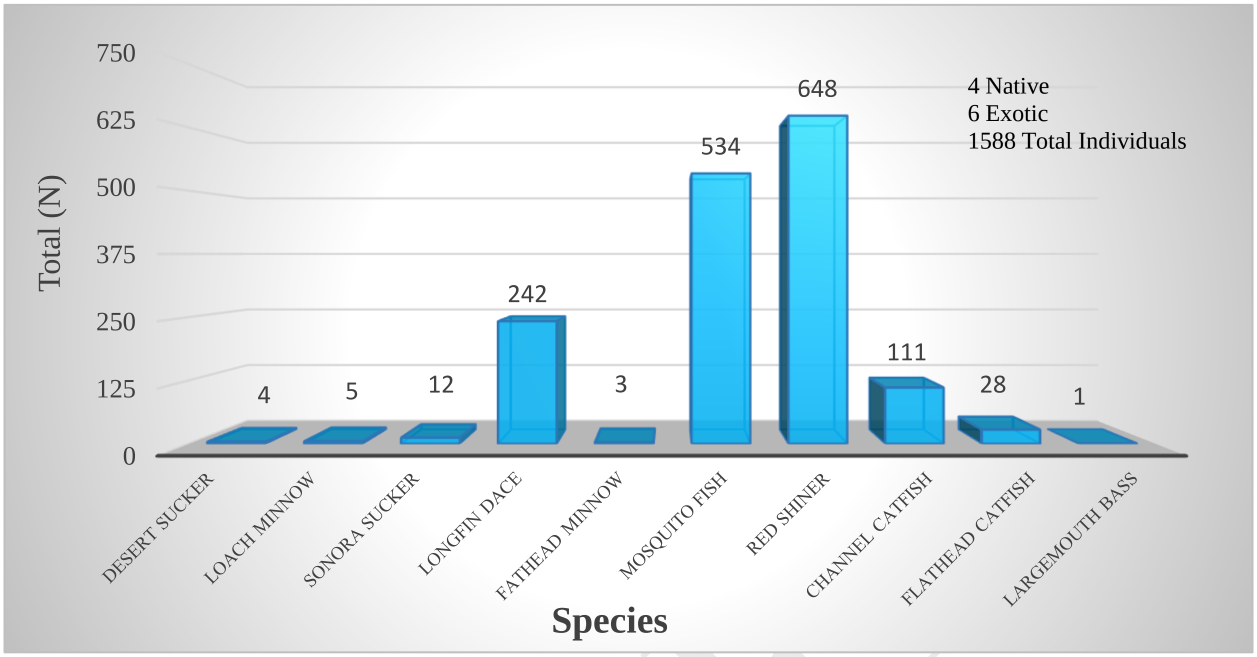


Figure 1 - Species Captured during 2019 Lower Box inventory

For comparison purposes among instream habitats, similar mesohabitats were combined into three main categories - runs, riffles and pools. Combined we sampled a total of 67 habitats. The number of run and riffle habitats encountered were similar, 24 and 28 respectively, while pool habitats were less numerous at only 15 across the entire site (Figure 3).

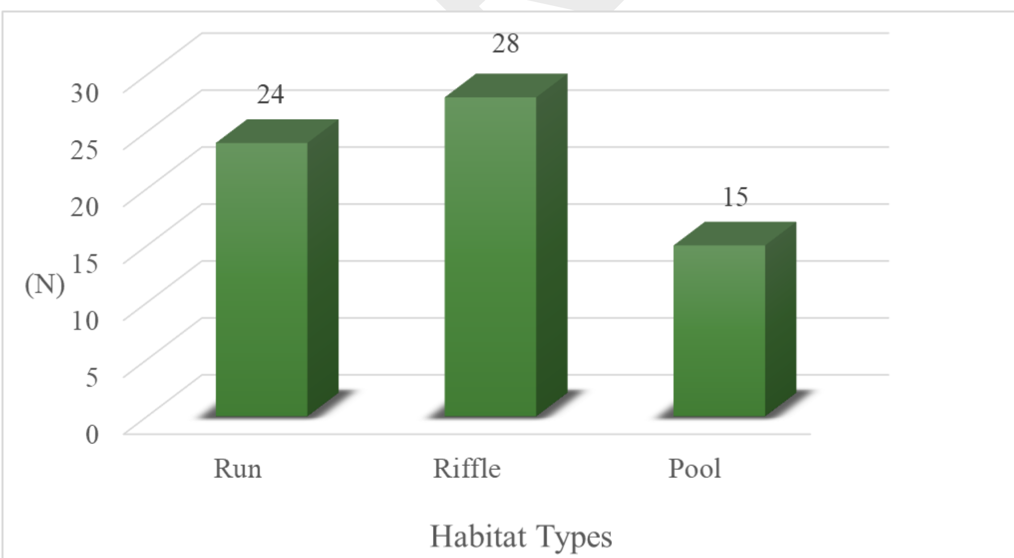


Figure 2 - Mesohabitats surveyed

The second most prolific mesohabitat by captured individuals were run habitats (n=671) (Figure 4). The most abundant native species in run habitat was longfin dace (n=83) and then Sonora sucker (n=4), the only other native species found. Five different non-native species were captured in run habitat with mosquito fish being the most abundant species captured (n=420). Red shiner (n=144), channels catfish (n=10), flathead catfish (n=9) and largemouth bass (1) were the other species captured in run habitats. Surprisingly, only two run habitats produced no captures (n=0). The natives desert sucker and loach minnow and the exotic fathead minnow were not captured in run habitats.

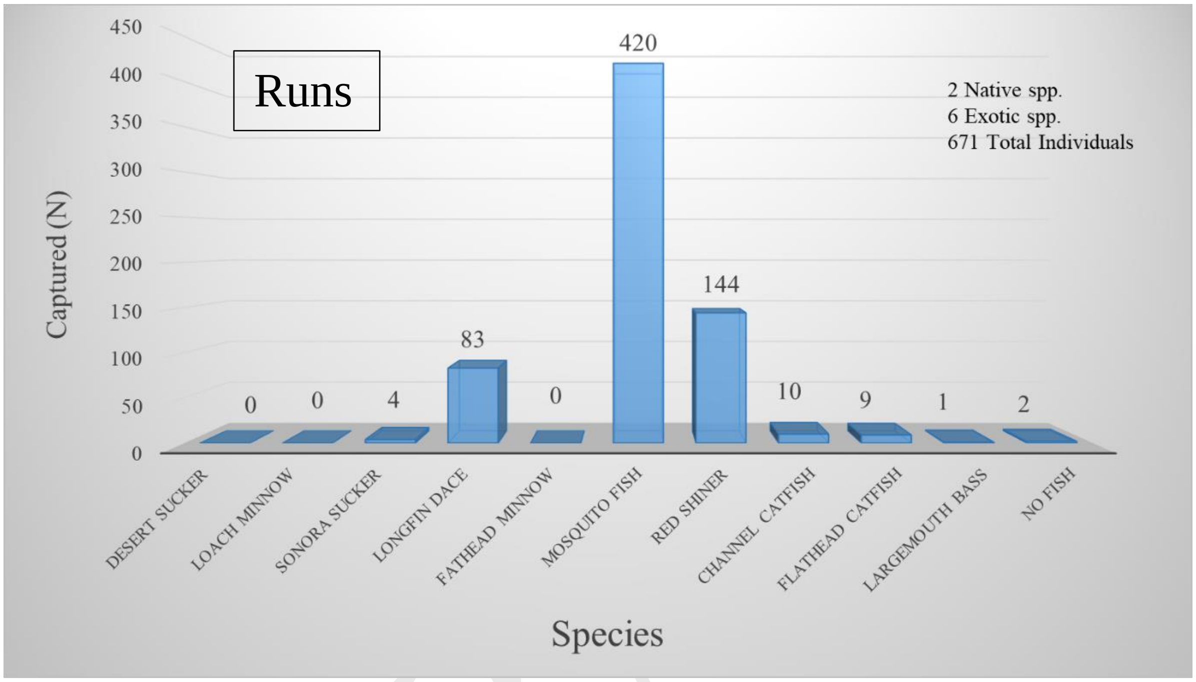


Figure 4 – Individuals captured in Run habitats enumerated by species

Riffles were the most productive mesohabitat among the three type with 706 individuals captured (Figure 5). All four native species captured during the survey were found in riffle habitat. The most abundant native species in riffle habitats was longfin dace (n=144). Sonora sucker (n=7), loach minnow (n=5), and desert sucker (n=4) were the other native fishes captured in riffle habitats. Four non-native species were captured in riffle habitats. Conversely to run habitats, red shiner (n=463) were by far the most abundant species across all taxa. Mosquito fish (n=40), channel catfish (n=33), flathead catfish (n=10) were the other exotic species captured. Only one riffle habitat produced no captures (n=0). The non-native fathead minnow and largemouth bass were not found in this habitat type.

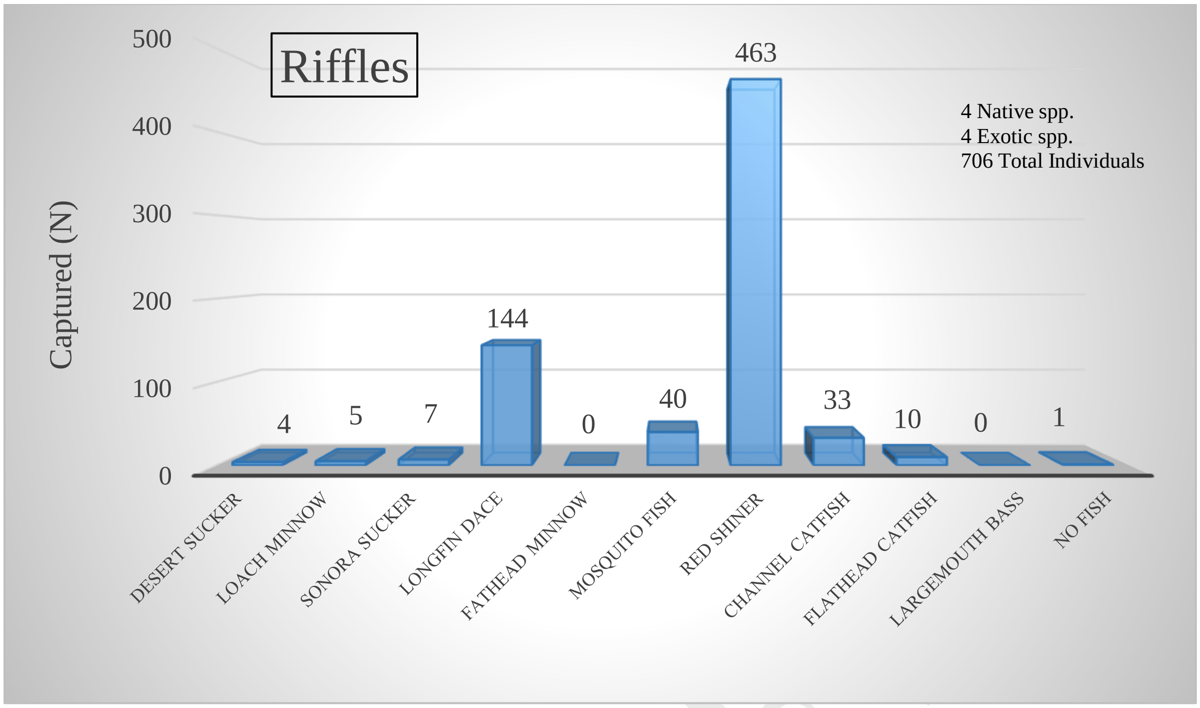


Figure 5 – Individuals captured in Riffle habitats enumerated by species

Pool habitats produced the least total number of captured individuals, as well as, the lowest number of species across all habitat types (n=211; 7 species) (Figure 6). As with run habitats, just two of the four native species were found in pool habitats with longfin dace (n=15) being the most abundant. The only other native species captured in pools was the Sonora sucker (n=1). Desert sucker and loach minnow were not captured in pool habitats. Non-native species captured in pool habitats included fathead minnow (n=3), flathead catfish (n=9), red shiner (n=41), channel catfish (n=68) with mosquito fish being the most prevalent with 74 individuals captured. One pool habitat resulted in no fish captured (n=0). Among non-native species, only largemouth bass was not found in this habitat type.

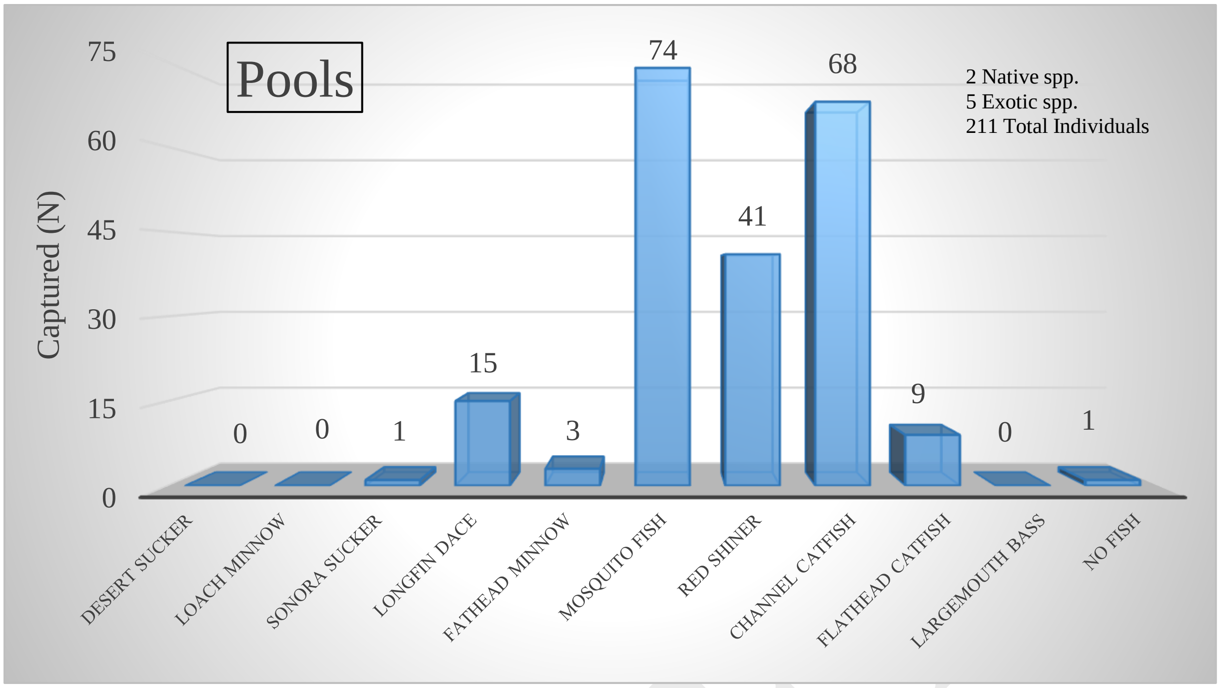


Figure 6 – Individuals captured in Pool habitats enumerated by species

As stated, riffle habitats (n=706) and run habitats (n=671) produced the most individual fishes, but pool habitats (n=211) were comparatively more productive across mesohabitats. Though there were fewer pools overall, compared to either run or riffle habitats, the capture ratio reveals that pools (0.071) produced nearly twice as many individuals as run (0.035) or riffle (0.039) habitats (Figure 7).

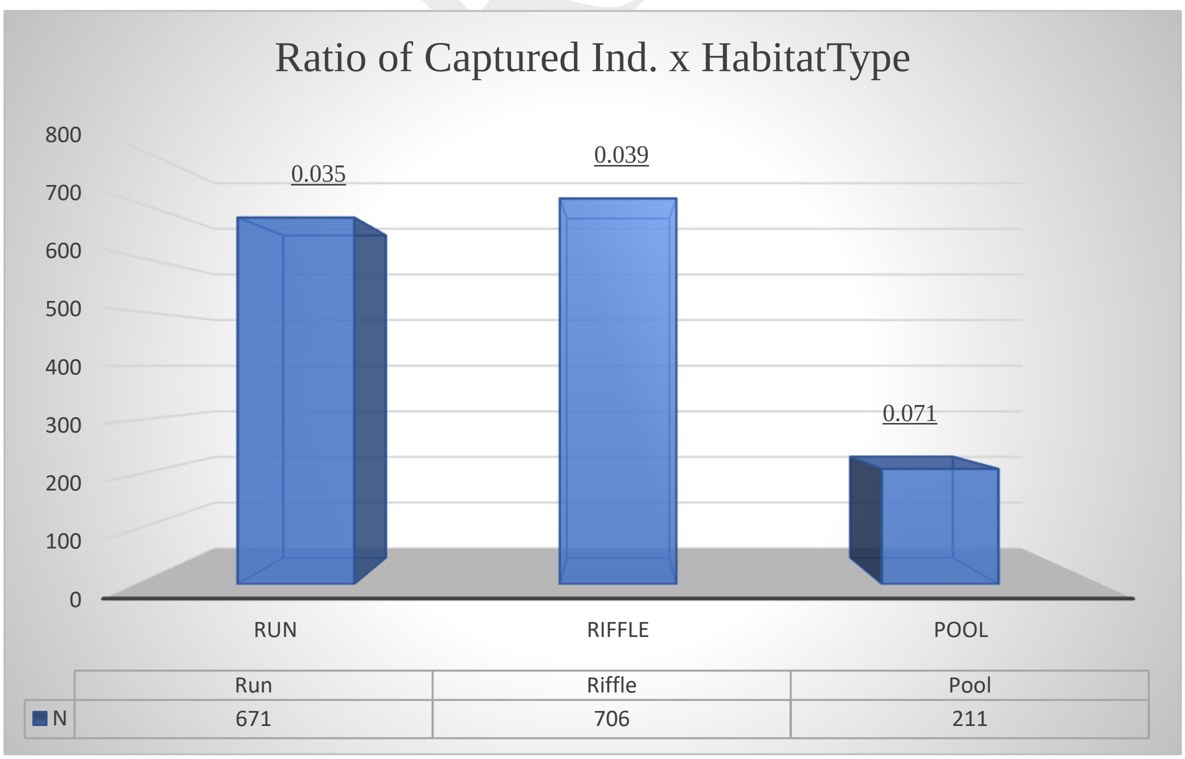


Figure 7 – Total individuals captured in each mesohabitat and the ratio by habitat type

Discussion

The purpose of this project was to ascertain the species composition of the fish community in the Gila River mainstem through the Gila River Lower Box ACEC in southwest New Mexico. Surveys along ca. nine miles of river, were performed with an emphasis placed on three target species - loach minnow, spikedace and Gila chub [sensu Roundtail chub]. Loach minnow was the only target species captured during this survey.

With the exception of a ~150-meter reach that was last sampled in 2007, the current stretch of the Gila River mainstem has not been systematically surveyed prior to this effort.

Though riparian habitat has significantly changed over the last two decades (Figure 8), the complement of native and non-native species has not meaningfully changed since livestock grazing was removed from the lower box in the early 1990s.

Figure 8 - Nichol's Canyon area looking upstream. Photo on the left shows the area in 1995, prior to livestock exclusion. Phot on the right shows the changes in riparian vegetation 20 years after cattle exclusion.

In fact, Propst and Stefferud (2011) found the same nine species we did with the exception that their surveys captured spikedace (1999), yellow bullhead (*Ameiurus natalis*) (1997) and common carp (*Cyprinus carpio*) (1998), whereas we did not collect any of these species. Conversely, we captured largemouth bass, which they did not. However, it should be noted that their surveys in the lower box centered on only one location at Fisherman's Point (~ 5 miles upstream of Sunset Dam), verses our ~9-mile survey of the entire stretch of the Lower Box. Even so, with significantly more stream miles sampled in this effort, for the most part, the same series of species were encountered.

One notable change was the increase in loach minnow captures in which they found just 2 individuals across all years sampled (~12 years), whereas we captured 5 individuals in just a single survey. However, we did sample far more suitable habitats (n=28) in 2019 than they did during their surveys. Unfortunately, data on the number of riffle habitats they sampled during their survey efforts are not available at this time so that a proportional comparison could be made. Further, this small difference could simply be due to dramatic habitat changes over the years at their site as riparian vegetation created a deeper, narrower stream with generally higher velocities and less riffle habitat (Propst and Stefferud 2011).

Another species notably absent from all known surveys in the Lower Box is speckled dace (*Rhinichthys osculus*). They have been documented in many tributaries to the Gila River including Blue Creek in recent surveys, but have not been captured in the mainstem in recent times. Data from spring 2000 surveys by Rinne (2000) revealed that speckled dace were captured upstream (Redrock) and downstream (Sunset Dam) of our site, but were unable to detect any speckled dace in their Nicol's Canyon site. In conjunction with the target species of this program, future survey efforts should also focus on speckled dace and attempt to discern the reasons for the absence and possible decline of this species in the Gila River mainstem in this area.

Though long-term declines in native fishes in the Gila River basin has occurred over the last 100 years, this survey effort does show a somewhat stable native fish fauna over the last several years, at least in Lower Box area. However, non-native species are well established and have increased (Figure 9) in the last several decades (Propst 2011; Rinne 2000). Exotic species continue to create an existential threat to native fish fauna in the Gila River basin. Future monitoring is suggested to detect possible changes across the area due to a varying climate and the associated warming that is occurring globally. Factors related to the changing climate such as decreased available water – both on the surface and below ground – are certain to influence the aquatic fauna in the Gila River Lower Box, including the targeted native fish species.

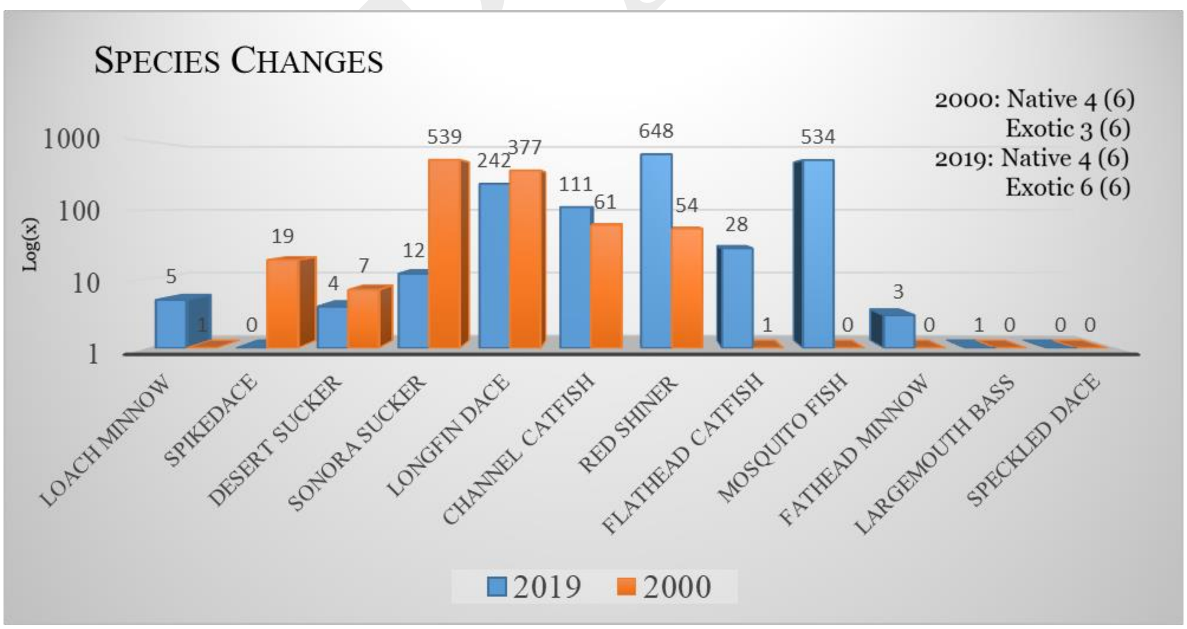


Figure 9 – Comparison of fishes collected by Rinne (2000) and this survey effort in the Gila River Lower Box area.

References

Page, L. M. (Chair), C. C. Baldwin, H. Espinosa-Pérez, C. R. Gilbert, K. E. Hartel, R. N. Lea, N. E. Mandrak, J. J. Schmitter-Soto, and H. J. Walker, 2016. Final report of the AFS/ASIH Joint Committee on the Names of Fishes on the taxonomy of Gila in the Lower Colorado River basin of Arizona and New Mexico to the Arizona Game and Fish Department, Wildlife Management Division, Phoenix, Arizona 85086. 1 September 2016.

Propst, David L. and Jerome A. Stefferud, 2011. Monitoring Gila River Fish Assemblages on US Bureau of Land Management Administered Lands. Report submitted to DOI-BLM, Las Cruces District Office, Las Cruces, New Mexico.

Propst, D. L., 2020. Monitoring Gila River Fish Assemblages on or near US Bureau of Land Management Administered Lands. Report submitted to DOI-BLM, Las Cruces District Office, Las Cruces, New Mexico.

Rinne, J. 2000. Summary data obtain from the author.

Appendix 1

Monitoring Gila River Fish Assemblages on or near US Bureau of Land Management Administered Lands

Submitted to

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INTRODUCTION

The Gila River drainage of southwest New Mexico historically supported at least 12 and perhaps 14 native fishes (Sublette et al. 1990, Propst 1999, Turner et al. 2019). Of these, six (Gila chub *Gila intermedia*, headwater chub *Gila nigra*, spikedace *Meda fulgida*, loach minnow *Tiaroga cobitis*, and Gila trout *Oncorhynchus gilae*) are endemic to the Gila River basin, three (roundtail chub *Gila* robusta, Sonora sucker *Catostomus insignis*, and desert sucker *Pantosteus clarkii*) are limited to the Colorado River basin, and two (longfin dace *Agosia chrysogaster* and Gila topminnow *Poeciliopsis occidentalis*) occur in the Colorado River and Rio Yaqui basins. Rio Grande sucker *Pantosteus plebeiuis*, recently documented as native to the upper Gila River drainage (Turner et al. 2019), also is native to the Rio Grande and Guzman basins. Speckled dace *Rhinichthys osculus*, in addition to the Gila River basin, occurs in most drainages west of the Continental Divide and north of Mexico (Minckley and Marsh 2009). Colorado pikeminnow *Ptychocheilus lucius* and razorback sucker *Xyrauchen texanus* were likely historical, but undocumented, inhabitants of the Gila River in New Mexico (LaBounty and Minckley 1972).

Since the late 1800s, numerous human-mediated activities have adversely affected native fishes and their habitats in the Gila River drainage (Miller 1961, Minckley and Douglas 1991, Minckley and Marsh 2009). Intentional and accidental introduction of nonnative fishes, crustaceans, and amphibians have posed additional challenges to native fish persistence (Douglas et al. 1994, Bryan et al. 2002, Minckley and Marsh 2009, Hedden et al. 2016). At least 17 nonnative fishes have been documented in the Gila River drainage within New Mexico (Propst et al. 2008). Recent mega wildfires (i.e., Miller Fire in 2011, Whitewater-Baldy Fire in 2012, and Silver Fire in 2013) have negatively impacted native fishes (Whitney et al. 2015a, Whitney et al. 2015b, Gido et al. 2019). In addition to these threats, global warming will reduce both aquatic habitat quantity and quality (Cook et al. 2015), making persistence of native fish assemblages in the Gila River drainage increasingly uncertain.

Monitoring of fish assemblages at sites within or near US Bureau of Land Management administered lands was undertaken to document changes, or lack, in abundance of native and nonnative species, to characterize habitat associations of each species, and to provide resource managers information for making management decisions. Information collected in a systematic manner over time will provide insights on response of fish assemblages to natural and human-induced disturbance and long-term population trends.

METHODS

Annual sampling to document status and trends of native and nonnative fishes at USBLM study sites occurred in October each year (Figure 1). Fish were collected by mesohabitat (i.e., backwater, pool, shoal, run, and riffle), which were sampled in rough proportion to their availability within a site, and relevant data were recorded by mesohabitat. Mesohabitats were visually identified by water depth and velocity (Table 1). Depending upon mesohabitat, specimens were obtained with a drag seine (3.05 x 1.8 m, 0.3 cm mesh), stunned with a battery-powered backpack electro-fisher and collected with a dipnet, or seine and electrofisher in combination. All captured fishes were identified and enumerated, with mass (g) and length (mm, total [TL] and standard [SL]) determined for all large-bodied native and nonnative fishes ≥75 mm TL. Specimens ≤70 mm TL were typically enumerated, but since 2017 total lengths were obtained on specimens collected, regardless of size. All native fishes were returned alive to mesohabitat of capture. Fish density was calculated as number individuals captured per total area sampled (#/m^2) at a site. Linear regression was used to assess the relationship between autumn species density and selected flow attributes for native fishes at Cherokee Canyon. Length-frequency histograms of commonly collected native fishes at Cherokee Canyon were constructed. For small-bodied species (i.e., longfin dace and loach minnow), individuals were tallied in 2-mm increments (e.g., 30-31, 32-33, and 34-35) while large-bodied species (i.e., Sonora sucker and desert sucker) were tallied in 20-mm increments (e.g., 51-70 [60], 71-90 [80], and 91-110 [100]).

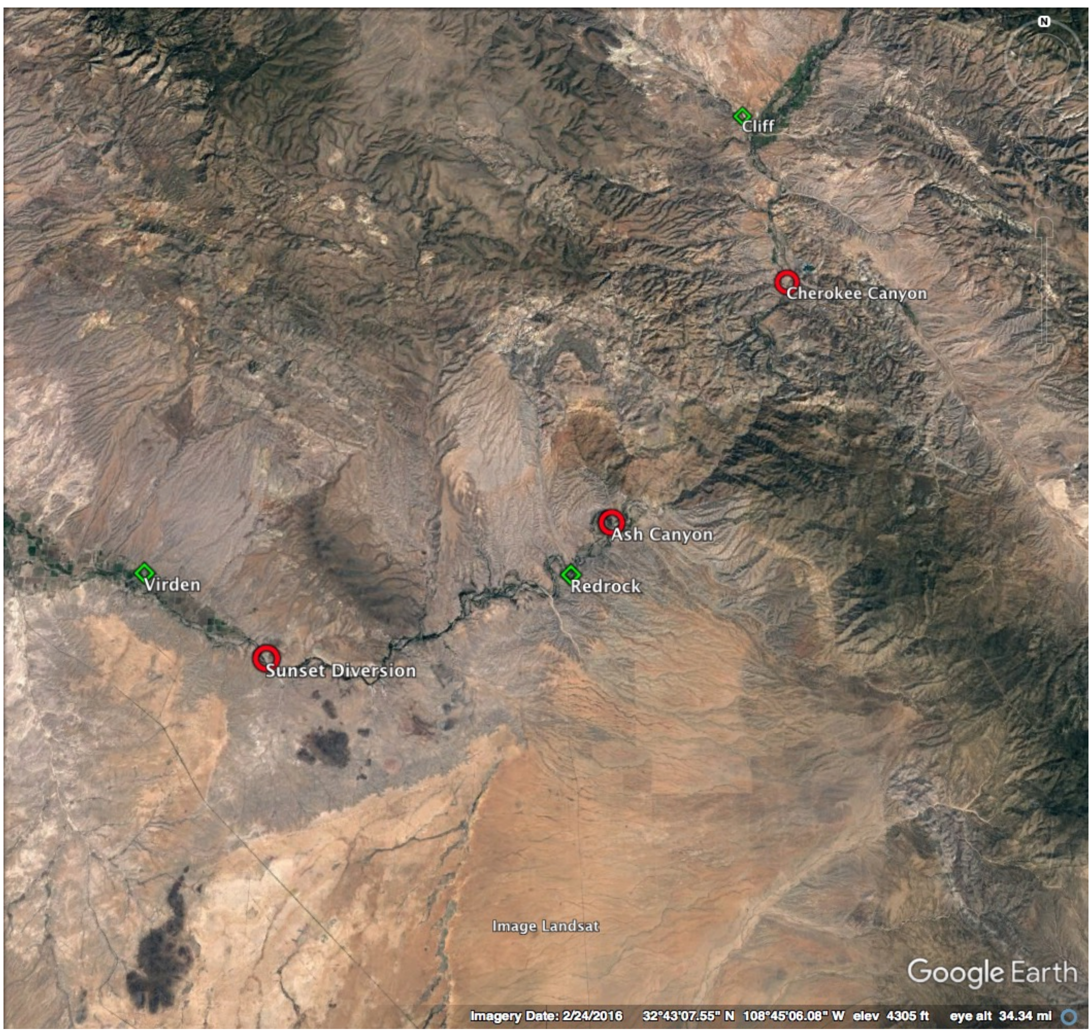

Figure 1. Location of US BLM Gila River study sites, Grant and Hidalgo counties, New Mexico.

Table 1. Physical attributes of Gila River, New Mexico aquatic mesohabitats.

Habitat	Water Velocity (m/s)	Depth (m)
Backwater/embayment (very slow-variable)	≤0.10	0.01-0.50
Pool (slow-deep)	0.10-0.30	≥0.30
Shoal (slow-shallow)	0.15-0.30	≤0.30
Run (moderate velocity & depth)	0.25-0.50	0.25-0.50
Riffle (rapid velocity-moderate depth)	≥0.40	≤0.40

The portion of each mesohabitat sampled was demarked with surveyor flags. Following specimen collection, sampled surface area of each mesohabitat, mean depth, and mean water velocity were determined, and predominant substrate visually estimated. Water quality parameters (temperature [°C], dissolved oxygen [mg/L], specific conductance [µS/cm], conductivity [µS/cm], salinity [0/00]) were measured at each site. Stream discharge was measured at each site. Because discharge was too elevated in early October 2016 at the Sunset Diversion site to allow efficient or safe sampling, data from late October 2016 sampling for another study at the site were used for this report.

RESULTS

Cherokee Canyon

When sampling began at this location in 2009, five native and four nonnative fishes were present (Table 2). Since then two additional nonnative fishes and one crustacean (northern crayfish *Orconectes virilis*) have been documented. In the 11 years of sampling, the fish assemblage at the site has experienced several moderate-to-high flow events, years with no discernable spring snowmelt runoff, and wildfire-produced ash and sediment flows. Following the 2012 Whitewater-Baldy Fire and monsoon floods in 2013, longfin dace was the only native fish present in October 2013, and it was rare. By October 2014, all native fishes present prior to wildfire and flood, except spikedace, were again present. Spikedace was not collected at the site until 2017. Stream discharge at time of sampling in 2013, 2014, 2015, 2016, and 2018 was comparatively high (Table 3), and this likely diminished sampling efficiency. Despite major disturbances in 2012, 2013, and 2014, native fishes were more common than nonnative fishes in all years, except 2018, since sampling began at Cherokee Canyon in 2009 (Figure 2). Spikedace was not collected in 2018, but red shiner, a nonnative, was collected. Nonnative western mosquitofish was the most common species and its numbers contributed to nonnative density exceeding that of natives in 2018. In contrast, native fishes substantially outnumbered nonnatives in 2019, and spikedace was moderately common.

Table 2. Density (#/m^2 sampled) of fishes and crustaceans collected at the Gila River Cherokee Canyon site, Grant County, New Mexico, 2009 – 2019. Prior to 2014, northern crayfish numbers were not recorded.

	Year										
Species	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**
Native											
Longfin dace	0.1395	0.5603	0.0457	0.0996	0.0204	0.1403	0.4216	0.6041	0.1940	0.0392	0.2483
Spikedace	0.0491	0.9515	0.0191	0	0	0	0	0	0.0378	0	0.0910
Loach minnow	0.1136	0.7083	0.1638	0.0285	0	0.0614	0.0083	0.0507	0.0416	0.0436	0.3028
Sonora sucker	0.0465	0.3418	0.0038	0.0976	0	0.0029	0.0125	0.0042	0.0176	0.0174	0.5255
Desert sucker	0.0207	0.4194	0.0191	0.0163	0	0.0058	0.1225	0.0591	0.0739	0.0348	0.4635
Total Native	0.3694	2.9813	0.2515	0.2420	0.0204	0.2104	0.5649	0.7182	0.3649	0.1350	1.7160
Nonnative											
Red shiner	0	0	0	0	0	0	0	0	0	0.0174	0.0372
Common carp	0	0	0	0	0	0	0	0	0.0009	0	0.0207
Fathead minnow	0.0026	0	0	0	0	0.0029	0	0	0	0.0131	0.0207
Yellow bullhead	0	0.0035	0	0	0	0	0	0	0	0	0
channel catfish	0	0	0	0	0	0	0	0	0.0009	0	0.0041
Flathead catfish	0	0	0.0038	0.0061	0	0.0029	0.0062	0	0.0009	0	0
Western mosquitofish	0.0026	0	0.1334	0.1016	0.0025	0	0.0021	0.1479	0.0009	0.1960	0.0207
Northern crayfish	-	-	-	-	-	0.0029	0.0021	0	0.0028	0	0.0041
Total Nonnative	0.0052	0.0035	0.1372	0.1077	0.0025	0.0087	0.0104	0.1479	0.0064	0.2265	0.1089
Area Sampled (m^2)	357.2	283.8	262.4	491.95	392.6	342.2	481.5	236.7	1082.4	229.6	241.7

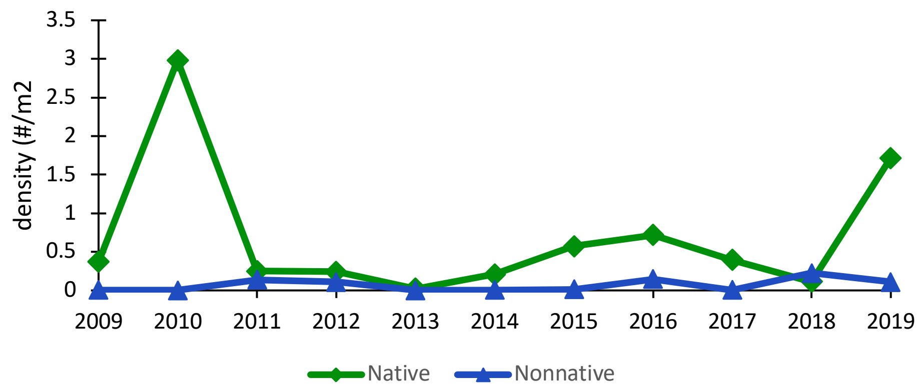

Figure 2. Density of native and nonnative fishes at Cherokee Canyon site, Grant County, New Mexico, 2009-2019.

Among mesohabitats, backwaters and embayments were the least common and shoal (slow velocity, shallow) or riffle (rapid velocity, shallow) was typically the most common (Figure 3). Pools (slow velocity, deep) were always present, except in 2016, and runs (moderate velocity, moderate depth) were present all years but one. Elevated flows at time of sampling and channel realignment contributed to low habitat diversity in 2016. In 2018, area of each mesohabitat, except backwater/embayment, was roughly equal (Figure 3). Proportion of each mesohabitat in 2019 was roughly comparable to that in 2018.

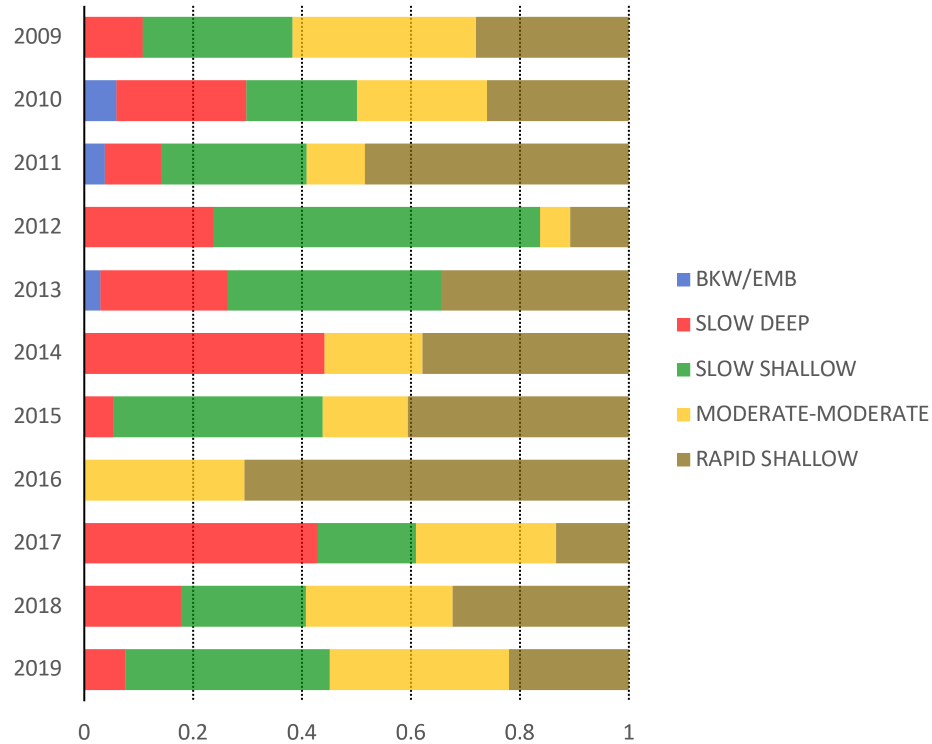

Figure 3. Proportion of each mesohabitat sampled at Gila River Cherokee Canyon Site, Grant County, New Mexico, 2009-2019.

Table 3. Physicochemical properties of Gila River at Cherokee Canyon site, Grant County, New Mexico, 2009-2019.

Year	Water Temp (°C)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	Salinity 0/00	Discharge (ft^3/s)
2009	18.6	8.9	375	427	0.2	39
2010	21.3	8.2	356	383	0.2	64
2011	21.1	9.3	375	405	0.2	62
2012	22.2	10.0	418	444	0.2	26
2013	20.7	8.5	331	360		116
2014	19.4	7.3	272	303	0.1	175
2015	15.8		250			232
2016						
2017	21.3	6.5	208	293		35
2018	16.6	8.2	267	318	0.15	
2019	11.8	8.8	312	416	0.20	27

Among native fishes, longfin dace was the least selective for a specific mesohabitat, with its occurrence in each roughly equal to the proportion of each mesohabitat present (Figure 4). Spikedace was most common in shoals, but also favored run habitats. Loach minnow was the most habitat specific native fish, being found almost exclusively in riffle habitats Although found in all mesohabitats, Sonora sucker tended to be more common in pool habitats and avoided shoals and riffles. Desert sucker was most common in riffles.

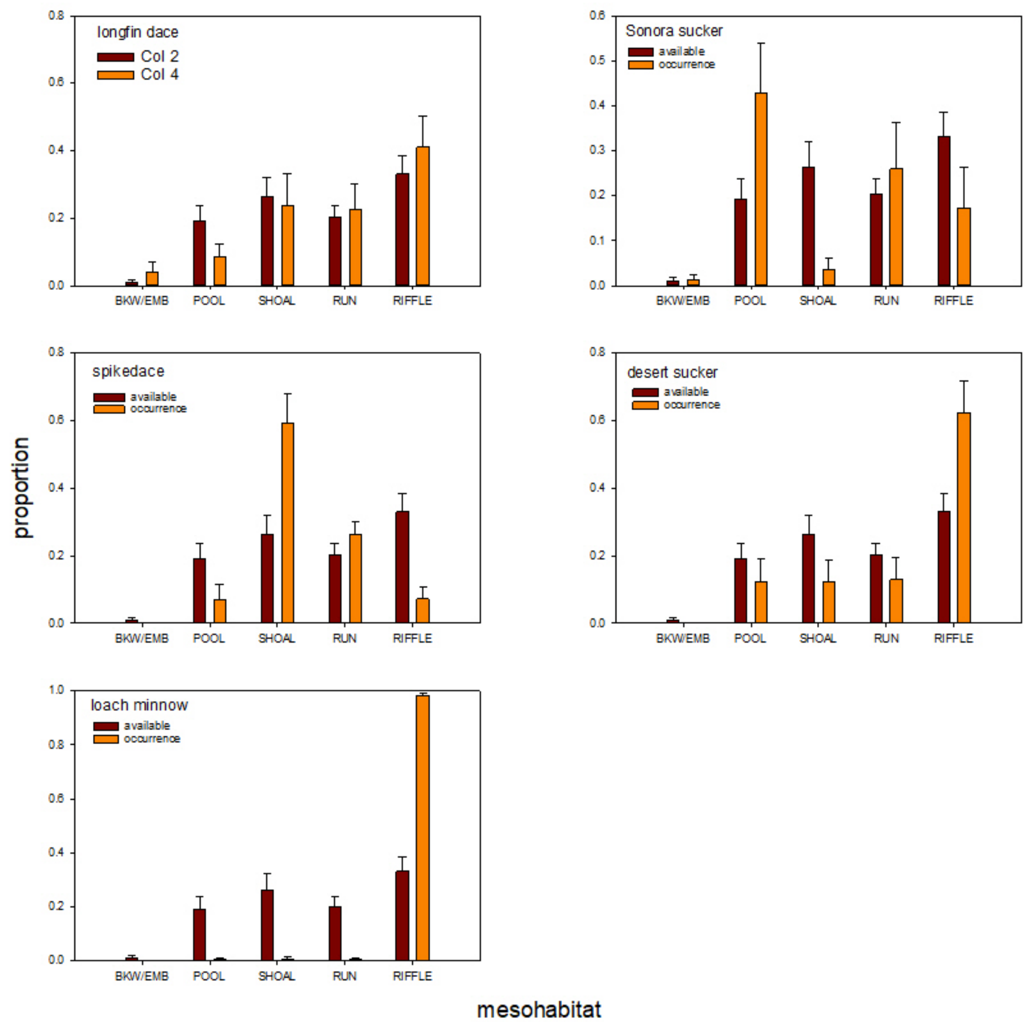

Figure 4. Occurrence (mean proportion) of longfin dace by mesohabitat in Gila River at Cherokee Canyon site (2009-2019) and mean proportion of each mesohabitat sampled at the site. Vertical lines = standard error.

Native fishes demonstrated variable responses to several flow regime attributes. Longfin dace autumn density was not significantly related to any flow attribute considered (Figure 5). Loach minnow autumn density was significantly related to minimum summer flow (P = 0.006) and marginally related to spring mean daily discharge (P = 0.080; Figure 6). Sonora sucker density was not related to any flow attribute (Figure 7), but that of desert sucker was related to spring mean daily discharge and minimum summer flow (P = 0.034 and 0.048, respectively; Figure 8). Spikedace was not collected in a sufficient number of years for statistically valid comparisons. If 2016 minimum flow datum and 2013 and 2017 mean annual daily discharge data are removed longfin dace density was significantly related to these two attributes (P <0.001 and P = 0.044, respectively). In 2016, autumn density of longfin dace was the highest (0.6041 individuals/m^2) for the sampling period and summer minimum flows were low for an extended period, perhaps enabling an extended spawning season and increased survival of age-0 individuals. Otherwise, there was nothing extraordinary about 2016 flows. Autumn densities of longfin dace, loach minnow, Sonora sucker, and desert sucker were outliers in 2013 and 2017. The likely explanation for low abundances of each species in these years was the monsoon flood in 2013 (second largest flood of record), about 3 weeks before autumn sampling, and two brief but large flow events (>7000 cfs) in spring 2017.

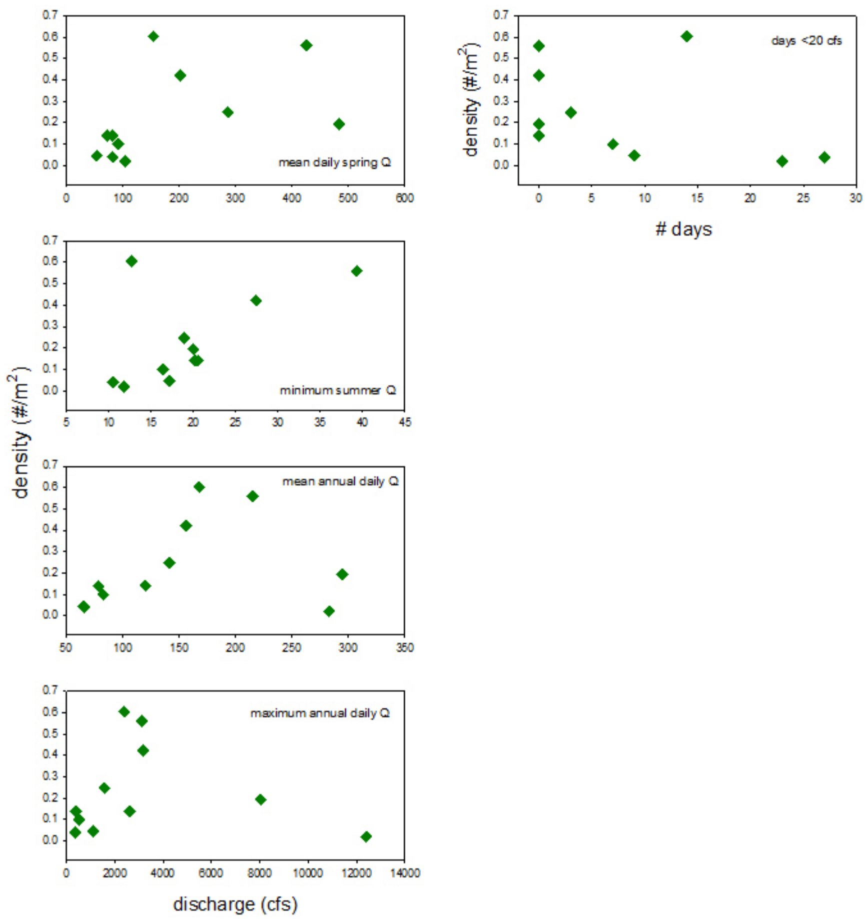

Figure 5. Relationship of longfin dace autumn density at Cherokee Canyon site with selected flow attributes.

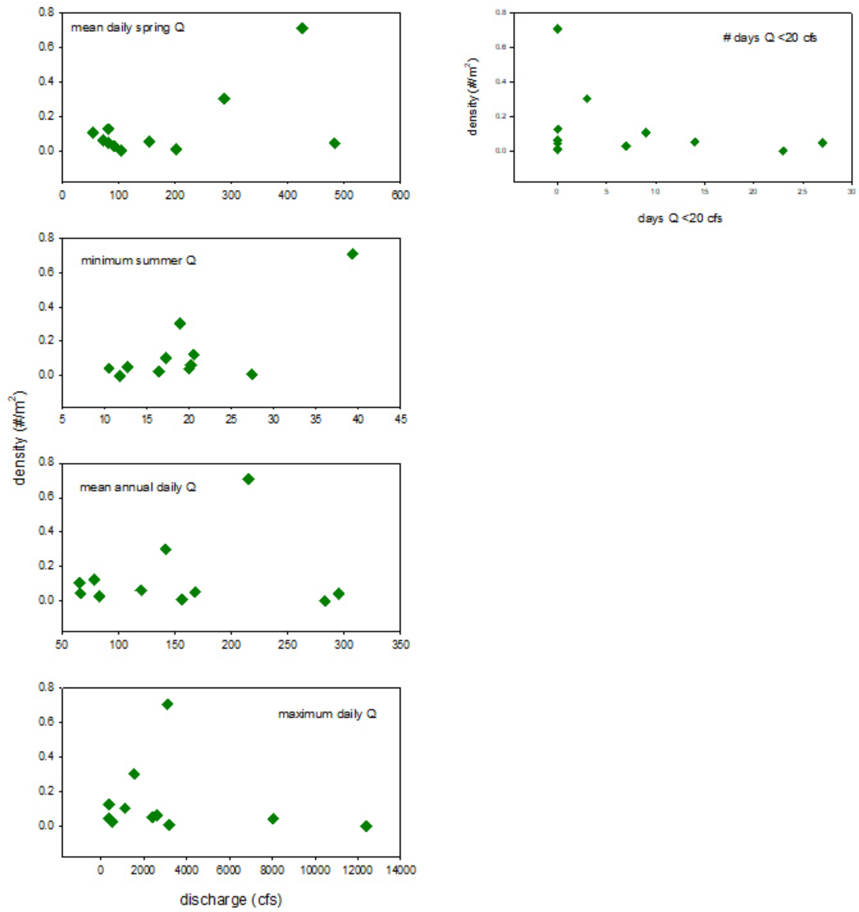

Figure 6. Relationship of loach minnow autumn density at Cherokee Canyon site with selected flow attributes.

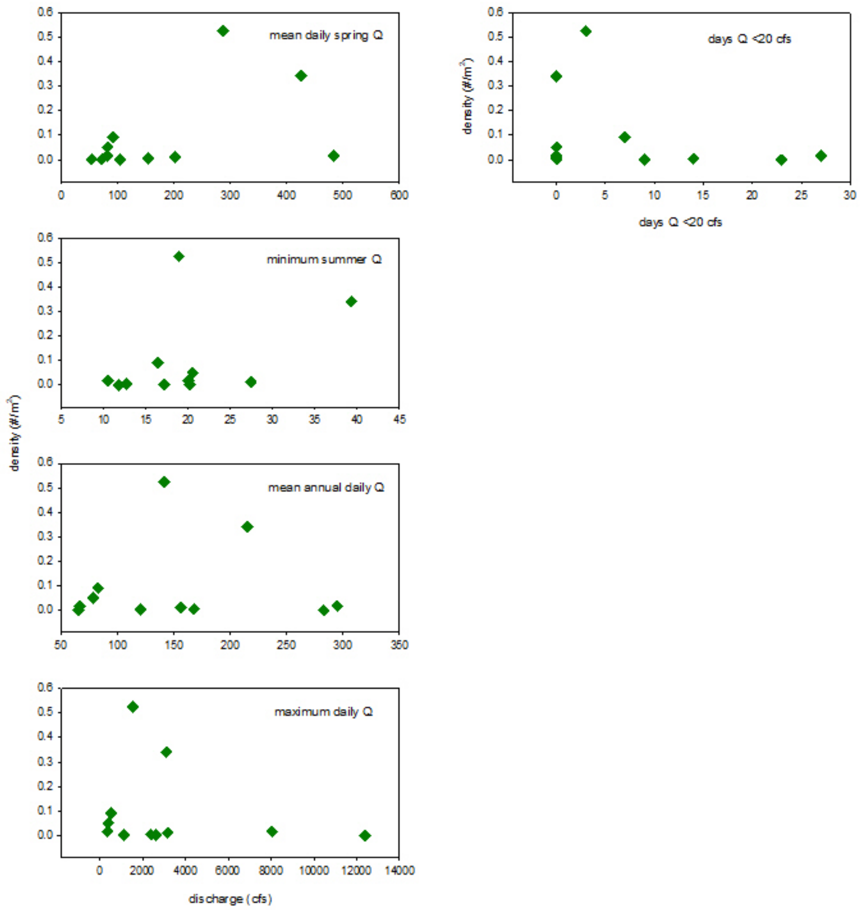

Figure 7. Relationship of Sonora sucker autumn density at Cherokee Canyon site with selected flow attributes.

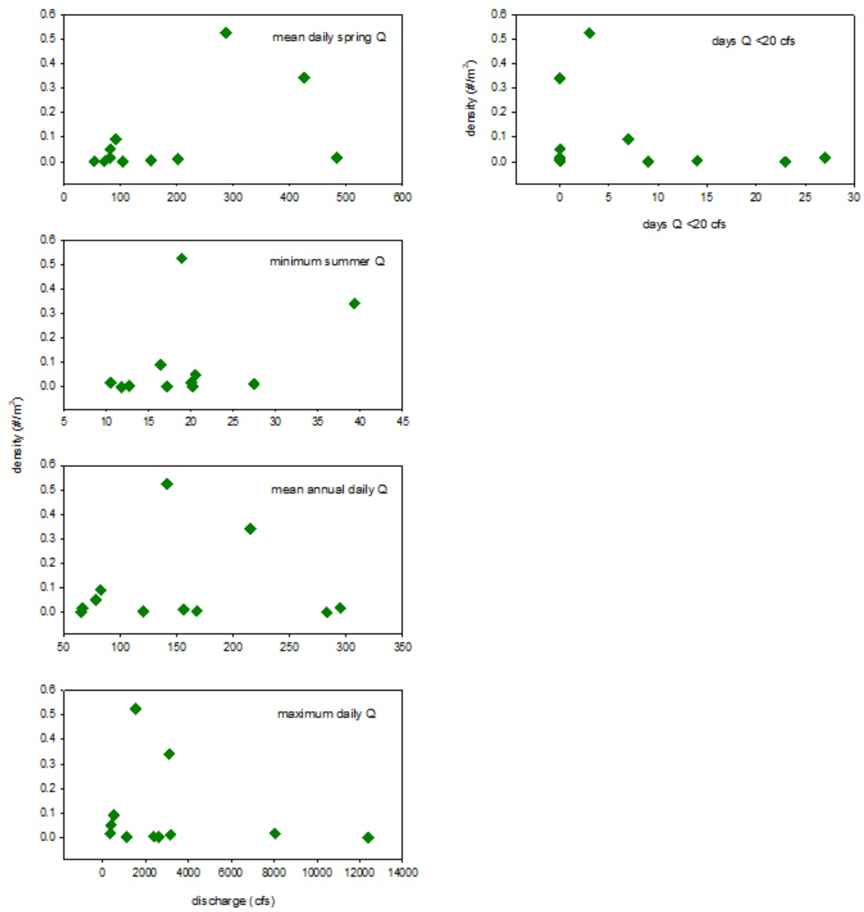

Figure 8. Relationship of desert sucker autumn density at Cherokee Canyon site and selected flow attributes.

Length frequency of longfin dace was variable across 2017 through 2019, with two distinct length classes in 2017, a cluster of a few comparatively large individuals in 2018, and a broad range of lengths in 2019 but no small individuals (Figure 9). Lengths of loach minnow were likewise variable across 2017-2019 (Figure 10); in 2017 and 2019 individuals ≤40 mm TL were likely spawned in year of collection (= age 0). Based on size range, age-1 and -2 loach minnow were collected in all years. Small (≤90 mm TL, likely age 0) Sonora sucker were captured in all years at Cherokee Canyon (Figure 11), except 2013 when no Sonora sucker was collected and 2014 when a single 124 mm specimen was captured. Few large adult Sonora suckers were collected at the Cherokee Canyon site. Desert sucker occurred at Cherokee Canyon site mainly as individuals ≤130 mm (Figure 12); larger individuals were rarely collected.

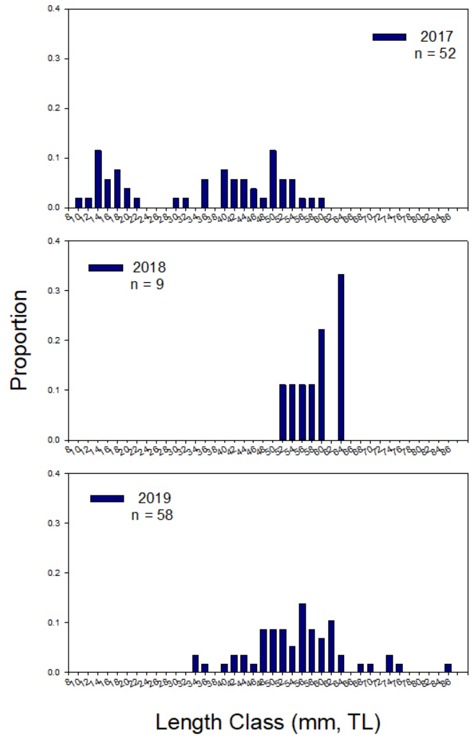

Figure 9. Length frequency of longfin dace at Cherokee Canyon site, 2017-2019.

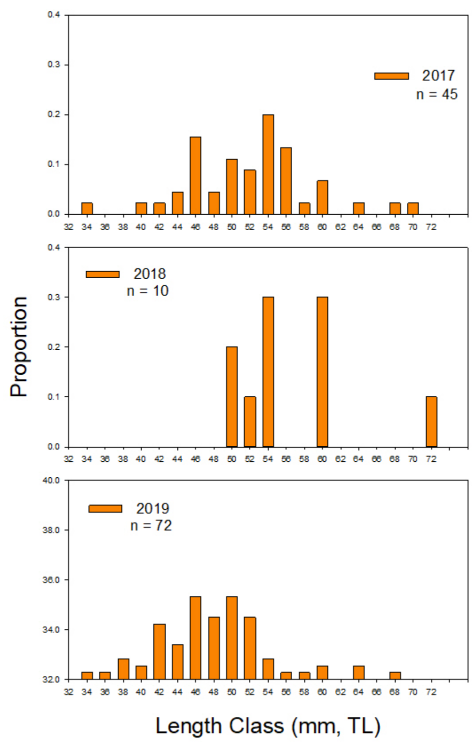

Figure 10. Length frequency of loach minnow at Cherokee Canyon site, 2017-2019.

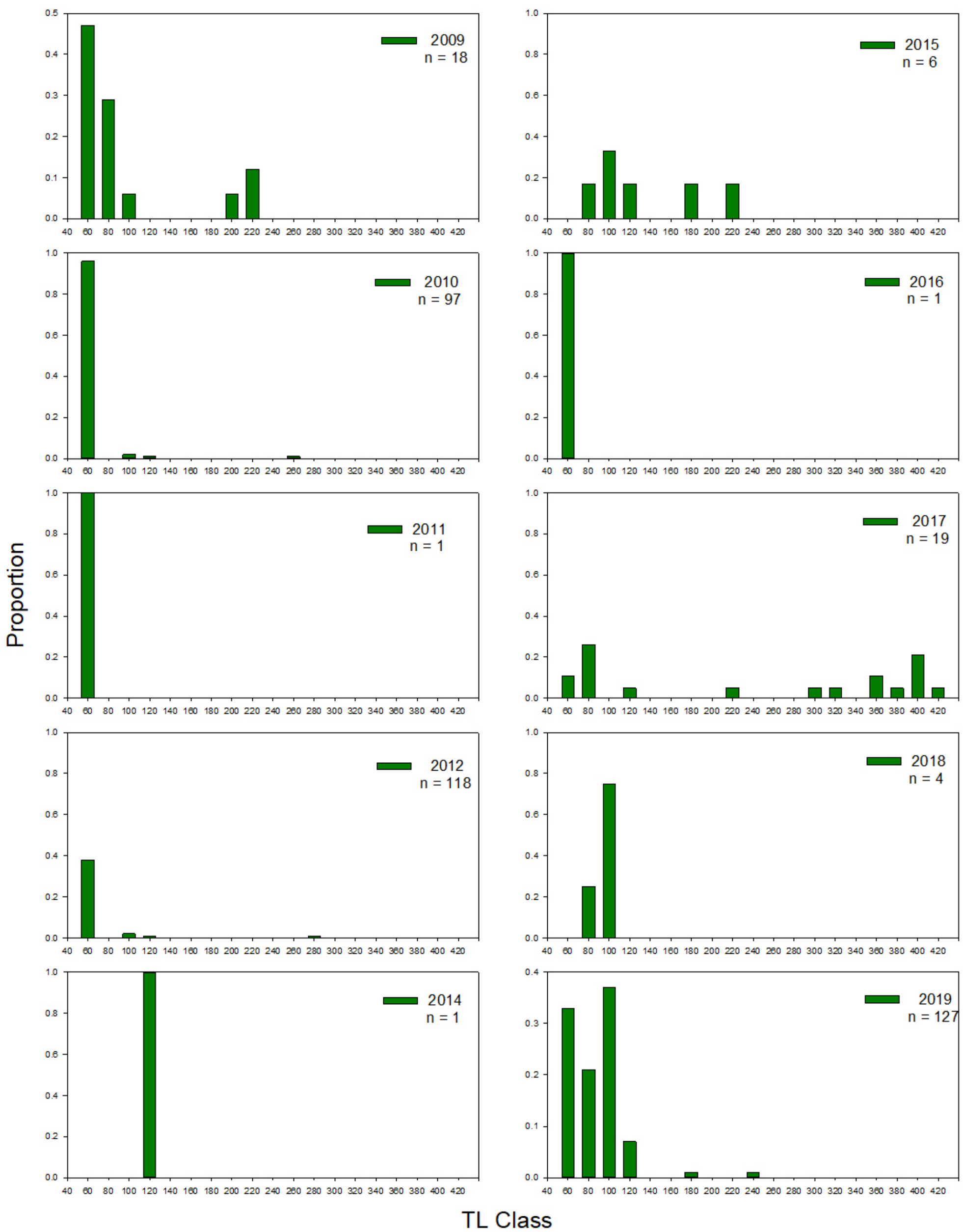

Figure 11. Length frequency of Sonora sucker at Cherokee Canyon site, 2009-2019. No Sonora sucker was collected in 2013.

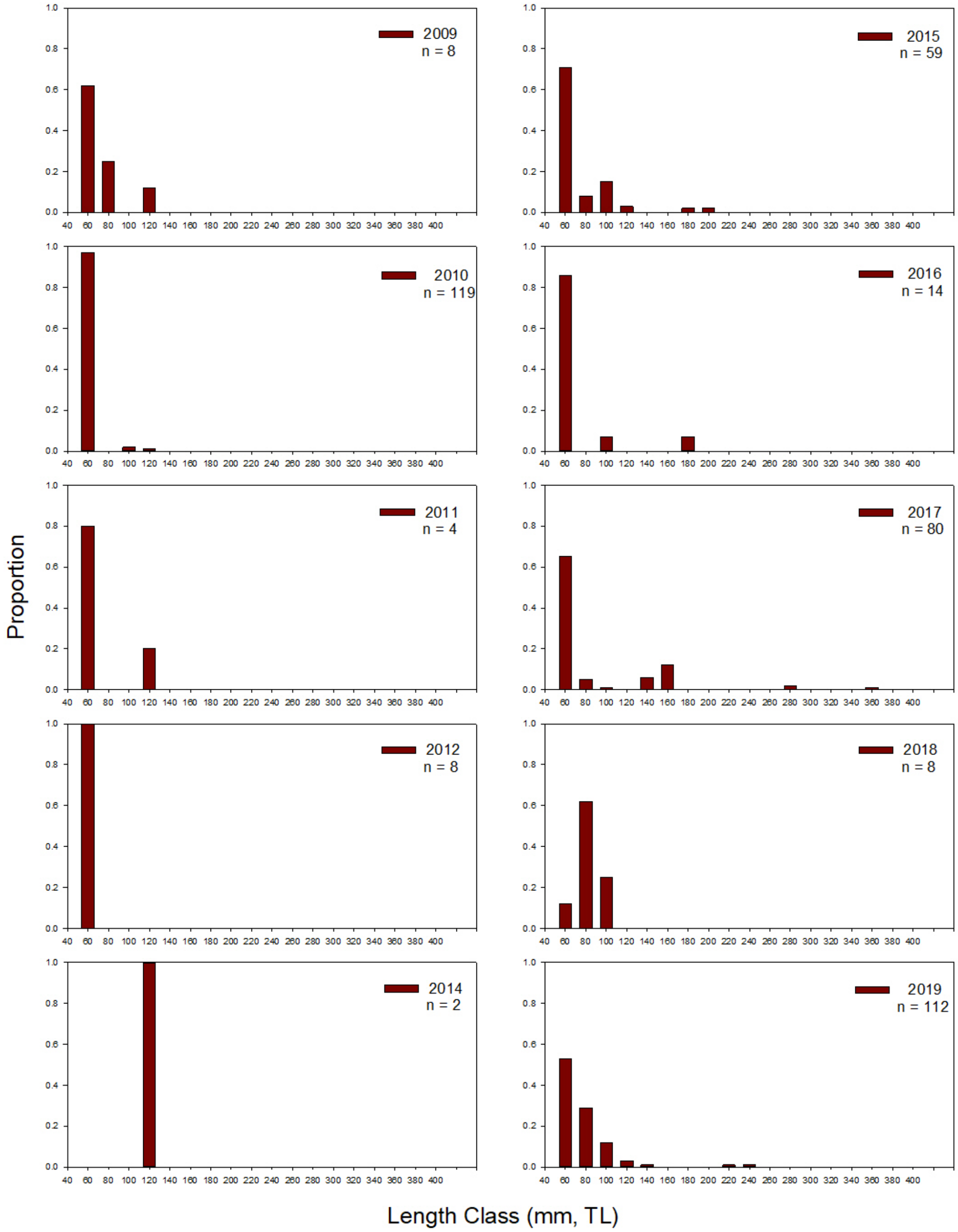

Figure 12. Length-frequency of desert sucker at Cherokee Canyon site, 2009-2019. No desert sucker was captured in 2013.

ASH CANYON

When sampled in 2019, discharge at the Ash Canyon site was low and water temperature was comparatively high (Table 4). Longfin dace was moderately common and loach minnow was more common than in any previous collection. Both sucker species were collected and desert sucker was moderately common (Table 5). Only three nonnative species were collected; red shiner was the most common. Only a single ictalurid, channel catfish, was collected in 2019. Since sampling began at Ash Canyon in 2012, native fish density has been greater than nonnative in all but three years (2012, 2013, and 2016; Figure 13). Loach minnow has been collected in all years and longfin dace and desert sucker in all but one (2012 and 2018, respectively). Red shiner was collected in all years and channel catfish was absent only in 2018.

Table 4. Physicochemical properties of Gila River at Ash Canyon site, Grant County, New Mexico, 2012-2018.

Year	Water Temp (C°)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	Salinity (‰)	pH	Discharge (ft^3/sec)
2012	12.3	9.8	347	459	0.2		13.7
2013	18.6		329	375		8.1	128.0
2014	20.0		300	332	0.2	7.3	160.4
2015	17.2		250				309.3
2016	17.9	8.3		341		8.2	214.2
2017	17.1	7.3	283	372		8.9	28.4
2018	14.9	8.4	264	327	0.2	9.0	122.6
2019	19.2	8.1	392	440	0.2		20.29

Table 5. Density (#/m^2 sampled) of fishes and amphibians collected at the Gila River Ash Canyon site, Grant County, New Mexico, 2012-2018.

	Year							
Species	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Native								
longfin dace	0	0.0111	0.1377	0.3121	0.2369	0.0340	0.3038	0.1095
loach minnow	0.0146	0.0111	0.0103	0.0080	0.0137	0.0043	0.0096	0.0231
Sonora sucker	0	0	0.0019	0.0064	0.0023	0	0	0.0046
desert sucker	0.0122	0	0.0150	0.0656	0.1458	0.0043	0	0.0971
Total Native	0.0268	0.0222	0.1649	0.3921	0.3986	0.0427	0.3134	0.2344
Nonnative								
red shiner	0.0316	0.2108	0.0056	0.0032	0.8041	0.0051	0.1254	0.0324
common carp	0.0097	0	0.0019	0	0	0.0007	0	0
fathead minnow	0.0049	0.1054	0	0	0.0979	0	0.0145	0
channel catfish	0.0511	0.0055	0.0094	0.0208	0.0319	0.0043	0	0.0015
flathead catfish	0.0195	0	0.0019	0	0.0046	0.0007	0	0
western mosquitofish	0	0.0444	0	0	0.0159	0	0.0530	0.0200
American bullfrog	0.0024	0	0	0	0	0	0	0
Total Nonnative	0.1192	0.3661	0.0188	0.0240	0.9544	0.0109	0.01447	0.0540
Area Sampled (m^2)	410.9	180.3	1067.7	624.7	439.0	2764	207.4	648.5

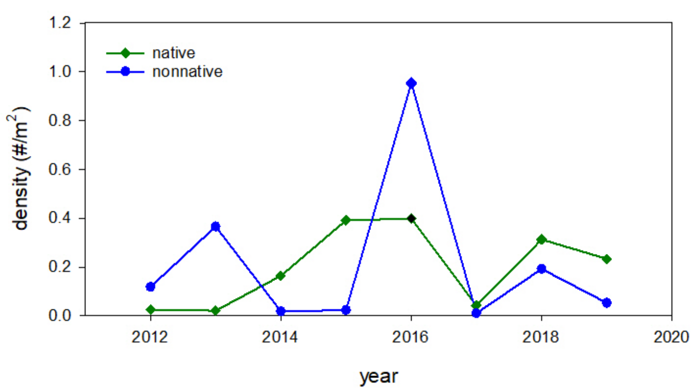

Figure 13. Density of native and nonnative fishes at Ash Canyon site, Grant County, New Mexico, 2012-2019.

Since sampling began at Ash Canyon in 2012, run and riffle mesohabitats have usually been the most common at the site. In 2019, run and riffle habitats comprised more than three-fourths of that sampled, no backwaters or embayments were present and pools were a fraction of habitat available (Figure 14). Longfin dace habitat occurrence roughly tracked with that of habitat sampled, except that it tended to not occur in riffles (Figure 15). Loach minnow was found almost exclusively in riffle habitat. Desert sucker was also most common in riffle habitat but was found in low numbers in other habitats. Red shiner, a nonnative, was similar to longfin dace in its occurrence in all habitats.

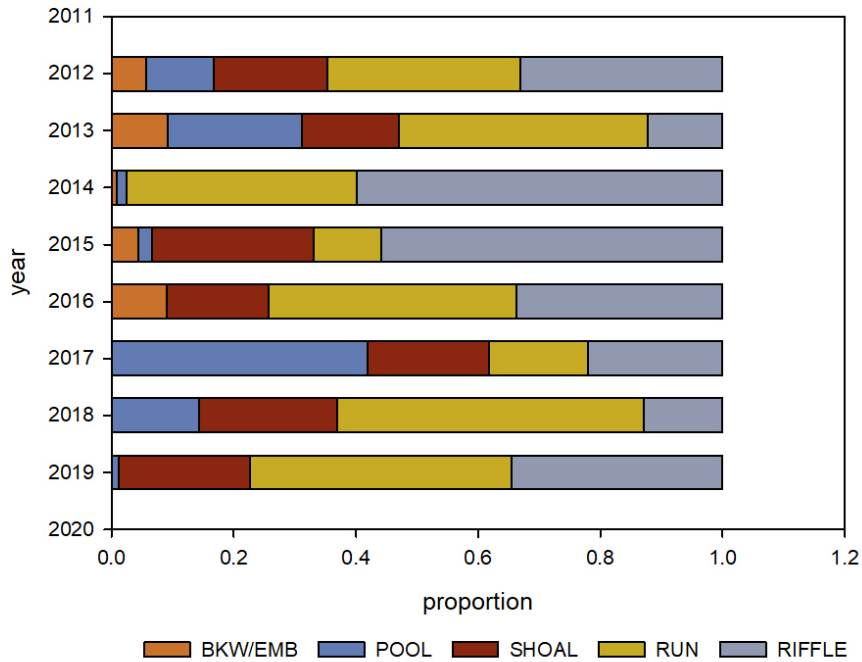

Figure 14. Proportion of each mesohabitat sampled at Gila River Ash Canyon Site, Grant County, New Mexico, 2012-2018.

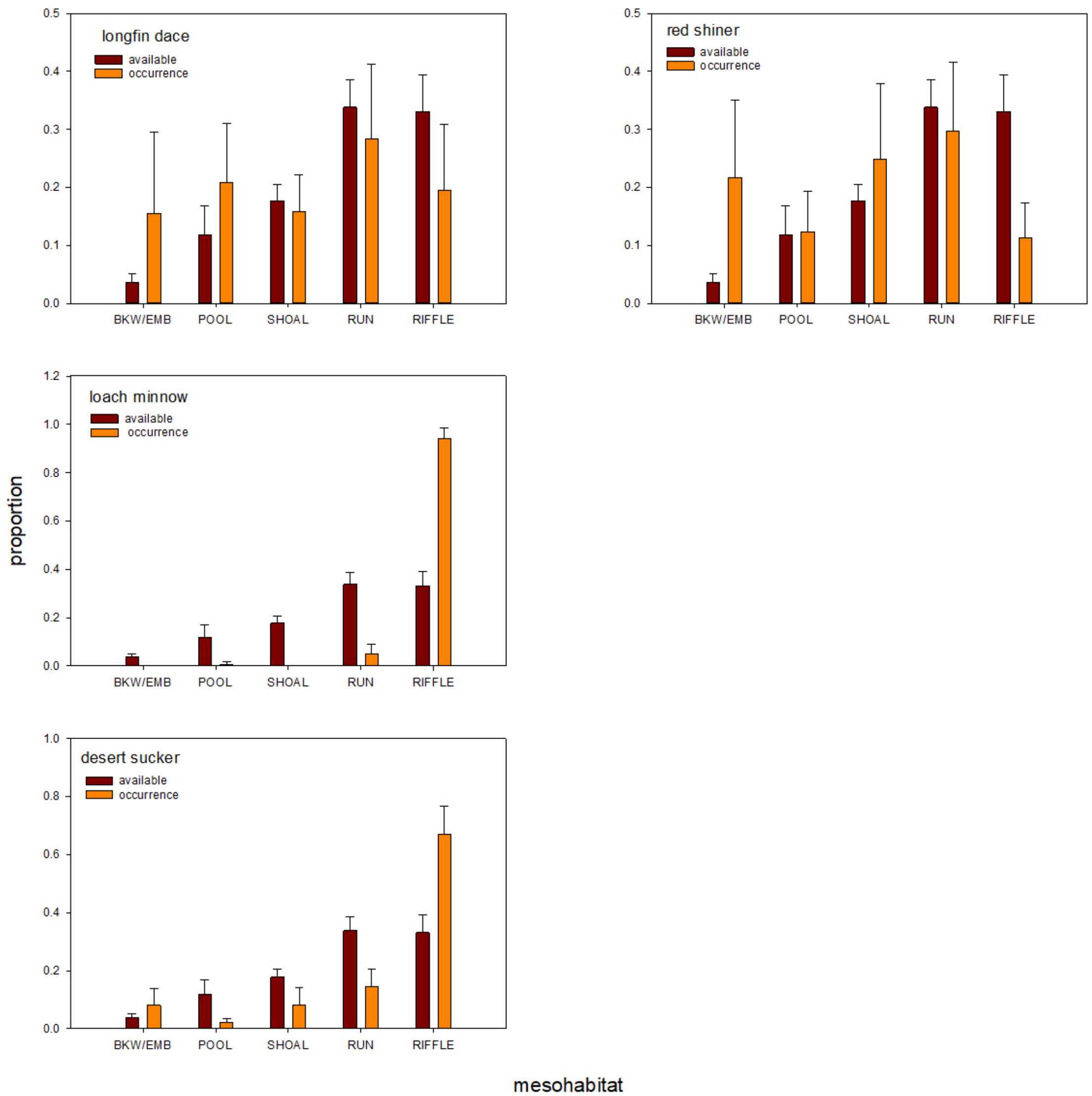

Figure 15. Occurrence (mean proportion) of longfin dace, loach minnow, desert sucker, and red shiner by mesohabitat in Gila River at Ash Canyon site (2012-2019) and mean proportion of each mesohabitat sampled at the site. Data from years species absent at site excluded from proportion occurrence calculations.

SUNSET DIVERSION

Water quality parameters in 2019 were not markedly different from those of previous years (Table 6). Discharge at time of sampling was extremely low with no water following over Sunset Diversion; all flow was diverted to Sunset Canal. Surface water at the site was maintained by canal seepage and groundwater intrusion. Discharge at the upstream Gila River near Redrock gage (#09431500) was 20 cfs on day of sampling. Despite low water, native fishes were comparatively common (Table 7). Both longfin dace and desert sucker were captured.

Nonnative red shiner and fathead minnow were present in low numbers but western mosquitofish was common. No channel catfish was captured.

Table 6. Physicochemical properties of Gila River at Sunset Diversion, Hidalgo County, New Mexico, 2010-2015.

Year	Water Temp (C°)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Specific Conductance (µS/cm)	Salinity (‰)	pH	Mean Daily Discharge (ft³/sec)
2010	18.4	8.0	347	397	0.2		54.0
2011	17.3	9.1	325	381	0.2		40.0
2012	21.4	6.6	398	446	0.2		14.3
2013	16.2		333	400		8.1	144.7
2014	15.5	6.7	256	313	0.1	6.9	114.4
2015	17.4		328				54.0
2016	16.3		294				94.8
2017	22.6	2.42	388	406		8.2	--
2018	15.8	8.4	281	341	0.2	8.9	--
2019	16.1	7.6	379	457	0.2		--

Table 7. Density (#/m² sampled) of fishes at Gila River Sunset Diversion site, Hidalgo County, New Mexico, 2010 – 2018.

			Year							
Species	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Native										
longfin dace	0.1587	0.0895	0.2239	0.0566	0.1240	0.0236	0.0196	0.8087	0.0182	0.1253
desert sucker	0	0	0.0718	0	0.0055	0.0036	0.0085	0.0146	0	0.0081
Total Native	0.1587	0.0895	0.2957	0.0566	0.1295	0.0272	0.0281	0.8233	0.0182	0.1334
Nonnative										
red shiner	0.0943	0.2595	0.0422	0.0602	0.0784	0.1074	0.3227	0.3231	0.0037	0.0040
common carp	0	0	0.0127	0	0.0018	0	0.0007	0	0	0
fathead minnow	0.0086	0.0209	0.0465	0.0495	0.0036	0.0195	0.0033	0.0183	0	0.0081
channel catfish	0.1029	0	0	0	0.0146	0.0026	0.0065	0.0037	0.0055	0
flathead catfish	0.0257	0	0	0	0	0.0005	0.0026	0.0091	0	0
western mosquitofish	0	0.1969	1.0689	0.0035	0	0.0257	0.0085	0.0621	0	0.2790
northern crayfish	0	0	0	0	0	0	0	0	0	0
Total Nonnative	0.2315	0.4773	1.1703	0.1132	0.0984	0.1556	0.3443	0.4162	0.01455	0.2911
Area	233.2	335.2	236.7	282.6	548.5	1946.7	1530.6	547.8	110.2	247.3

Because high flows limited sampling in 2018 to the diversion dam splash apron, habitat consisted only of pools and riffles, but in 2019 with limited surface water a greater mix of mesohabitats was present (Figure 16). In 2019 no water flowed over Sunset Diversion and surface water within the study site was maintained by seepage from the adjacent canal and groundwater recharge. Longfin dace occurrence closely tracked proportion of habitat sampled at Sunset Diversion (Figure 17).

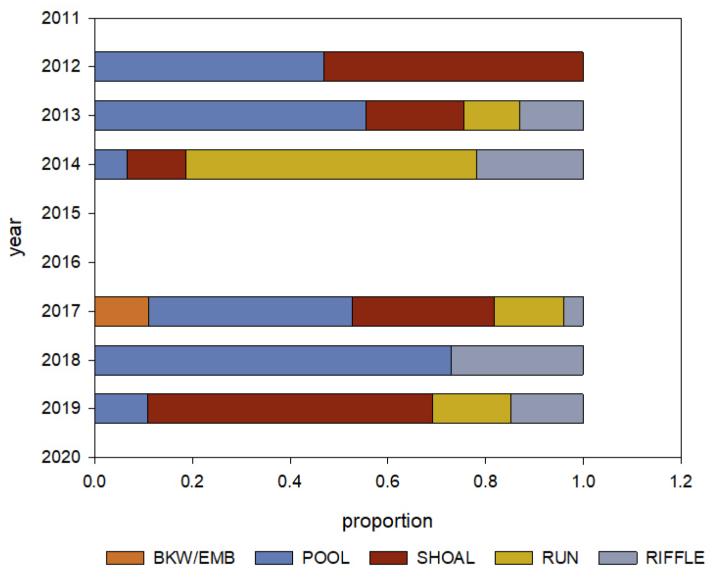

Figure 16. Proportion of each mesohabitat sampled at Gila River Sunset Diversion site, Hidalgo County, New Mexico, 2012-2019.

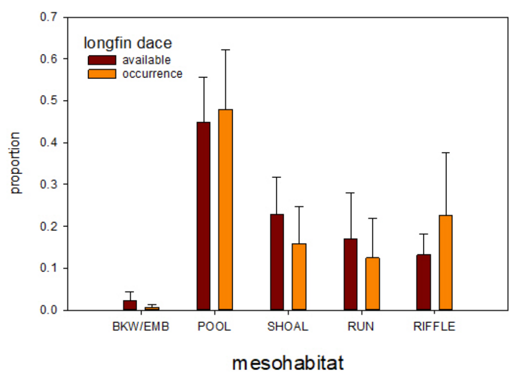

Figure 17. Occurrence (mean proportion) of longfin dace by mesohabitat in Gila River at Sunset Diversion (2012-2019) and mean proportion of each mesohabitat sampled at the site.

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