Gila River Basin Native Fishes Conservation Program:
Arizona Game and Fish Department's Native Fish Conservation Efforts During 2018

Cooperative Agreement R16AC00077
Between Bureau of Reclamation and Arizona Game and Fish Department
Annual Report

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Program Cooperators:

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OVERVIEW

The Gila River Basin Native Fishes Conservation Program (Program; previously known as the Central Arizona Project [CAP] Fund Transfer Program) was developed to partially mitigate impacts of the CAP on threatened and endangered native fishes of the Gila River basin. The U.S. Fish and Wildlife Service (USFWS) concluded in a 1994 biological opinion that the CAP would be a conduit for transfers of nonnative fishes and other aquatic organisms from the lower Colorado River (where the CAP originates) to waters of the Gila River basin. That opinion identified the spread and establishment of nonnative aquatic organisms as a serious long-term threat to the status and recovery of native aquatic species, following a long history of habitat loss and degradation. Impacts of nonnatives include predation, competition, hybridization, and parasite and pathogen transmission.

The 1994 USFWS opinion concluded that operation of the CAP would jeopardize the continued existence of four native threatened or endangered fish species: Gila Topminnow *Poeciliopsis occidentalis occidentalis*, Spikedace *Meda fulgida*, Loach Minnow *Rhinichthys cobitis*, and Razorback Sucker *Xyrauchen texanus*. The Service also concluded that the CAP would adversely modify designated critical habitat of Spikedace, Loach Minnow, and Razorback Sucker. Five reasonable and prudent alternatives were specified: 1) construction and operation of barriers to prevent the spread of nonnative fishes from the CAP to native fish habitats, 2) monitoring of nonnative fish, 3) transfer of funds to USFWS to recover natives, 4) transfer of funds to USFWS to manage nonnatives and research to support that management, and 5) inform and educate the public about native fishes and the impacts caused by nonnative fishes. The transfer of funds under reasonable and prudent alternatives 3 and 4 became known as the CAP Funds Transfer Program. In a 2001 revision of the 1994 opinion, the reasonable and prudent alternatives became conservation measures. In a 2008 revision, the newly-listed endangered Gila Chub[1] *Gila intermedia* and Chiricahua Leopard Frog *Lithobates chiricahuensis* were added to the Program as species affected by operation of the CAP, and the Santa Cruz River drainage was added to its geographic scope.

The Program is funded by the U.S. Bureau of Reclamation (Reclamation), and is directed by the USFWS and Reclamation in cooperation with the New Mexico Department of Game and Fish (NMDGF) and Arizona Game and Fish Department (Department). Reclamation began taking over administration of the funding Program from USFWS in 2015. The Department and Reclamation finalized a one-year agreement (R16AC00077) in August 2016, which was modified and extended to five years in August 2017. The Program mission is to undertake and support conservation actions (recovery and protection) for federal/state-listed or candidate fish species native to the Gila River basin by implementing existing and future recovery plans for those fishes. There are finalized and approved recovery plans for four of the five priority species, and a draft recovery plan for the Gila Chub (U.S. Fish and Wildlife Service 1984, 1991a, 1991b,

[1] See paragraph on page 2 describing the taxonomic reclassification of Gila Chub into Roundtail Chub.

1998, 2002, 2015). There were several draft revised recovery plans for Gila Topminnow, one of which (USFWS 1999) was posted on the USFWS Ecological Services web site. The Loach Minnow and Spikedace recovery plans are being revised.

In addition to the fish and frog species specified above, other species mentioned in this report include: Longfin Dace *Agosia chrysogaster*, Speckled Dace *Rhinichthys osculus*, Woundfin *Plagopterus argentissimus,* Desert Pupfish *Cyprinodon macularius,* Desert Sucker *Catostomus clarki*, Sonora Sucker *Catostomus insignis*, Green Sunfish *Lepomis cyanellus*, Channel Catfish *Ictalurus punctatus*, Black Bullhead *Ameiurus melas*, Smallmouth Bass *Micropterus dolomieu*, Fathead Minnow *Pimephales promelas*, Red Shiner *Cyprinella lutrensis*, Western Mosquitofish *Gambusia affinis,* Goldfish *Carassius auratus*, Gila Trout *Oncorhynchus gilae,* and Brown Trout *Salmo trutta*. Other aquatic species mentioned include Lowland Leopard Frog *Lithobates yavapaiensis,* Chiricahua Leopard Frogs *Lithobates chiricahuensis,* American Bullfrog *Rana catesbeiana,* Sonora Mud Turtle *Kinosternon sonoriense*, Northern Crayfish *Orconectes virilis,* Red Swamp Crayfish *Procambarus clarkii* and Northern Mexican Gartersnake *Thamnophis eques,*.

This report summarizes Program work performed by the Department during 2018. For each priority action, work completed during 2018 is presented, followed by recommendations.

PERFORMANCE MEASURES

Cooperative Agreement R16AC00077 between U.S. Bureau of Reclamation and Arizona Game and Fish Department specified the following annual performance measures.

1. Complete a minimum of three repatriation stockings and one non-indigenous species control action.

   Results: During 2018 Department staff completed repatriation stockings into 17 waters (Appendix 1). Also during the performance period Department staff completed 7 non-indigenous species control actions: four nonnative fish removal efforts in Red Tank Draw, one in the Blue River, one in Redfield Canyon, and one in LaBarge Spring.

2. Monitor fish to determine if population(s) have established at all locations where repatriations were attempted within the previous 3 to 5 years, or other period as agreed upon by the CAP Technical and Policy committees. The number of years to monitor is based on life-span and age-at-maturity of the species, and is three years for Gila Topminnow and Desert Pupfish, and five years for Spikedace, Loach Minnow, and Roundtail Chub.

   Results: During 2018, Department staff conducted post-stocking monitoring of 45 populations (Appendix 2): 3 Loach Minnow, 4 Spikedace, 11 Desert Pupfish, 22 Gila

Topminnow, and 5 Roundtail Chub. Sites where native fish were repatriated and subsequent monitoring information indicated that the species had established populations are reported in Appendix 3.

3. Monitor to determine if non-indigenous fish have been eradicated where non-indigenous control was attempted within the previous year or other period as agreed upon by the Technical and Policy committees.

   Results: During 2018, Department staff monitored four locations where nonnative fish removals have been implemented: Blue River, Redfield Canyon, Spring Creek, and Red Tank Draw.

4. Attempt to spawn all Loach Minnow and Spikedace populations held at the Department's Aquatic Research and Conservation Center (ARCC).

   Results: In 2018, all Loach Minnow and Spikedace populations at ARCC spawned. ARCC produced 3,214 Aravaipa Creek Spikedace, 352 upper Gila River Spikedace, 195 Gila River Forks Spikedace, 6 Blue River Loach Minnow, 1,848 Aravaipa Creek Loach Minnow, 1,627 San Francisco River Loach Minnow, and 1,207 Gila River Forks Loach Minnow.

GENERAL ACTIVITIES

Department staff administered and managed Program projects identified in the agreement. Staff entered data into survey and stocking datasets, and checked data for accuracy. Department staff finalized the 2017 annual report, began analyzing data and drafting the 2018 annual report, and drafted the 2019 annual work plan, Environmental Assessment Checklists, and a monitoring plan for Eagle Creek. Staff coordinated with intra-agency staff, other agencies, and private landowners to continue work on existing projects and to develop potential new projects. Staff also developed and gave oral and poster presentations at the 2018 annual Desert Fishes Council Meeting. The Program manager also hired new staff.

PRIORITY ACTIONS

General methods

Fish Stockings: The Department coordinates with USFWS about locations to stock and sources and lineages of fish to use. Fish for repatriations were collected, transported, and stocked according to Department fish collection, transport, and stocking protocols (best management practice #4; AGFD 2011), and Hazard Analysis and Critical Control Point (HACCP) practices. Fish were collected from pre-determined waters inhabited by desired lineage. Fish were collected using gear appropriate for the given water; typical gear types were seines, minnow traps, or electrofishing. Fish were placed into aerated 5-gallon buckets from which they were

sorted to confirm species and assess condition. Fish were then transferred into a 100-qt transport cooler(s) equipped with aerators and filled with well water that was treated with salt and Amquel®. At the repatriation site, the fish were transferred from the transport cooler back to aerated 5-gallon buckets and carried to the stocking location. Water quality characteristics in the buckets and the stocking location were measured. Conductivity (µS), salinity (mg/L), total dissolved solids (mg/L), pH, and water temperature (°C), were measured using a Hach® Combo meter, and dissolved oxygen (mg/L) using a Sper Scientific® dissolved oxygen meter. Fish were acclimated to stocking site conditions by exchanging 25 to 50% of transport bucket water with stream water, about every 10 minutes, until bucket temperatures were within one degree of the stream. Fish were sorted a final time to verify species, assess condition, and determine a final count and then released into the stream.

Data recorded for stocking included: site name, date, time of arrival and stocking, participants, type of transport container, water quality in the tanks and site (water temperature, pH, conductivity) counts of individuals stocked, condition of fish, fish behavior after release, and number of mortalities.

Fish Surveys: Backpack electrofishing was used at 100-m transects (except in the Blue River where transects are 200-m long) to survey repatriated populations of Spikedace, Loach Minnow, and Roundtail Chub, and to assess habitats for fish repatriations. The number of transects sampled was determined by target reach, with a minimum of three transects for short reaches and at least 12% of the reach length in longer streams (e.g., there were twelve 200-m transects in the 18 km of the lower Blue River). A backpack electrofisher (Smith-Root; Model 12-B) was used to electrofish upstream through each transect in a single pass. Stunned fish were netted with dip nets (tear-drop shaped, 0.43 m x 0.37 m with 2 or 3 mm mesh). At the upstream end of each major mesohabitat type (pool, run, riffle, cascade) within a transect, fish were processed and data were recorded. Captured fish were identified to species and counted. All Spikedace, Loach Minnow, Roundtail Chub were measured to the nearest millimeter in total length (mm TL). Other species were counted within two size classes for small bodied fishes (≤40 and > 40 mm TL for Speckled Dace and Longfin Dace; ≤20 and >20 mm TL for Desert Pupfish and Gila Topminnow) and three size classes for large bodied fish (<50, 50-100, and >100 mm TL; e.g. Desert Sucker, Smallmouth Bass). With the exception of topminnow and pupfish, fish less than 20 mm TL were categorized as larvae. After processing, fish were released alive just downstream from where they were captured. Data recorded for each sampling effort included: site name, site location (GPS coordinates), length of site, date, time, participants, gear type, gear settings, gear dimensions, seconds shocked, species of fish captured, size class of fish, and counts of individuals within each species-size-class category.

Minnow traps or hoop nets baited with dry Gravy Train® dog food were used to survey for Gila Topminnow, Desert Pupfish, and some Roundtail Chub populations. Promar® collapsible minnow traps (0.46 m long x 0.3 m wide, with 2 mm mesh) were used for Gila Topminnow and

Desert Pupfish monitoring, whereas Promar® collapsible mini-hoop nets (0.85 m long x 0.3 m diameter circular hoops, with 9 mm mesh) were used for Roundtail Chub monitoring. Typically 10 traps were set in each location. Traps were set for a minimum soak time of two hours, and fish were processed and released alive back to the location of capture. Data recorded for each sampling effort included: site name, site location (GPS coordinates), date, time, participants, gear type, gear dimensions, set and pull times for each trap set, species of fish captured, size class of fish (≤20 mm or >20 mm), and counts of individuals within each species-size-class category.

Evaluation of Species Establishment: The goal of repatriation efforts is to establish populations of Spikedace, Loach Minnow, Gila Topminnow and Roundtail Chub[1] and to thus contribute to recovery of these species. A species is considered to have established (a successful repatriation) when it is reproducing to the point where it is self-sustaining (Griffith et al. 1989, Bright and Smithson 2001, Armstrong and Seddon 2007), and as per the Spikedace recovery plan (USFWS 1991) with characteristics of abundance, age-class structure, and recruitment in the range of natural variation. To assess this goal, post-stocking monitoring data were collected for each repatriated species to evaluate species presence, an index of abundance, population size structure, and dispersion. Arguably, the two most important of these four measures for determining if a species has established are population size structure and an index of abundance.

The objectives of monitoring are to:

1. determine presence of repatriated fish species and non-native fish species;
2. evaluate trends in relative abundance (estimated as catch-per-unit effort) of the repatriated species, extant native fish species, and non-native piscivores;
3. evaluate size-structure of each population of fish species to detect reproduction and recruitment to the population;
4. determine if repatriated species have dispersed outside of the stocking area.

Presence of individuals during post-stocking monitoring is evidence that the species has persisted, but not in and of itself evidence of population establishment. Presence of juvenile fish is evidence of reproduction, and the proportion of all individuals that are juvenile is evidence of year-class strength. Size structure is used as an indicator of age-structure. Presence of age-0, age-1, and older size classes for several years in a row, and consistently high catch rates for several years in a row is an indication that a population has established. Capture of individuals beyond stocking locations is evidence of dispersal.

After stocking, a site is monitored for several years to determine whether or not the species has established a population. The number of years of monitoring was dependent upon species, and generally exceeded the life span of the species by at least one year. For Gila Topminnow and Desert Pupfish, which typically live only one to two years, two years may be sufficient to detemine if they

[1] Some of the chub repatriations were of species formerly classified as Gila Chub.

have established a population. However, if no fish are detected in three consecutive monitoring events, the population may be considered extirpated (Weedman and Young 1995). Therefore, three years of post-stocking monitoring will be used for Gila Topminnow and Desert Pupfish. Spikedace and Loach Minnow can live three to four years, so monitoring for five years post-stocking should be sufficient to determine if the species has established a population, because all fish stocked will have died by that time. Roundtail Chub typically live about seven years. However, a yearly examination of size structure for five years after stocking is probably sufficient to determine if Roundtail Chub are established.

At one year post stocking, any juvenile fish captured (less than 20 mm TL for Gila Topminnow and Desert Pupfish, less than 40 mm TL for Spikedace and Loach Minnow and less than 50 mm TL for Roundtail Chub) would be the result of a recent spawning event, and therefore not a stocked fish. Repatriated populations will be monitored periodically after establishment by one or more of the cooperators for at least 10 years to determine population persistence and viability.

Nonnative Piscivore Removal: Nonnative fishes were typically removed using traps and electrofishing, except in the Blue River, where snorkeling and spearfishing was also used (Robinson et al. 2010). A variety of traps were used, depending on habitat size: hoop nets (0.5 m diameter, 2 m long, and 6 mm mesh) and mini-hoop nets (Promar® TR-502 collapsible traps; cylindrical, 0.85 m long x 0.3 m wide, with 9 mm mesh) baited with dry dog food (Gravy Train®).Traps were dispersed throughout the targeted reach and were primarily set in pools or runs that were more than 1-m deep. Traps were set during the afternoon and retrieved 2 to 22 hours later. For backpack electrofishing, typically the entire targeted reach was shocked, and any nonnative fish captured were removed.

In the Blue River, snorkelers used spear fishing equipment (JBL Enterprises, 1.5 m polespear affixed with a three pronged, barbless, Paralyzer spear tip; or a JBL Enterprises Mini-Carbine spear fishing gun) to remove large-bodied piscivorous nonnative fish. To improve the chances of sighting fish, sampling was restricted to 8:30 am to 4:30 pm when the sun was high in the sky. All pools ≥1m deep in the project reach were surveyed via snorkeling, and each pool was snorkeled through three times. The following data were recorded at each pool: coordinates (UTM, NAD 83 northing and easting), reach number or name, pool number, estimated pool length (m), width (m), and depth (m), date, snorkeling start and end time for each diver, species captured, number of each species, total length (TL, mm) of each individual fish, water clarity (m distance that fish can be accurately identified; estimated with polespear), and snorkeling crew member names.

Evaluation of Nonnative Removal: There are two general goals for nonnative removals: control or eradication. For situations where there aren't any barriers to invasions of nonnative species, the goal is to control the nonnative population until barriers can be installed. When barriers to upstream invasion of nonnative fishes are in place, the goal is eradication. Multiple removals are conducted

until goals are achieved. The catch of nonnatives across removal events will be examined, and a decrease in abundance of the target nonnative species to low levels or to zero will be evidence of control. Absence of nonnatives for five or more consecutive removal events will indicate eradication.

Acquire Spikedace, Loach Minnow and rare populations of other native fish (Task AZ-2003-2)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 2. Maintain and operate ASU topminnow holding facility and the Aquatic Research and Conservation Center (ARCC) to support the Program's recovery efforts for imperiled fishes in the Gila River Basin through the establishment of refuge populations of genetically distinctive stocks as insurance against extinction in the wild, captive propagation for repatriation, and applied research.

Recovery Objectives:

- Spikedace recovery objective 8.1. Determine wild stocks suitable for contribution to hatchery stocks.
- Spikedace recovery objective 8.2. Collect and transfer wild stocks to suitable facility.
- Loach Minnow recovery objective 8.1. Determine wild stocks suitable for contribution to hatchery stocks.
- Loach Minnow recovery objective 8.2. Collect and transfer wild stocks to suitable facility.
- Gila Chub draft recovery plan objective 4. Establish and maintain refuge populations in protected ponds or hatcheries as appropriate.
- Gila Topminnow 1999 draft revised recovery plan objective 1.1. Maintain refugia populations of natural populations to ensure survival of the species.

Background: The purpose of this task is to acquire Spikedace and Loach Minnow from all extant lineages and bring them to the Department's ARCC, or another facility, for propagation and to establish refuge populations. The goal is to have 500 adults on station for each lineage. There are few natural populations left, and they need to be protected. Removing too many fish from a wild population could negatively impact it. The number of fish to remove from a given population is a coordinated decision between USFWS and state wildlife agencies, and is usually based on estimated number of fish in the stream derived from the most recent monitoring. Typically fish are removed within a few months of the most recent monitoring. If necessary, new individuals are brought into ARCC every year to maintain the population size and genetic diversity with wild stock.

Loach Minnow (N=115, from Aravaipa Creek) were first brought into the facility in 2002, to develop propagation techniques (Childs 2004). In 2005, 35 Spikedace and an additional 27 Loach Minnow were brought in from Aravaipa Creek (Ward 2008). Spikedace and Loach Minnow brought into ARCC to establish and maintain the refuge-broodstock populations are summarized in Table 1.

Results: In August 2018, Department and USFWS staff discussed how many Loach Minnow could be removed from the Blue River to supplement the population at ARCC. Based on the number captured (326) during monitoring in the lower reach during 2017, and an assumption that less than 50% of the fish were captured in the area monitored, and the fact that fish would be removed from both the lower and upper reaches, the USFWS decided that 300 Loach Minnow could be removed from the entire Blue River in 2018. The Department decided to attempt to remove roughly equal numbers from the upper and lower reaches. On September 12, 2018, Department staff collected a total of 164 Loach Minnow from the upper Blue River, Grant Creek, and Campbell Blue Creek and transported the fish to ARCC with no mortalities. A total of 13 fish were collected from lower Grant Creek (within 700 m of the mouth), 127 fish from Campbell Blue Creek (between Blue River Ranch and Luce Ranch Road), and 24 from the mainstem Blue River (23 at Cole Flat and 1 near Upper Blue River Campground) using backpack electrofishers.

On October 3, 2018, Department staff collected a total of 59 Loach Minnow from the lower Blue River near Juan Miller Crossing and transported the fish to ARCC with no mortalities. The number removed was less than our target (136), because only 122 were captured during the annual monitoring completed immediately before the removal, and thus we did not want to negatively impact the local abundance.

On December 13, 2018, ARCC staff acquired 145 Gila Forks lineage Loach Minnow and 1 Gila Forks lineage Spikedace from NMDGF and transported the fish back to ARCC. The NMDGF should be contacted to determine how the target number to remove was determined and whether or not those goals were met.

Collections of other lineages were not completed because either fish were not abundant enough to warrant collection or repatriations using those lineages were not planned for 2019. Collections from Aravaipa were postponed because USFWS had not yet communicated number of fish to collect.

Recommendations: Continue to collect Spikedace and Loach Minnow from remnant populations, with goals to minimize impact on remnant population but acquiring the number of fish necessary to maintain a refuge population of at least 500 adults. More Loach Minnow should be collected from the Blue River and brought into ARCC to attain or exceed 500 broodstock. More Aravaipa Spikedace and Loach Minnow will be brought into ARCC to maintain the

broodstocks. ARCC staff should coordinate with NMDGF regarding acquiring more stock of the New Mexico lineages.

We recommend that at a minimum, a formula be created and used to determine how many fish can be removed from a given stream each year. In general what is needed is an estimate of the total population in the stream and an estimated proportion that could be removed without negatively impacting the population. Suggested variables to include in the formula are the number of fish captured during the most recent monitoring, length of stream sampled during the monitoring, proportion of fish in that reach that were captured (or catchability), total length of stream, and a desired proportion of the total population that could be safely removed without negatively impacting the total population. If a more complex formula is desired, the PVA model developed for the upper Gila River Spikedace and Loach Minnow populations could be used to inform biologically appropriate numbers of fish to collect without negatively impacting donor populations (Pine et al. 2013, Pine et al. 2017). Data from fall monitoring should be used for these formulas because it accounts for spring reproduction of target populations. Removal of fish should occur as soon after monitoring as possible.

Muleshoe ecosystem stream and spring repatriations (Task AZ-2003-1)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 4. Remove nonnative aquatic species threats.
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

- Spikedace recovery objective 6.3. Reintroduce Spikedace to selected reaches.
- Spikedace recovery objective 6.4. Monitor success/failure of reintroductions.
- Loach Minnow recovery objective 6.3. Reintroduce Loach Minnow to selected reaches.
- Loach Minnow recovery objective 6.4. Monitor success/failure of reintroductions.
- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 2.4 Protect habitats of reestablished or potential populations from detrimental nonnative aquatic species.
- Gila Topminnow 1999 draft revised recovery plan objective 3. Monitor natural and reestablished populations and their habitats.
- Desert Pupfish recovery objective 2. Re-establish Desert Pupfish populations.
- Desert Pupfish recovery objective 5. Monitor and maintain natural, re-established, and refugia populations.

- Gila Chub draft recovery plan objective 1.3.1. Eliminate or control problematic nonnative aquatic organisms
- Gila Chub draft recovery plan objective 2. Ensure representation, resiliency, and redundancy by expanding the size and number of populations within Gila chub historical range via replication of remnant populations within each RU.
- Gila Chub draft recovery plan objective 7. Monitor remnant, repatriated, and refuge populations to inform adaptive management strategies.

Background: The purpose of this action is to establish Spikedace, Loach Minnow, Gila Topminnow, and Desert Pupfish into various waters on the Muleshoe Ranch Cooperative Management Area. The Muleshoe CMA is located on the western slopes of the Winchester and Galiuro mountains. The various waters and stream reaches are described in Robinson et al. (2010), and Love-Chezem et al. (2015a). Fish stockings began in 2007, when Spikedace and Loach Minnow were stocked into Hot Springs Canyon and Redfield Canyon; both species were again stocked into Redfield Canyon in 2008 and 2010, and into Hot Springs Canyon each year through 2011. In 2007, Roundtail Chub[1], Sonora Sucker, and Speckled Dace were translocated upstream of a waterfall in Redfield Canyon to expand their range in that system. Gila Topminnow and Desert Pupfish were stocked into Swamp Springs Canyon (2007 and 2008), Cherry Spring Canyon (2007 and 2008), and Secret Spring (2007 and desert pupfish only in 2010). Gila Topminnow and Desert Pupfish were stocked into Headquarters Spring in 2008, and in 2010 more pupfish were added. Gila Topminnow were stocked into Wildcat Canyon in 2014, Bass Canyon in 2014 and 2015 and Double R Canyon in 2017. Gila Topminnow were moved 100 meters further upstream in Wildcat Canyon in 2017 to expand their distribution. Desert Pupfish were stocked into Larry & Charlie Tank in 2009 and into Mint Spring in 2015 and 2016.

By the end of 2016, Loach Minnow were considered established in Hot Springs Canyon because adults were consistently captured and there was evidence of recruitment every year since the last stocking in 2011. Spikedace persist in Hot Springs Canyon but it is unclear if they are established because recruitment has not been detected every year and numbers captured have steadily decreased since 2012. Both Spikedace and Loach Minnow failed to establish in Redfield Canyon. Gila Topminnow are established in Swamp Springs Canyon, Headquarters Spring, Secret Spring, and Redfield Canyon and likely failed to establish in Cherry Spring Canyon. Desert Pupfish are established in Larry and Charlie Tank and in Secret Spring, but failed to establish in Swamp Springs Canyon, Cherry Spring Canyon, and Headquarters Spring.

On June 13, 2017, The Nature Conservancy (TNC), Department, USFWS, and Bureau of Land Management (BLM) staff performed wet-dry mapping in Hot Springs Canyon. There was about 3.4 km of continuous flow, starting at about 1.3 km downstream of the lower access trail in Reach 2, and extending about 725 m downstream from Bass Canyon. In Reaches 1 and 2 there

[1] Chub in Redfield Canyon were previously classified as Gila Chub.

were 39 points identified as potential Spikedace habitat (eddies below riffles or small falls), but the width of the stream was typically 1-2 m wide. So, if each point was equivalent to 5 m of prime habitat, then that would correspond to 195 m of habitat.

Both Redfield Canyon and Hot Springs Canyon drainages are occupied by other native fishes including: Roundtail Chub[1], Speckled Dace, Longfin Dace, Desert Sucker, and Sonora Sucker.

Results:

Nonnative Control. During June 12-13, 2018, Department staff performed a Green Sunfish removal in Redfield Canyon. Single-pass backpack electrofishing was conducted from the Swamp Springs confluence at the downstream end of perennial water (UTM 12S 562988 3588818) upstream to the Sunfish Barrier (UTM 12S 563858 3589841). Staff electrofished for 5,373 seconds and captured 15 Green Sunfish (CPUE = 10.05 fish/hour). Other species captured included 69 Roundtail Chub[1], 12 Sonora Sucker, and 5 Longfin Dace. On June 13, 2018, 10 mini-hoop nets and 8 minnow traps were set in reach 3 near the wilderness boundary (Figure 1) for a minimum soak time of approximately 2 hours resulting in the capture of 129 Green Sunfish (59-221 mm TL). Gila Topminnow of both juvenile and adult size classes were visually abundant upstream of the main pool, and five adults were captured in five dipnet sweeps. All Green Sunfish captured were removed. Overall, a total of 144 Green Sunfish were removed from Redfield Canyon. Unlike the last three years, Green Sunfish numbers increased in the upper perennial section (Reach 1 and the upper end of Reach 2), suggesting that movement still occurs between reaches 3 and 1 (Figure 2). Green Sunfish numbers in Reach 3 remain high, and this location is likely the source of Green Sunfish to the upper reach. The proposed barrier location is upstream of the perennial water in reach 3, which will likely secure the upstream native fish populations from further invasions of Green Sunfish. After the barrier is constructed, the goal of Green Sunfish removal efforts can shift from control to eradication.

Monitoring of Repatriated Populations. On September 18, 2018, Department, TNC, and Reclamation staff monitored Hot Springs Canyon for Loach Minnow and Spikedace; Mint Spring for Desert Pupfish; and Upper Bass Canyon, Lower Bass Canyon, and Double R Canyon for Gila Topminnow. In Hot Springs Canyon, sampling crews captured 30 Loach Minnow, 1 Spikedace, 3 Gila Topminnow, 202 Roundtail Chub[2], 51 Sonora Sucker, 242 Desert Sucker, 223 Speckled Dace, and 243 Longfin Dace (Table 2). Loach Minnow catch rates have fluctuated annually since 2009 due to changing environmental conditions, particularly flooding (Figure 3). Loach Minnow continue to reproduce and recruit into this population with all size classes captured in 2018, and the population persisted despite severe drought conditions in early 2018 (Figure 4). Consistent annual catch rates and evidence of reproduction since the final stocking suggests Loach Minnow are established in Hot Springs Canyon. One Spikedace was captured in

[1] Chub in Hot Springs and Redfield canyons were previously classified as Gila Chub.
[2] Roundtail Chub at these locations were previously classified as Gila Chub

2018 (Figure 5), which is consistent with relatively low Spikedace captures since 2015. Spikedace are still persisting and apparently reproducing in the system since the last stocking in 2012 and fish typically only live 2 to 3 years (Figure 6). Gila Topminnow captured in Hot Springs Canyon likely dispersed downstream from either Wildcat Canyon or Bass Canyon. Establishment of a population of Gila Topminnow in Hot Springs Canyon is possible if fish continue to colonize from upstream tributaries.

On September 17, 2018, Department staff captured 55 Desert Pupfish in Mint Spring (Table 3), which was nearly the same number captured in 2017 (56). All pupfish captured were greater than 20 mm TL, so the species may not have reproduced in Mint Spring in 2018, although reproduction was documented in 2017. It is possible that the seine was not as effective at capturing young of year fish as minnow traps, so both methods should be implemented next year.

On September 17, 2018, Department staff monitored Double R Canyon for Gila Topminnow. Staff failed to capture Gila Topminnow in 10 minnow traps set in Double R Canyon (Table 3). A single Roundtail Chub[1] (50-100 mm TL) was captured.

On September 17, 2018, Department staff monitored upper Bass Canyon for Gila Topminnow. A total of 3 Gila Topminnow were captured (Table 3) which was the same number captured in 2017. Two of the topminnow were captured in minnow traps, while the third topminnow was captured in a dip net sweep near the Jackson Cabin Road Crossing. Reproduction previously occurred in 2016 and 2017 so suitable habitat exists for reproduction within this reach. Also captured in upper Bass Canyon were 71 Roundtail Chub[1]. Gila Topminnow were not captured in 10 seine hauls carried out in lower Bass Canyon in 2018. Other species captured in lower Bass Canyon included 80 Roundtail Chub[1], 2 Longfin Dace, 1 Desert Sucker, 1 Sonora Sucker and 1 Speckled Dace.

Repatriation Stockings. On November 20, 2018, Department staff stocked Gila Topminnow into Double R Canyon and Bass Canyon. A total of 1,068 topminnow were collected from the San Pedro River Preserve and transported in aerated 150 quart coolers. There were 8 mortalities during stocking and transport. A total of 499 Gila Topminnow were stocked in Double R Canyon near the 2017 stocking site (UTM 12S 571727/3579843). The remaining 561 topminnow were stocked in upper Bass Canyon about 100 meters upstream from the previous stocking location (UTM 12S 572046/3579704). Fish were in good condition and displayed normal behavior at the time of release.

Recommendations: If a barrier is not installed in Redfield Canyon, attempts should be made to contact private landowners and secure permission to access to lower Redfield Canyon. If permission is granted, the goal of Green Sunfish removal efforts should shift from control to eradication, and the frequency and intensity of removal efforts should be increased. Most removal efforts should be focused during winter to early spring before Green Sunfish spawn.

However, if the landowners do not grant access, only control will be possible, because the Green Sunfish on the private property will remain a source for upstream migration of the species. In that case, it is likely that one or two intense removal efforts per year would suffice to keep Green Sunfish numbers low in the upper reach.

As of the end of 2018, the multi-agency Muleshoe Native Fish Conservation Team had completed seven years of post-stocking monitoring in Hot Springs Canyon. Loach Minnow are considered established in Hot Springs Canyon, but Spikedace numbers have decreased and may not establish or have established a very small population. It is likely that there is not sufficient habitat for a Spikedace population in Hot Springs Canyon. Therefore, no additional stockings of Spikedace are recommended for Hot Springs Canyon. Annual monitoring of fishes in Hot Springs Canyon should be continued, as recommended by the multi-agency team.

Monitoring of Gila Topminnow in Bass Canyon and Double R Canyon should continue until 2021 because both locations were augmented in 2018. Seines will be used in combination with minnow traps with the goal of increasing detection of Gila Topminnow.

Monitoring of Desert Pupfish in Mint Spring should continue until at least 2019. More Desert Pupfish should be periodically stocked into Mint Spring, Larry & Charlie Spring, and Secret Spring to maintain genetic variability.

Fresno Canyon repatriations (Task AZ-2006-1)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 1. Identify critical streams and populations in need of protection and potential replication.
    - Goal 4. Remove nonnative aquatic species threats.
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 3. Monitor natural and reestablished populations and their habitats.
- Gila Chub draft recovery plan objective 2. Ensure representation, resiliency, and redundancy by expanding the size and number of populations within Gila chub historical range via replication of remnant populations within each RU.
- Gila Chub draft recovery plan objective 7. Monitor remnant, repatriated, and refuge populations to inform adaptive management strategies.

Background: The purpose of this action was to establish viable populations of Gila Topminnow and Roundtail Chub[1] into Fresno Canyon after the stream was treated with rotenone in 2007 to remove Green Sunfish. After the treatment, Gila Topminnow naturally colonized from upstream Coal Mine Canyon, but topminnow and Longfin Dace were also stocked in 2008. Choice of chub lineage to stock was limited to the three remnant populations in the Santa Cruz drainage: Cienega Creek, Sabino Canyon, and Sheehy Spring. Both Cienega Creek and Sheehy Spring are not replicated, but need to be, but Sheehy was the higher priority because of its very limited population size and distribution. Therefore, the stocking of Roundtail Chub[1] from Sheehy Spring was planned, but delayed until after a Habitat Conservation Plan could be completed for the private land on which Sheehy Spring is located. The Habitat Conservation Plan for San Rafael Cattle Company was completed in late 2016. Catch rates of chub in Sheehy Spring have been low (less than 90 captured) since 2011, so this small population is at risk of extirpation from stochastic events. Reproduction was evident in most years, but 2009 had the highest percentage of fish <50 mm TL (54.3%) and the highest total number of fish captured (385). It is unclear why catch rates were so much higher in 2009 than the other years.

Results: In December 2018, Department, USFWS and the landowner discussed the issue of chub in Sheehy Spring and came to an agreement that some chub could be removed in 2019.

Recommendations: Fewer than 100 chub have been captured in Sheehy Spring every year since 2011, so the population could become extirpated if a stochastic event altered environmental conditions in the spring channel or if habitat quality worsens. Because there is now tentative agreement amongst parties, in 2019 the Department plans to collect some chub from Sheehy Spring and bring them to ARCC for propagation. Progeny produced will be stocked into Fresno Canyon, and some may also be stocked into Pasture 9 Tank. In addition to USFWS, State Parks will be coordinated with for stocking into Fresno Canyon, as it is on their property. Coordination with the San Rafael Ranch owner will be necessary during planning and before any chub are stocked into Pasture 9 Tank.

[1] Chub to be repatriated into Fresno Canyon were previously classified as Gila Chub.

Before moving chub to ARCC, a fish health assessment should be completed on mosquitofish (surrogate for chub) in Sheehy Spring. Also, before moving chub from ARCC to wild sites, a fish health assessment will be completed on longfin dace at ARCC. Other actions that would benefit the chub population at Sheehy Spring included: 1) improve habitat at Sheehy Spring; thin out the riparian vegetation to provide more open water; and 2) decrease competition and predation by eradicating Western Mosquitofish and relocating Sonora Mud Turtles to the Santa Cruz River.

If plans to remove chub from Sheehy Spring fall through, then stocking Cienega Creek chub into Fresno Canyon should be considered. For this option, BLM needs to be brought into the coordination, and a fish health assessment of chub, or longfin dace as a surrogate, from Cienega Creek will be necessary. If no pathogens or parasites of concern are detected, and if all agencies are in consensus, then the translocation could proceed.

Bonita Creek renovation and repatriations (Task AZ-2007-2)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 4. Remove nonnative aquatic species threats.
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

- Spikedace recovery objective 6.2.5 Reclaim as necessary to remove non-native fishes.
- Spikedace recovery objective 6.3. Reintroduce Spikedace to selected reaches.
- Spikedace recovery objective 6.4. Monitor success/failure of reintroductions.
- Loach Minnow recovery objective 6.2.5 Reclaim as necessary to remove non-native fishes.
- Loach Minnow recovery objective 6.3. Reintroduce Loach Minnow to selected reaches.
- Loach Minnow recovery objective 6.4. Monitor success/failure of reintroductions.
- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 2.4 Protect habitats of reestablished or potential populations from detrimental nonnative aquatic species.
- Gila Topminnow 1999 draft revised recovery plan objective 3. Monitor natural and reestablished populations and their habitats.
- Desert Pupfish recovery objective 2. Re-establish Desert Pupfish populations.

- Desert Pupfish recovery objective 5. Monitor and maintain natural, re-established, and refugia populations.

Background: The Department, BLM, Reclamation, and USFWS began implementing a native fish restoration project in Bonita Creek near Safford during 2008 with the construction of a fish barrier. The same year, a reach between the City of Safford infiltration gallery dike and the constructed fish barrier was chemically treated with rotenone to eliminate nonnative fishes (Robinson et al., 2009). Following the renovation, salvaged native fishes Roundtail Chub[1], Longfin Dace, Speckled Dace, Sonora Sucker, and Desert Sucker were returned to the treated reach. In addition, federally-listed Loach Minnow, Spikedace, Desert Pupfish, and Gila Topminnow were translocated to the treated reach. Nonnative fish were found in the treated reach in 2009, and BLM began leading mechanical removal efforts. Plans to stock more threatened and endangered fish into the treated reach were postponed until the nonnative fishes could be eradicated.

The Department stocked the same threatened and endangered fish into upper Bonita Creek (above the infiltration gallery), which is free of nonnative fishes except Fathead Minnow. Spikedace were stocked near Red Knoll in 2009, and both Spikedace and Loach Minnow were stocked near Red Knoll in 2010 (Figure 7). Desert Pupfish and Gila Topminnow were stocked at Lee Trail in 2010 and at Red Knoll in 2011. Of the species stocked, only Gila Topminnow were captured during annual monitoring by BLM, and appeared to have established at Red Knoll. The agencies discussed additional stockings, and in 2014 Desert Pupfish and Gila Topminnow were stocked near the Reservation Boundary, and Gila Topminnow and Loach Minnow near Midnight Canyon. More Gila Topminnow and Desert Pupfish were stocked near the Reservation Boundary in 2015.

The Department monitored for these three species after stocking because the stocking locations were outside of the BLM fixed monitoring sites. At the Reservation Boundary stocking site, no Gila Topminnow were captured in 2015, 31 were captured in 2016 and 280 were captured in 2017. At the Midnight Canyon stocking site, 143 topminnow were captured in 2015, 55 were captured in 2016 and 85 were captured in 2017. Desert Pupfish have not been detected at the Reservation Boundary stocking site since 2015. Loach Minnow were last detected by the Department downstream of Midnight Canyon during monitoring in 2015 (Figure 8).

Results: On October 15, 2018, Department staff monitored for Gila Topminnow, Desert Pupfish, and Loach Minnow in Bonita Creek. Collapsible minnow traps were set at the reservation boundary stocking pool and in a side channel near the confluence with Midnight Canyon to monitor for Gila Topminnow. At the Reservation Boundary stocking site, 96 Gila Topminnow were captured, and 338 Gila Topminnow were captured at the Midnight Canyon stocking site

[1] Chub in Bonita Creek were previously classified as Gila Chub.

(Table 4). Department staff captured an additional 64 Gila topminnow in 18 dip net sweeps downstream of the initial stocking location at Reservation Boundary. Both size classes of Gila Topminnow were captured indicating that reproduction had occurred. Gila Topminnow are widely distributed within Bonita Creek, and is considered established at both the Reservation Boundary site and the Midnight Canyon site. Desert Pupfish were not captured at the Reservation Boundary site (Table 4), making this the fourth year that Desert Pupfish were absent from the catch. The beaver pond where Desert Pupfish were initially stocked has not filled since 2017, and pupfish likely no longer exist at this site. Loach Minnow were monitored using single-pass electrofishing at three 100-m sites downstream of the Midnight Canyon confluence (Table 5). Loach Minnow were not captured, making it the third consecutive year that none have been captured, although a single eDNA sample collected in 2017 tested positive for Loach Minnow, so a few individuals may still persist in Bonita Creek.

Recommendations: This project can be considered complete, and taken off the priority list. Monitoring of Desert Pupfish and Gila Topminnow at the Reservation Boundary sites and Gila Topminnow at the Midnight Canyon site, is no longer needed, as Gila Topminnow appear to be established and Desert Pupfish failed to establish. Loach Minnow also seem to have failed to establish. No additional stockings of Loach Minnow are recommended at this time, because the Department, BLM, and USFWS never reached a consensus as to whether or not there was sufficient habitat for Loach Minnow in the reach between Red Knolls and Midnight Canyon. Therefore we recommend focusing Loach Minnow repatriation efforts to other streams where the species is more likely to establish populations.

Gila Topminnow stockings (Task AZ-2002-1)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 3. Monitor natural and reestablished populations and their habitats.
- Desert Pupfish recovery objective 2. Re-establish Desert Pupfish populations.
- Desert Pupfish recovery objective 5. Monitor and maintain natural, re-established, and refugia populations.

Overall Background: The purpose of this action is to establish Gila Topminnow populations within historic range of the species throughout the Gila River Basin in Arizona. The target is six new establishments per year. Desert Pupfish are sometimes stocked into the same sites because the species utilize similar habitats. The Department coordinates with USFWS about locations to stock and sources and lineages of fish to use. The strategy is to stock over 500 Gila Topminnow initially and for any subsequently needed augmentations to establish a population. Populations are typically augmented if fewer than 100 fish are captured or observed during monitoring. After stocking, the populations are monitored at 6-months and then annually thereafter for three years after the last stocking event. If they are considered established after the third post-stocking monitoring, then the monitoring responsibilities are passed on to other Department programs or other agencies, and augmentation responsibilities are passed on to other Department programs. Monitoring techniques are consistent from year to year for a given site, and usually involve a minimum of 10 minnow trap sets per site, but dip nets or seines are sometimes used if habitat is amenable.

Sites Visited During 2018:

Arnett Creek

Background: In 1992, the Department, Tonto National Forest, and USFWS identified an opportunity to reestablish a native fish community in Arnett Creek and its tributary Telegraph Canyon. In the late 1990s, a fish barrier was built, the stream was chemically treated to remove nonnative fishes, and a few native fish were stocked. Unfortunately those fish did not establish populations, likely because too few were stocked and drought greatly reduced the amount of perennial water in the system.

The partners re-evaluated the stream in 2007, and determined that the small amount of habitat was probably only suitable for Longfin Dace and Gila Topminnow. The plan was to stock Longfin Dace first, and if they established a population, to move forward with Gila Topminnow. Longfin Dace were stocked in 2007, and they did establish. During 2010-2015, Department staff surveyed the few tanks and potential perennial reaches upstream of the proposed stocking locations and did not detect any nonnative fish.

In May 2017, Department staff acquired Redrock lineage of Gila Topminnow from Timbucktwo Tank and stocked 522 into Arnett Creek. Only 74 Gila Topminnow were captured during post-stocking monitoring of Arnett Creek in October, 2017.

Results: On July 9, 2018, Department staff monitored for Gila Topminnow in Arnett Creek. Department staff carried out 9 dipnet sweeps and captured 6 juvenile Gila Topminnow (≤ 20 mm TL) and 6 Longfin Dace. Arnett Creek was nearly dry at the time of sampling with only Longfin dace present in the initial stocking pool (UTM 12S 487210/3680563) which was reduced to less

than one square meter of surface area. All topminnow were captured in a second pool approximately 1.1 kilometers downstream (486404/3681072), which was also nearly dry at less than 2 square meters of surface area and a max depth of less than 20 centimeters. Department staff also visited Telegraph Canyon, which is a tributary to Arnett Creek, and found two short flowing reaches, each with several pools and Longfin Dace present. Telegraph Canyon appears to have higher quality topminnow habitat that Arnett Creek, especially during drought periods.

Recommendations: We recommend that no more Gila Topminnow be stocked into Arnett Creek because of the lack of sufficient water during drought. However, Gila Topminnow in Arnett Creek should be monitored until at least 2020, to determine if they failed to or did establish; the latter seems unlikely. The U. S. Forest Service (USFS) was scheduled to complete the removal of invasive oleander in Telegraph Canyon in early 2018. Once the oleander removal is completed, Gila Topminnow should be stocked into Telegraph Canyon, and then monitored for at least three years to determine establishment.

Black Canyon City Heritage Park Pond

Background: Black Canyon City Heritage Park Pond is located within the Agua Fria Drainage in Yavapai County, Arizona. In 2006, the Albin Family donated 30 acres of land, which included a large pond, to Black Canyon City. The Black Canyon City Council then contacted the Department to inquire about establishing native fish populations within this man-made pond. In August 2011, Department staff stocked 3,000 Gila Topminnow and 986 Desert Pupfish into Black Canyon City Heritage Park Pond. In November 2012, Department staff stocked an additional 205 Desert Pupfish into the pond. Both Gila Topminnow and Desert Pupfish became established in the pond.

In fall 2016, the Department and Black Canyon City decided to drawdown and dry the pond to eliminate Western Mosquitofish and Tilapia that were illegally stocked into the pond. Before the drawdown, Desert Pupfish were salvaged from the pond and held overwinter at the Department Headquarters' warehouse. Gila Topminnow were not salvaged because of the close similarity to Western Mosquitofish. The pond was drained, left to dry for several weeks, and refilled. In March 2017, Department staff stocked 122 of the salvaged Desert Pupfish into Black Canyon City Heritage Park Pond. In November 2017, Department staff monitored the pond and in collapsible minnow traps captured 23 Desert Pupfish and 3 American Bullfrogs (tadpoles) were captured. In seine hauls, 599 Desert Pupfish and several American Bullfrogs (tadpoles and adults) were captured.

Results: On June 1, 2018, Department staff acquired Sharp Spring lineage Gila Topminnow from Robbins Butte Wildlife Area's Stop Sign Pond and stocked 734 into Black Canyon City Heritage Park Pond. Fish behaved normally upon release; there were six mortalities during translocation.

On August 23, 2018, Department staff monitored Gila Topminnow and Desert Pupfish in the Black Canyon City Heritage Park Pond. Department staff set 20 collapsible minnow traps for a minimum of 2 hours and captured 315 Desert Pupfish, 140 Gila Topminnow and 45 bullfrog tadpoles. Department staff carried out five seine hauls and captured an additional 189 Desert Pupfish, 1,287 Gila Topminnow and 53 bullfrog tadpoles. Nearly twice the number of Gila Topminnow stocked in June were captured during monitoring in August, indicating that topminnow are actively reproducing in this system. Similarly, Desert Pupfish appear to be reproducing well, with 172 fish captured being less than 20 millimeters in total length.

Recommendations: Desert Pupfish in Black Canyon City Heritage Park Pond should be monitored annually until at least 2020 to determine if the population establishes. Additional Desert Pupfish should be stocked in the pond to increase the founding population size. Gila Topminnow should be monitored until 2021, unless more are stocked. Roundtail Chub[1] can be stocked in 2019 or later, after Desert Pupfish are established.

Charlebois Spring

Background: Charlebois Spring is located in the Salt River Drainage within Tonto National Forest in the Superstition Wilderness. In June 1983, Charlebois Spring was stocked with 200 Gila Topminnow and the population persisted there until 2006, until disappearing for unknown reasons. In 2015, Department staff confirmed the presence of Gila Topminnow in La Barge Canyon, roughly 7 km downstream of Charlebois Spring. It is likely that these Gila Topminnow came from Charlebois Spring and were flushed downstream during heavy monsoon rains. Since Gila Topminnow persisted at Charlebois Spring for over 20 years, Department staff recommended restocking the species back into the site. Department staff restocked Charlebois Spring in May, 2017 with 622 Gila Topminnow. The topminnow were mixed lineage stock from Rio Salado Audubon Center.

Results: On October 22, 2018, Department staff surveyed for Gila Topminnow at Charlebois Spring. Department staff set 11 collapsible minnow traps in the main spring and several downstream pools and captured 870 Gila Topminnow. An additional 54 topminnow were captured in 27 dip net sweeps from the main spring down to LaBarge Canyon. Gila Topminnow were dispersed throughout the wetted section of Charlebois Spring and much more abundant than during 2017 monitoring when only 18 topminnow were captured.

Recommendations: Gila Topminnow in Charlebois Spring should be monitored until at least 2020 to determine if they establish. Additional stockings may occur if deemed necessary. Vegetation removal is recommended to reduce shade over the spring and open up the canopy for Gila Topminnow.

[1] Chub to be stocked into Black Canyon City Heritage Pond were previously classified as Gila Chub.

Hidden Water Spring

Background: Hidden Water Spring is located in Cane Spring Canyon, about 0.6 km upstream of the confluence with Cottonwood Creek which flows into Saguaro Lake. Gila Topminnow were first stocked into Hidden Water Spring in 1976 and 1981 and were detected in 2010, but then not in 2011, 2012, or 2013. Therefore, Department staff stocked 544 Gila Topminnow in 2016; Peck Canyon lineage from Phoenix Zoo. In October 2017, Department staff monitored Hidden Spring and captured 401 Gila Topminnow, 283 Longfin Dace, and 163 Lowland Leopard Frog tadpoles in 11 minnow traps. In the seine hauls, 24 Gila Topminnow, 60 Longfin Dace), and 9 Lowland Leopard Frogs (1 adult, 8 tadpoles) were captured.

Results: On October 17, 2018, Department staff monitored Gila Topminnow at Hidden Water Spring. Department staff set 11 collapsible minnow traps for a minimum soak time of 2 hours and captured 191 Gila Topminnow and 58 Longfin Dace. An additional 62 topminnow were captured in 12 dip net sweeps and 59 topminnow in six seine hauls. Longfin Dace and Lowland Leopard Frogs were present throughout the entire wetted section of Hidden Water Spring. Gila Topminnow are reproducing in Hidden Water Spring as 113 juvenile fish (≤ 20 mm TL) were captured.

Recommendations: Gila Topminnow in Hidden Water Spring should be monitored until at least 2020 to determine if they establish. Additional stockings may occur if deemed necessary.

International Wildlife Museum

Background: The Safari Club International Wildlife Museum (IWM) at 4800 Gates Pass Road, Tucson, has an outdoor exhibit pond consisting of three large, connected pools with a water pump that recirculates water through the system. In 1998, IWM was issued a Wildlife Holding Permit to display federally endangered native fish for educational purposes, as well as to act as a refuge for native fish populations. Subsequently, Gila Topminnow and Desert Pupfish were stocked into the IWM outdoor exhibit pond in 1999. Roundtail Chub[1] were salvaged from O'Donnell Creek before an antimycin treatment to remove nonnative fish and translocated to IWM in 2002.

In August 2015, Western Mosquitofish were detected in the IWM outdoor exhibit pond. As a result, Department staff salvaged Desert Pupfish and Roundtail Chub[1] from the pond and IWM drained and dried the pond to remove Western Mosquitofish. IWM also repaired leaks and then refilled the pond in 2016. Department staff stocked 356 salvaged Desert Pupfish on September 23, 2016 after the pond was refilled. In 2017 Department staff removed 10 illegally introduced Goldfish from the IWM outdoor exhibit pond.

[1] Roundtail Chub at IWM were previously classified as Gila Chub

Results: On June 20, 2018, Department staff stocked 611 Gila Topminnow into the ponds at the International Wildlife Museum (IWM). There were 111 mortalities during transport and stocking which may be attributable to not salting fish transport coolers because of high conductivity in source water and difficulty tempering fish due to elevated water temperatures at the stocking location (30.8 C). Gila Topminnow (Peck Canyon lineage) were acquired from the Phoenix Zoo.

Recommendations: We recommend that the Department's Native Aquatics program-Topminnow-Pupfish staff or Region V fisheries staff take over all nonnative removal, native fish stocking, and monitoring activities at IWM. Alternatively, IWM staff might be permitted to take over nonnative removals and monitoring. Regardless, additional removal efforts should occur in the IWM outdoor exhibit pond to remove nonnative Goldfish. Additional Desert Pupfish should be stocked in the pond to increase the founding population size. Roundtail Chub[1] could be restocked into the pond when fish are available. A few Razorback Suckers could also be stocked to facilitate outreach and education of IWM visitors.

Las Cienegas NCA - Bill's Wildlife Pond

Background: Bill's Wildlife Pond is located in the Gardner Canyon drainage about 2.1 km upstream of the confluence with Cienega Creek. In spring of 2016, BLM informed the Department that work on the pond was completed and it was ready for fish. Bill's Wildlife Pond was stocked with 841 Gila Topminnow (Cienega Creek lineage) in 2016. Department staff monitored Bill's Wildlife Pond in 2017 and only captured 18 Gila Topminnow, and the population was augmented with an additional 636 topminnow.

Results: On May 10, 2018, Department staff collected 196 Gila Topminnow from Clyne Pond (Cienega Creek lineage) and transported them in an aerated cooler to Bill's Wildlife Pond. A total of 190 topminnow were stocked into the pond with six mortalities during transport.

On August 8, 2018, Department staff set 10 minnow traps in Bill's Wildlife Pond and captured a total of five Gila Topminnow. Hundreds of Gila Topminnow were observed; but as in previous surveys, they were difficult to capture with minnow traps in this pond.

Recommendations: Bill's Wildlife Pond has been stocked three times with poor returns in monitoring, so we will continue to monitor this population until 2020 to determine if there is establishment. Alternative sampling approaches may be used (i.e. floating minnow traps, seining) to see if capture efficiency can be improved. Additional stockings may occur if deemed necessary. Water quality is a potential area of concern for Bill's Wildlife Pond, as a turbid brownish/yellow water color has now been observed on multiple occasions and should be investigated.

[1] Chub at IWM and Clyne Pond were previously classified as Gila Chub.

Las Cienegas National Conservation Area - Clyne Pond

Background: Clyne Pond is located in the Mud Springs Canyon drainage about 10.5 km upstream of the confluence with Cienega Creek. The pond is adjacent to a private ranch, and the rancher uses the pond to provide water to his livestock. On August 19, 2015 Department and BLM staff stocked 501 Gila Topminnow (Cienega Creek lineage) into Clyne Pond. Since no Gila Topminnow were detected during sampling in August 2016, Department and BLM staff stocked an additional 541 Gila Topminnow on August 30, 2016. The pond was augmented with an additional 76 Roundtail Chub[1] from Cienega Creek in 2016 and 75 Roundtail Chub[1] salvaged from Cienega Creek in 2017. Roundtail Chub[1] were not captured during monitoring in 2017.

Results: In early 2018, BLM staff reported that Clyne Pond could dry because of ongoing drought conditions. Therefore, on May 10, 2018, Department staff attempted to salvage chub from Clyne Pond. The pond was down to about 2.5 feet deep and about 35 m across. Sago pondweed was very thick and covered the entire pond. Staff performed two bag seine hauls across the pond, but because of the pondweed, they were ineffective. Staff then set 14 mini-hoop nets dispersed around the perimeter and a couple in the middle. After 2 hours they pulled them but did not capture any fish; they did capture 3 Leopard Frog tadpoles. No chub were observed in the pond either. So, this is the fourth time that traps have been set and no chub captured: May 10, 2018 (14 mini-hoop nets); April 21, 2017 (6 hoop nets set by BLM); on August 22, 2017 (10 large hoop nets), and on August 7-8, 2017 (15 mini-hoop nets and 18 minnow traps). So, if there are any chub left, they are rare or are not going into traps for some reason. They did observe hundreds of Gila Topminnow around the margins of the pond. They salvaged 101 Gila Topminnow and translocated them to Bill's Wildlife Tank on Las Cienegas NCA.

On August 6, 2018, Department staff set eight minnow traps and two mini-hoop nets in Clyne Pond and captured a total of 12 Gila Topminnow and a single Chiricahua Leopard Frog. Roundtail Chub[1] were not captured or observed. Gila Topminnow appeared to be visually more abundant than the catch suggests. However, the pond was nearly dry during sampling and few locations in the pond contained deep enough water for minnow traps to fish effectively.

Recommendations: Gila Topminnow and Roundtail Chub[1] monitoring in Clyne Pond should continue until at least 2020 to determine if they establish. More fish of both species may be stocked if deemed necessary and water levels improve.

Las Cienegas NCA - Cieneguita Wetland Crescent Pond

Background: Crescent Pond is one of three ponds in the Cieneguita Wetland in the Empire Gulch drainage about 2.1 km upstream of the confluence with Cienega Creek. It was previously referred to as Cieneguita Wetland Pond #3. In July 2013, Department and BLM staff stocked 290

[1] Chub in Cline Pond were previously classified as Gila Chub.

Desert Pupfish and 240 Gila Topminnow into Crescent Pond. The Desert Pupfish were acquired from Robbins Butte Wildlife Area's Twin Tanks, Desert Botanical Garden, Deer Valley High School, McDowell Mountain Regional Park's Nursery Tank, International Wildlife Museum, and Spur Cross Conservation Area. The Gila Topminnow were captured from Cienega Creek. On August 29, 2016, Department and BLM staff stocked 216 Desert Pupfish into Crescent Pond. These fish were acquired from Cottonwood Tank at Robbins Butte Wildlife Area. Both size classes of Gila Topminnow and Desert Pupfish were captured each year from 2014 through 2017.

Results: On August 7, 2018, Department staff set ten minnow traps in each of the three Cieneguita Ponds. A total of 652 Gila Topminnow and 63 Desert Pupfish were captured in Crescent Pond. This was the fifth consecutive year after stocking that Gila Topminnow were detected Crescent Pond and each year over 500 were captured.

On August 21, 2018, Department staff stocked 24 Desert Pupfish into Crescent Pond to maintain the genetic diversity of the existing population. Pupfish were collected from Mandarin and Arizona Pond at Phoenix Zoo (22) and Nina Mason Pulliam Rio Salado Audubon Pond (2).

Recommendations: Both Gila Topminnow and Desert Pupfish are considered established at Crescent Pond. Monitoring can be shifted to another Department Program or another agency. Periodically a few Desert Pupfish and Gila Topminnow should be stocked to maintain genetic variability.

Las Cienegas National Conservation Area - Cieneguita Wetland Egret Pond

Background: Egret Pond is one of three ponds in the Cieneguita Wetland in the Empire Gulch drainage about 2.1 km upstream of the confluence with Cienega Creek. It was previously referred to as Cieneguita Wetland Pond #1. In May 2013, Department and BLM staff stocked 751 Gila Topminnow (from Cienega Creek) and on August 19, 2015 they stocked 99 Desert Pupfish into Egret Pond. On August 29, 2016, Department and BLM staff stocked an additional 252 Desert Pupfish into Egret Pond. These pupfish were acquired from Cottonwood Tank at Robbins Butte Wildlife Area. Both size classes of Gila Topminnow were captured each year of monitoring from 2014 through 2017. Both size classes of Desert Pupfish were captured in 2016 and 2017.

Results: On August 7, 2018, Department staff set ten minnow traps in each of the three Cieneguita Ponds. A total of 993 Gila Topminnow and 40 Desert Pupfish were captured in Egret Pond. Gila Topminnow has been captured for five consecutive years post-stocking, and each year over 500 individuals were captured. Desert Pupfish (both size classes) have also been captured for five consecutive years.

On August 21, 2018, Department staff stocked 173 Desert Pupfish into Egret Pond to maintain the genetic diversity of the existing population. Pupfish were collected from Cottonwood and Twin Tanks at Robbins Butte Wildlife Area (77), Mandarin and Arizona Pond at Phoenix Zoo (93) and Nina Mason Pulliam Rio Salado Audubon Pond (3).

Recommendations: Gila Topminnow and Desert Pupfish are considered established at Egret Wildlife Pond. Monitoring can be shifted to another Department program or another agency. Periodically a few Desert Pupfish and Gila Topminnow should be stocked to maintain genetic variability.

Las Cienegas National Conservation Area - Cieneguita Wetland Heart Pond

Background: Heart Pond is one of three ponds in the Cieneguita Wetland in the Empire Gulch drainage about 2.1 km upstream of the confluence with Cienega Creek. It was previously referred to as Cieneguita Wetland Pond #4. On May 6, 2013, Department and BLM staff stocked 199 Desert Pupfish in Heart Pond. These fish were acquired from Cottonwood Tank at Robbins Butte Wildlife Area, as well as the International Wildlife Museum. During sampling in August 2014, 328 Desert Pupfish were captured; however, in July 2015, only 31 Desert Pupfish were detected (Love-Chezem et al. 2015b, Mosher et al. 2016). As a result, Department and BLM staff stocked an additional 99 Desert Pupfish on August 19, 2015. These fish were acquired from Robbins Butte and TNC Lower San Pedro River Preserve pond (Mosher et al. 2016). During monitoring in August 2016, 73 Desert Pupfish were captured and in August 2017, 24 Desert Pupfish were captured.

Results: On August 7, 2018, Department staff set ten minnow traps in each of the three Cieneguita Ponds. A total of 83 Desert Pupfish and one Gila Topminnow were captured in Heart Pond. Topminnow have not been stocked in Heart Pond, so the origin of the single topminnow captured is unclear.

On August 21, 2018, Department staff stocked 173 Desert Pupfish into Heart Pond to maintain the genetic diversity of the existing population. Pupfish were collected from Cottonwood and Twin Tanks at Robbins Butte Wildlife Area (85), Mandarin and Arizona Pond at Phoenix Zoo (85) and Nina Mason Pulliam Rio Salado Audubon Pond (3).

Recommendations: Desert Pupfish are considered established, so monitoring can be shifted to another Department program or another agency. Periodically a few Desert Pupfish should be stocked to maintain genetic variability.

Las Cienegas NCA - Cottonwood Tank

Background: Cottonwood Tank is located in the Gardner Canyon drainage about 5.2 km upstream from the confluence with Cienega Creek. The pond is one of a set of two connected

ponds, and is separated from the second pond by a berm and fence. Livestock are allowed in the north pond but are excluded from the south pond. On July 15, 2013, Department and BLM staff stocked 269 Desert Pupfish into the south pond. Since only 4 Desert Pupfish were captured during monitoring in August 2014, Department and BLM staff stocked an additional 177 Desert Pupfish in October 2014. During sampling in July 2015, 851 Desert Pupfish were captured. However, only 34 Desert Pupfish were captured in both 2016 and 2017. The existing Cottonwood Tank population was augmented with 155 individuals following monitoring in 2017.

Results: On August 7, 2018, Department staff set ten minnow traps in Cottonwood Tank and captured a total of 47 Desert Pupfish and 1 Chiricahua Leopard Frog. Only three of the fish captured were less than 20 millimeters in length, indicating that limited reproduction is occurring in this system.

Recommendations: Desert Pupfish were last stocked in 2017, so monitoring needs to continue until at least 2020 to determine if they establish. Alternative sampling approaches may be used (i.e. floating minnow traps, seining) to see if capture efficiency can be improved during monitoring.

Las Cienegas NCA - Gaucho Tank

Background: Gaucho Tank is located in the Gardner Canyon drainage about 1.3 km east of Cottonwood Tank. Gila Topminnow were discovered in Gaucho Tank in 2014, and likely were inadvertently transferred to the pond in aquatic plants when preparing the pond for frogs. Because the founding population size was unknown, Department staff translocated 512 Gila Topminnow from Cienega Creek to Gaucho Tank in 2014 to increase genetic diversity. During sampling in July 2015, 1,145 Gila Topminnow, 25 Desert Pupfish, and 1 leopard frog tadpole were captured. Desert Pupfish were not originally stocked into Gaucho Tank, so it is possible that Desert Pupfish were also unintentionally introduced when aquatic vegetation was translocated into the pond. Since the founding population size was unknown, Department staff stocked 365 Desert Pupfish into Gaucho Tank in August 2015. Numbers of fish captured during annual monitoring increased from 1,132 Gila Topminnow and 56 Desert Pupfish in 2016 to 2,785 Gila Topminnow and 166 Desert Pupfish in 2017.

Results: On August 7, 2018, Department staff set ten minnow traps and one mini-hoop net in Gaucho Tank and captured a total of 450 Gila Topminnow, 129 Desert Pupfish and 6 Chiricahua Leopard Frogs. Juvenile fish accounted for more than 85% of the Desert Pupfish captured (110 of 129) so substantial reproduction is occurring and the population appears to be self-sustaining at this time.

Recommendations: Hundreds to thousands of Gila Topminnow were captured in the four years of post-stocking monitoring for Gila Topminnow, so the species is considered established in

Gaucho Tank. Both size classes of Desert Pupfish have been captured in the three years of post-stocking monitoring, so they are also considered established in Gaucho Tank. Monitoring can be shifted to another Department program or another agency.

Las Cienegas NCA - Nogales Spring

Background: Nogales Spring is located in the upper portion of the Wakefield Canyon drainage, about 10 km upstream of the confluence with Cienega Creek. Department and BLM staff stocked 833 Gila Topminnow (Cienega Creek lineage) in May 2012. Nogales Spring was visually surveyed by Department and BLM staff on July 10th, 2012, who observed about 50-100 large and 50 small Gila Topminnow. However, no fish were seen or captured during monitoring in July 2013. Habitat looked suitable in pools downstream, so Department staff stocked 485 more Gila Topminnow in August 2013. However, only 3 Gila Topminnow were captured in August 2014, and none in July 2015. The site appeared to have suitable habitat and was subsequently stocked with 612 Gila Topminnow in August 2015. In August 2016 only five Gila Topminnow were captured and in August 2017 only three Gila Topminnow were captured.

Results: On August 8, 2018, Department staff monitored Gila Topminnow at Nogales Spring and failed to capture or observe any fish in 20 dip net sweeps. It appears that gaps have developed in the travertine, and some locations that were previously pools are now dry.

Recommendations: Since Gila Topminnow were not captured or observed in 2018, two more monitoring trips should be completed to confirm extirpation. However, it seems unlikely that they will establish, and we recommend that another Department program or another agency complete the last two surveys. Establishment may be hindered by high CO_2 concentrations, heavy stream shading, or potentially limited habitat during low-flow periods.

Las Cienegas National Conservation Area – Spring Water Wetland

Background: Spring Water Wetland is located just east of Cienega Creek about 0.4 km upstream of the confluence with Spring Water Canyon. Department and BLM staff stocked 674 Gila Topminnow in May 2013; the fish were acquired from Cienega Creek. Over 8,000 Gila Topminnow were captured during monitoring in 2014, over 1,000 in 2015, and over 12,000 in 2016. In June of 2017, Department and USFWS staff salvaged 85 Roundtail Chub[1] from Cienega Creek and stocked them into Spring Water Wetland due to concerns about potential post-fire effects from the Sawmill Fire.

Results: On August 7, 2018, Department staff set 18 minnow traps and two mini-hoop nets in Spring Water Wetland and captured 1,161 Gila Topminnow and 71 Roundtail Chub[1]. Gila Topminnow and Roundtail Chub were fully counted in the first four minnow traps processed, but topminnow were released from the remaining traps because a severe thunderstorm closed in on

[1] Roundtail Chub stocked into Spring Water Wetland were previously classified as Gila Chub

the area. All Roundtail Chub[1] captured in the remaining 14 minnow traps and two mini-hoop nets were counted and assigned to a size class. The juvenile Roundtail Chub[1] size class (<50 mm TL) comprised more than 71% of the total catch (51 of 71 fish) so reproduction had occurred because only 22 individuals less than 50 mm TL were initially stocked.

Recommendations: Gila Topminnow are considered established in Spring Water Wetland. However, because Roundtail Chub[1] were stocked in 2017, monitoring should continue until at least 2020. Because the population was started with relatively few individuals, several hundred more Roundtail Chub[1] from Cienega Creek should be stocked to help the population establish and to improve the genetic diversity of the Spring Water Wetland population.

San Pedro Riparian NCA - Murray Spring

Background: Murray Spring is an east flowing tributary of the San Pedro River. A perennial section begins about 2.8 km west of the San Pedro River and extends about 1.6 km through a cienega and has pools, runs, and glides. A wastewater treatment facility exists about 1.8 km upstream and provides groundwater input to Murray Spring. About 1.5 km upstream from the confluence with the San Pedro River, is a concrete structure that seems to act as a barrier and prevents nonnative fishes from moving upstream. Gila Topminnow and Desert Pupfish were stocked in Murray Spring in 2011, 2013, 2014 and 2017. However, neither species appears to be establishing, as fewer 11 topminnow were captured each year from 2012 through 2017, and fewer than 6 pupfish were captured each year from 2013 through 2017. Longfin Dace however have increased since an unplanned translocation of 50 fish from below to above the barrier. It is possible that Longfin Dace are affecting the ability of Gila Topminnow and Desert Pupfish to establish at the site due to competition for habitat and resources. The creek is also thick with sedges and cattails which has decreased available pool habitat for Gila Topminnow and Desert Pupfish over the years.

Results: On August 6, 2018, Department staff set 13 mini-hoop nets and carried out 7 dipnet sweeps at Murray Spring and captured a total of 57 Gila Topminnow, 84 Longfin Dace and 35 crayfish above the barrier. An additional 4 Gila Topminnow, 4 Desert Sucker, 12 Longfin Dace, 84 crayfish and a single juvenile Sonora Sucker were captured in four seine hauls downstream of the barrier. This is the most Gila Topminnow that have ever been captured during monitoring, but also the first year since 2014, that Desert Pupfish were not captured or observed.

Recommendations: Gila Topminnow in Murray Spring should be monitored until at least 2020 to determine if they establish. Since cattails have greatly expanded in the stream bottom and very few pools are left, stream channel improvements at this site are recommended. It is unknown if BLM, on whose property Murray Spring is located, has any plans to improve the habitat.

Mud Spring-Coronado National Forest.

Background: Mud Spring is located on the southwest slope of the Huachuca Mountains in the Sycamore Canyon drainage within the upper San Pedro River drainage on the Coronado National Forest. The pond is at 1,700 m elevation and has a surface area of about 255 m^2 and is about 2 m deep in the middle. The pond is fed by a spring and is on the south-facing slope of the hills, which should moderate winter water temperatures. The pond is surrounded by frog fence to prevent the incursion of American Bullfrogs. The pond is encircled by sedges, and chara covers most of the bottom in the open water areas. The pond is occupied by Chiricahua Leopard Frog and is to be a Mexican Gartersnake repatriation site.

Results: On August 29, 2018, Department staff collected Sharp Spring lineage Gila Topminnow from the captive population at Arizona State University. The fish were transported to Mud Spring (UTM 12S 558197/3473517), and 494 were stocked; an additional 6 died during the translocation. Fish behaved normally upon release. When fish were stocked the pond had a water temperature of about 30°C, a dissolved oxygen concentration of 15.6 mg/L, and a pH of 9.93. The high pH may be problematic for Gila Topminnow establishment, but as mentioned, fish behaved normally upon release.

Recommendations: The pH in Mud Spring was high at the time of stocking, so water quality should be monitored going forward. Gila Topminnow should be monitored in Mud Spring until at least 2021 and additional stockings should occur as necessary.

Peterson Ranch Pond.

Background: Peterson Ranch pond, at 1892 m elevation in Coronado National Forest, is located in Scotia Canyon, tributary to the Santa Cruz River in the San Rafael Valley. The pond is fed by a spring which moderates the winter temperatures in the pond. The pond is about 670 m^2 and has a maximum depth of about 3 m, and is surrounded by frog fencing. The pond is inhabited by Chiricahua Leopard Frogs, Longfin Dace (stocked in 2015), and Mexican Gartersnakes (introduced in 2018).

Results: On August 8, 2019, Department staff stocked 762 Gila Topminnow (Sharp Spring lineage) into Peterson Ranch Pond. Fish behaved normally upon release, but many of the smaller ones were chased by Longfin Dace. In addition, there were 142 Gila Topminnow mortalities, all of which were small individuals (≤ 20 mm TL). We observed 50-75 Longfin Dace, so that species has persisted since they were stocked. The pond water was clear, had about 90% open water, with Chara covering much of the bottom, and the shoreline vegetated with rushes.

Topminnow were acquired from Robbins Butte Stop Sign Pond and Swimming Pool Pond. Although topminnow were abundant and easily captured at Stop Sign Pond a few months earlier, on August 8, only small and mid-sized fish were captured. Normally small fish are not translocated. However, staff were concerned about being able to collect 500 in total for the translocation, so a couple hundred of those small to mid-sized fish were kept for translocation.

Staff then went to Swimming Pool Pond, where they were able to collect larger fish, and ended up with about 900 fish for translocation.

Recommendations: Peterson Ranch pond should be monitored annually until 2022, unless more topminnow are stocked, and then monitoring will extend three years after the final stocking. If fewer than 100 topminnow are captured in 2019, then more will be stocked that year to further attempt to establish a population.

Robbins Butte Wildlife Area – Cottonwood Tank
Background: Robbins Butte Wildlife Area is located southwest of Buckeye, south of the Gila River and just west of Highway 80. Cottonwood Tank is located about 800 m west of the wildlife area headquarters. Cottonwood Tank contains an established population of Desert Pupfish, and was last stocked with 625 pupfish in 2010. Cottonwood Tank was monitored in 2018, because it was near Swimming Pool Tank and Stop Sign Tank, and because it was a planned source for a Desert Pupfish translocation to Las Cienegas ponds later that year.

Results: On July 3, 2018, Department staff captured a total of 172 Desert Pupfish in Cottonwood Tank by setting 10 minnow traps for a minimum soak time of two hours. The pupfish population continues to do well at this location.

Recommendations: The Department recommends periodic monitoring to confirm the population persists and is abundant.

Robbins Butte Wildlife Area – Stop Sign Tank.
Background: Robbins Butte Wildlife Area is located southwest of Buckeye, south of the Gila River and just west of Highway 80. Stop Sign Tank is located just north of the entrance road, and about 2.1 km west of Highway 80. Department staff stocked 571 Gila Topminnow in April 2010. The fish were acquired from Deer Valley High School (Bylas Spring lineage), and Desert Harbor High School (Redrock Canyon lineage).

Department staff monitored the Gila Topminnow in the pond during November 2010, June 2011 and June 2012, and captured over 4,000 topminnow each time, so topminnow were considered established (Pearson et al. 2013). Over 1,000 were captured in June of 2013 for an experiment at ARCC. However, Department staff visited the site in 2014 and did not capture or see any fish. The same was true in nearby Swimming Pool Pond. The Wildlife Area Manager reported that the pond was very green with algae and that boy scouts had removed cattails from the pond, and it was cloudy the day of removal. Too much sediment may have been kicked up and caused the pond to go anoxic, killing all of the fish. Department staff thought that the topminnow were likely extirpated from these two ponds, and recommended that water be pumped into the pond on a more regular basis to improve conditions for fish. Department staff also planned to restock Gila

Topminnow into the pond. In August 2015, Department staff collected Sharp Spring lineage Gila Topminnow from AD Wash, Buckhorn Spring, and ASU Animal Care Facility and stocked 554 into Stop Sign Tank. A single Gila Topminnow was captured during monitoring in 2016 and 652 topminnow were captured in 2017.

Results: On July 3, 2018, Department staff captured a total of 1,138 Gila Topminnow in Stop Sign Tank by setting 10 minnow traps for a minimum soak time of two hours. There were 470 mortalities during sampling. It appears that the tank may have been strongly stratified at the time of sampling with an anoxic layer present just below the surface that caused the high level of mortality. Water quality appears to be an ongoing issue in this location.

Recommendations: Gila Topminnow was restocked in 2015, after they were thought to have been extirpated. Since the 2015 stocking, three years of monitoring have been completed and over 600 topminnows comprised of both size classes, were captured in each of the last two years. Therefore, Gila Topminnow is once again considered established in Stop Sign Tank. However, due to the ongoing water quality issues, this tank should still be monitored periodically to ensure persistence. Department staff recommend that the Area Manager add water to the pond more often to help improve water quality.

Robbins Butte Wildlife Area – Swimming Pool Tank.

Background: Robbins Butte Wildlife Area is located southwest of Buckeye, south of the Gila River and just west of Highway 80. Swimming Pool Tank is located near the headquarters. Department staff stocked 639 Gila Topminnow in November 2009. The fish were acquired from ARCC and were Sharp Spring lineage.

Department staff monitored the Gila Topminnow in the pond during November 2010, June 2011 and June 2012, and captured over 4,000 topminnow each time, so topminnow were considered established (Pearson et al. 2013). However, Department staff visited the site in 2014 and did not capture or see any fish. The Wildlife Area Manager reported that the pond had been drawn down most of the way during maintenance of an adjacent road. Afterwards water was not added and conditions became unsuitable for the fish. Department staff recommended that water be pumped into the pond on a more regular basis to improve conditions for fish. In August 2015, Department staff collected Sharp Spring lineage of Gila Topminnow from AD Wash, Buckhorn Spring, and ASU Animal Care Facility and stocked 558 into Swimming Pool Tank. A total of 91 topminnow were captured during monitoring in 2016, and 390 topminnow were captured in 2017.

Results: On July 3, 2018, Department staff captured a total of 1,480 Gila Topminnow and 1 Desert Pupfish in Swimming Pool Tank by setting 10 minnow traps for a minimum soak time of two hours. Desert Pupfish have not been stocked in Swimming Pool Tank so the origin of the pupfish is unclear, but it was likely transported from nearby Cottonwood or Twin Tanks.

Recommendations: Gila Topminnow was restocked in 2015, after they were thought to have been extirpated. Since the 2015 stocking, three years of monitoring have been completed. The numbers captured have steadily increased, and over 350 topminnows comprised of both size classes, were captured in each of the last two years. Therefore, Gila Topminnow is once again considered established in Swimming Pool Tank. However due to the history of accidental drainage, this location should be monitored periodically to ensure persistence. Department staff recommends that the Area Manager maintains water levels in the tank high at all times, and periodically allow some out flow to improve water quality.

Robbins Butte Wildlife Area – Twin Tanks

Background: Robbins Butte Wildlife Area is located southwest of Buckeye, south of the Gila River and just west of Highway 80. Twin Tanks is located about 300 m west of the headquarters. Twin Tanks contains an established population of Desert Pupfish and was last stocked with 196 pupfish in 2010. It was monitored in 2018 because it is near Swimming Pool Tank and Stop Sign Tank, and because it was a planned source of Desert Pupfish for a translocation to Las Cienegas Ponds later that year.

Results: On July 3, 2018, Department staff captured a total of 286 Desert Pupfish in Twin Tank by setting 5 minnow traps in each half of Twin Tank for a minimum soak time of two hours.

Recommendations: Department staff recommends periodic monitoring to confirm the population persists and remains abundant.

Rock Spring.

Background: Rock Spring is located in the Mazatzal Mountains within the Tonto National Forest about two miles west of Highway 87 near Sunflower, Arizona. The spring is in the stream bed and typically produces about a 0.25 km perennial stream immediately downstream; the remaining section of stream is intermittent or ephemeral (Bahm and Carter 2007). In the perennial section of the stream, two pools are located above and three pools below a 1.5 m tall dam. The perennial portion is fenced with a four-strand barbed wire fence to exclude livestock and protect habitat. Gila Topminnow (middle Santa Cruz River lineage) were initially stocked in Rock Spring (above and below the dam) in 2013, and later augmented below the dam in 2014 (Frear et al. 2015). Department staff captured 49 Gila Topminnow in October 2013, 130 in August 2014 and 53 in June 2015; both size classes were captured each time (Frear et al. 2015; Mosher et al. 2016). In July 2016, Department staff captured 794 Gila Topminnow and observed 150 Gila Topminnow. Gila Topminnow were not captured or observed in 2017 and only one Longfin Dace was captured. Department staff thought that drought had shrunk available habitat down so small that only the dace survived.

Results: On July 16, 2018, Department staff monitored Rock Spring for Gila Topminnow by setting 10 collapsible minnow traps for a minimum soak time of two hours. Department staff also carried out six dip net sweeps. No fish were captured or observed during sampling. A total of eight Sonoran Mud Turtles were captured in minnow traps and several more were observed. The absence of fish suggests that Rock Spring may have gone dry or nearly dry at least once during the last two years.

Recommendations: Rock Spring should be monitored at least one more time to confirm that Gila Topminnow are absent. A temperature logger should be installed in the deepest portion of the main pool to determine its permanence.

Sabino Canyon.

Background: Sabino Canyon is located northeast of Tucson, Arizona within the Coronado National Forest and Sabino Canyon Recreation Area. Sabino Creek, a tributary to the Santa Cruz River, flows southwest through Sabino Canyon and empties into Tanque Verde Wash in Tucson. Sabino Creek was chemically treated in 1999 to remove nonnative Green Sunfish, and afterwards was stocked with salvaged Roundtail Chub[1] (Ehret and Dickens 2009a). In August 2015, Department, Coronado National Forest, and USFWS staff stocked 510 Gila Topminnow into Sabino Canyon Recreation Area near a location locally known as The Crack. Gila Topminnow were collected the previous day from Cienega Creek and Road Canyon Tank (Cienega Creek lineage). Since only 72 Gila Topminnow were captured during sampling in June 2016, Department and BLM staff stocked an additional 985 Gila Topminnow on August 30, 2016. These fish were collected earlier in the day from Road Canyon Tank (Cienega Creek lineage). A total of 105 Gila Topminnow were captured during monitoring efforts in June, 2017.

Results: On June 7, 2018, Department staff monitored Gila Topminnow in Sabino Canyon and captured a total of 276 Gila Topminnow and 959 Roundtail Chub[1]. A total of 84 Gila Topminnow and 788 Roundtail Chub[1] were captured in 13 minnow traps, 192 Gila Topminnow and 163 Roundtail Chub[1] in three seine hauls, and eight Roundtail Chub[1] in five dip net sweeps. For both species, juvenile and adult size classes were captured.

On June 8, 2018, Department staff reevaluated habitat in a reach of Sabino Canyon located approximately 250 meters upstream from the confluence with East Fork Sabino Canyon. The results of the habitat assessment can be found in the habitat assessment section of this report. Later that same date, several thousand Gila Topminnow and several hundred Roundtail Chub[1] were visually observed in a series of four large pools just downstream of Sabino Lake Dam. These lower pools appeared to be an ideal location to collect Gila Topminnow to move to the pools above the East Fork confluence due to the abundance of fish, easy access and the potential for several of the lower pools to dry before monsoon rains arrive.

[1] Chub stocked into Sabino Canyon were previously classified as Gila Chub.

On June 21, 2018, Department staff stocked 557 Gila Topminnow into a large pool (UTM 12S 520784/3581144) in Sabino Canyon upstream of East Fork Sabino Canyon confluence. Fish behaved normally upon release. There were 54 mortalities during transport, which are attributable to sloshing in the buckets during the 1.5 hour hike up to the site. Gila Topminnow were collected the previous afternoon in Sabino Creek in one of the large pools immediately below Sabino Dam. Fish were triple sorted, to ensure that no chub or any other species were collected.

Recommendations: Annual monitoring should continue in the recreation area until 2019 and near the East Fork Sabino Creek until 2021. In the recreation area, the location below Sabino Dam should be included as one of the monitoring sites. Additional stockings may occur if deemed necessary, particularly in the reach near East Fork. Pending further coordination with USFWS and USFS, Roundtail Chub[1] should be stocked in the pools near the East Fork confluence to expand the upstream distribution of chub in Sabino Creek. In future years, consideration should be given to stocking Roundtail Chub[1] further upstream near West Fork Sabino Creek at a location known as Hutch's pool.

Sheepshead Canyon

Background: Sheepshead Canyon is located within the Coconino National Forest north of Cornville, Arizona. Perennial water begins below a dry waterfall about 1.84 km upstream of the confluence with Oak Creek. The perennial reach is comprised of a network of channels, pools, and wetlands that are maintained by ground water discharge from numerous springs and seeps within the drainage. A diversion ditch is located about 0.6 km downstream of the dry waterfall and flows southeast to private property in Cornville. In September 2014, 819 Gila Topminnow (Middle Santa Cruz River lineage) were stocked into Sheepshead Canyon: 336 in the pool below the dry waterfall and 483 into the pool above the diversion ditch (Mosher et al. 2016). Only two Gila Topminnow were captured during monitoring in June, 2015 and an additional 511 Gila Topminnow were stocked immediately after the monitoring; 241 at the lower site and 270 at the upper site. Similarly, two Gila Topminnow were captured during monitoring in September, 2016. So, in October 2016, Department staff stocked an additional 216 in the upper site 361 into the lower sites, and 79 in a middle pool located about 150 m upstream of the lower site. During monitoring in September 2017, no topminnow were captured at the upper or lower stocking sites, but about 300 were observed at the upper site. However, at the middle location, 83 topminnow were captured and about 50 observed.

Results: On September 4, 2018, Department set five collapsible traps in the upper stocking pool and seven in and near the lower stocking pool; traps soaked for at least two hours. At the upper stocking site (below the waterfall), they captured a single Gila Topminnow and two Sonoran mud turtles. About 150 Gila Topminnow were visually observed while nets were soaking, but

[1] Chub in Sabino Canyon were previously classified as Gila Chub

they were swimming over the deepest water where nets were not as effective at catching fish. No fish were captured or observed at the lower stocking site or in the pool immediately below the diversion. The middle pool was visited and visually inspected, but no topminnows were observed. It is unclear why Gila Topminnow are not persisting in the lower two pools, which appear to have good topminnow habitat with plenty of cover and velocity refuge and adequate sunlight.

Recommendations: Gila Topminnow were last stocked in 2016, therefore monitoring should continue until at least 2019. About 1,990 fish have been stocked in Sheepshead Canyon since 2014; however, captures of fish during annual monitoring has consistently been low. An assessment of water level during the early summer drought period should be an informative step in determining factors currently limiting persistence of Gila Topminnow.

San Rafael Cattle Company -- Pasture 9 Tank

Background: San Rafael Cattle Company Ranch is located in the San Rafael Valley near the border of Mexico. Pasture 9 Tank is located near the foot of Jones Mesa north of Parker Canyon. The pond has a surface area of about 220 m^2, and a depth up to 3 m. Bulrush covers the north and west shores and submersed pondweed and duckweed cover much of the water surface. On September 16, 2016, Department staff stocked 643 Gila Topminnow into Pasture 9 Tank. Fish were Sharp Spring lineage and were acquired from Robbins Butte Wildlife Area Swimming Pool Pond. In June 2017, Department and USFWS staff performed two bag seine hauls across about half of the pond, and captured 31 Gila Topminnow. Large amounts of aquatic vegetation were caught in the seine, which both slowed the haul and the subsequent processing.

Results: On August 29, 2018, Department staff performed one bag seine haul across about half of the pond and captured 52 Gila Topminnow, and a large amount of pondweed and duckweed. The purpose of the seine haul was mainly to confirm that topminnow were still present before more fish were stocked. After completing the seine haul, Department staff stocked 137 Gila Topminnow into Pasture 9 Tank. Fish behaved normally upon release. Topminnow (Sharp Spring lineage) were acquired from Arizona State University Animal Care Facility. There were four mortalities during the translocation.

Recommendations: Gila Topminnow were stocked in 2018, so monitoring should continue until 2021 unless more are stocked next year. If few fish are captured in 2019, we recommend a third stocking. We recommend that bulrush be thinned from the middle of the pond towards the shore, but more importantly that pondweed be removed from the middle of the pond to provide more open water for Gila Topminnow. Allowing cattle in for a short duration might accomplish the vegetation thinning goals.

Tortilla Creek

Background: Tortilla Creek is located within the Salt River Drainage in the Tonto National Forest and flows into Canyon Lake near Tortilla Flat, AZ. Tortilla Creek has an established population of Gila Topminnow in the lower-most section of the creek. Gila Topminnow in the lower section of Tortilla Creek likely originated from a population stocked in Mesquite Tank #2 (above Unnamed Drainage #68-B) on June 3, 1982. A valve on the dam of Mesquite Tank #2 was opened, allowing it to drain and completely dry out. As a result, Gila Topminnow washed downstream and established a population in Unnamed Drainage #68-B and later dispersed into perennial pools in lower Mesquite Creek and lower Tortilla Creek. Due to steep gradient and waterfall barriers, Gila Topminnow did not disperse upstream into the upper perennial section of Tortilla Creek (about 4.3 km upstream of the confluence with Mesquite Creek). In March 2016, Department staff assessed habitat in the upper section, and deemed it suitable for Gila Topminnow. The only fish species present in this upper perennial section were nonnative Fathead Minnow; which are thought to have few negative interactions with native fish. In June, 2017 Department staff stocked 548 Gila Topminnow (Peck Canyon lineage) into upper Tortilla Creek about 4.5 km upstream of the confluence with Mesquite Creek. A total of 829 Gila Topminnow were captured during monitoring in November, 2017.

Results: On November 1, 2018, Department staff monitored Gila Topminnow in Tortilla Creek by setting 10 minnow traps in pools near the original stocking location (UTM 12S 467239/3708608) and captured a total of 1,982 Gila Topminnow, with 373 fish being less than 20 mm total length. A total of 65 Fathead Minnow and one Sonoran Mud Turtle were also captured. Department staff also carried out 15 dipnet sweeps near the original stocking location and captured an additional 38 topminnow. Nearly twice as many Gila Topminnow (829) and fewer Fathead Minnow (110) were captured in 2018 than during monitoring in November 2017. Abundance of both species is trending in the right direction, and the Gila Topminnow population appears well on its way to becoming established. Because the upper and lower sections are separated by several miles of typically dry streambed, and several waterfalls, the topminnow in these two sections could be considered separate populations.

Recommendations: Gila Topminnow in upper Tortilla Creek should be monitored until at least 2020 to determine if they establish. Additional stockings may occur if deemed necessary.

West Fork Pinto Creek

Background: West Fork Pinto Creek is a tributary to Pinto Creek and is located in the Salt River Drainage within the Tonto National Forest. West Fork Pinto Creek is predominantly dry near Miles Ranch Trailhead; however, there is a ~150 m long perennial section (based on 2017 estimates) located about 500 m downstream of the confluence of Spencer Spring Creek. This upper perennial section has series of shallow runs and pools and is inhabited by Longfin Dace. Downstream of the Miles Ranch Trailhead, there are several large plunge pools also inhabited by Longfin Dace. Further downstream is a waterfall below which Green Sunfish, Longfin Dace and

Desert Sucker were detected in 2016. After three habitat assessments in 2016 and 2017, and discussions between the Department, USFS, and USFWS, the Department stocked 705 Gila Topminnow (Sharp Spring lineage) in upper West Fork Pinto Creek in May, 2017. Department staff captured 398 Gila Topminnow (238 ≤ 20 mm TL) during monitoring in October, 2017.

Results: On May 29, 2018, Department and Tonto NF staff visited West Fork Pinto Creek after inspecting nearby Paradise Spring. The amount of water was about 25-50% less than when monitoring was completed in October 2017. But there were still Gila Topminnow and Longfin Dace present. There were about 5-6 fairly large pools (3-m across or more) a couple of which were up to about 0.5 m deep. There was some connecting water between some of these pools, but not between others.

On July 10, 2018, Department staff monitored Gila Topminnow in West Fork Pinto Creek and found low flow conditions; there was only about 30 m of water. Department staff captured a total of 23 Longfin Dace with 4 dip net sweeps in an isolated downstream pool (UTM 12S 491397/3700238) but failed to capture any Gila Topminnow. Department staff sampled a series of pools from (490977/3700128) to (490864/3700056) and captured 9 Gila Topminnow and 35 Longfin Dace in 12 dipnet sweeps and 5 seine hauls. Minnow traps were not set due to absence of sufficiently deep habitat. Only one juvenile Gila Topminnow (≤ 20 mm TL) was captured indicating limited reproduction, and it appears the topminnow population has experienced a substantial decrease in abundance li due to severe drought conditions.

Recommendations: Monitoring of West Fork Pinto Creek should continue until 2021 unless more fish are stocked, and then will continue for three years after the last stocking. Habitat is limited in upper West Fork Pinto Creek and this section of stream can likely only support Gila Topminnow and Longfin Dace. West Fork Pinto Creek downstream of Miles Ranch should be surveyed again to determine if any Gila Topminnow dispersed down there, and to further assess it as another location to stock Gila Topminnow in the drainage. The pools above the waterfall should be assessed again to determine if sufficient habitat is present for Roundtail Chub[1].

Spring Creek (Oak Creek tributary) repatriations (Task AZ-2013-1)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 4. Remove nonnative aquatic species threats.
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

[1] Chub to be repatriated were previously classified as Gila Chub.

Recovery Objectives:

- Spikedace recovery objective 6.2.5 Reclaim as necessary to remove non-native fishes.
- Spikedace recovery objective 6.3. Reintroduce Spikedace to selected reaches.
- Spikedace recovery objective 6.4. Monitor success/failure of reintroductions.
- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 3. Monitor natural and reestablished populations and their habitats.
- Gila Chub draft recovery plan objective 1.3.1. Eliminate or control problematic nonnative aquatic organisms.

Background: Spring Creek is a tributary to Oak Creek in the Verde River drainage, and contains Roundtail Chub[1], Speckled Dace, Longfin Dace, Sonora Sucker, Desert Sucker, and Northern Mexican Gartersnake. A small diversion dam about 0.95 km upstream of Oak Creek seemingly prevented most nonnative fishes from entering the stream above, but there were some records from the 1970s and 1980s of Smallmouth Bass and Fathead Minnow. Green Sunfish were detected below the diversion dam in 2011, and in May 2014 Green Sunfish were captured 2.5 km above the dam. Department staff began removal efforts immediately and completed seven removals in June and July 2014, after which the Department's CAMP staff assumed responsibility of the removal efforts above the dam and completed an additional five days of removal in 2014, three removals in 2015, and two removals in 2016.

The purpose of this multi-agency project was to protect the existing Spring Creek population of Roundtail Chub[2] and other native aquatic species against possible future upstream incursion of nonnative fishes from Oak Creek and the Verde River. Additional benefits would accrue from securing habitat for stocking Spikedace, Gila Topminnow, and possibly Loach Minnow.

Reclamation finished construction of a fish barrier about 1.1 km upstream from Oak Creek in April 2015. On May 11, 2015, Department staff stocked 221 Spikedace (Aravaipa Creek lineage), and on August 12, they stocked 668 Gila Topminnow (Lower Santa Cruz lineage) near Willow Point Road. During the first monitoring in September 2015, Department staff captured three Spikedace and three Gila Topminnow. During the second monitoring in September 2016, no Spikedace were captured. However, one Spikedace (died after capture) was captured during the CAMP Green Sunfish removal. Because so few Spikedace and Gila Topminnow were captured during monitoring, on October 18, 2016, Department staff stocked 67 more Spikedace and 341 Gila Topminnow near Willow Point Road and an additional 347 Gila Topminnow in the large pool above the barrier. Few Spikedace were available from ARCC at the time of stocking

[1] Chub in Spring Creek were previously classified as Gila Chub.

in 2016, which is why so few were stocked. A total of 11 Spikedace and 207 Gila Topminnow were captured during monitoring in September, 2017.

Results: On February 21, 2018, Department staff stocked 1,076 Spikedace near the Willow Point Road crossing. There were five mortalities during the translocation process. Before stocking, 512 fish were held in cages for approximately three hours as part of an eDNA research study.

During September 4-5, 2018, Department staff monitored Gila Topminnow and Spikedace in Spring Creek. Department staff targeted topminnow by setting 10 collapsible minnow traps in the large pool upstream of the barrier and captured a total of 497 Gila Topminnow, 471 of which were >20 mm TL and 26 were ≤ 20 mm TL (Table 6). Gila Topminnow were visually abundant in the pool formed upstream of the diversion, and presence of young of year fish suggests that the population is reproducing.

Department staff targeted Spikedace by electrofishing one fixed 100 meter reach and two randomly selected 100 meter reaches in Spring Creek. A total of 20 Spikedace were captured, which is the best return since stocking began in 2015 (Figure 9). The mean size of Spikedace was 58 millimeters TL (min = 40mm TL, max = 74mm TL; Figure 10). The presence of small Spikedace (40 mm TL) suggests some reproduction may have occurred in Spring Creek. The literature suggests that Spikedace spawn in April to June and reach 35-40 mm standard length by November of their first year of life. Given that Spikedace were last stocked in February 2018, it is unlikely that the smallest fish captured was stocked in 2018. In addition to the Spikedace, 257 Roundtail Chub[1], 143 Speckled Dace, 95 Desert Sucker, 8 Longfin Dace and 18 crayfish were captured during electrofishing (Table 7).

On December 5, 2018, Department staff collected 500 Aravaipa lineage Spikedace from the captive stock held at ARCC and translocated the fish to Spring Creek near the Willow Point Road Crossing. There were no mortalities during the translocation process.

Recommendations: Since Gila Topminnow and Spikedace were stocked in 2018, monitoring should continue until at least 2021. Additional stockings may occur if deemed necessary. Because of the proximity of this site to ARCC and recent advances in Spikedace rearing techniques, this may be an ideal system to evaluate factors contributing to post-stocking survival of Spikedace which could benefit translocation strategies going forward.

Blue River native fish restoration (Task AZ-2002-3)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 4. Remove nonnative aquatic species threats.

[1] Chub in Spring Creek were previously classified as Gila Chub

- Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
- Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

- Spikedace recovery objective 6.2.5. Reclaim as necessary to remove non-native fishes.
- Spikedace recovery objective 6.3. Reintroduce Spikedace to selected reaches.
- Spikedace recovery objective 6.4. Monitor success/failure of reintroductions.
- Loach Minnow recovery objective 6.2.5 Reclaim as necessary to remove non-native fishes.
- Loach Minnow recovery objective 6.3. Reintroduce Loach Minnow to selected reaches.
- Loach Minnow recovery objective 6.4. Monitor success/failure of reintroductions.

Background: The Blue River Native Fish Restoration Project is implemented by the Department, Forest Service, Reclamation, and USFWS, with goals to protect and restore the entire assemblage of native fishes within the Blue River drainage and benefit their conservation status within the Gila River Basin (Reclamation 2010). The major components of the project are construction of a fish barrier, mechanical removal of non-native fishes, and repatriation and monitoring of federally listed warm-water fishes in the Blue River. The focus of the project is in the lower 19 km of the Blue River, from Fritz Ranch to the confluence with the San Francisco River (Figure 11), but additional activities were envisioned upstream (Figure 12) if actions were successful in the lower reach. The Reclamation-funded fish barrier, located in the Blue River about 0.8 km upstream from the confluence with the San Francisco River, was completed in June 2012. Later in the same month, 539 Spikedace and 142 Roundtail Chub were stocked into the lower Blue River above the barrier (Figure 13, Figure 14). Spikedace were upper Gila River lineage and Roundtail Chub were Eagle Creek lineage and both were acquired from ARCC, but some chub were also directly translocated from Eagle Creek. Efforts to remove non-native piscivorous fish from the lower Blue River began before barrier construction (Robinson et al. 2010) and continued annually after the barrier was installed.

During annual post-stocking monitoring, Spikedace catch rates were relatively flat during 2012 through 2014, but then increased from 2015 through 2017 (Figure 13). Following the 2015 monitoring, 296 more Spikedace were stocked into the lower Blue River. Electrofishing catch rates for Roundtail Chub showed a similar pattern, but hoop net catch rates have been more variable from year to year. An additional 876 more Roundtail Chub were stocked into the lower Blue River before the monitoring in 2015 (Figure 14).

The ongoing mechanical removal effort appears to be effective at eradicating nonnative piscivorous fish in the Blue River (Figure 15). Nonnative fish are removed both during removal

trips, and during annual post-stocking monitoring of native fishes. Catfish were the main targets of initial removal efforts, and were removed by snorkeling and spearfishing. During the first removal, in June 2009, 70 Channel Catfish and 4 Flathead Catfish were removed from the Blue River between Fritz Ranch and the mouth (Robinson et al. 2010). Following 2011 Wallow Fire related fish kills and fish barrier construction, only seven Channel Catfish were captured and removed during the June 2012 removal, but one Green Sunfish was also detected (the first record in the drainage; Robinson et al. 2013). During the November 2012 annual monitoring, catfish were not captured, but 106 Green Sunfish were captured and removed, throughout the lower Blue River.

In 2013, Department staff carried out an intensive trapping effort between Steeple Creek and Fritz Ranch to determine if Green Sunfish had dispersed upstream, but no Green Sunfish were captured (Robinson et al. 2014). During June 2013 removals in the lower reach, a total of three Channel Catfish were observed and subsequently removed, and 37 Green Sunfish were observed of which 5 were removed. An additional six Green Sunfish were detected during annual monitoring in 2013.

In 2014, no catfish and eight Green Sunfish were detected during the June removal. In addition to the annual snorkeling and spearfishing to remove catfish, two trips to remove Green Sunfish, by trapping and electrofishing, were completed (Robinson and Love-Chezem 2015). Twelve Green Sunfish were captured and removed during these two trips.

In 2015, Department staff carried out a Green Sunfish removal effort in addition to the two annual trips. A total of nine Green Sunfish were captured and removed and seven were detected while snorkeling (Robinson et al. 2016). No catfish were detected in 2015.

In 2016 one Green Sunfish was captured and removed, but none were detected in 2017. The number of Green Sunfish detected during annual monitoring and the total number removed during all activities has decreased since 2012 (Figure 15). No Channel Catfish have been detected since 2013.

USFWS staff monitored above and below the fish barrier November 14-15, 2017 as part of the post barrier construction effort, and detected five Channel Catfish and one Green Sunfish below the barrier (Ehlo 2017). The nonnative fish captured below the fish barrier were PIT tagged and released to evaluate the barrier's effectiveness.

Native fish conservations activities in the middle Blue River (McKittrick Creek confluence upstream to The Box; Figure 12) began in 2016 when 1,194 Roundtail Chub were stocked between The Box and Cole Flat. In 2017, Department monitored Roundtail Chub with 18 hoop nets set overnight in randomly selected pools, and captured 57 Roundtail Chub. Immediately

following the chub monitoring, Department staff collected 448 Spikedace from the Blue River at Juan Miller crossing and translocated them to the Blue River at Cole Flat. Spikedace were held in cages as part of an eDNA study before release, which may have contributed to some post-stocking mortality.

In September 2017, Department staff also monitored the Roundtail Chub population in Quinsler's Pond (aka Lazy YJ Ranch Pond; aka Tohakidule Pond). Quinsler's Pond was stocked with 373 Roundtail Chub (Eagle Creek lineage) from ARCC in August 2015. In September 2017, Department staff set 22 hoop nets overnight, and captured 274 adult Roundtail Chub (85-223 mm TL). Five of the chub were <100 mm TL indicating that the species had reproduced in the pond.

Results: The Department completed native fish conservation actions in the lower Blue River and middle Blue River during 2018. Results of the lower Blue River are presented first.

During June 25-27, 2018, Department staff performed the annual large-bodied piscivore removal. They visited 128 pools or locations that were previously pools. A total of 72 pools were snorkeled, 18 pools that were too shallow to snorkel were visually observed, and 24 pools were dry, primarily in the lowest reach. In addition a single mini-hoop net was set in each of eight pools that were too turbid to visually observe fish or had complex habitat where Green Sunfish could potentially be missed. Of these eight pools, five were surveyed only with a mini-hoop net. An additional mini-hoop net was set in an off-channel pool at the confluence with Clear Creek. Nine locations that are not currently pool habitat were not snorkeled, visually observed, or trapped. No Green Sunfish or Channel Catfish were observed or captured in the lower Blue River. Green Sunfish have not been detected since 2016 and Channel Catfish have not been detected since 2013 (Figure 15). An estimated 1,813 Spikedace, 2,866 Roundtail Chub, 1 Loach Minnow, 1,348 Desert Sucker, 1,361 Sonora Sucker, 770 Longfin Dace, 220 Speckled Dace and 652 Northern Crayfish were observed.

During October 1-3, 2018, Department and Reclamation staff performed the annual fish monitoring in the lower Blue River. They set hoop nets overnight in 23 randomly selected pools throughout reaches two through six and captured a total of 89 Roundtail Chub, 54 Sonora Sucker, 2 Desert Sucker, and 219 crayfish (Table 8). Department and Reclamation staff also electrofished 10 randomly selected and two fixed 200 meter transects (Table 9). In general, fewer fish were captured in 2018 than 2017, however, Spikedace and Loach Minnow are still abundant and found throughout the monitoring reach (Figure 13, Figure 16). The Roundtail Chub catch in 2018 was more than double the 2017 catch for both the electrofishing survey (2017 = 116, 2018 = 249; Figure 14) and netting survey (2017 = 37, 2018 = 89). This increase in abundance appears to be due to two strong year classes of sub-adult chub (Figure 17). The average length of Roundtail Chub captured by electrofishing was 143.1 mm TL (min = 45, max = 345) suggesting that there is substantial reproduction and a wide range of size classes present. Two year-classes

of Spikedace were obvious in length-frequency histograms from 2016 and 2017 data, but the smaller year-class was generally absent from the 2018 electrofishing data (Figure 18). However, juvenile Spikedace (≤ 40 mm) were readily captured by seining just downstream from Juan Miller Crossing. Loach Minnow size structure in 2018 was similar to 2017, with mostly adult fish captured (Figure 19). Spikedace, Roundtail Chub and Loach Minnow are still distributed throughout the river and fish from the strong 2017 year class overwintered well for all three species despite drought conditions. Importantly, this was the first year that nonnative fish (Green Sunfish, Fathead Minnow, Red Shiner) were not captured or observed. Unfortunately, the PIT tag reader was left at headquarters so no Roundtail Chub were scanned in 2018.

On September 9, 2018, Department staff monitored the Roundtail Chub in Quinsler's Pond near the upper Blue River. They set 12 large hoop nets overnight and captured 145 Roundtail Chub (mean TL = 179.2 mm; Figure 20), 101 Sonora Sucker, 3 Desert Sucker, and 56 Northern Crayfish. Roundtail Chub remain abundant in Quinsler Pond despite the lack of evidence of successful reproduction in 2018. However, in late spring of 2018, the landowner opened the pond outlet to allow some fish to disperse into the Blue River, so smaller fish could have migrated out of the pond.

On September 9-11, 2018, Department staff performed annual monitoring in the middle Blue River between The Box and McKittrick Creek. They electrofished ten random and two fixed 100-meter transects and captured a total of 23 Roundtail Chub, 6 Spikedace, 43 Loach Minnow, 246 Longfin Dace, 686 Desert Sucker, 188 Sonora Sucker, 341 Speckled Dace and one Brown Trout (Table 10). In addition, large hoop nets were set overnight in 15 randomly selected pools throughout the monitoring reach. A total of 17 Roundtail Chub, 15 Sonora Sucker, 4 Desert Sucker, 24 Longfin Dace, 5 Speckled Dace, and 143 crayfish were captured in hoop nets (Table 11). Roundtail Chub catch declined from 2017 to 2018 despite additional electrofishing effort and no juvenile Roundtail Chub were captured within the monitoring reach, which suggests reproduction is currently limited (Figure 21, 22). Relative abundance of Spikedace was quite low during 2018 monitoring (Figure 23). However, there is some evidence that reproduction may have taken place because Spikedace ≤ 40 mm TL were captured and Spikedace were last stocked in the fall of 2017 (Figure 24). Spikedace stocked in 2017 were collected from Juan Miller crossing and held in instream cages as part of an eDNA study, which may have stressed the fish to the point where substantial post-release mortality could have occurred, thus contributing to the low relative abundance during monitoring.

On October 3, 2018 Department staff collected 294 Spikedace by seining near Juan Miller Crossing for about two hours. Fish were transferred to an aerated cooler and translocated to the middle Blue River at Cole Flat (UTM 12S 667150/3713200). A total of 291 Spikedace were stocked with three mortalities during transport.

Recommendations: Continued monitoring of Spikedace and Roundtail Chub in the lower Blue River should continue until at least 2019, even though the monitoring data indicate that these

species have established. However, it seems worthwhile to continue monitoring the lower Blue River on a long-term basis to track abundances of Spikedace, Roundtail Chub, and Loach Minnow, but this monitoring could be completed by another Department program or another agency.

Green Sunfish removals in the lower Blue River should be continued for at least one to three more years to confirm that they are eradicated. Sediment and debris have accumulated on the concrete apron below the barrier in recent years, potentially making the barrier more passable for nonnative fishes, so snorkeling will serve as an early detection method should the barrier fail. Snorkeling continues to be the best method for detecting Green Sunfish and should be used in combination with hoop netting.

In the middle Blue River, Roundtail Chub should be monitored through 2021 and Spikedace through 2022 to determine if populations have established. There were few suitable pools for placing hoop nets, and the vast majority of them were shallow enough to effectively sample by electrofishing. Furthermore, slightly more chub were captured by electrofishing than by hoop nets. Therefore, we recommend that hoop netting be discontinued in 2019, and electrofishing be used as the sole means of post-stocking monitoring of Spikedace and Roundtail Chub in the middle Blue River. Additional Spikedace and Roundtail Chub should be stocked if necessary to establish populations.

Miscellaneous stock tank surveys (Task AZ-2004-1)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 3. Protect native fish populations from nonnative fish invasions.

Recovery Objectives:

- Gila Chub draft recovery plan objective 2.1. Prepare and protect streams appropriate for replications
- Spikedace recovery objective 6.2.3 Assess status of non-native fishes in the watershed.
- Loach Minnow recovery objective 6.2.3 Assess status of non-native fishes in the watershed.
- Gila Topminnow 1999 draft revised recovery plan objective 2.4 Protect habitats of reestablished or potential populations from detrimental nonnative aquatic species.

Background: The purpose of this action was to survey all stock tanks in stream systems where nonnative fish removal efforts and fish barriers were planned, to determine the sources of nonnative fishes. Stock tank surveys have been completed in the O'Donnell Creek drainage (Ehret and Frederick 2008), Mineral Creek drainage (Crowder and Robinson 2011; Crowder et

al. 2014), Blue River drainage (Crowder et al. 2013), the Grapevine Canyon drainage (New River; Robinson 2009; Robinson 2016), most of the Sonoita Creek drainage (Ehret and Dickens 2009b) and the Red Tank Draw (Rarick/Mullican Canyon) drainage. These surveys were typically completed by making several hauls with a large bag seine across the ponds.

Results: The only work completed on this task in 2018 was acquisition of GIS and satellite imagery information for tanks in the Verde River drainage, and preliminary site selection.

Recommendations: Stock tank surveys should be incorporated into specific removal projects in the future, and therefore this project should be removed from the priority list in 2019.

Assess potential repatriation waters (Task AZ-2008-1)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 1. Identify critical streams and populations in need of protection and potential replication.

Recovery Objectives:

- Spikedace recovery objective 6.2. Identify river or stream systems for reintroductions.
- Loach Minnow recovery objective 6.2. Identify river or stream systems for reintroductions.
- Gila Topminnow 1999 draft revised recovery plan objective 2.1. Identify habitats suitable for reestablishment of Gila topminnow.
- Gila Chub draft recovery plan objective 2.1. Prepare and protect streams appropriate for replications.

Background: The purpose of this project is to assess perennial waters in the Gila River Basin to determine if they are suitable for repatriations of Spikedace, Loach Minnow, Gila Topminnow, Roundtail Chub, or other native fishes. Assessments are restricted to waters known to be perennial, or where riparian cover indicates potential perennial water. For potential Spikedace, or Loach Minnow, and sometimes Roundtail Chub establishment locations a standardized habitat assessment protocol is used (Anderson 2015). Using this protocol, habitat is assessed along 10 evenly spaced transects within 100-m reaches. The number of reaches surveyed is equal to 10% of the length of perennial water. If fish survey information is lacking, each of these reaches or a subsample is also sampled for fishes, typically using backpack electrofishing. For Gila Topminnow, a different method is used, as potential sites can be ponds or short isolated sections of stream. The vast majority of potential topminnow sites assessed are at elevations <1600 m, as recommended the draft revised recovery plan (Weedman 1999); the only exceptions are sites where temperature logger information indicates thermally stable water year-round. The total

length and average width of wetted habitat is measured. Each pool or pond is measured for length, width, and maximum depth. Coves, backwaters, and other areas of potential high-flow refuge are noted, as is elevation. If fish survey information is lacking, traps, dip nets, or seines are typically used to determine if the location is inhabited by fishes. Below are summaries of each of the waters assessed during 2018, with coordinates provided in Table 12.

Results: A map showing locations of each of the streams assessed is in Figure 25.

Dix Creek. On July 31, 2018, Department Staff evaluated stream habitat for Loach Minnow and Gila Topminnow in lower Dix Creek by documenting the location and approximate lengths of all pools and riffles from the confluence of Left Prong Dix Creek and Right Prong Dix Creek (UTM 12S 671783/3673462) downstream approximately 1.5 kilometers to where flows become sub-surface near Martinez Ranch (671727/3674884). A single standardized habitat survey was completed on a 100-m reach of stream (downstream start: 671688/3674608; elevation 1500 m) to better characterize stream microhabitat within this reach. The 100-m reach was comprised of 59 m of riffle, 19 m of run, and 22 m of pool habitat. Mean embeddedness of cobbles in riffles ranged from 4 to 44%, with and overall mean of 22%. The three pools in the 100-m reach had maximum depths of 0.32, 0.41, and 0.72 m, and had relatively straight banks, so likely would not provide much velocity refuge during floods. More than 1.3 kilometers of apparently perennial habitat exists in lower Dix Creek above the Martinez Ranch Diversion, which likely acts as a barrier during low-flow periods but may be passable to fish during floods. Within that 1.3 km reach there was 998 m of riffle and 515 m of pool-run habitat for a pool:riffle ratio of 0.52. Therefore, there seems to be sufficient habitat for Loach Minnow in lower Dix Creek. There appears to be much less sufficient habitat for Gila Topminnow in lower Dix Creek.

Recommendations: Habitat quality and quantity should be evaluated in lower Dix Creek during low flow conditions (May or June) to determine whether suitable habitat and perennial flow occurs year-round. Due to the relatively short reach length (1.3 km) and uncertainty around habitat quality during early summer drought conditions, lower Dix Creek should be considered as a low priority potential introduction location for Loach Minnow and Gila Topminnow. Another potential concern is the absence of a sufficient fish barrier at flood flows which could allow invasion of nonnative fish, like Green Sunfish, from the San Francisco River.

Gardner Canyon Drainage. On September 25, 2018, Department staff sampled Sweetwater Dam pond, Cave Creek, and Gardner Canyon within the Gardner Canyon drainage. Department staff sampled Sweetwater Dam pond (UTM 12S 519194/3508774; elevation 1734 m) in an attempt to verify reports of Goldfish and Western Mosquitofish. Sweetwater Dam creates a small impoundment on Cave Creek which is tributary to Gardner Canyon in Santa Cruz County. Department staff set five minnow traps for a soak time of about one hour, completed three seine hauls and five dip net sweeps and captured a total of 1,305 Western Mosquitofish and 7 Goldfish. Adult and juvenile size classes of both species were captured, indicating reproduction is occurring. More than 100 large adult goldfish were visually observed. A temperature logger

was placed in Sweetwater Dam pond on November 27, 2018, to assess winter water temperatures. The logger will be retrieved in spring, 2019.

Department staff sampled Cave Creek from the crossing of Gardner Canyon Road (UTM 12S 523048/3509620) downstream to the Apache Springs Ranch property boundary. Department staff completed six dip net sweeps and captured a total of 63 Western Mosquitofish. Mosquitofish were not captured during fish surveys of Cave Creek in 2007. It is possible that mosquitofish dispersed downstream out of Sweetwater Dam into Cave Creek. Department staff did not visit a location in East Sawmill Canyon (UTM NAD 83; 521514/ 3509806), where in August 2018, the Department's Terrestrial Branch staff reported Western Mosquitofish.

Department staff sampled Gardner Canyon from the upstream start of perennial water, as identified by previous surveys (UTM 12S 523036/2508454), downstream to the Apache Springs Ranch Boundary. Longfin Dace were the only species observed downstream of the natural fish barrier within the surveyed reach. Most of the habitat in Gardner Canyon consists of bedrock runs and pools which likely would not provide Gila Topminnow with much velocity refuge during flood events. However, one pool (523044/3508480; 1594 m elevation) was identified above the current Longfin Dace barrier, which appears suitable for Gila Topminnow and was identified as suitable for Gila Topminnow in a previous survey by Department staff in 2004 (Foster and Mitchell 2004). However, this location is at the limit of the preferred elevation, and a temperature logger previously installed in a different location in Gardner Canyon by Department staff in 2008, revealed winter water temperatures that were deemed too low for Gila Topminnow.

Recommendations: Nonnative fish should be removed from Sweetwater Dam, Cave Creek, and East Sawmill Canyon due to the proximity to the Cienega Creek populations of Roundtail Chub[1] and Gila Topminnow. If nonnative fish were to be removed, Sweetwater Dam appears to be suitable for Cienega Creek lineage Roundtail Chub[1] and potentially Gila Topminnow, pending an assessment of winter water temperatures. There does not currently appear to be habitat in Cave Creek for native fish other than Longfin Dace. A location in East Sawmill Canyon, about 1.8 km upstream with the confluence with Cave Creek should be surveyed because Western Mosquitofish were observed there in August 2018, which was the first time the species was recorded there over six previous surveys spanning 24 years. It is unclear if Western Mosquitofish at that location dispersed from springs further upstream, of if they moved upstream from Cave Creek.

Because of previous water temperature data, Gardner Canyon should be low priority for further evaluation of habitat suitability for Gila Topminnow. If it is further evaluated, Department staff should install a temperature logger in the pool above the Longfin Dace barrier to evaluate whether winter water temperatures remain suitable for Gila Topminnow before moving forward

[1] Chub in Cienega Creek drainage were previously classified as Gila Chub.

with any translocation. It has been nearly 9 years since the last time a temperature logger was installed, and a deeper pool may have more stable water temperatures year-round than the previous logger location. If water temperatures are suitable, Cienega Creek lineage Gila Topminnow could be introduced into the pool pending consultation with partner agencies.

Hardscrabble Creek. During October 28-29, 2018, Department staff evaluated native fish habitat in Hardscrabble Creek from the confluence with Fossil Creek upstream about 7 kilometers. Department staff angled in pools throughout the surveyed reach and carried out visual observations. Smallmouth Bass and Desert Sucker were captured and observed in the lower 3 kilometers of Hardscrabble Creek, but Green Sunfish were captured and observed throughout the entire 7 kilometer survey reach, despite the presence of a large (~10 meter height) vertical waterfall barrier (UTM 12S 440942/3800680) located about 4.5 kilometers upstream from the confluence with Fossil Creek. A total of 13 Green Sunfish were captured in one minnow trap and three mini-hoop nets set overnight above the barrier. It seems likely that Green Sunfish are dispersing from an upstream source in the Hardscrabble Creek drainage, potentially from private ponds in Strawberry.

Recommendations: Aquatic habitat throughout the surveyed reach is ideal for Roundtail Chub, however the source of Green Sunfish should be identified before attempting to carry out any native fish restoration work in Hardscrabble Creek. Green Sunfish would need to be eradicated from the ponds and the stream above the waterfall before chub could be stocked.

Neighbor Spring. On September 26, 2018, Department staff assessed native fish habitat in an 800-m reach of Neighbor Spring, which is tributary to Parker Canyon downstream of Parker Canyon Lake. Department staff surveyed the perennial reach as determined from previous surveys (start: UTM 12S 550231/3474576; end: 550916/3474856). Only three small pools were documented within the surveyed reach with long reaches of the streambed consisting of marshy grass and sedges with no clear channel. A majority of the surveyed reach was dry or nearly dry. Pool habitat in Neighbor Spring appears to provide limited, but suitable habitat for Gila Topminnow. Staff carried out 12 dip net sweeps in the three pools and captured two Longfin Dace and one small (~50 mm TL) Green Sunfish. Longfin Dace were not visually abundant and appeared to be restricted to only two pools. A survey by Region V personnel in 2008 suggested Green Sunfish may have been dispersing from an unnamed tank (552378/3475817) in the headwaters of the Neighbor Spring drainage. The tank was surveyed in September 2018 by setting five mini-hoop nets and three minnow traps overnight. Two Sonoran Mud Turtles were captured, but no fish, so this tank does not appear to be a source of Green Sunfish to the Neighbor Spring drainage. There does not appear to be a fish barrier in the Neighbor Spring drainage, so Green Sunfish and other species may be able to disperse upstream from Parker Canyon during wet periods. Therefore, the potential for native fish conservation is limited. Crayfish were captured during previous surveys but were not captured or observed in 2018.

Recommendations: Until the invasion method and distribution of Green Sunfish is better understood, Gila Topminnow should not be stocked in Neighbor Spring. The perennial reach of Neighbor Spring should be electrofished sometime in early summer to better understand distribution and abundance of Green Sunfish.

Romero Canyon. On July 11, 2018, Department staff assessed habitat in Romero Canyon for Roundtail Chub[1] and Gila Topminnow. Department staff hiked downstream from the first crossing of Romero Canyon Trail (UTM 12S 511674/3586580) to the current upstream distribution of Roundtail Chub[1] (511644/3586741), where the survey began. The approximate length, width and depth of all pools over 0.5 meters in depth was documented. The location or approximate dimensions of pools shallower than 0.5 meters was not recorded, because of concern that recent rains may have increased the depths of some pools from summer minimum levels. Four pools and three potential barriers were documented between the upper distribution of chub and the first trail crossing. Two of these pools in particular, were substantially larger than all other pools encountered during the survey, with approximate lengths of 18 and 30 meters and widths of 8 and 15 meters, respectively. Upstream of the first trail crossing, an additional nine pools and four potential barriers to upstream movement of fish were documented. A majority of these pools were within 600 meters of the first trail crossing with the most upstream pools located approximately 1.6 km upstream of the first trail crossing. Department staff were not able to survey up to the target end point above the upper slot canyon due to incoming thunderstorms, but did observe several large permanent pools and apparent barriers from the trail. A potential concern is that this uppermost reach has a high gradient and habitat is relatively simple (bedrock pools with rectangular shape) so may provide little velocity refuge during high discharge events. Virtually all of the surveyed pools upstream of where chub now occur had similar or greater lengths, widths and depths to downstream pools containing chub. Therefore, it is likely that the surveyed pools could support translocated chub, extending upstream chub distribution by up to 1.6 km. In contrast, there appears to be much less suitable habitat for Gila Topminnow. The largest pool surveyed (1124 m elevation), immediately downstream from the first trail crossing appears to have sufficient velocity refuge habitat for Gila Topminnow to persist during high discharge events, as well as another smaller pool with some cattail habitat just upstream.

Recommendations: Stream habitat in Romero Canyon is highly fragmented, with numerous potential barriers to upstream passage of fish. However, suitable and potentially higher quality pool habitat currently exists upstream of the Roundtail Chub[1] occupied reach. As a result, chub could be stocked upstream to expand their distribution in this system. Pending consultation with collaborating agencies, Roundtail Chub[1] should be moved further upstream into suitable habitat. Gila Topminnow could also potentially be introduced to this system, but because habitat is limited, stocking is of lower priority.

[1] Roundtail Chub in Romero Canyon were previously classified as Gila Chub

Sabino Canyon. On June 8, 2018, Department staff evaluated habitat in a reach of Sabino Canyon located approximately 250 meters upstream from the confluence with East Fork Sabino Canyon. This same location was assessed by Department staff in 2017. Three large pools (17-35 meters in length) with maximum depths exceeding 2 meters were documented, along with several other shallower and narrower pools. All pools appeared to be fishless, but the habitat in these pools has a high potential to support both Gila Topminnow and Roundtail Chub[1] and could likely also support Desert Sucker and Speckled Dace.

Recommendations: Gila Topminnow were translocated from below Sabino Dam to the uppermost of the three large pools on June 21, 2018. Roundtail Chub[1] should be translocated from lower Sabino Canyon to these pools in 2019.

Sevenmile Wash. On July 31, 2018, Department staff surveyed the tributary to Sevenmile Wash at Jones Water Campground for native fish habitat. Despite the presence of a riparian area, no surface water was found within the surveyed reach.

Recommendations: This location should not be considered for future native fish restoration because surface water is not present year round.

Strayhorse Creek. On August 13, 2018, Department staff evaluated aquatic habitat at three randomly selected 100-meter sites in Strayhorse Creek above the waterfall (UTM 662217/3706731) and one site in Little Strayhorse Creek. The standardized habitat protocol was followed to collect aquatic habitat data including widths, depths, substrate size and embeddedness, macrohabitat type and length and stream shading. Most of the system was dry, with interrupted sections of perennial water. In Strayhorse Creek, the downstream-most transect was comprised of 96 m of riffle and 4 m of pool, the middle transect had 57 m riffle, 28 m run, and 15 m pool, and the upstream-most transect had 71 m riffle, 4 m run, and 24 m of pool. In the riffles, average embeddedness of cobbles in transects ranged from 15 to 84% with an overall mean of 45%. Overall, cobble or larger substrates (excluding bedrock) comprised only 17% of substrates. Mean width across all transects was 1.2 m, and mean depth was 0.04 m. Despite recent monsoon rains, overall in Strayhorse Creek there was less than 1 km of perennial water, which was broken up into several interrupted sections. The one transect in Little Strayhorse Creek had 50 m riffle, 9 m run, and 41 m pool. Mean embeddedness of cobbles along transects ranged from 17 to 77%, with and overall mean embeddedness of 38%. Cobble or larger substrates (excluding bedrock) comprised 44% of substrates. Average wetted width at transects was 1.4 m, and mean depth was 0.07 m. No fish were observed in Strayhorse or Little Strayhorse Creek.

Recommendations: Results of the habitat surveys suggest that there is very limited and highly fragmented habitat for Loach Minnow in Strayhorse and Little Strayhorse Creeks upstream of the barrier. Therefore, we do not recommend that Loach Minnow be stocked into this system

[1] Chub in Sabino Canyon were previously classified as Gila Chub.

upstream of the waterfall. The section downstream of the waterfall may have suitable habitat, particularly in the 1-2 km immediately below the waterfall, but there are not any other barriers further downstream, so Loach Minnow could already inhabit Strayhorse Creek below the waterfall. We recommend that eDNA samples be collected, or an electrofishing survey be conducted in Strayhorse Creek downstream of the waterfall to attempt to detect Loach Minnow.

Temporal Gulch. On September 26, 2018, Department staff assessed native fish habitat within a 500 meter reach of Temporal Gulch near Anaconda Spring (start: UTM 12S 519186/3498737 end:518984/3498903). Stream habitat consisted of shallow bedrock runs interspersed with larger pools. Longfin Dace were visually abundant throughout the surveyed reach, but only a single large Desert Sucker was observed. Stream habitat does not appear to be suitable for Gila Topminnow at this time, as little velocity refuge or cover is present. Unfortunately, one large Green Sunfish (209 mm TL) was captured in a seine haul and a second was visually observed in the same pool (518998/3498797). Green Sunfish were not documented in previous surveys of Temporal Gulch from 1991 to 2007 or a survey of stocks tanks within the Temporal Gulch drainage (Ehret and Dickens 2009b). Therefore, it is likely that Green Sunfish were illegally introduced to Temporal Gulch.

Recommendations: The surveyed reach of Temporal Gulch does not appear to have suitable habitat for Gila Topminnow at this time. However, there may be some limited habitat available for Roundtail Chub[1]. An electrofishing survey should take place during early summer to determine the distribution and abundance of Green Sunfish within the surveyed reach of Temporal Gulch.

Thomas Creek. On August 28, 2018, Department staff completed a standardized habitat survey at a single 100-meter transect in Thomas Creek. Habitat was comprised of 67 m of riffle and 33 m of pool. About 32% of the substrate at transects was bedrock, and about 15% was cobble or larger. Embeddedness was inadvertently not recorded. Mean width of the stream at transects was 0.9 m. There was little connected flow in the stream with only about 400 meters of wetted habitat available. Speckled Dace and Longfin Dace were visually observed from the first slot canyon pool that had water up to an apparent fish barrier (UTM 12S 666337/369268). Department staff also walked 2 km up Squaw Creek (tributary to Thomas), but only encountered about 40 m of perennial water, where they did observe a single Speckled Dace.

Recommendations: Due to low amounts of cobble, limited flow and high fragmentation, there does not currently appear to be suitable habitat for Loach Minnow in Thomas Creek, therefore we do not recommend translocation of any fish species into Thomas Creek or its tributary Squaw Creek.

[1] Chub potentially to be stocked at this location were previously classified as Gila Chub

Aquatic Research and Conservation Center O&M (Task HA-2006-2)

Strategic Plan Goals**:**

- Scientific Foundation
    - Goal 3. Improve propagation techniques for Spikedace and Loach Minnow
- Preventing Extinction and Managing Toward Recovery
    - Goal 2. Maintain and operate ASU topminnow holding facility and the Aquatic Research and Conservation Center (ARCC) to support the Program's recovery efforts for imperiled fishes in the Gila River Basin through the establishment of refuge populations of genetically distinctive stocks as insurance against extinction in the wild, captive propagation for repatriation, and applied research.

Recovery Objectives:

- Spikedace recovery objective 8. Plan and conduct investigations on captive holding, propagation and rearing.
- Loach Minnow recovery objective 8. Plan and conduct investigations on captive holding, propagation and rearing.
- Gila Topminnow draft revised (1999) recovery objective 1.1. Maintain refugia populations of natural populations to ensure survival of the species.
- Desert Pupfish recovery objective 2. Reestablish Desert Pupfish populations.
- Gila Chub draft recovery plan objective 4. Establish and maintain refuge populations in protected ponds or hatcheries as appropriate.

Background: Reclamation funded construction of a native fish conservation facility on the grounds of the Department's Bubbling Ponds Hatchery. The main purposes of the facility were to develop propagation techniques for Loach Minnow and Spikedace, to establish refuge populations of all lineages, and to propagate fish for repatriations. A wet lab was constructed in 2000, a well was installed in 2003 to supply water to the facility, and open-air production and grow-out building was constructed in 2007. Table 13 shows, for Spikedace and Loach Minnow, the size of the broodstock and number of fish produced from 2007 through 2018; some information is missing. See Task AZ-2003-1 (Acquire Spikedace, Loach Minnow and rare populations of other native fish) for background information on each lineage. Number of fish brought into ARCC each year can be found in Table 1.

Other fish species were brought to the facility for similar purposes as Loach Minnow and Spikedace. Woundfin were brought to the facility in 2008 to attempt to produce offspring for stocking into the Hassayampa River. Gila Topminnow (Sharp Spring lineage) and Desert Pupfish were brought to the facility in 2009 for a competition experiment, but most were stocked out afterwards. Eagle Creek Roundtail Chub were brought to the facility in 2010 to establish a refuge population, so fish produced could be stocked into the Blue River. In 2012, the Cottonwood

Springs lineage of Gila Topminnow was brought in to establish a broodstock so that fish produced could be used in repatriations. The facility holds various other species for research or educational purposes.

The facility was originally named Bubbling Ponds Native Fish Conservation Facility, but in 2015 was renamed the Aquatic Research and Conservation Center (ARCC). Beginning in 2014, Reclamation began providing funds (through USFWS) for a variety of improvements to ARCC, including a new outdoor building to hold more tanks, a new quarantine building, and new ponds.

Results: The Department continued to operate ARCC in 2018. The ARCC maintains refuge populations of three lineages of Spikedace (Aravaipa Creek, upper Gila River, and Gila River Forks) and four lineages of Loach Minnow (Blue River, Aravaipa Creek, San Francisco River, and Gila River Forks). In 2018, ARCC produced 3,214 Aravaipa Creek Spikedace, 352 upper Gila River Spikedace, 195 Gila River Forks Spikedace, 6 Blue River Loach Minnow, 1,848 Aravaipa Creek Loach Minnow, 1,627 San Francisco River Loach Minnow, and 1,207 Gila River Forks Loach Minnow (Table 13). Due to limited space at ARCC, all lineages not included in the propagation study were split into two or more tanks with variable densities and spawned similarly to previous years.

During 2018, ARCC staff started testing fish density, thought to be a key contributing factor for captive propagation success of Spikedace and Loach Minnow. This research examined how fish density in spawning raceways affects total larval fish production. Using the Aravaipa lineages of both species, raceways were setup at 3 different densities for a total of 6 raceways. Loach Minnow were given nest sites consisting of medium sized cobbles arranged in 15-cm circles spaced 38 cm from edge of nest to edge of nest. Larval fish were manually removed once per week, counted and logged. Algae was also carefully removed once per week to minimize potential effects of high algal biomass on spawning. All tank setup parameters were carefully matched between density study raceways based on the requirements for each species. Detailed logs were kept regarding larval fish removed each week and any larval or brood mortalities. A second spawn report was compiled at the end of the season for future use detailing all setup and operational parameters. Temperature loggers were placed in each study tank to help determine if fluctuations may be contributing to more or less larval fish produced. Light and temperature loggers were located in both the spawning and holding cages to compare light intensity to determine how it might affect algae growth that may indirectly influence spawn success.

Using the study design presented to partners in 2017, staff began a more controlled set of experiments to help improve production starting with fish density as mentioned above. After the success of 2018, staff plan on running a second year of density trials if brood stock counts are high enough. Brood stock counts depend on wild fish availability and what time of year they are collected. This study plan is designed to help inform other staff and agency partners what

research will be implemented to help increase production of Spikedace and Loach Minnow with the available resources at the facility.

Physical improvements to ARCC completed in 2017 such as the installation of the 20 linear spawning raceways have directly contributed to the success of 2018. No new large scale property improvements were completed in 2018.

In late 2018 ARCC staff sent a draft version of the hatchery operation manual with a complete appendix to Department Research Branch staff for additional edits. A printed version is currently available at ARCC for staff and visitors and has already become a useful reference tool. New staff, visitors and volunteers now have easy access to hatchery operation information and should be greatly aided in learning the unique requirements of this facility. This document along with an annual spawning report that has been completed for the last two seasons will help protect the facilities collective knowledge of captive propagation for Spikedace and Loach Minnow and will ensure a smooth transitions should a change of management occur in the future.

Recommendations: For 2019, ARCC staff will finalize the hatchery operation manual. They also will focus on a second year of the density study using the Aravaipa lineage of both species. This is to increase the number of replicates and to ensure that the pattern of lower density raceways resulting in the highest larval production holds true for a second year. Staff will also start a small-scale paired-propagation study to determine if it is possible to spawn these species in small systems such as aquaria. Lastly, fish will be tagged with visible implant elastomer to help track fish throughout the facility, track the age class of individuals, and give managers a new tool to help with post-stocking research and monitoring.

Expand Roundtail Chub[1] population in Harden Cienega Creek (Task AZ-2014-1)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 1. Identify critical streams and populations in need of protection and potential replication.
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

[1] Roundtail Chub in Harden Cienega Creek were previously classified as Gila Chub

- Gila Chub draft recovery plan objective 2. Ensure representation, resiliency, and redundancy by expanding the size and number of populations within Gila chub historical range via replication of remnant populations within each RU.

Background: Harden Cienega Creek is a tributary to the San Francisco River near the New Mexico state line. Roundtail Chub[1] chub distribution was limited to approximately 2 km of stream below a natural waterfall barrier. In April 2013, Department staff surveyed above the waterfall and determined that about 1.4 km of perennial water existed above the waterfall that was suitable for Roundtail Chub[1]. Department staff recommended that chub be moved above the waterfall to expand their distribution in Harden Cienega Creek and the CAP Policy committee approved the project in February 2014. On April 9, 2015, Department staff translocated 102 Roundtail Chub[1] from lower Harden Cienega Creek to above the waterfall. Monitoring in 2017 detected several hundred chub representing all size classes.

Results: During October 10 to 11, 2018, Department staff monitored Roundtail Chub[1] above the natural barrier in Harden Cienega Creek. Department staff set twelve mini-hoop nets from the upper end of perennial water (UTM 12S 676720/3673459) downstream to near the lower stocking location (676284/3673788). Nets soaked overnight for a minimum of 17 hours. A total of 304 Roundtail Chub[1] were captured with a mean total length of 104 millimeters (min = 66, max = 204; Figure 26). Roundtail Chub[1] are certainly established above the barrier and have dispersed to virtually all available habitat. Department staff also captured five Roundtail Chub[1] below the barrier and translocated them to near the upper end of perennial water to maintain genetic diversity. Staff had planned on collecting more individuals, but due to not having appropriate gear to safely descend the barrier, were restricted to setting hoop nets from the top, with limited success.

Two Green Sunfish (150 and 152 mm TL) were captured in the second permanent pool downstream of the intermittent reach (676720/3673459) and removed. One Green Sunfish was captured approximately 30 meters downstream of this pool in 2017. Because Green Sunfish are being captured well upstream of the barrier, it is likely that there is an upstream source of Green Sunfish in the Harden Cienega drainage.

Recommendations: The upstream source of Green Sunfish in the Harden Cienega Creek drainage should be identified. There are many tanks upstream in the drainage, with more than half located in New Mexico, so it is worth working with our counterparts in New Mexico to identify the source of Green Sunfish. Upper Harden Cienega Creek should continue to be monitored until at least 2020. However, because the initial population was started with 102 fish, several hundred more fish should be translocated above the waterfall to maintain genetic diversity.

Fish health assessments of translocation populations (Task AZ-2014-2)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.

Recovery Objectives:

- Gila Chub draft recovery plan objective 2.2. Ensure representation, resiliency, and redundancy by expanding the size and number of populations within Gila chub historical range via replication of remnant populations within each RU.
- Gila Topminnow 1999 draft revised recovery plan objective 1.6. Prohibit the introduction or release of nonnative aquatic species detrimental to Gila Topminnow into areas occupied by natural or long-lived reestablished populations.
- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila Topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 2.5. Prohibit the introduction or release of nonnative aquatic species into areas occupied by reestablished populations or identified as potential habitat for reestablished populations.
- Desert Pupfish recovery objective 2. Re-establish Desert Pupfish populations.

Background: To minimize the transfer of unwanted parasites and pathogens from one location to another, the Department assesses the health of fish in all donor sites before any translocation. Department staff collects 30 to 60 fish, typically of the species to be translocated, and either the Department's Fish Health Specialist or an outside organization (e.g., USFWS Southwest Native Aquatic Resource and Recovery Center, or Washington Animal Disease Diagnostic Laboratory) assesses the fish. In 2015, the Department finished construction and outfitting of its fish health laboratory at the Phoenix headquarters, so starting in 2016 all health assessments could be performed by the Department's Fish Health Specialist.

Results: On May 15, 2018, Department staff collected 65 Gila Topminnow from Stop Sign Tank at Robbins Butte Wildlife Area and transported fish back to Department headquarters for a fish health assessment. No pathogens or parasites of concern were detected in the subsequent assessment.

On May 15, 2018, Department staff collected 63 Gila Topminnow from Swimming Pool Tank at Robbins Butte Wildlife Area and transported the fish back to Department headquarters for a fish health assessment. No pathogens or parasites of concern were detected in the subsequent assessment.

On May 15, 2018, Department staff collected 65 Gila Topminnow from Nina Mason Pulliam Rio Salado Audubon Center pond and transported the fish back to Department headquarters for a fish health assessment. No pathogens or parasites of concern were detected in the subsequent assessment.

On August 13, 2018, Department and Reclamation staff collected 60 Roundtail Chub[1] from Sabino Canyon below Sabino Dam and transported the fish to Department headquarters for a fish health assessment. No pathogens or parasites of concern were detected in the subsequent assessment.

On August 13, 2018, Department and Reclamation staff collected 60 Gila Topminnow from the lower San Pedro Riparian Preserve and transported the fish to Department headquarters for a fish health assessment. No pathogens or parasites of concern were detected in the subsequent assessment.

On August 21, 2018, Department staff collected 60 Gila Topminnow from Timbucktwo Tank near Arivaca, AZ and transported the fish back to Department headquarters for a fish health assessment. During the subsequent fish health assessment, intestinal trematodes (flukes) were detected in about 20% of the fish. Therefore any fish from this location used in a translocation should be treated with Praziquantel before translocation.

Recommendations: In 2016, the Department's Fish Health Specialist indicated that an assessment is valid for only one year. Therefore, all translocation donor sites will be assessed no more than 12 months before the translocation. This project should be removed from the priority list and instead be reported under each individual project stocking.

Eagle Creek repatriations (Task AZ-2018-1)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 1. Identify critical streams and populations in need of protection and potential replication.
    - Goal 3. Protect native fish populations from nonnative fish invasions.
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

- Spikedace recovery objective 6.3. Reintroduce Spikedace to selected reaches.

[1] Roundtail Chub in Sabino Creek were previously classified as Gila Chub

- Spikedace recovery objective 6.4. Monitor success/failure of reintroductions.
- Loach Minnow recovery objective 6.3. Reintroduce Loach Minnow to selected reaches.
- Loach Minnow recovery objective 6.4. Monitor success/failure of reintroductions.
- Gila Chub draft recovery plan objective 2. Ensure representation, resiliency, and redundancy by expanding the size and number of populations within Gila chub historical range via replication of remnant populations within each RU.
- Gila Chub draft recovery plan objective 7. Monitor remnant, repatriated, and refuge populations to inform adaptive management strategies.
- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 3. Monitor natural and reestablished populations and their habitats.

Background: Eagle Creek is a tributary to the Gila River near Clifton Arizona, and flows across U.S. Forest, San Carlos Apache, and private lands. Native fish documented from Eagle Creek include Spikedace, Loach Minnow, Roundtail Chub[1], Speckled Dace, Longfin Dace, Desert Sucker, Sonora Sucker, and Gila Trout. However, Spikedace were last recorded in 1989 and Loach Minnow in 1997. Various nonnative fish species occupy Eagle Creek but the upper reach above the confluence with Willow Creek is now occupied by only native species. Freeport McMoran pumps water from the Black River into Eagle Creek for use at the Morenci Mine; nonnative fish from the Black River are thus transmitted into the Eagle Creek drainage. Freeport McMoran committed to building a barrier on upper Eagle Creek above the Willow Creek confluence as part of a management plan. Reclamation is providing engineering expertise for design of the barrier. The Department will repatriate Spikedace and Loach Minnow upstream once the barrier is constructed. Gila Topminnow will be considered for establishment in the reach upstream of the barrier.

Results: In 2018, Department staff developed a draft monitoring plan for Eagle Creek in preparation for barrier construction and native fish reintroduction.

Recommendations: Reclamation indicated that the barrier would likely not be constructed until 2019. The Department recommends additional eDNA sampling in upper Eagle Creek in 2019 to lend further confirmation that Spikedace and Loach Minnow are extirpated from this reach. Pre-barrier fish surveys in upper Eagle Creek in 2019 will help verify absence of Spikedace and Loach Minnow, and allow for comparisons of fish community before and after barrier completion.

[1] Both Roundtail Chub and the form previously classified as Gila Chub are documented in Eagle Creek.

Red Tank Draw native fish restoration (Task AZ-2016-2)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 1. Identify critical streams and populations in need of protection and potential replication.
    - Goal 4. Remove nonnative aquatic species threats.
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

- Gila Chub draft recovery plan objective 1.3.1. Eliminate or control problematic nonnative aquatic organisms.
- Gila Chub draft recovery plan objective 7. Monitor remnant, repatriated, and refuge populations to inform adaptive management strategies.
- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila Topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 2.4 Protect habitats of reestablished or potential populations from detrimental nonnative aquatic species.
- Gila Topminnow 1999 draft revised recovery plan objective 3. Monitor natural and reestablished populations and their habitats.

Background: Red Tank Draw is a tributary to Wet Beaver Creek on the Coconino National Forest. Red Tank Draw is occupied by Roundtail Chub[1], Longfin Dace, Desert Sucker, Sonora Sucker, and several nonnative species including Green Sunfish, Black Bullhead, Fathead Minnow, and Northern Crayfish. Roundtail Chub[1] inhabit a perennial reach between the USGS gage and the confluence of Rarick and Mullican Canyons. Perennial pools exist in the tributaries Rarick Canyon and Mullican Canyon that support nonnative fishes. The perennial portion of Red Tank Draw is about 2,420 m long (with some short dry sections) and is isolated from upstream invasion of nonnative fish from Wet Beaver Creek by about a 7.7 km reach that is intermittent to ephemeral, but is potentially passable during high flows. There are no waterfalls in the 7.7 km immediately upstream from Wet Beaver Creek. The purpose of this project is to remove Green Sunfish and Black Bullhead from the Roundtail Chub[1] occupied reach, and the entire drainage above the chub occupied reach if possible. A comprehensive survey of stock tanks in the Red Tank Draw drainage above the chub occupied reach in 2017 found only Fathead Minnow occurred in the Rarick Canyon drainage (Rarick Tank and Gnat Tank). Unfortunately, Green

[1] Chub in Red Tank Draw were previously classified as Gila Chub.

Sunfish and Black Bullhead were detected in Mullican Place Tank in the Mullican Canyon drainage. Mullican Place Tank is immediately downstream of Bruce Place Tank which is on private property. The landowner indicated that fish were present in Bruce Place Tank, but denied access for sampling in 2017.

Results: A full summary of number of fish captured by removal effort from 2016 to 2018 can be found in Figure 27.

On April 27, 2018, Department and Reclamation staff backpack electrofished through about 1,780 m of Red Tank Draw, beginning at the downstream end of perennial water and ending about 645 m from the upstream end of perennial water; there were a few dry sections in that reach. They shocked for 3,505 seconds and captured and removed a total of 70 Green Sunfish, 41 Fathead Minnow and one Black Bullhead via backpack electrofishing. A total of 42 Roundtail Chub[1] were captured and returned to the stream. Four mini-hoop nets were also set for a minimum of 2 hours, but no fish were caught in the hoops.

On June 19, 2018, Department staff backpack electrofished through about 2,269 m of Red Tank Draw from the bottom end of perennial water up to 154 m from the upstream end of perennial water. They shocked for 7,580 seconds and captured and removed a total of 340 Green Sunfish, 176 Fathead Minnow and 4 Black Bullhead. They also set five mini-hoop nets in the large, lowermost pool and captured and removed an additional 88 Green Sunfish and 6 Fathead Minnow. A total of 195 Roundtail Chub[1] were captured in the nets and returned to the stream.

On July 5, 2018, Department staff electrofished through about 1,845 m of Red Tank Draw, up to about 290 m from the upstream end of perennial water. Staff electrofished for 5,822 seconds and captured and removed a total of 304 Green Sunfish, 34 Fathead Minnow and 4 Black Bullhead via backpack electrofishing. They also set 10 mini-hoop nets in pools full of cattails, and captured and removed an additional 15 Green Sunfish, 1 Fathead Minnow and 9 Black Bullhead. A total of 122 Roundtail Chub[1] and 3 Desert Sucker were captured in the nets and returned to the stream.

On July 17, 2018, Department staff assessed stream habitat and fish community in Rarick Canyon, tributary to Red Tank Draw. A potential waterfall identified in satellite photographs, was confirmed (UTM 12S 437657/3843902), and is located about 2,050 m upstream from the confluence with Mullican Canyon. Isolated pools were visually assessed from this large waterfall barrier (~10 m tall) upstream to the downstream extent of a previous survey of Rarick Canyon (440148/3844833). Six potential permanent pools were identified within this reach using satellite imagery before the survey. All six pools had depths of at least 1.5 meters and were up to 40 meters in length and 15 meters in width. Flow was present in nearly the entire surveyed reach of Rarick Canyon, likely due to recent rains.

[1] Roundtail Chub in Red Tank Draw were previously classified as Gila Chub

Fathead Minnow were visually observed throughout the surveyed reach. Unfortunately, two Black Bullhead were also observed upstream of the 10-m waterfall barrier. Three mini-hoop nets were set in this pool for a soak time of about 4 hours, but no bullhead were captured. Five more mini-hoop nets were set in two other pools and only captured three Fathead Minnow. The presence of Black Bullhead suggests that the larger pools in Rarick Canyon are likely permanent. Suitable pool habitat appears to exist for Roundtail Chub[1] above the 10-m waterfall barrier and chub from Red Tank Draw could potentially be translocated above the barrier. Unfortunately, Black Bullhead would need to be removed before any translocation of Roundtail Chub[1] can take place. A more complete understanding of the abundance and distribution of Black Bullhead above the waterfall barrier, will better inform which removal methods should be pursued.

On July 23, 2018, Department electrofished through about 500 m of Red Tank Draw near the upper end of the perennial reach, ending about 210 m from the upstream end of perennial water. Staff shocked for 4,749 seconds and captured and removed a total of 84 Green Sunfish, 110 Fathead Minnow and 1 Black Bullhead. They also set seven hoop nets in pools too deep or complex for effective shocking and captured and removed an additional 26 Green Sunfish and 31 Black Bullhead. A total of 105 Roundtail Chub[1] and 2 Desert Sucker were captured in the nets and returned to the stream. Staff also walked to the upstream end of perennial water and identified a large deep pool that should be surveyed in future trips.

During July 25-26, 2018, Department staff electrofished through about 1,740 m of Red Tank Draw from the downstream end of perennial water to where electrofishing began on July 23. They shocked for 3,035 seconds and captured and removed a total of 95 Green Sunfish, 10 Fathead Minnow and 16 Black Bullhead. A total of 67 Roundtail Chub[1] were also captured and returned to the stream. They also set 11 mini-hoop nets and 2 minnow traps overnight (approximately 21 h) in three pools too deep to effectively electrofish, and captured and removed an additional 8 Green Sunfish, 2 Black Bullhead and 225 crayfish. Also, two mini-hoop nets and two minnow traps were set for about 4 hours in an off-channel pool that was not electrofished during the previous removal efforts. A total of 15 Green Sunfish and 7 Black Bullhead were captured and removed from this pool. Overnight sets did not effectively catch Green Sunfish and Black Bullhead and the high number of crayfish in nets set overnight (mean catch per net = 17.3) may have negatively impacted capture efficiency. On July 26, Department staff also angled the large deep pool (max depth about 2 m; UTM 12S 436488/3841960) at the upstream end of the removal reach for one hour and removed four large Green Sunfish (mean length = 187 mm TL). Numerous young-of-year Green Sunfish were observed in this pool on July 25th and intensive trapping may be necessary in this area to minimize the spread of Green Sunfish downstream.

Recommendations: Department staff recommends that a nonnative removal plan be developed for Rarick Canyon and Red Tank Draw. Department staff recommends a fish survey through all wetted habitat in Rarick Canyon above the 10-m waterfall, to determine the distribution and abundance of Black Bullhead above the waterfall so that a removal effort can be better planned and implemented. If Bullhead are widely distributed, then a piscicide treatment would be the

most effective method of removal, and that treatment could then be planned. If the bullhead were limited to just a few downstream pools, then either a treatment or a mechanical removal could be implemented. If a piscicide treatment is implemented, then the two tanks in Rarick Canyon drainage with fish (Rarick Tank and Gnat Tank) should also be treated to eradicate nonnative fish from the drainage. After Black Bullhead is eradicated, Roundtail Chub[1] and Gila Topminnow can be translocated to the tinaja pools in Rarick Canyon.

Department staff recommend that nonnative fish be eradicated from the two tanks in Mullican Canyon drainage that had fish present (Mullican Place Tank and Bruce Place Tank), which are the likely sources of Green Sunfish and Black Bullhead to Red Tank Draw downstream. However, Bruce Place Tank is on private land and further attempts to talk to the landowner to see if cooperation could be gained are recommended.

Sharp Spring native fish restoration (Task AZ-2016-3)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 1. Identify critical streams and populations in need of protection and potential replication.
    - Goal 4. Remove nonnative aquatic species threats.
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

- Gila Chub draft recovery plan objective 1.3.1. Eliminate or control problematic nonnative aquatic organisms.
- Gila Chub draft recovery plan objective 2. Ensure representation, resiliency, and redundancy by expanding the size and number of populations within Gila Chub historical range via replication of remnant populations within each RU.
- Gila Chub draft recovery plan objective 7. Monitor remnant, repatriated, and refuge populations to inform adaptive management strategies.

[1] Roundtail Chub in Red Tank Draw were previously classified as Gila Chub

- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila Topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 2.4 Protect habitats of reestablished or potential populations from detrimental nonnative aquatic species.
- Gila Topminnow 1999 draft revised recovery plan objective 3. Monitor natural and reestablished populations and their habitats.

Background: Sharp Spring is a tributary to the Santa Cruz River in the San Rafael Valley, about 2 km from the U.S.A. – Mexico border, and is on San Rafael State Natural Area. Sharp Spring is perennial, and flows through a series of cienega pools; the larger pools have numbered staff gauges to help detect changes over time. Sharp Springs was historically occupied by Gila Topminnow. Nonnative Western Mosquitofish were first found in Sharp Springs in 1979. Monitoring by the Department and partners documented the disappearance of Gila Topminnow, which has not been detected since 2002. The extirpation was attributed to predation and competition with nonnative mosquitofish, and reduced flooding. The purpose of this project is to eradicate Western Mosquitofish from Sharp Spring, and then repatriate Gila Topminnow and Roundtail Chub[1]. The Sharp Springs lineage of Gila Topminnow would be translocated from one or more of the replicate populations in the state. Roundtail Chub[1] from the nearby Sheehy Spring may be translocated to Sharp Spring.

During June 2013, Department staff attempted to dry the pools in Sharp Spring by pumping water out. They pumped down the two uppermost pools, but because of the large amount of fine sediment in the bottom of the pools, could not pump all of the water out. The pools partially refilled overnight, and mosquitofish were observed in the downstream pool the next morning. The effort was terminated because the pools could not be completely dried. Afterwards, other ideas for eradicating the mosquitofish were proposed including: treating with rotenone, treating with ammonia, heating the water in each pool, adding organic matter to the pools to create anoxic conditions, covering the pools with black plastic or adding dye to the pools to create anoxic conditions.

Results: No work was completed on this project in 2018, because Arizona State Parks never communicated with, or gave the Department permission to move forward with the project.

Recommendations: Department staff thinks that the most effective way to eradicate mosquitofish from Sharp Spring would be treatment with rotenone. The Department will coordinate with State Parks to see if they will approve of the project. This project should be removed from the priority list until State Parks approves moving forward with the removal.

[1] Chub in Sheehy Spring to be repatriated into Sharp Spring were previously classified as Gila Chub.

Boyce Thompson Ayer Lake native fish restoration (Task AZ-2000-1)

Strategic Plan Goals:

- Preventing Extinction and Managing Toward Recovery
    - Goal 4. Remove nonnative aquatic species threats.
    - Goal 5. Replicate populations and their associated native fish community into protected streams and other surface waters.
    - Goal 9. Monitor to quantitatively measure and evaluate project success in improving the status of target species and their habitats.

Recovery Objectives:

- Gila Topminnow 1999 draft revised recovery plan objective 2.2. Reestablish Gila topminnow in suitable habitats following geographic guidelines.
- Gila Topminnow 1999 draft revised recovery plan objective 3. Monitor natural and reestablished populations and their habitats.
- Gila Chub draft recovery plan objective 1.3.1. Eliminate or control problematic nonnative aquatic organisms.
- Gila Chub draft recovery plan objective 7. Monitor remnant, repatriated, and refuge populations to inform adaptive management strategies.
- Desert Pupfish recovery objective 2. Re-establish Desert Pupfish populations.
- Desert Pupfish recovery objective 5. Monitor and maintain natural, re-established, and refugia populations.

Background: Ayer Lake at Boyce-Thompson Arboretum, near Superior, has served as a refuge for Gila Topminnow and Desert Pupfish since the 1970's. In addition, Arizona Game and Fish Department uses these Ayer Lake populations to establish new populations of these two species throughout the Gila River Basin. Gila topminnow was first stocked into Ayer Lake in 1971, then in 1972, and 1978. Desert pupfish were first stocked in 1977. Nonnative fish invaded the reservoir, and so Ayer Lake was chemically treated with piscicides three times; in 1979 to remove black bullhead, in 1980 to again remove black bullhead, and in 1983 to remove Western Mosquitofish. After the third renovation, a mixed stock of Monkey Springs and Monkey Springs-Cocio Wash-Bylas Springs populations of Gila Topminnow were stocked in 1985 (USFWS 1998). However, Hedrick et al. (2001) found only alleles from Monkey Springs, so that is the lineage considered replicated in Ayer Lake. A mixed Lower Colorado River Delta stock of Desert Pupfish were acquired from Santa Clara Slough, Dexter National Fish Hatchery, and Deer Valley High School (USFWS 1993) and stocked in 1984 and 1985. During 1986 monitoring, nonnative Fathead Minnow were discovered in the pond, and have been present ever since. Red Swamp Crayfish, another nonnative species, was first observed during 1976 monitoring, and it continues to inhabit Ayer Lake. Western Mosquitofish was detected in November 2010, after which the Department discontinued using Ayer Lake as a source of Gila

Topminnow for translocations. In addition to the fish species, native herptiles Sonoran Mud Turtle and Lowland Leopard Frog inhabit the lake, as do native aquatic plants such as cattails *Typha* spp. and hard-stem bulrush *Schoenoplectnus acutus*, and a wide array of aquatic invertebrates.

In 2008, Arizona State Parks staff were concerned about treating Ayer Lake with a piscicide, because watchable invertebrates (dragonflies and damselflies) would also be temporarily eradicated and the lake's water was needed for irrigation. However, in 2015, the Director of Boyce Thompson Arboretum agreed to again consider partially draining the pond and treating it to remove the nonnative species. The park was going to try to install a new well, after which the pond could be partially drained and the treatment done. Funding fell through for the new well, and as of the end of 2018, no new funding sources had been identified.

The purpose of this project is to eradicate the nonnative fishes, and if possible the nonnative crayfish from Ayer Lake and then reestablish Gila Topminnow and Desert Pupfish, and possibly establish Roundtail Chub[1].

Results: No work performed on this task during 2018 because the State Park was waiting on funding for a new well.

Recommendations: Department staff should contact Boyce Thompson State Park to determine if they have installed a new well. Determine what steps are necessary to move forward with eradication of nonnative fishes from Ayer Lake. This project should be removed from the priority list until State Parks is ready for the Department to perform the removal.

PROJECTS REMOVED FROM PRIORITY LIST

Arnett Creek repatriations. Merged into Gila Topminnow Stockings.

Arizona trout streams Loach Minnow repatriations. Removed from list because the Department CAMP program is implementing this project.

Fossil Creek repatriations. Completed in 2016.

Mineral Creek drainage renovation and repatriations. Removed until State Land Department approves of wildlife translocations on their managed lands.

Post-repatriation evaluations. This project was removed from the priority list because post-repatriation evaluations (monitoring) are reported under each specific priority action.

Transfer Roundtail Chub[1] and Gila Topminnow to New Mexico. Removed from priority list until New Mexico is ready to request more fish.

[1] Chub at these locations were previously classified as Gila Chub.

Sands Draw repatriations. This project was removed from the priority list in 2016 until BLM has the habitat ready for fish.

West Fork Pinto repatriations. Merged into Gila Topminnow Stockings.

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FIGURES

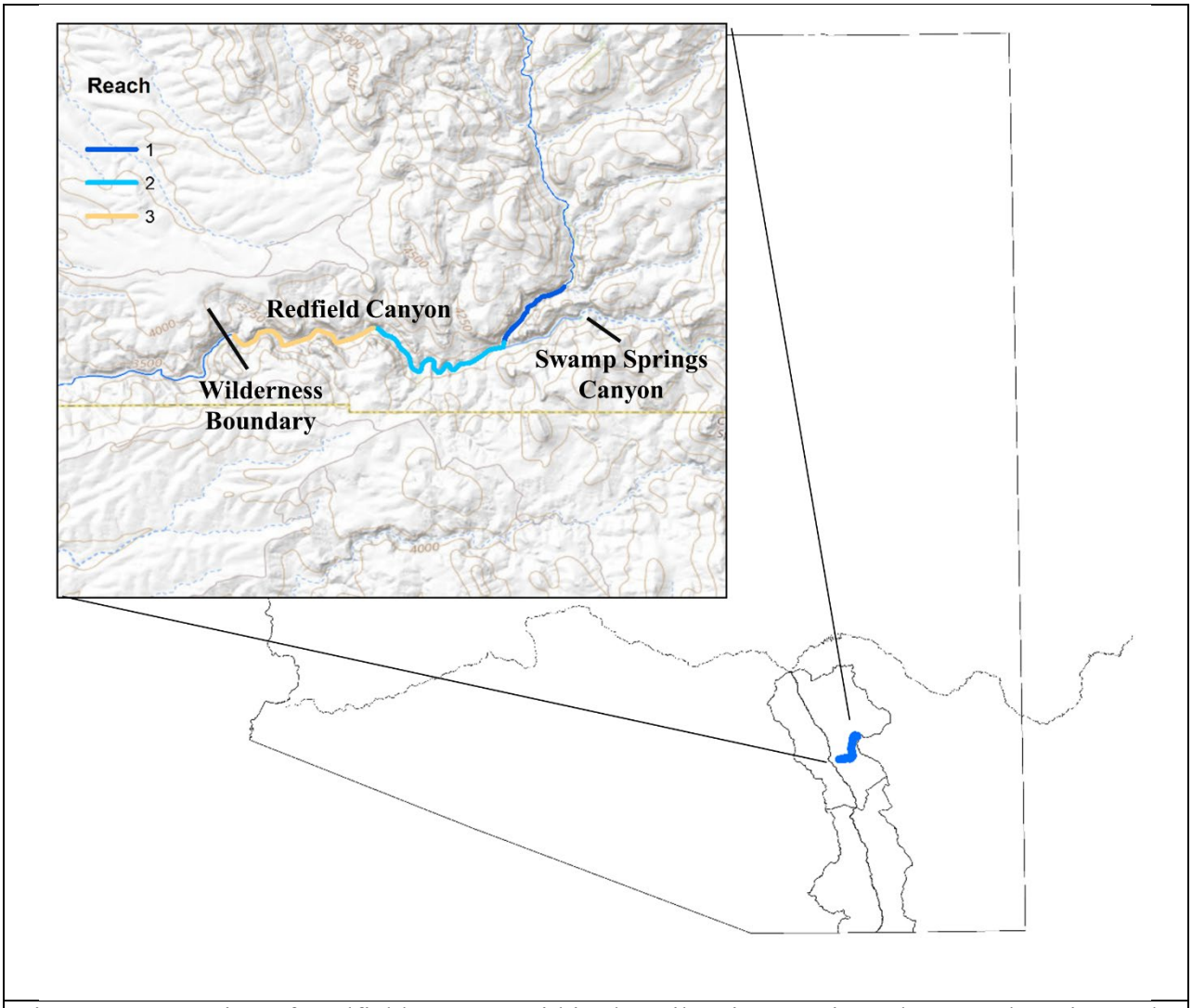

Figure 1.—Location of Redfield Canyon within the Gila River Basin and San Pedro River sub-basin. Inset map shows the location of sampling reaches 1 (Swamp Springs Confluence upstream to Barrier), 2 (Rock House tributary upstream to Swamp Springs Confluence), and 3 (Wilderness Boundary upstream to Rock House tributary).

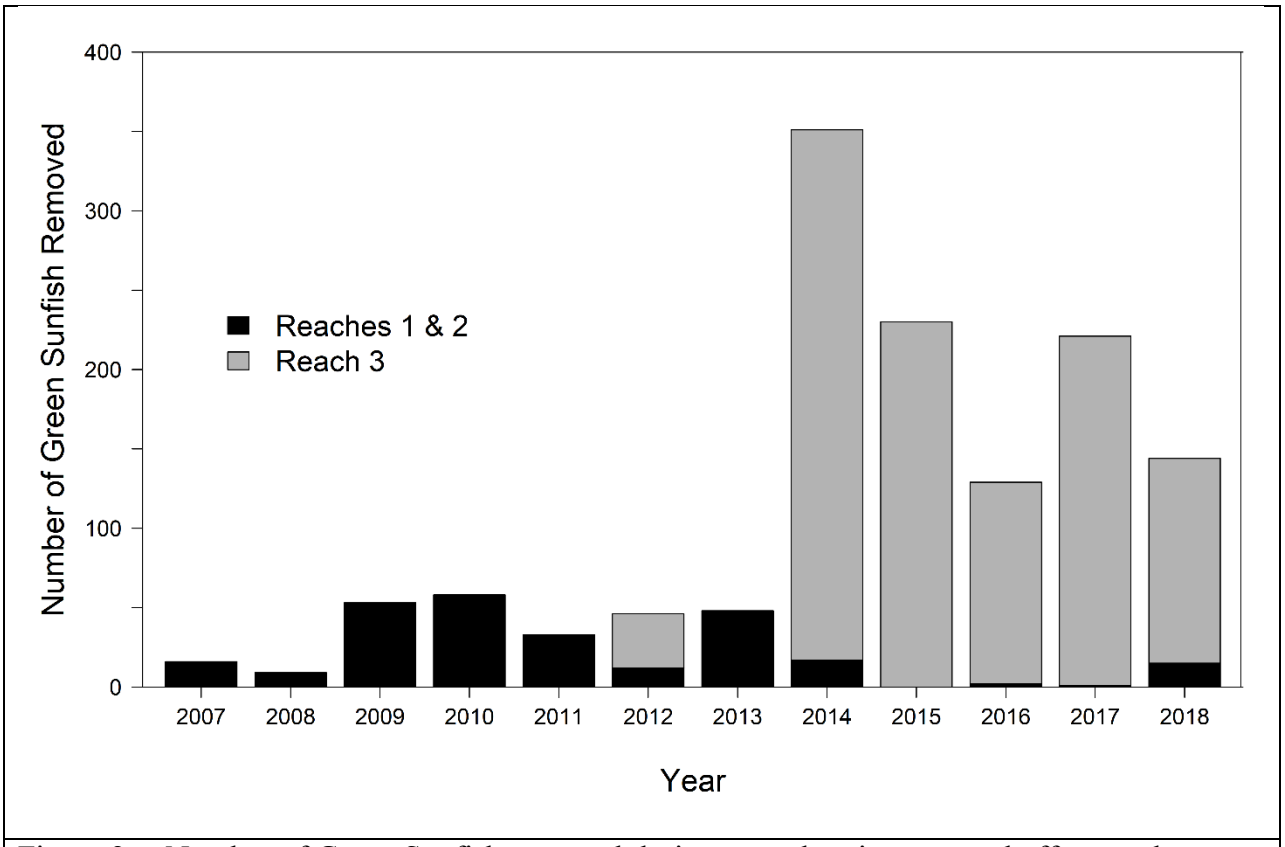

Figure 2.—Number of Green Sunfish removed during annual spring removal efforts and autumn monitoring from three reaches of Redfield Canyon, Arizona during 2007-2018. Location and description of reaches within Redfield Canyon shown in Figure 1.

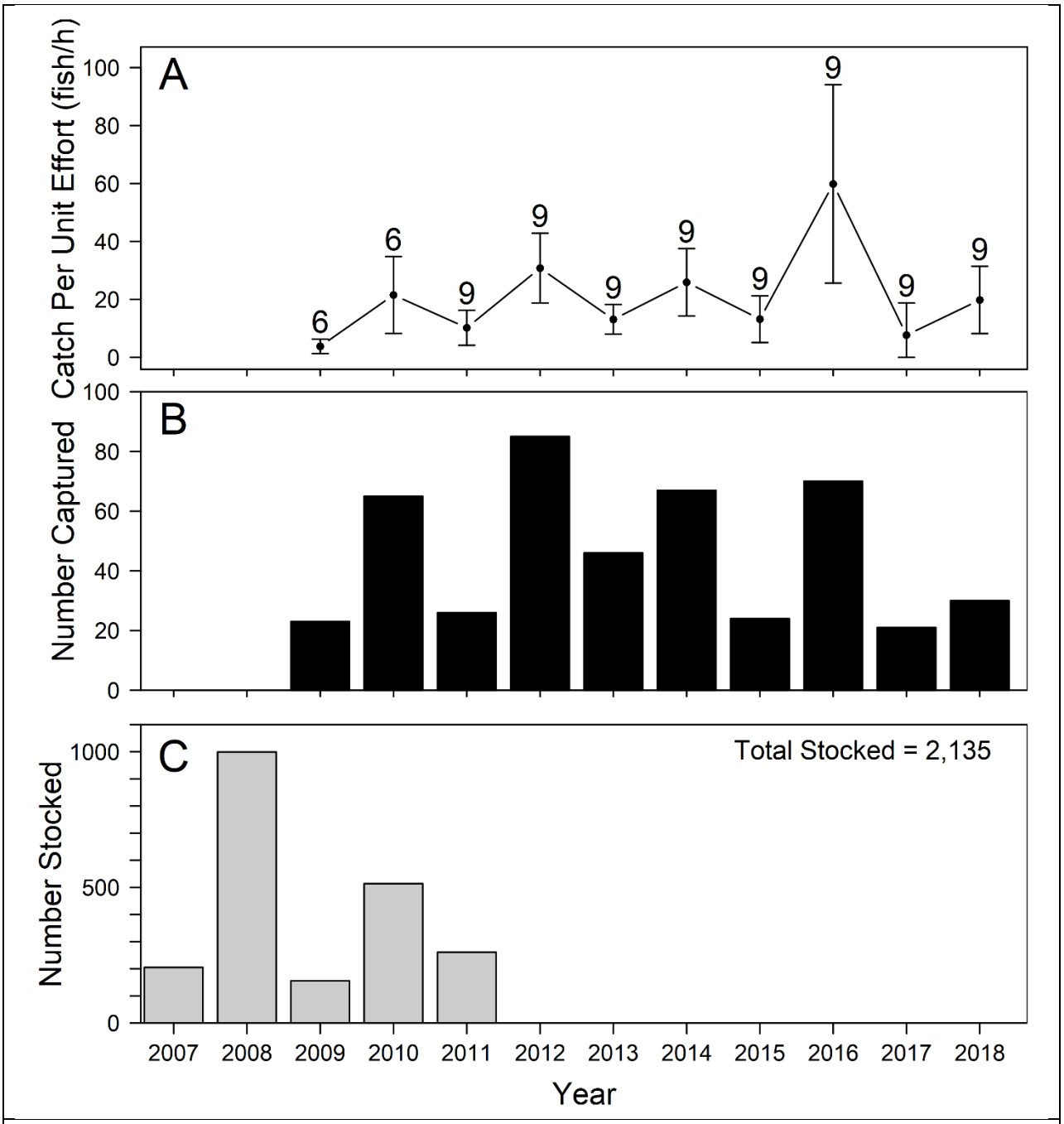

Figure 3.—Summary of Loach Minnow captured and stocked in Hot Springs Canyon, AZ, annually from 2007 to 2018 with (A) mean annual backpack electrofishing catch per unit effort (fish/hour) with standard error bars and the number of 100 meter transects sampled above the error bar, (B) total number of fish captured, and (C) total number of fish stocked.

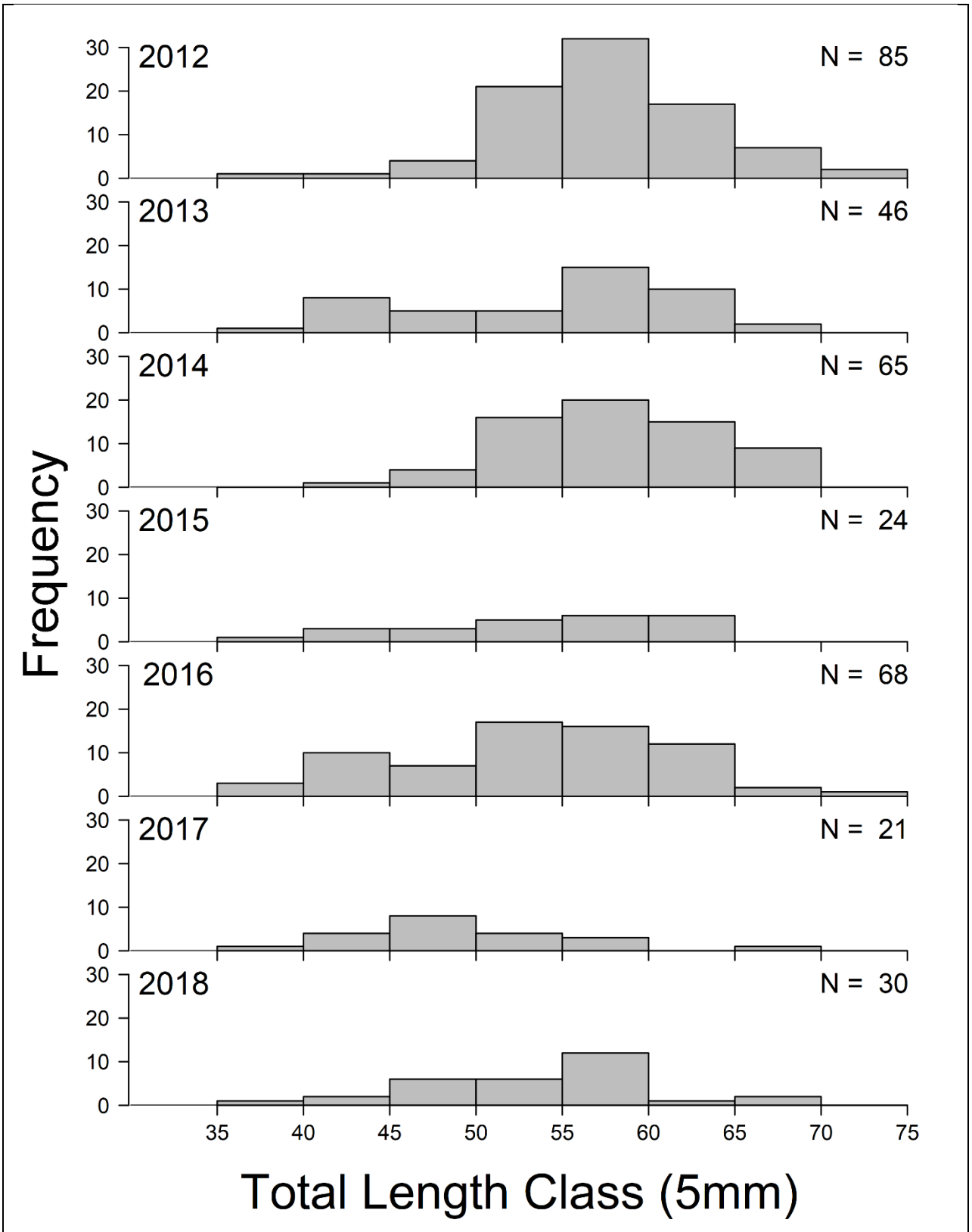

Figure 4.—Length frequency distributions of Loach Minnow captured during annual monitoring in Hot Springs Canyon, 2012 through 2018.

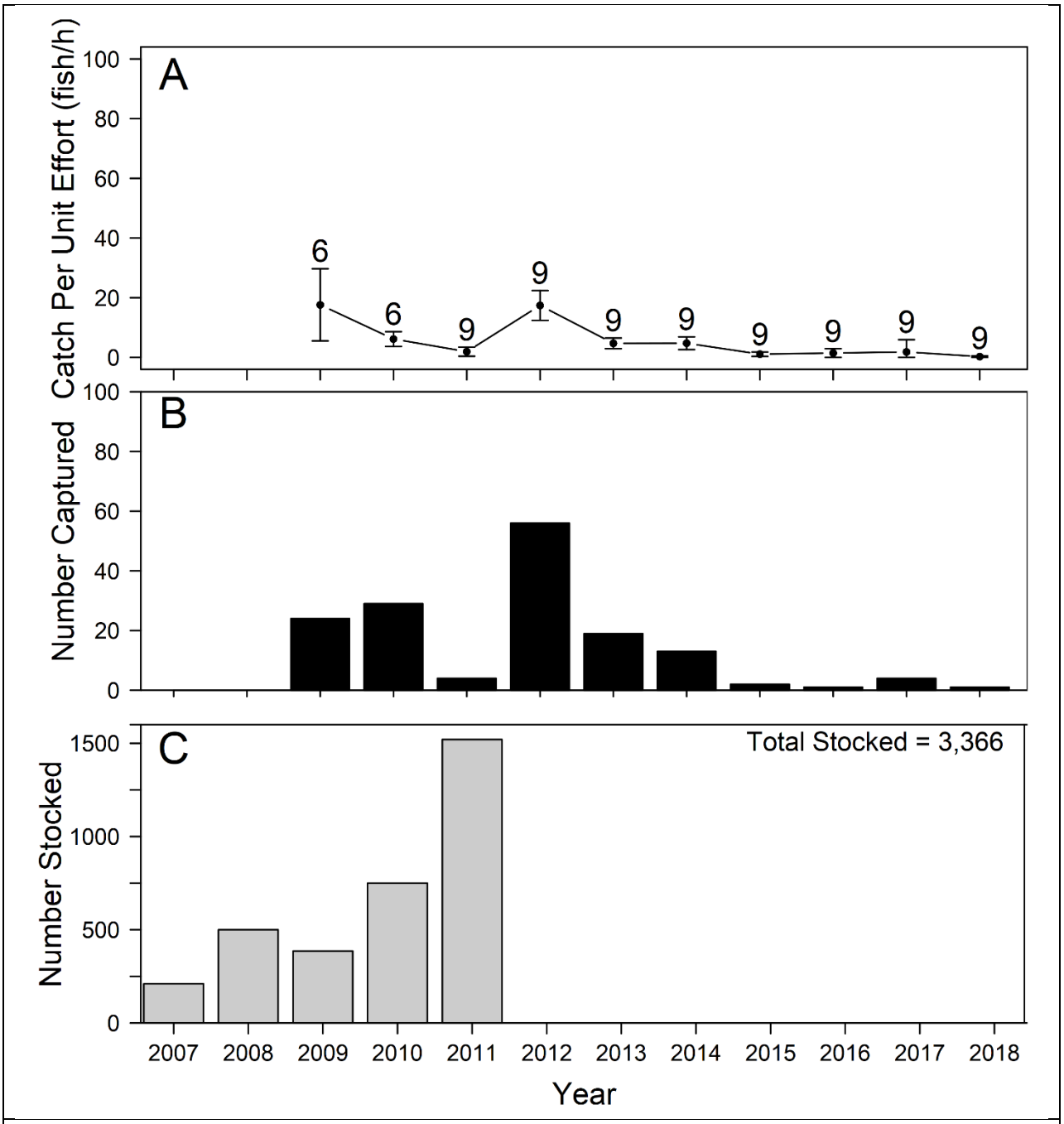

Figure 5.—Summary of Spikedace captured during annual and stocked in Hot Springs Canyon, AZ, annually from 2007 to 2018 with (A) mean annual backpack electrofishing catch per unit effort (fish/hour) with standard error bars and the number of 100 meter transects sampled above the error bar, (B) total number of fish captured, and (C) total number of fish stocked.

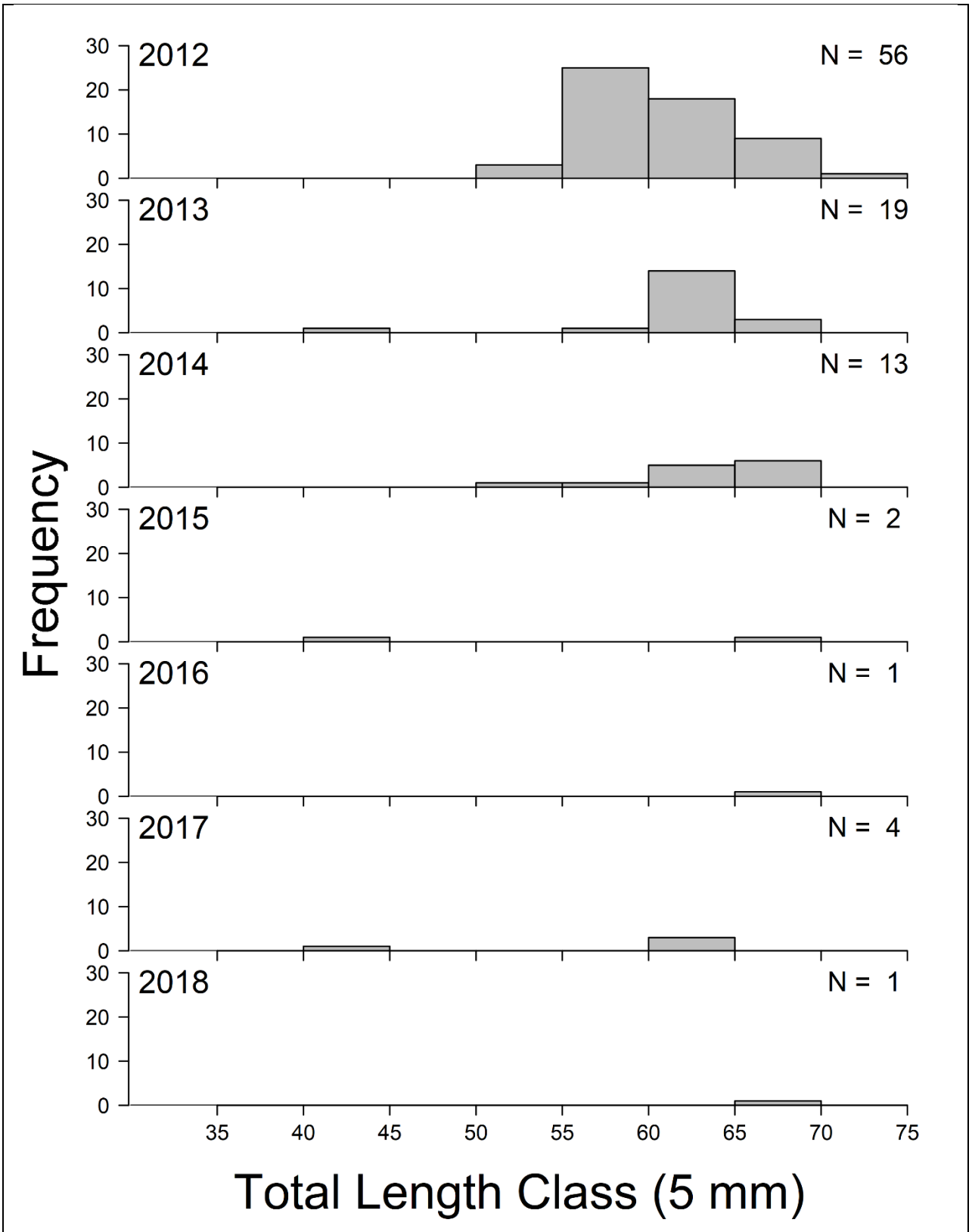

Figure 6.—Length frequency distributions of Spikedace captured during annual monitoring in Hot Springs Canyon, 2012 through 2018.

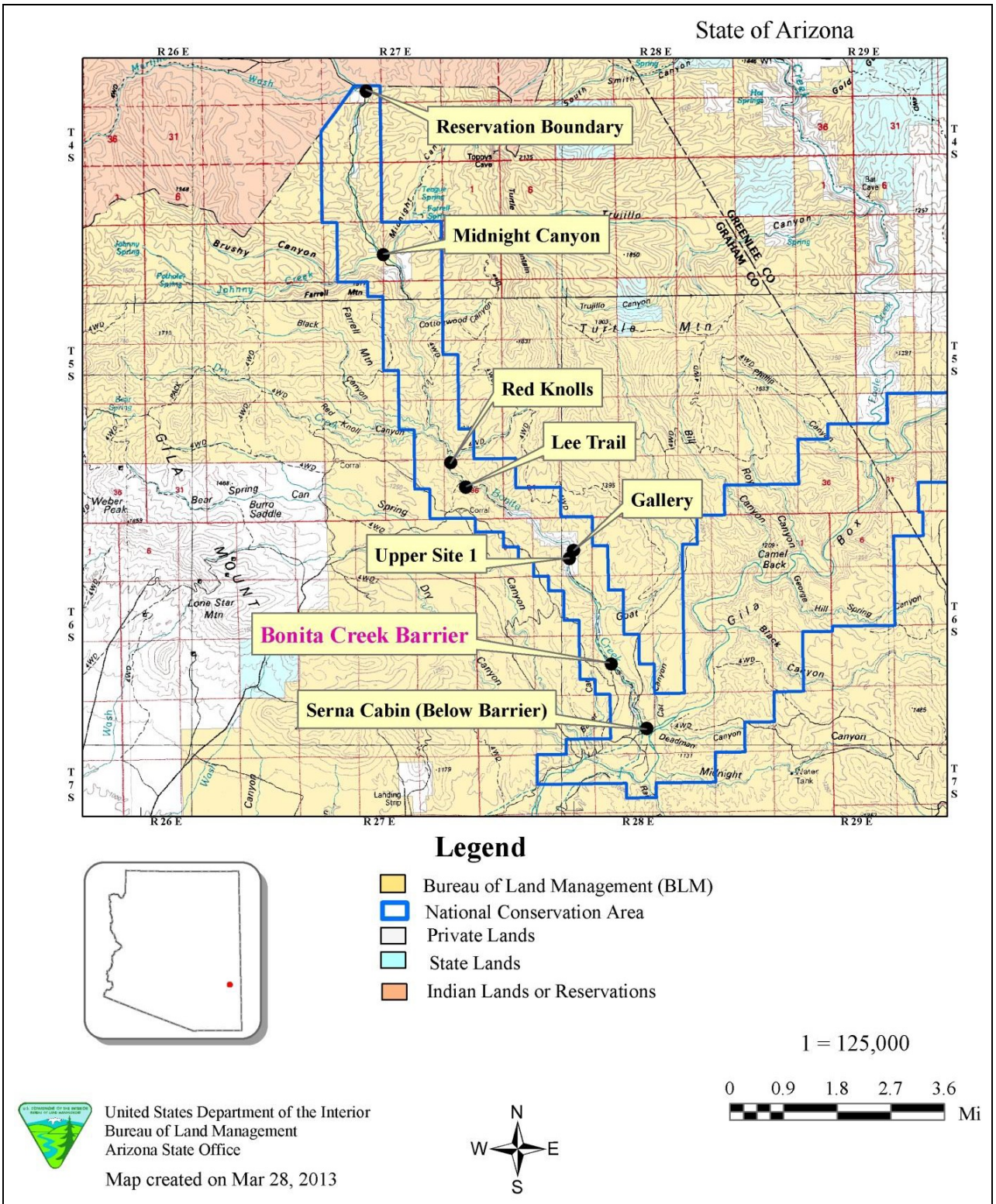

Figure 7.—Map showing locations of Bureau of Land Management monitoring sites in Bonita Creek, north of Safford, Arizona.

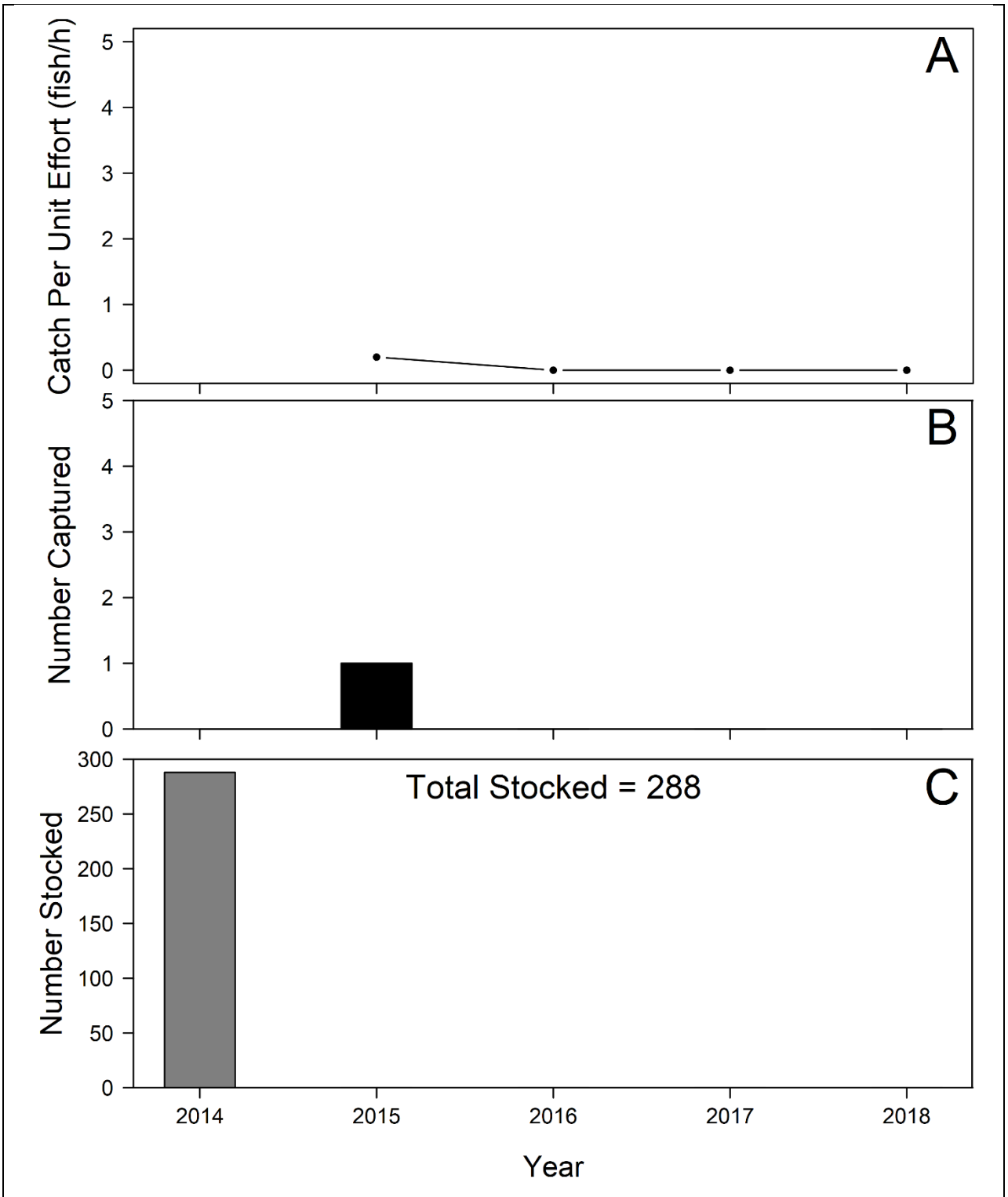

Figure 8.—Summary of Loach Minnow captured and stocked in Bonita Creek, AZ, annually from 2014 to 2018 with (A) mean annual backpack electrofishing catch per unit effort (fish/hour), (B) total number of fish captured, and (C) total number of fish stocked.

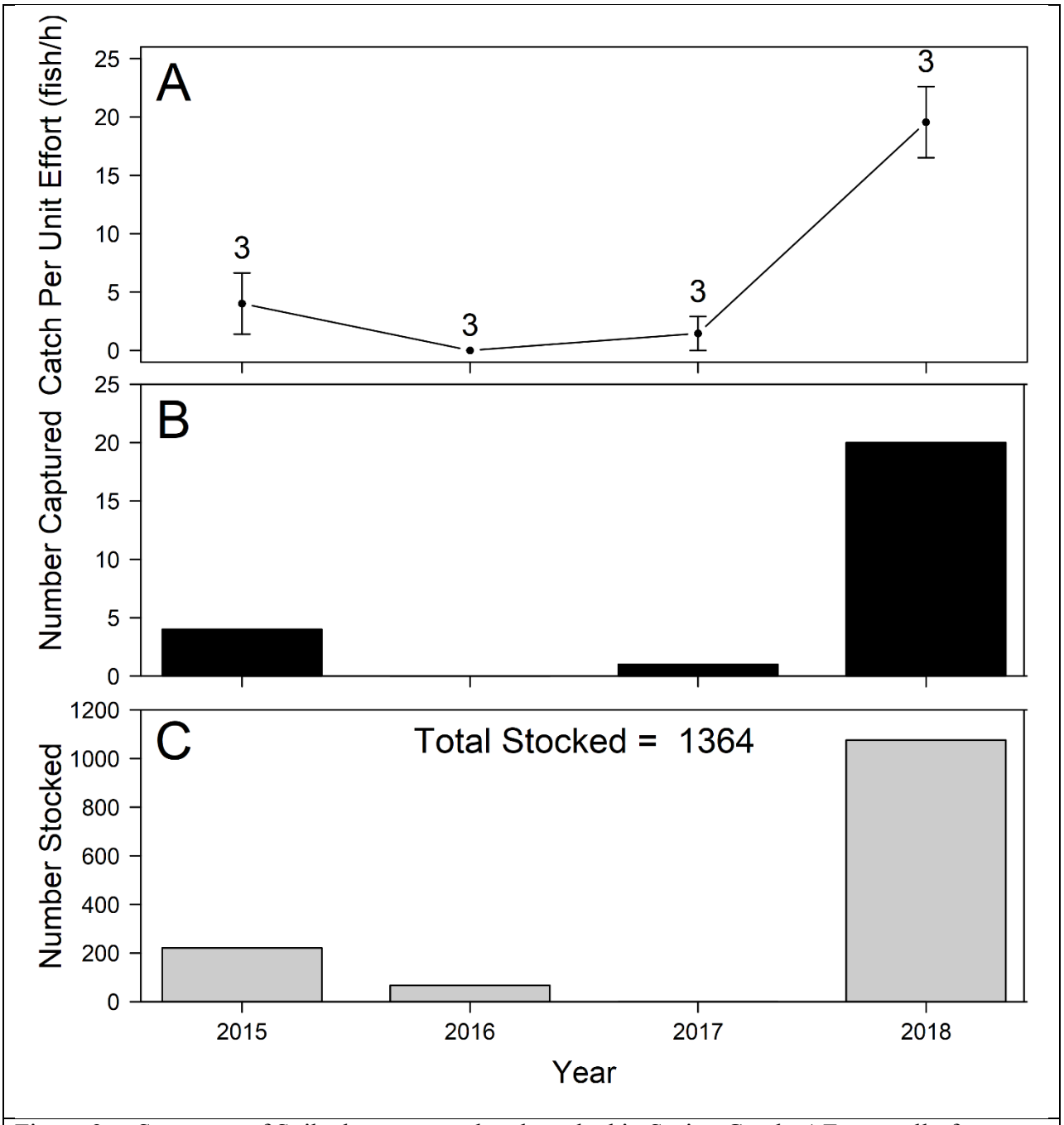

Figure 9.—Summary of Spikedace captured and stocked in Spring Creek, AZ, annually from 2015 to 2018 with (A) mean annual backpack electrofishing catch per unit effort (fish/hour), (B) total number of fish captured, and (C) total number of fish stocked.

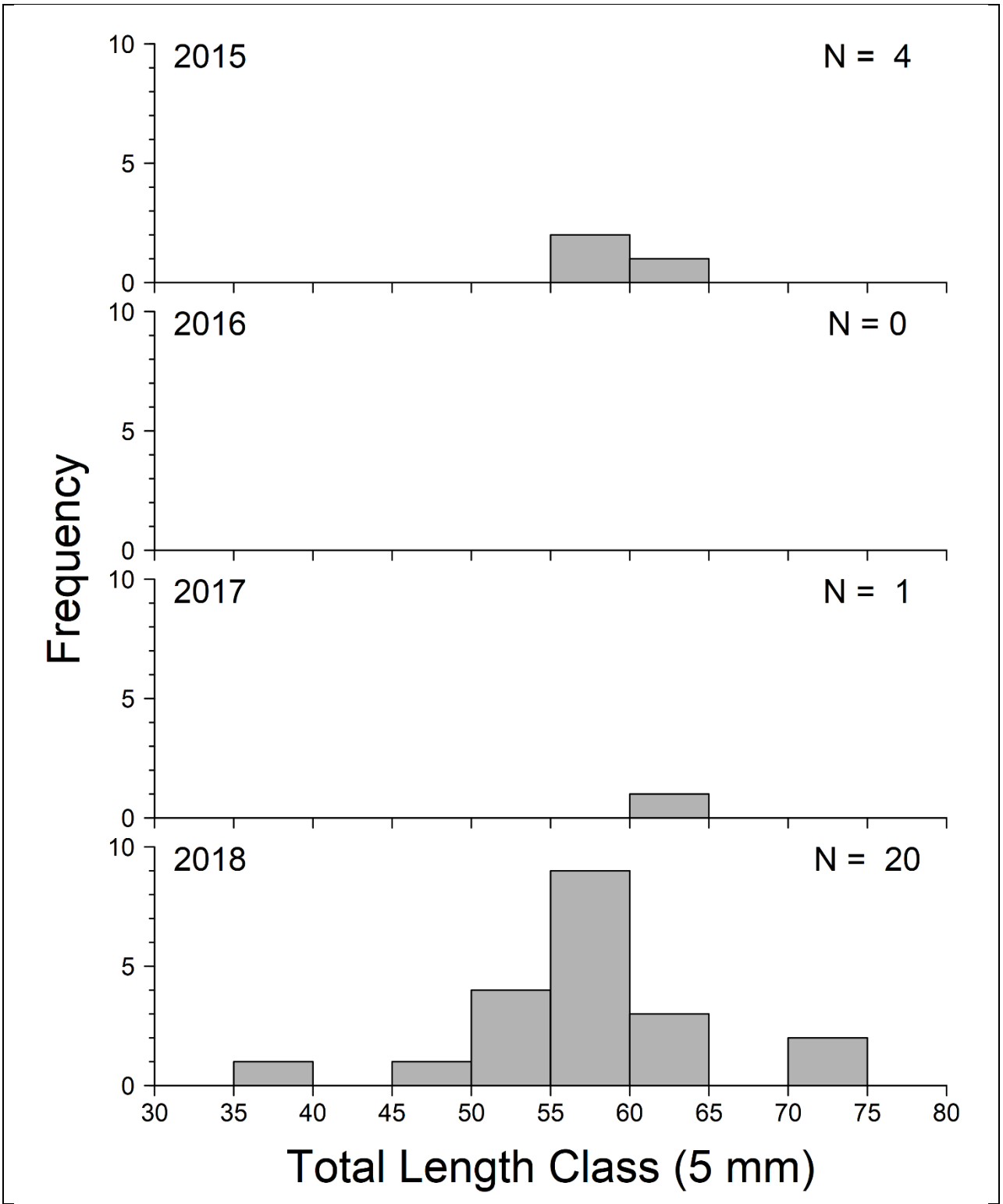

Figure 10.—Length frequency distributions of Spikedace captured during annual monitoring in Spring Creek, 2015 through 2018.

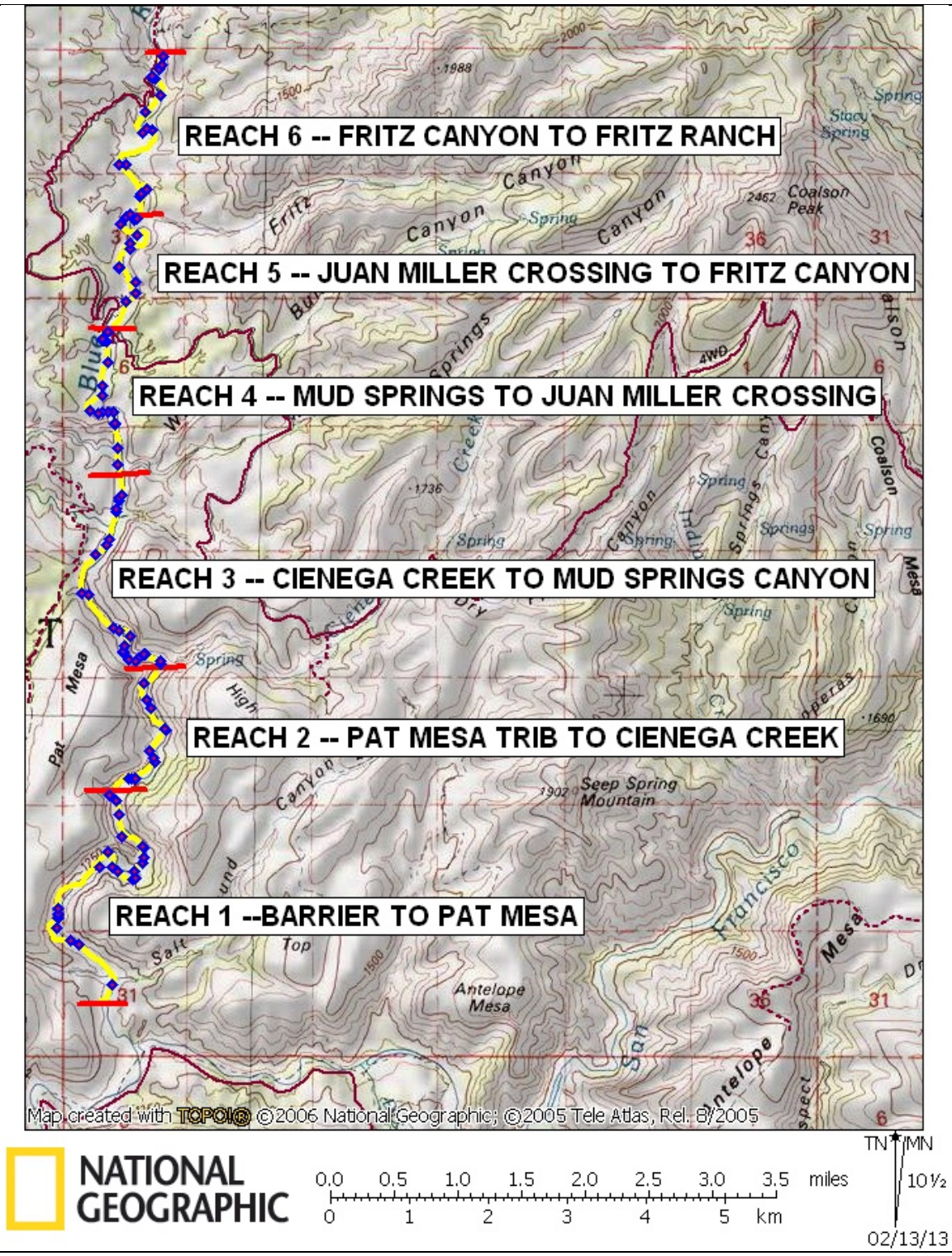

Figure 11.—Map of the lower Blue River, Arizona showing the project reach (yellow line) divided by the red lines into the six sub-reaches. The blue dots are pools with maximum depth >1 m.

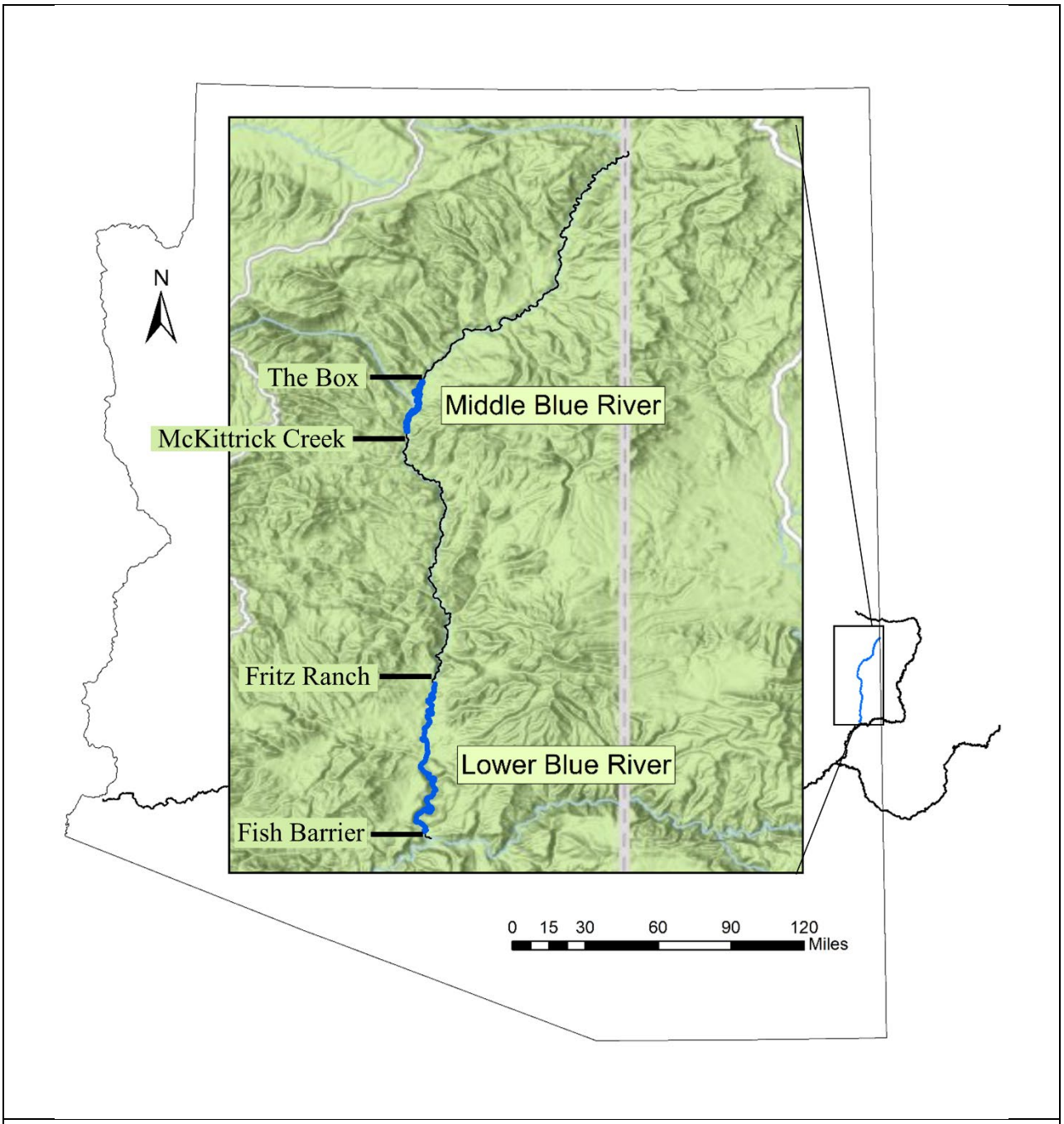

Figure 12.—Map showing the middle (The Box downstream to Fritz Ranch), and lower (Fritz Ranch downstream to the barrier) project areas of the Blue River.

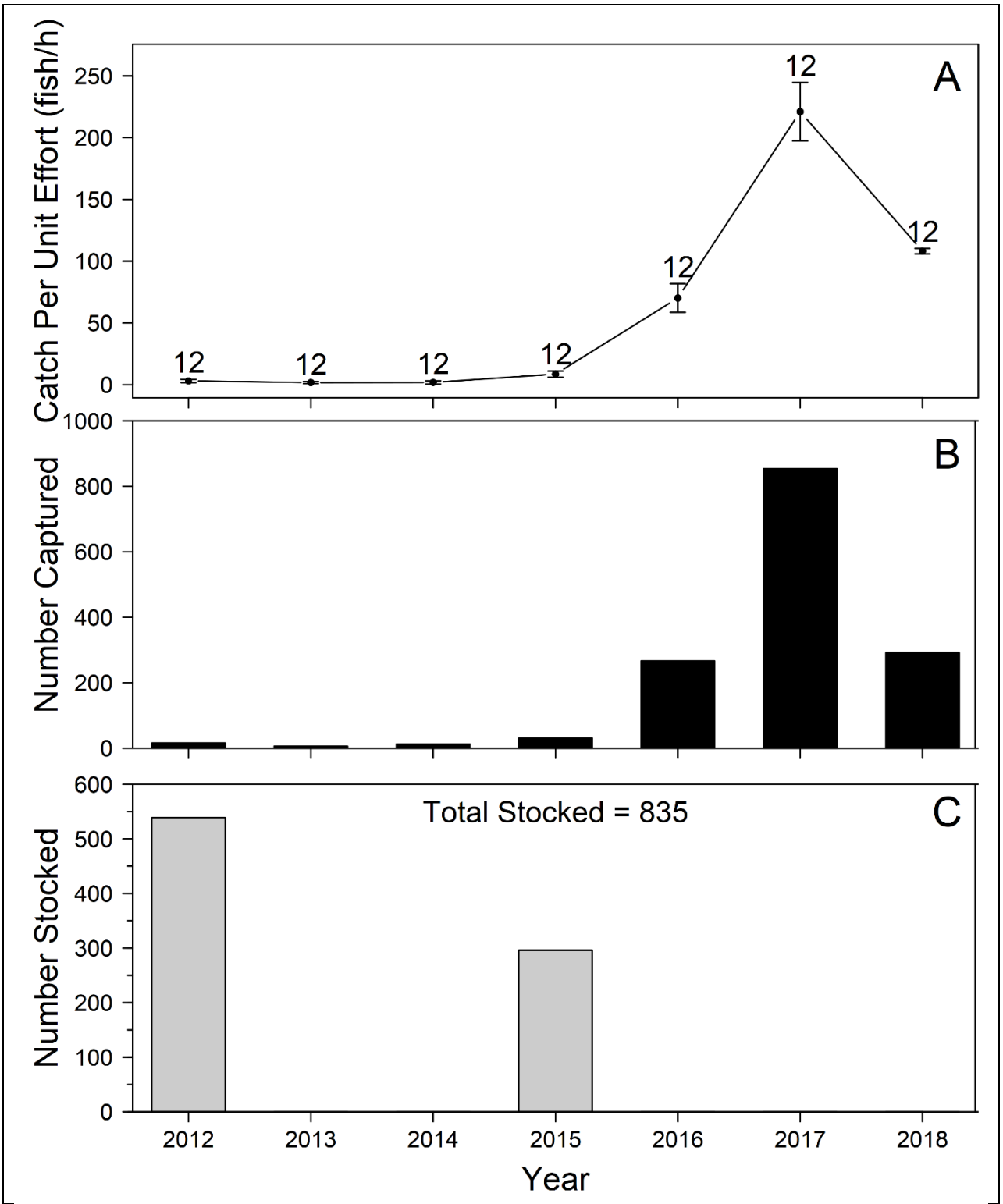

Figure 13.—Summary of Spikedace captured and stocked in lower Blue River, annually from 2012 to 2018 with (A) mean annual backpack electrofishing catch per unit effort (fish/hour) with standard error bars and the number of 100 meter transects sampled above the error bar, (B) total number of fish captured, and (C) total number of fish stocked.

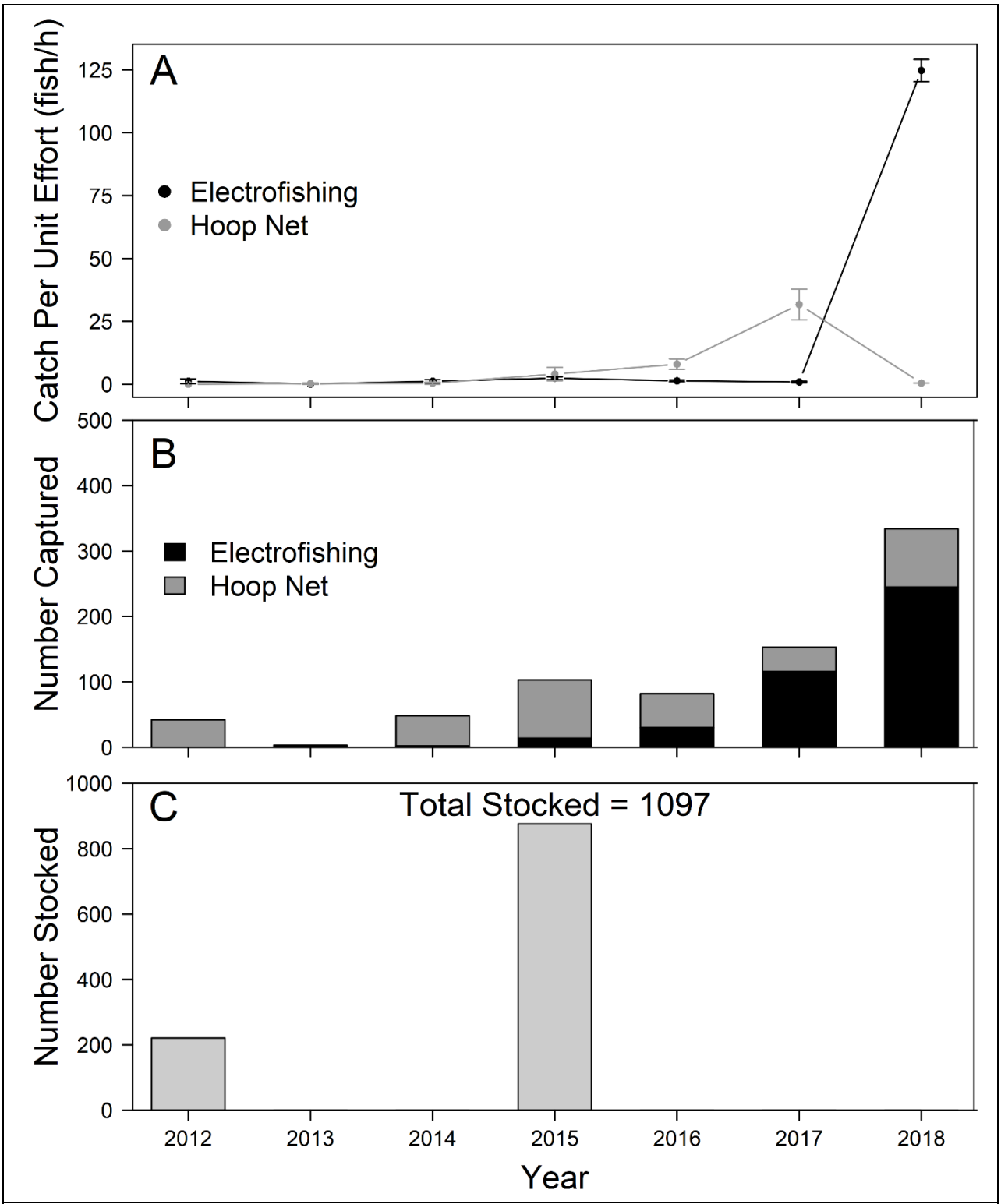

Figure 14.—Summary of Roundtail Chub captured and stocked in lower Blue River, annually from 2012 to 2018 with (A) mean annual backpack electrofishing (black) and hoop net (gray) catch per unit effort (fish/hour) with standard error bars, (B) total number of fish captured by gear type, and (C) total number of fish stocked. Number of transects sampled not shown for ease of visualization.

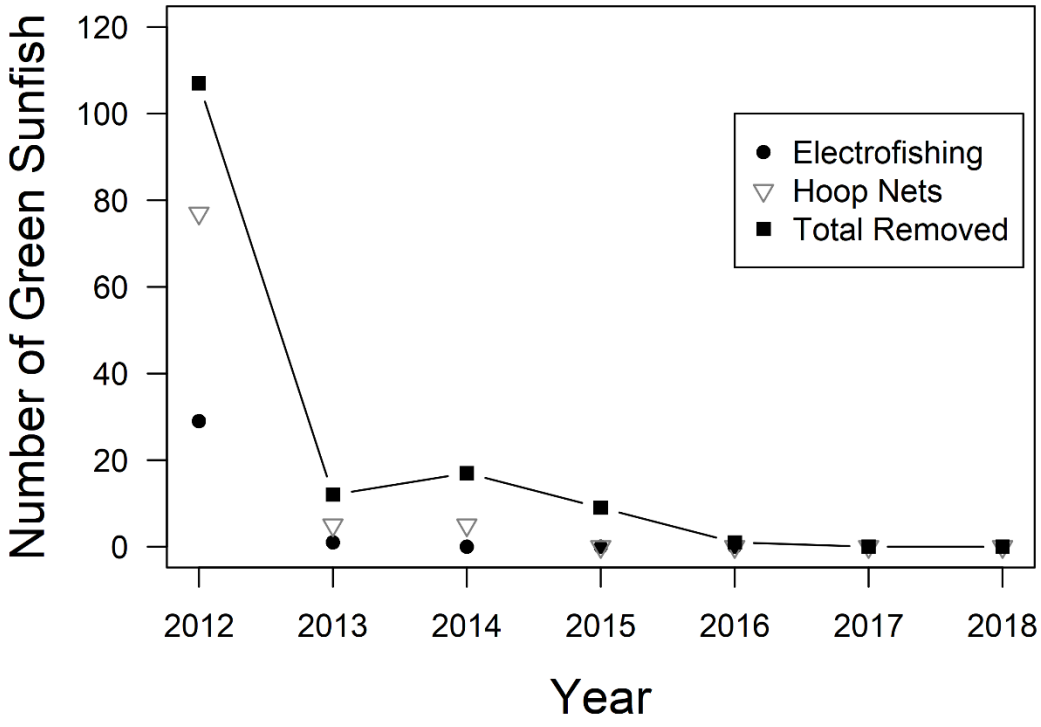

Figure 15.—Green Sunfish catch by gear type (electrofishing and hoop nets) and total number of individuals removed each year during all activities from the lower Blue River, Arizona, 2012 through 2018.

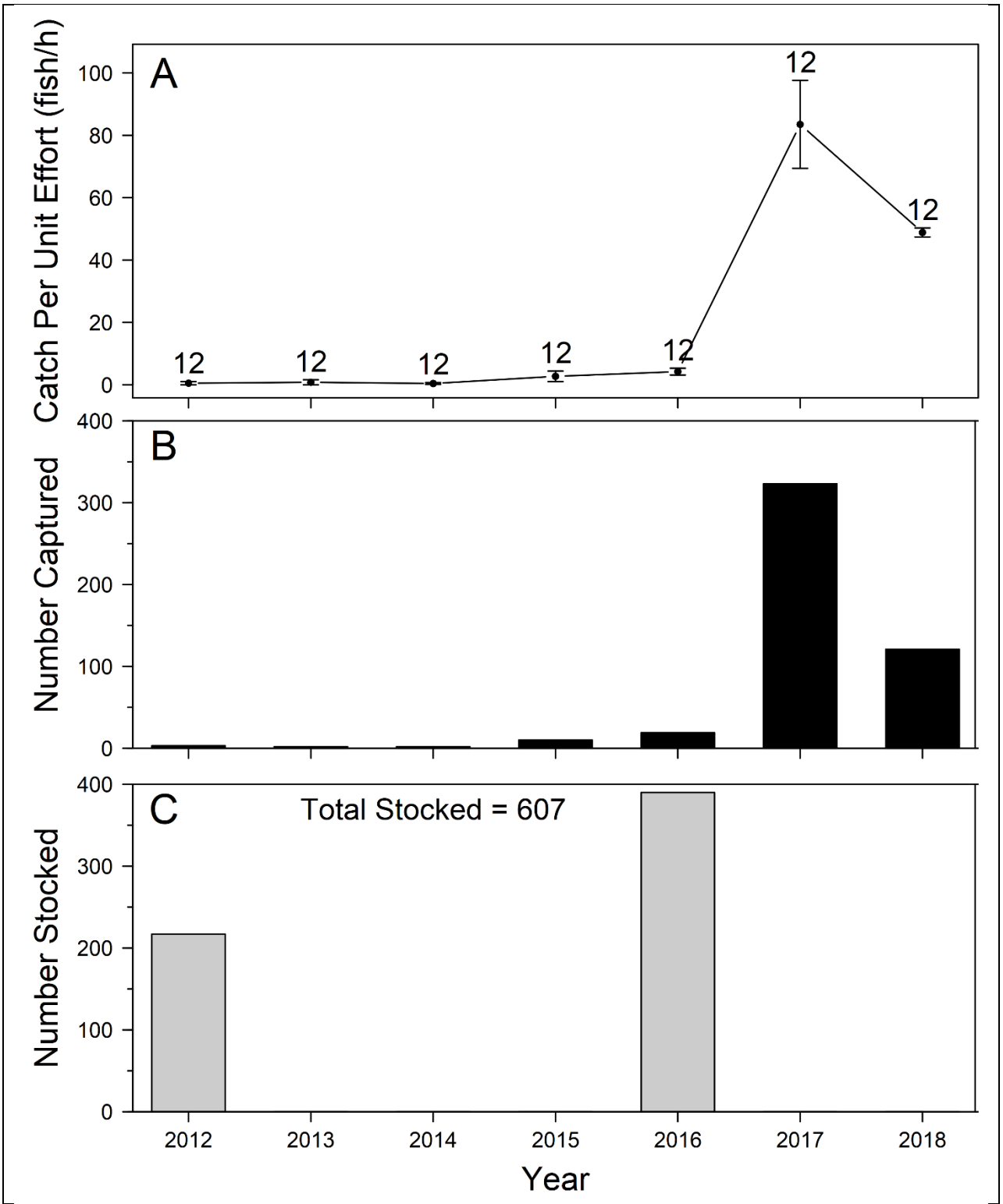

Figure 16.—Summary of Loach Minnow captured and stocked in the lower Blue River, annually from 2012 to 2018 with (A) mean annual backpack electrofishing catch per unit effort (fish/hour) with standard error bars and the number of 100 meter transects sampled above the error bar, (B) total number of fish captured, and (C) total number of fish stocked.

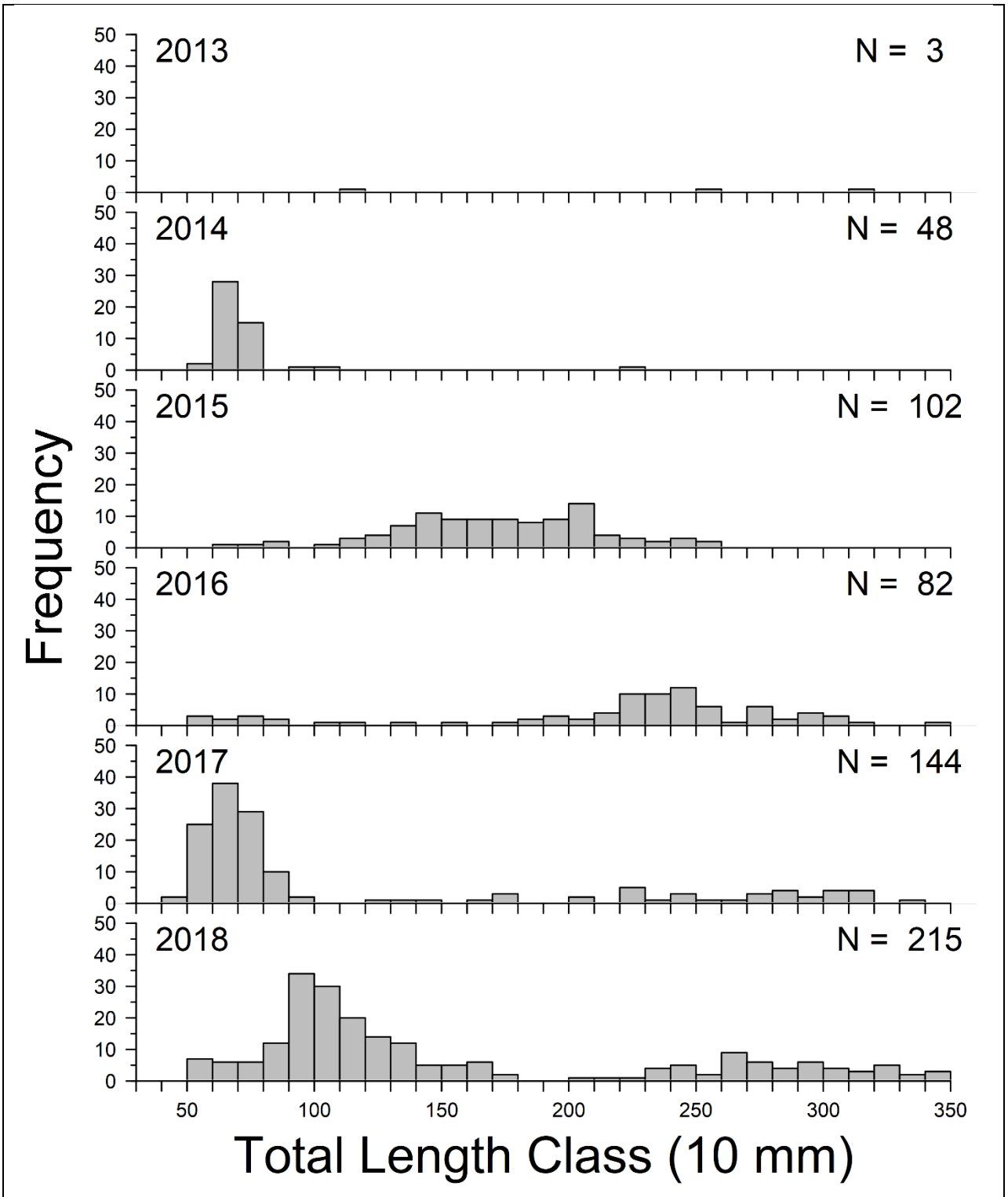

Figure 17.—Length frequency distributions of Roundtail Chub captured during annual monitoring in the lower Blue River, 2013 through 2018.

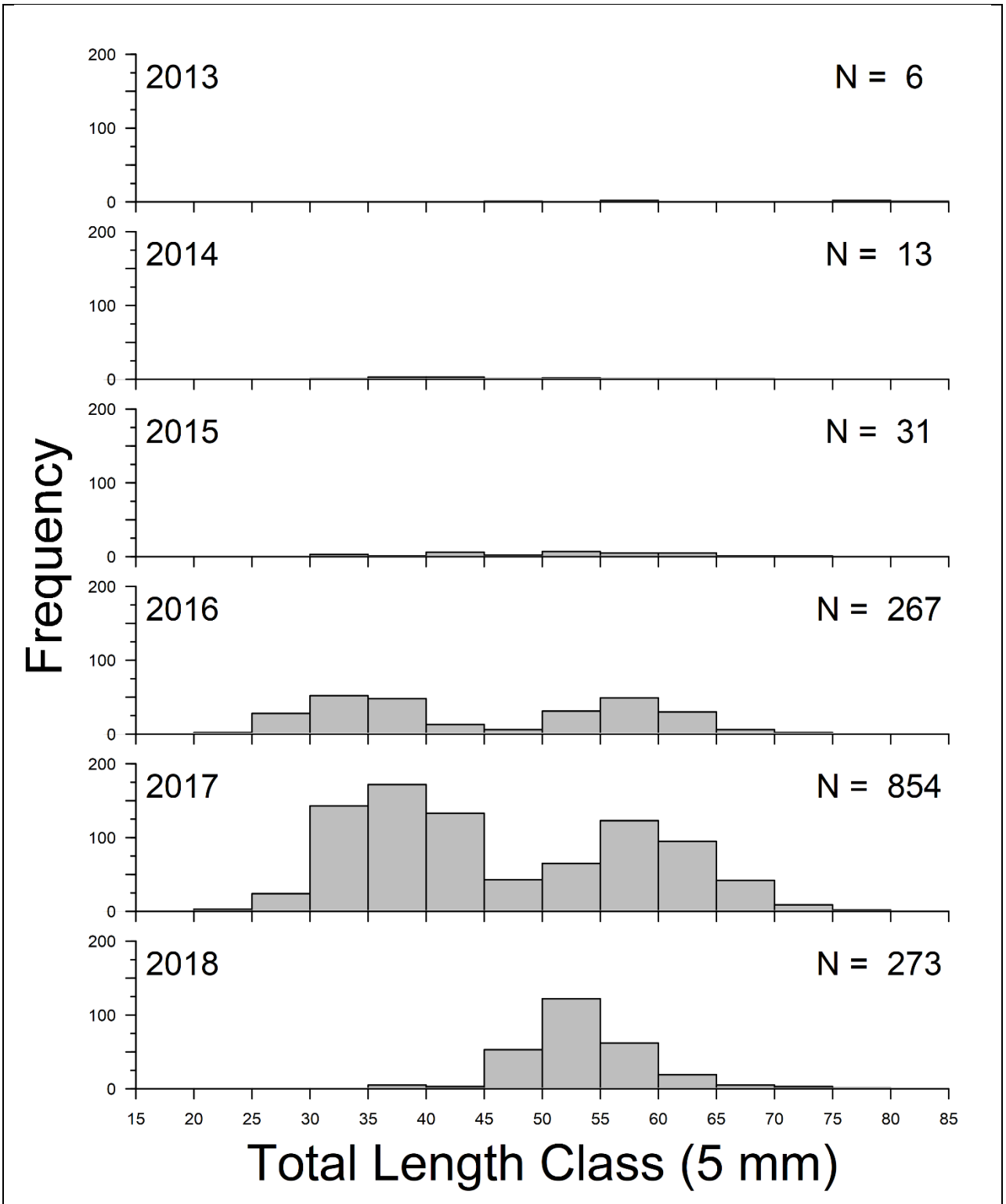

Figure 18.—Length frequency distributions of Spikedace captured during annual monitoring in the lower Blue River, 2013 through 2018.

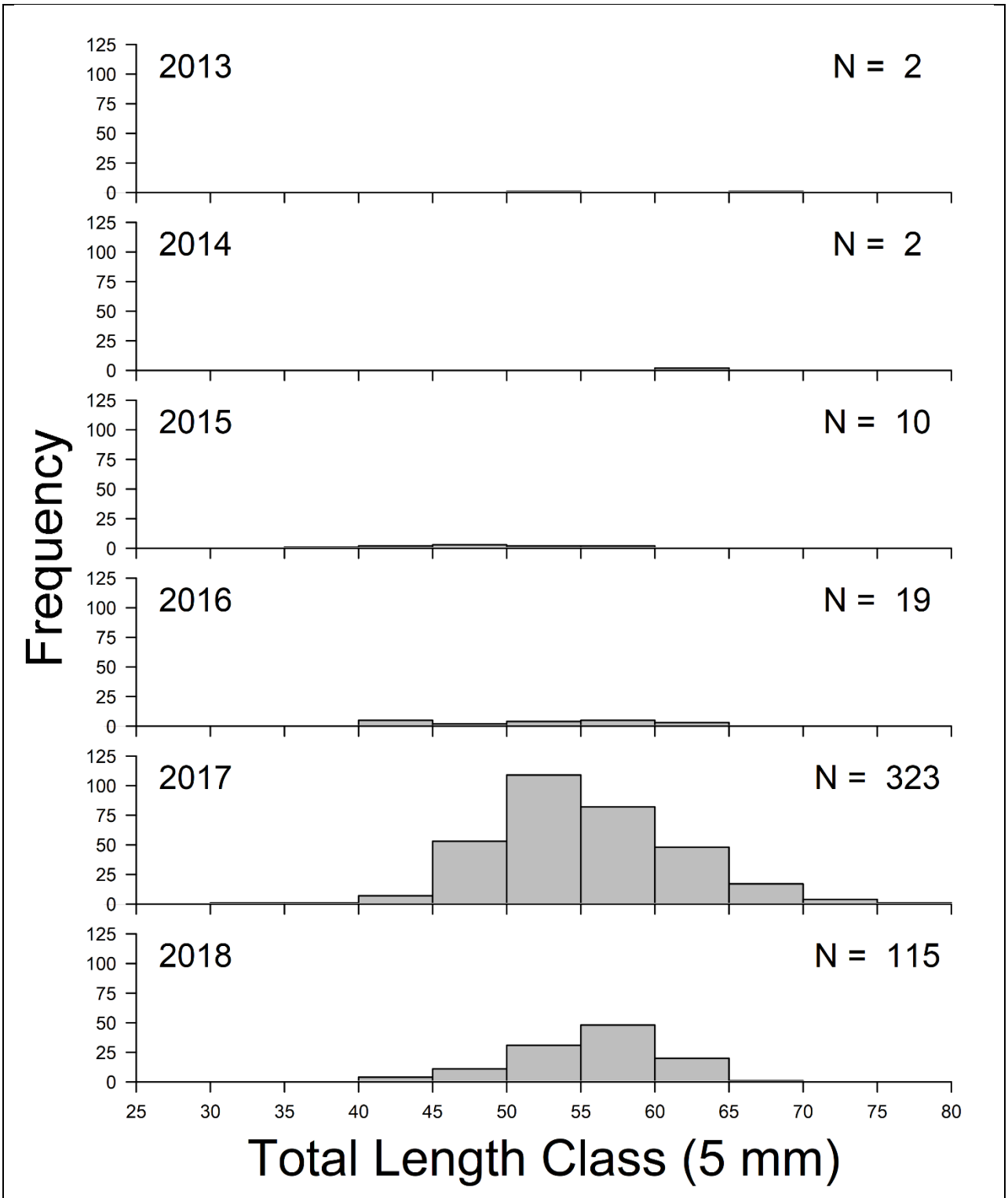

Figure 19.—Length frequency distributions of Loach Minnow captured during annual monitoring in the lower Blue River, 2013 through 2018.

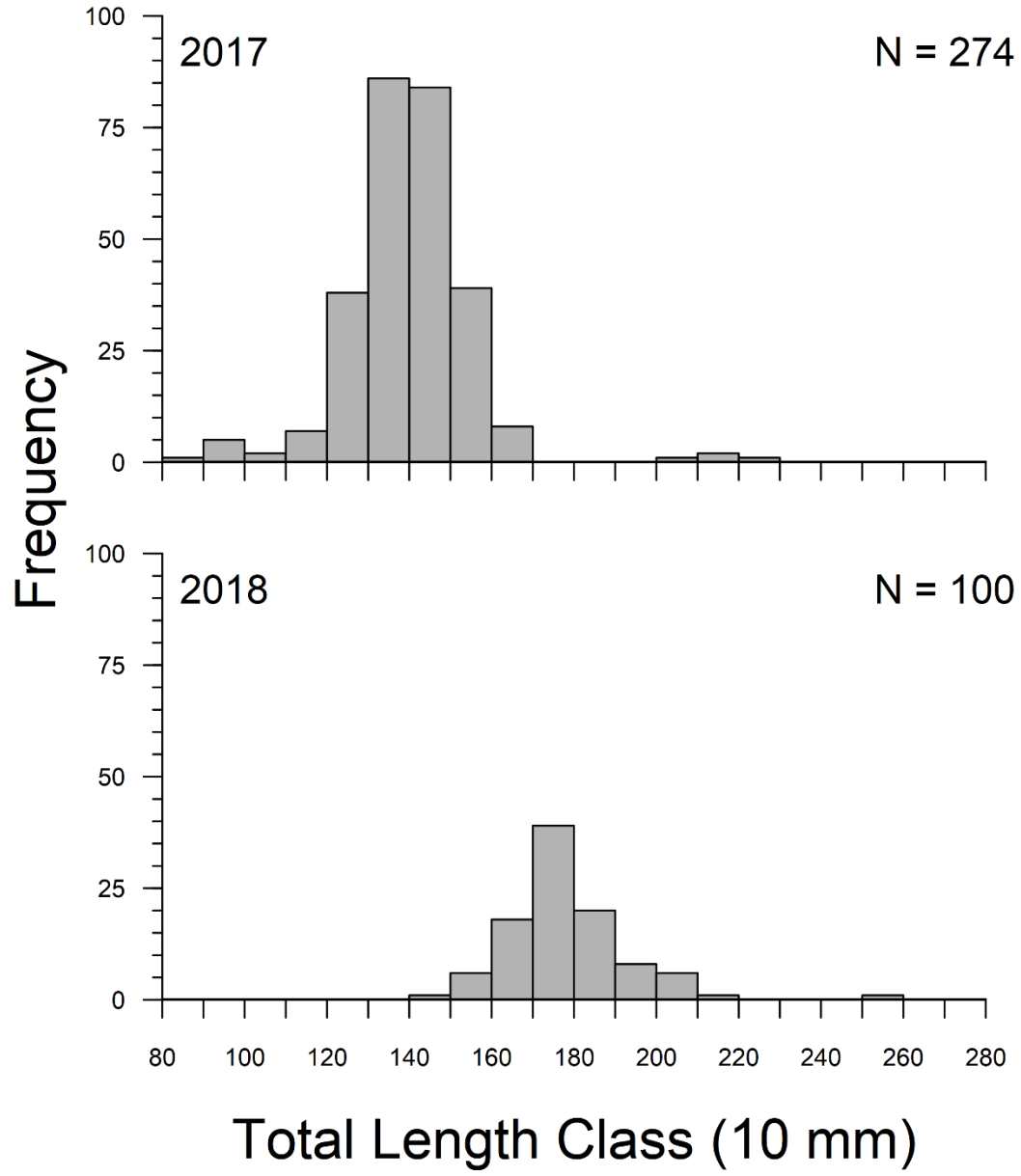

Figure 20.—Length frequency distribution of Roundtail Chub captured during annual monitoring in Quinsler Pond, from 2017 to 2018. Only the first 100 Roundtail Chub captured were measured in 2018.

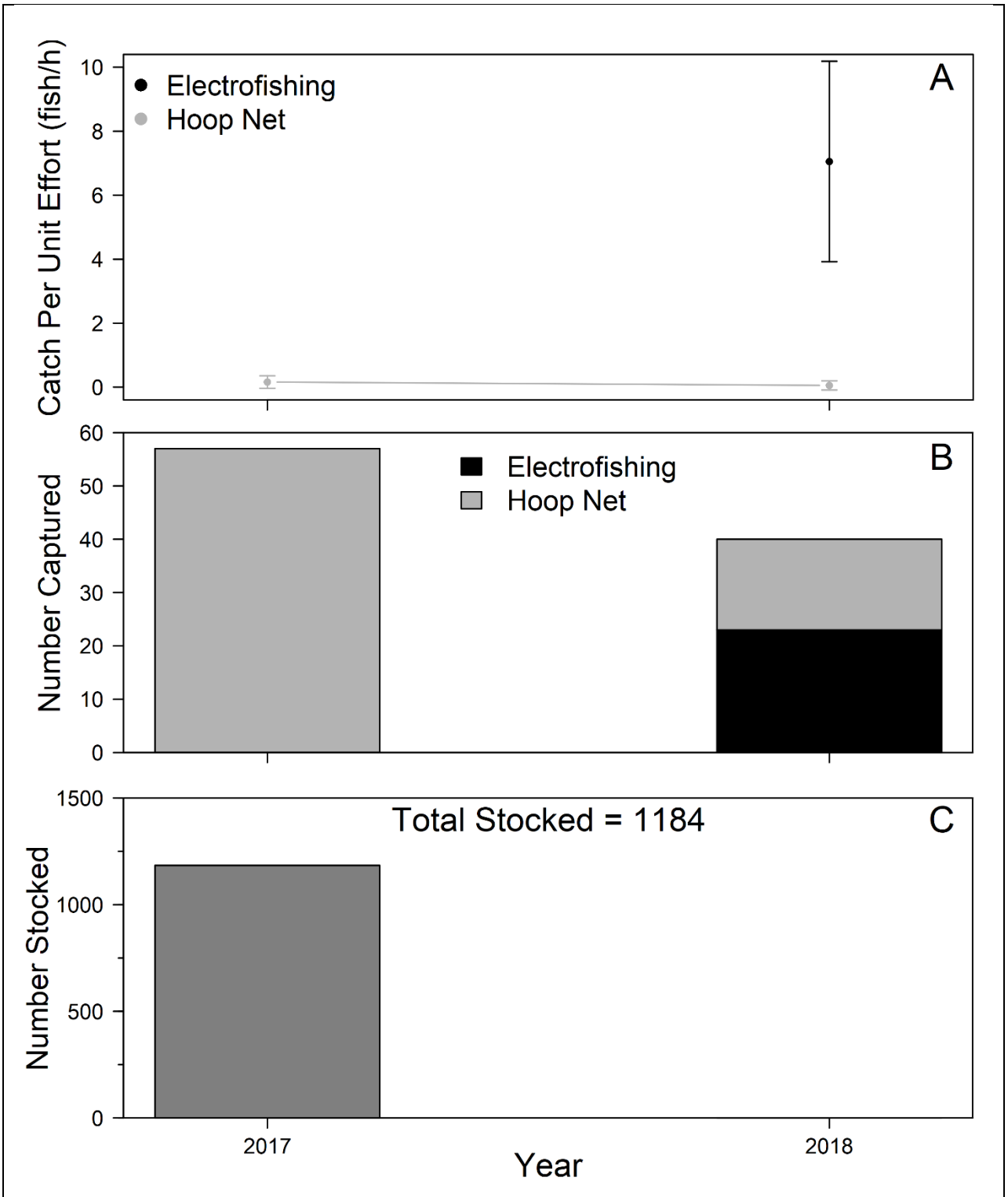

Figure 21.—Summary of Roundtail Chub captured and stocked in the middle Blue River, annually from 2017 to 2018 with (A) mean annual backpack electrofishing catch per unit effort (fish/hour) with standard error bars and the number of 100 meter transects sampled above the error bar, (B) total number of fish captured, and (C) total number of fish stocked.

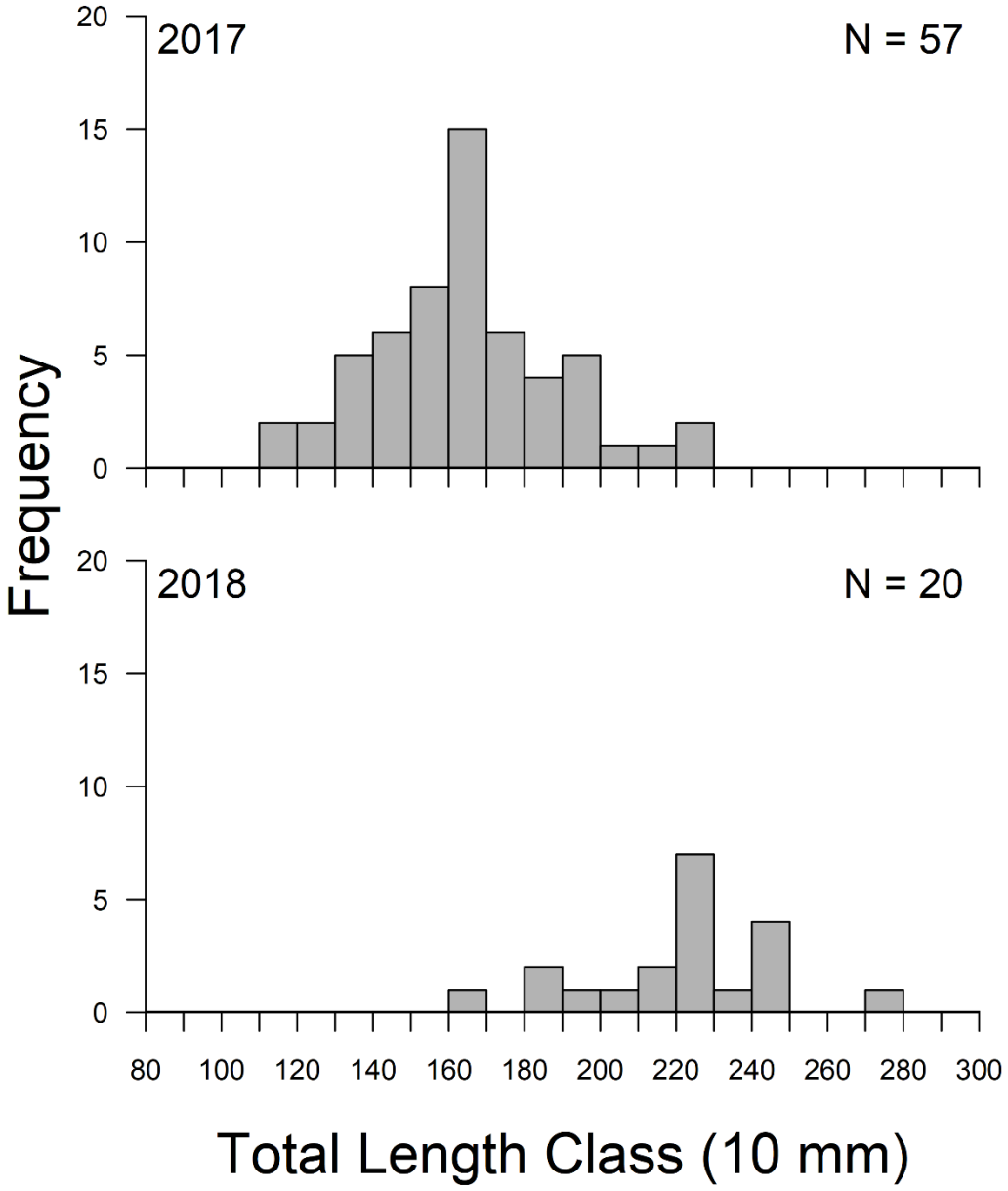

Figure 22.—Length frequency distribution of Roundtail Chub captured during annual monitoring in the middle Blue River, from 2017 to 2018.

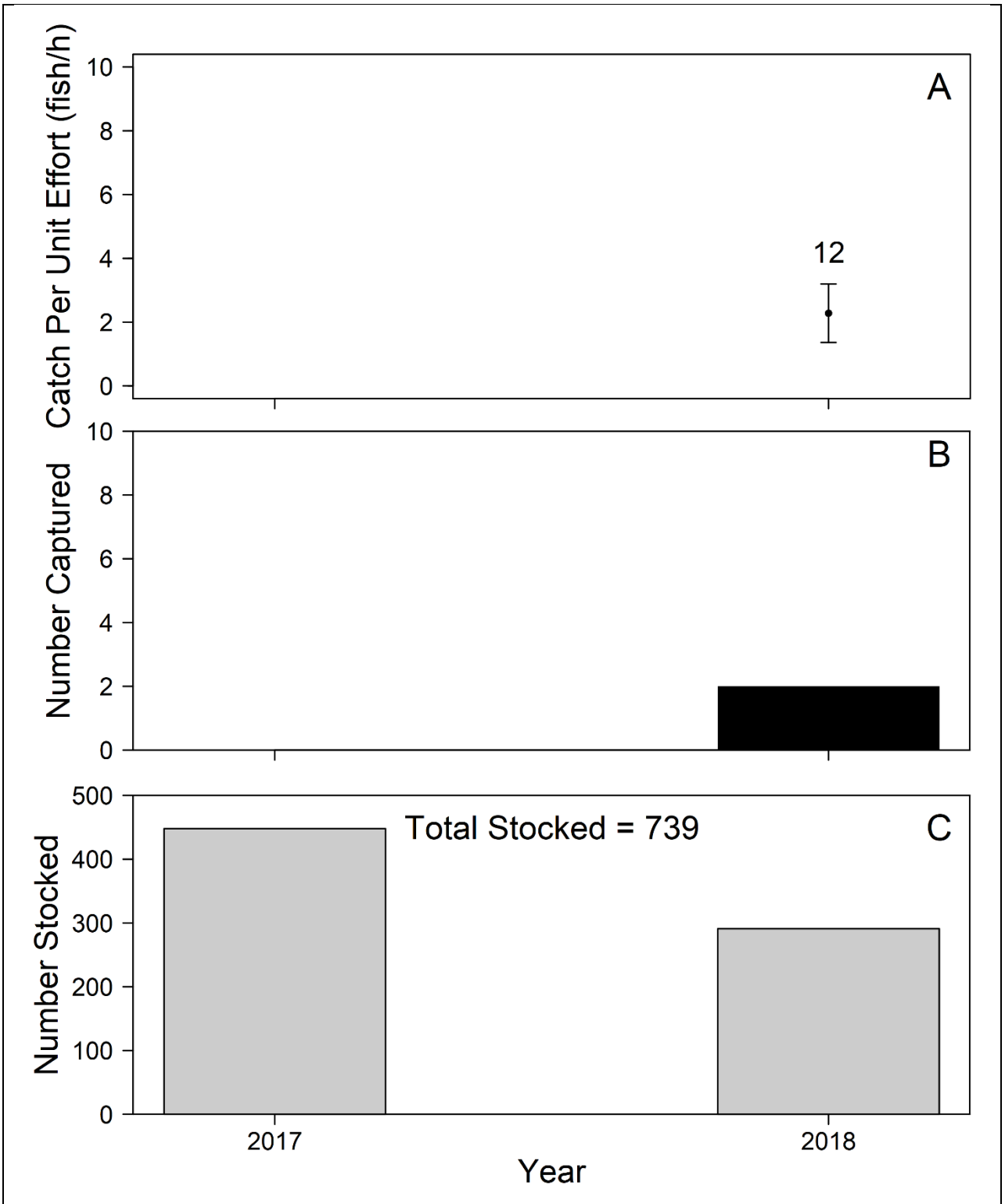

Figure 23.—Summary of Spikedace captured and stocked in the middle Blue River, annually from 2017 to 2018 with (A) mean annual backpack electrofishing catch per unit effort (fish/hour) with standard error bars and the number of 100 meter transects sampled above the error bar, (B) total number of fish captured, and (C) total number of fish stocked.

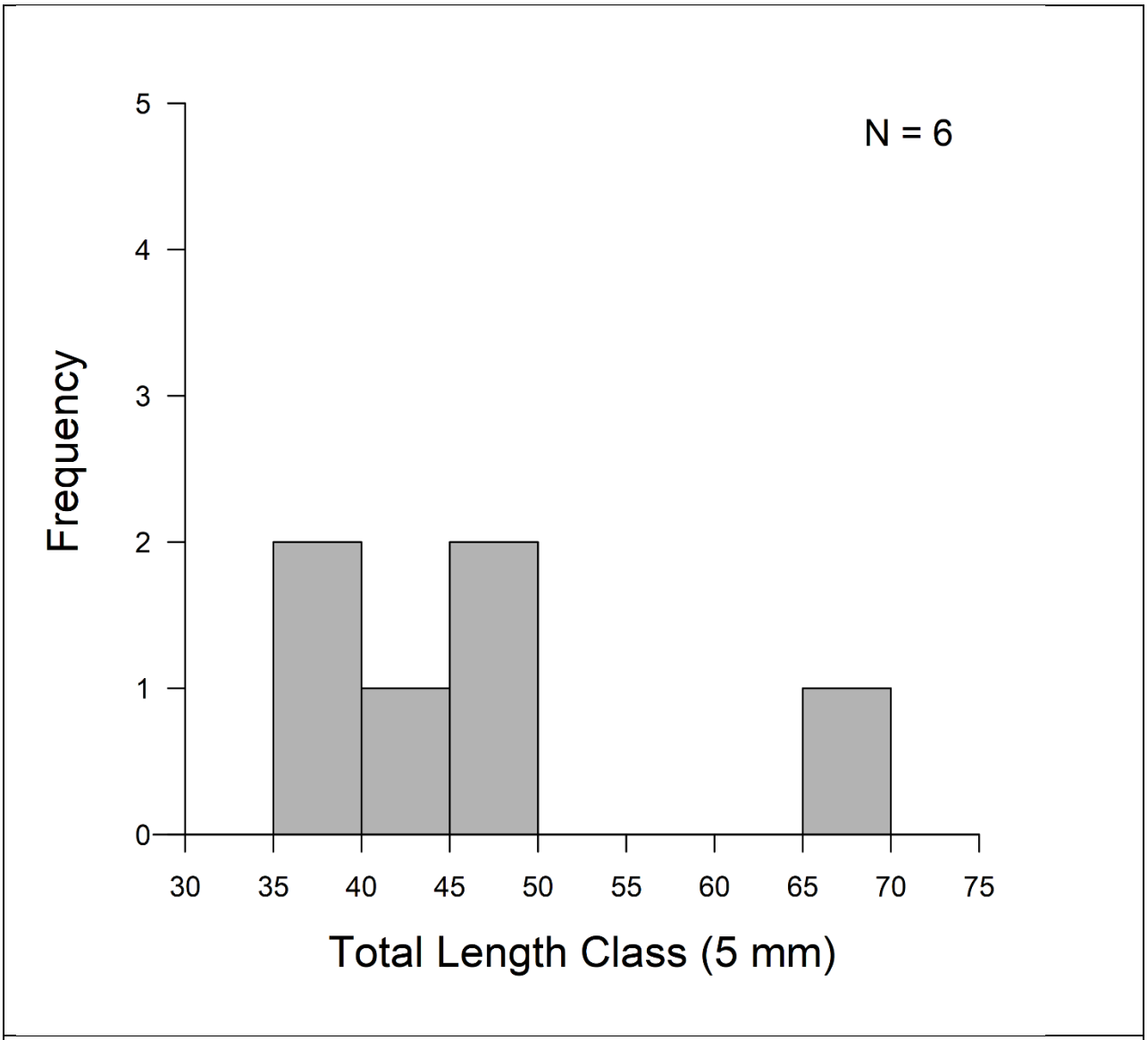

Figure 24.—Length frequency distribution of Spikedace captured during annual monitoring in the middle Blue River, 2018.

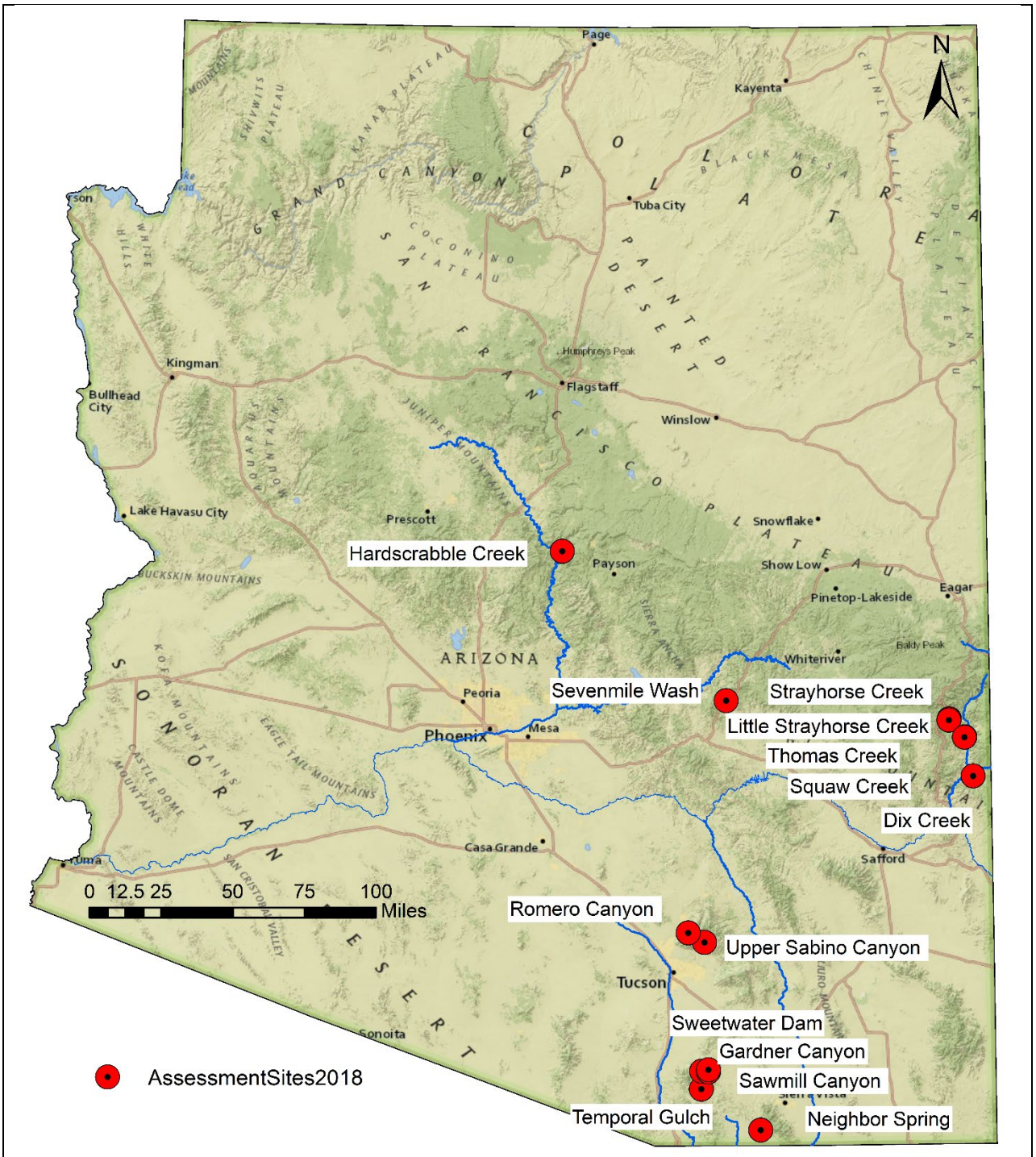

Figure 25.—Map showing locations of streams and ponds assessed for suitable fish habitat in the Gila River basin in 2018.

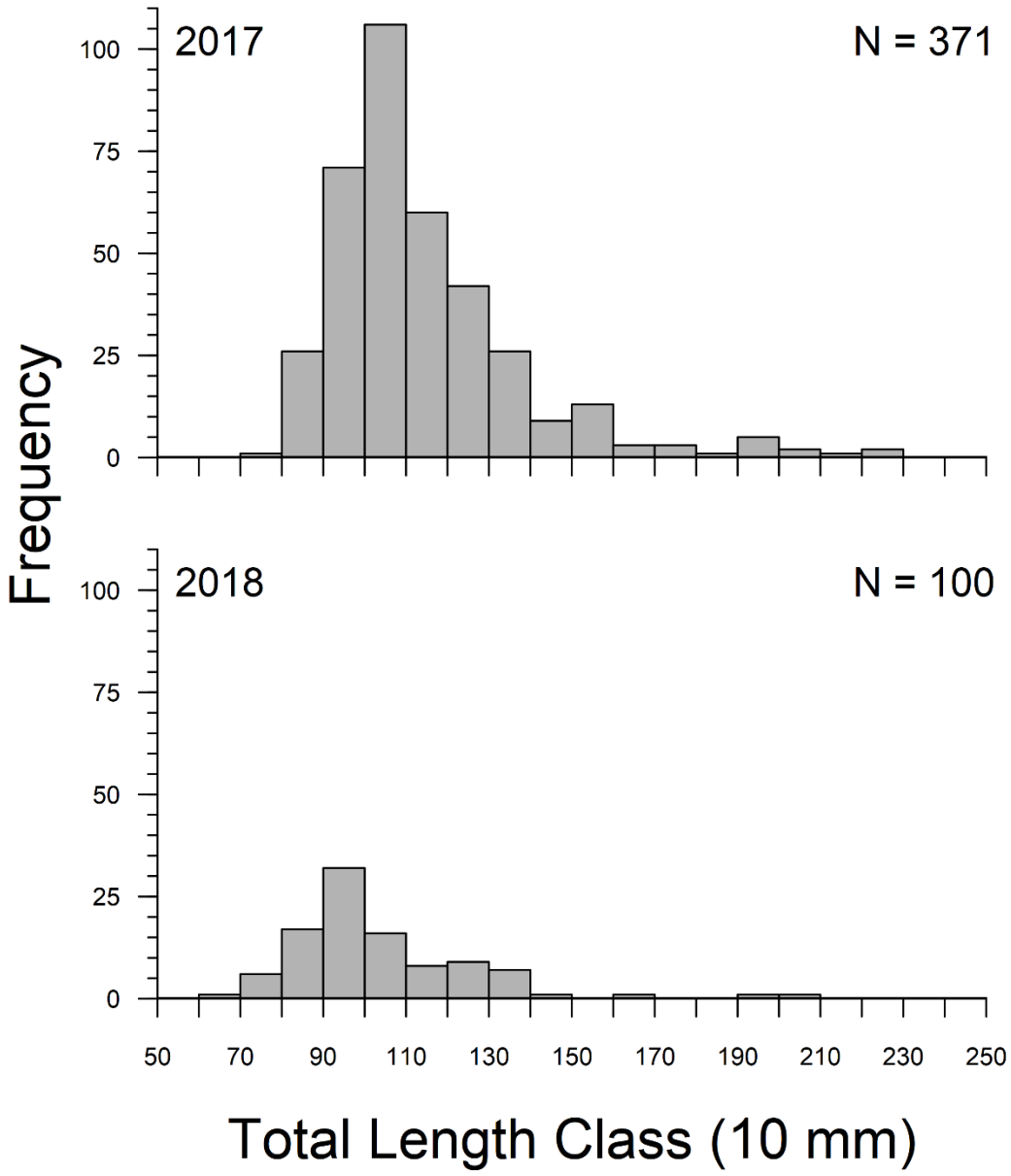

Figure 26.—Length frequency distribution of Roundtail Chub captured during annual monitoring above the waterfall barrier in Harden Cienega Creek, from 2017 to 2018. Only the first 100 Roundtail Chub captured were measured in 2018.

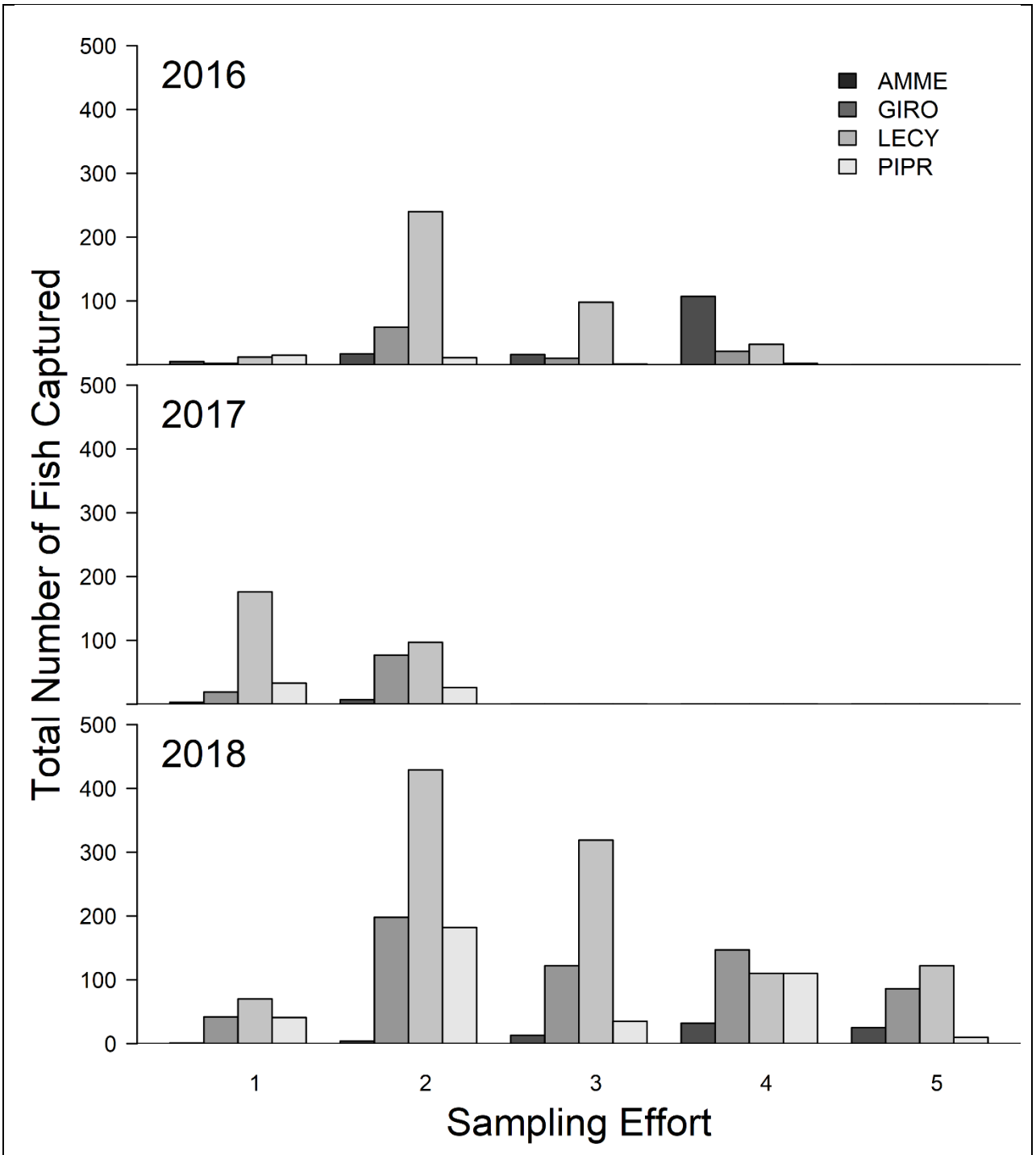

Figure 27.—Summary of species (AMME = Black Bullhead, GIRO = Roundtail Chub[1], LECY = Green Sunfish, PIPR = Fathead Minnow) captured by sampling effort in Red Tank Draw from 2016 to 2018. Total number of fish captured includes fish captured by backpack electrofishing, mini-hoop nets, minnow traps and angling.

[1] Chub in Red Tank Draw were previously classified as Gila Chub.

TABLES

Table 1.—Summary of number of Spikedace (MEFU) and Loach Minnow (RHCO), of each lineage, brought into the Aquatic Research and Conservation Center from 2007 to 2018.

Taxa	Extant Lineage/Stream	2007[1]	2008[2]	2009[3]	2010[4]	2011[5]	2012	2013[6]	2014[7]	2015[8]	2016[9]	2017[10]	2018
MEFU	Upper Gila River, NM	640		148									
	Gila River Forks, NM			17	250	148			XX				1
	Aravaipa Creek (& tribs)	258		220		XX		XX	26	150	80	160	
RHCO	Upper Gila River, NM	143											
	Gila River Forks, NM			48	100	434			61			110	145
	San Francisco R., NM (& tribs)							41					
	Blue River (& tribs)	71	50	91		27					12		223
	Aravaipa Creek (& tribs)	254		110		XX		XX	48	50	200	100	

1. Robinson 2007; Ward 2008.
2. Robinson 2008
3. Robinson 2009
4. Robinson 2010
5. Robinson 2011
6. Robinson 2014
7. Crowder and Robinson 2015
8. Robinson 2016
9. Robinson et al. 2017
10. Robinson and Mosher 2018

Table 2.—Summary of fish captured during single-pass backpack electrofishing at nine 100-m transects in Hot Springs Canyon within three survey reaches on September 18, 2018. Shown for each reach is the number of transects sampled (N), number of fish captured (#Ind), the mean relative abundance (number of fish captured per hour of electrofishing effort; #Ind/h) and standard error of mean relative abundance (SE).

Reach	N	Statistic	Gila Topminnow	Loach Minnow	Roundtail Chub[1]	Spikedace	Desert Sucker	Longfin Dace	Sonora Sucker	Speckled Dace
3	3	#Ind	2	1	33		24	53		26
		#Ind/h	1.91	0.96	38.75		28.69	61.94		29.28
		SE	(1.91)	(0.96)	(16.99)		(13.25)	(22.41)		(7.17)
2	3	#Ind	1	16	102	1	111	111	12	120
		#Ind/h	1.16	35.51	132.88	0.75	168.60	150.15	14.21	181.91
		SE	(1.16)	(33.79)	(45.19)	(0.75)	(80.76)	(40.56)	(8.55)	(87.75)
1	3	#Ind		13	67		107	79	39	77
		#Ind/h		22.94	125.31		189.06	154.23	68.24	144.89
		SE		(13.07)	(34.45)		(106.60)	(10.28)	(42.35)	(36.94)
Total	9	#Ind	3	30	202	1	242	243	51	223
		#Ind/h	1.02	19.80	98.98	0.25	128.78	122.10	27.48	118.69
		SE	(0.63)	(10.39)	(20.42)	(0.22)	(41.38)	(18.21)	(14.52)	(32.10)

[1] Roundtail Chub at this location previously classified as Gila Chub

Table 3.—Total number of fish captured (#Ind) and relative abundance (fish per trap hour; #Ind/h) in minnow traps in Bass Canyon and Double R Canyon, and relative abundance (fish per square meter seined) in Mint Spring on September 17, 2018 at Muleshoe Ranch CMA, Arizona. N indicates the number of minnow traps set or seine hauls.

Stream	N	Statistic	Gila Topminnow	Roundtail[1] Chub	Desert Pupfish	Total
Bass Canyon-Upper	10	#Ind	2	71		73
		#Ind/h	0.47	2.00		1.84
		SE	(0.00)	(0.45)		(0.31)
Double R Canyon	10	#Ind		1		1
		#Ind/h		0.50		0.50
		SE		(0.00)		(0.00)
Mint Spring	6	#Ind			55	55
		#Ind/h			0.66	0.66
		SE			(0.16)	(0.16)

[1] Chub in these locations were previously classified as Gila Chub

Table 4.—Summary of fish captured in minnow traps at two locations in Bonita Creek during annual monitoring on October 15, 2018. Included is the number of traps (N), number of individuals captured (#Ind), mean relative abundance (fish captured per net hour; #Ind/h), and standard error of mean relative abundance (SE).

Location	N	Statistic	Gila Topminnow	Roundtail [1] Chub	Desert Sucker	Sonora Sucker	Fathead Minnow	Total
Midnight Canyon	10	#Ind	338	107	1	3	3	452
		#Ind/h	7.91	2.04	0.33	0.32	0.33	3.63
		SE	(3.57)	(0.40)	(0.00)	(0.00)	(0.00)	(0.55)
Reservation Boundary	10	#Ind	96	19				115
		#Ind/h	6.50	2.31				3.78
		SE	(3.22)	(0.66.)				(0.43)

Table 5.—Summary of fish captured in three 100-m electrofishing transects in Bonita Creek during annual monitoring on October 15, 2018. Shown is the number of fish captured in each transect (#Ind), and the number of fish captured per hour of electrofishing effort (#Ind/h), and the overall mean and standard error of mean catch rate.

Transect	Statistic	Gila Topminnow	Roundtail Chub[1]	Desert Sucker	Longfin Dace	Sonora Sucker	Speckled Dace	Fathead Minnow
13-Fixed	#Ind	93	43	56	42	38	46	
	#Ind/h	697.5	322.50	420.00	315.00	285.00	345.00	
06-Random	#Ind	39	54	37		67	31	
	#Ind/h	126.83	175.61	120.32		217.89	100.81	
09-Random	#Ind	18	85	116	6	82	66	1
	#Ind/h	52.17	246.38	336.23	17.39	237.68	191.30	2.90
Total	#Ind	150	182	209	48	187	143	1
	Mean	292.17	248.16	292.19	110.79	246.86	212.37	0.97
	SE	(144.11)	(29.99)	(63.12)	(72.28)	(14.08)	(50.40)	(0.68)

[1] Chub in these locations were previously classified as Gila Chub.

Table 6.—Summary of fish captured in minnow traps near the barrier at Spring Creek during annual monitoring on September 4, 2018. Included is the number of traps (N), number of individuals captured (#Ind), mean relative abundance (fish captured per net hour; #Ind/h), and standard error of mean relative abundance (SE).

N	Statistic	Gila Topminnow	Roundtail Chub[1]	Desert Sucker	Speckled Dace
10	#Ind	497	342	7	3
	#Ind/h	14.00	6.83	1.33	0.49
	SE	(6.46)	(2.53)	(0.58)	(0.16)

Table 7.—Summary of fish captured at three 100 meter electrofishing transects in Spring Creek during annual monitoring during September 4-5, 2018. Shown is the number of fish captured in each transect (#Ind), and the number of fish captured per hour of electrofishing effort (#Ind/h), and the overall mean and standard error of the mean catch rate.

Transect	Statistic	Roundtail chub[1]	Spikedace	Desert Sucker	Longfin Dace	Speckled Dace	Northern Crayfish
Random-12	#Ind	36	6	18		37	20
	#Ind/h	99.31	16.55	49.66		102.07	
Random-05	#Ind	88	5	30	1	55	6
	#Ind/h	289.58	16.45	98.72	3.29	180.99	
Fixed-2	#Ind	133	9	47	7	49	2
	#Ind/h	379.10	25.65	133.97	19.95	139.67	
Total	#Ind	257	20	95	8	141	28
	#Ind/h	256.00	19.55	94.11	7.75	140.91	
	SE	(58.33)	(2.16)	(17.29)	(4.37)	(16.12)	

[1] Chub in these locations were previously classified as Gila Chub.

Table 8.—Summary of fish captured in hoop nets within five survey reaches in the lower Blue River during annual monitoring during October 1-3, 2018. Included is the number of traps (N), number of individuals captured (#Ind), mean relative abundance (fish captured per net hour; #Ind/h), and standard error of mean relative abundance (SE) by reach.

Reach	N	Statistic	Roundtail Chub	Desert Sucker	Sonora Sucker	Northern Crayfish
2	4	#Ind	25	1	6	19
		#Ind/h	0.35	0.01	0.08	0.28
		SE	(0.19)	(0.01)	(0.02)	(0.14)
3	6	#Ind	28		15	38
		#Ind/h	0.23		0.12	0.31
		SE	(0.07)		(0.05)	(0.12)
4	5	#Ind	27		25	83
		#Ind/h	0.27		0.26	0.89
		SE	(0.09)		(0.15)	(0.37)
5	4	#Ind	6		8	62
		#Ind/h	0.11		0.15	0.48
		SE	(0.06)		(0.02)	(0.37)
6	5	#Ind	3	1		17
		#Ind/h	0.03	0.01		0.62
		SE	(0.02)	(0.01)		(0.40)
Total	24	#Ind	89	2	54	219
		#Ind/h	0.20	<0.01	0.12	0.52
		SE	(0.05)	(<0.01)	(0.04)	(0.13)

Table 9.—Summary of fish captured at 12, 200-meter electrofishing transects in the lower Blue River during annual monitoring from October 1-3, 2018. Shown for each reach is the number of transects sampled (N), number of fish captured (#Ind), the mean relative abundance (number of fish captured per hour of electrofishing effort; #Ind/h) and standard error of mean relative abundance (SE).

Reach	N	Statistic	Loach Minnow	Roundtail Chub	Spikedace	Desert Sucker	Longfin Dace	Sonora Sucker	Speckled Dace
2	2	#Ind	16	29	55	58	7	16	55
		#Ind/h	27.45	46.46	92.06	94.64	11.77	27.11	90.33
		SE	(18.84)	(3.39)	(43.25)	(22.87)	(6.03)	(15.62)	(27.17)
3	2	#Ind	7	34	22	72	27	28	18
		#Ind/h	12.84	61.99	41.20	129.22	46.64	51.34	35.95
		SE	(4.07)	(22.5)	(6.12)	(63.45)	(37.87)	(16.26)	(12.29)
4	2	#Ind	20	69	41	146	21	84	32
		#Ind/h	36.84	125.97	75.77	268.59	38.13	153.45	59.22
		SE	(8.07)	(28.67)	(29.01)	(42.01)	(19.42)	(29.96)	(26.85)
5	3	#Ind	46	92	66	126	18	91	52
		#Ind/h	59.57	117.86	84.85	157.98	21.56	118.12	67.87
		SE	(5.23)	(52.63)	(11.39)	(53.92)	(16.10)	(29.63)	(7.04)
6	3	#Ind	33	25	111	327	36	86	115
		#Ind/h	30.26	25.84	120.65	321.98	40.78	79.89	117.79
		SE	(12.21)	(7.02)	(29.26)	(69.63)	(16.19)	(23.24)	(5.11)
Total	Total	#Ind	122	249	295	729	109	305	272
		#Ind/h	35.31	74.99	86.21	202.06	31.67	88.15	77.33
		SE	(5.61)	(15.92)	(11.13)	(31.08)	(7.47)	(14.52)	(9.22)

Table 10.—Summary of fish captured within each survey reach at 12, 100-meter electrofishing transects in the middle Blue River during annual monitoring from September 9-11, 2018. Shown for each reach is the number of transects sampled (N), number of fish captured (#Ind), the mean relative abundance (number of fish captured per hour of electrofishing effort; #Ind/h) and standard error of mean relative abundance (SE).

Reach	Statistic	Loach Minnow	Roundtail Chub	Spikedace	Desert Sucker	Longfin Dace	Sonora Sucker	Speckled Dace	Brown Trout
1	#Ind	11	1	1	283	156	63	102	
	#Ind/h	10.22	0.95	1.22	270.29	166.10	60.31	123.05	
	SE	(6.17)	(0.95)	(1.22)	(27.42)	(50.71)	(8.81)	(28.70)	
2	#Ind	17	3	3	191	71	55	113	
	#Ind/h	22.27	3.23	3.47	241.86	93.57	67.37	147.52	
	SE	(9.08)	(3.22)	(2.11)	(19.59)	(29.00)	(14.89)	(44.22)	
3	#Ind	15	19	2	212	19	70	108	1
	#Ind/h	16.20	22.33	2.46	240.98	21.58	77.08	95.35	1.38
	SE	(11.05)	(8.60)	(2.46)	(75.80)	(14.26)	(18.91)	(34.78)	(1.38)
Total	#Ind	43	23	6	686	246	188	341	1
	#Ind/h	15.73	7.05	2.28	253.48	105.79	66.86	124.28	0.35
	SE	(4.24)	(3.13)	(0.92)	(19.04)	(25.67)	(6.64)	(18.24)	(0.35)

Table 11.—Summary of fish captured in hoop nets in the middle Blue River during annual monitoring during September 9-11, 2018. Included is the number of traps (N), number of individuals captured (#Ind), mean relative abundance (fish captured per net hour; #Ind/h), and standard error of mean relative abundance (SE).

Reach	N	Statistic	Roundtail Chub	Desert Sucker	Longfin Dace	Sonora Sucker	Speckled Dace	Northern Crayfish
1	4	#Ind		2	22	3		88
		#Ind/h		0.02	0.21	0.03		0.83
		SE		(0.02)	(0.11)	(0.02)		(0.27)
2	5	#Ind	1	2	2	6	5	40
		#Ind/h	<0.01	0.02	0.02	0.05	0.04	0.32
		SE	(<0.01)	(0.02)	(<0.01)	(0.03)	(0.02)	(0.11)
3	5	#Ind	16			6		15
		#Ind/h	0.19			0.07		0.18
		SE	(0.15)			(0.04)		(0.01)
Total	24	#Ind	17	4	24	15	5	143
		#Ind/h	0.06	0.01	0.08	0.05	0.02	0.45
		SE	(0.04)	(<0.01)	(0.04)	(0.02)	(0.01)	(0.12)

Table 12.—Waters assessed during 2014 through 2018 to determine suitability for native fish repatriations, showing coordinates (NAD 83 UTM, zone 12S) of the upstream and downstream points for each reach assessed, the estimated length of perennial water within the assessed reach at the time of the survey, and the species for which the water was considered be suitable for.

			Upstream		Downstream				
Date	Water Name	Basin	Easting	Northing	Easting	Northing	Elevation (m)	Perennial Length (m)	Suitable for Species
04/01/2014	South Fork Deadman Crk	Verde	452891	3770077	450817	3772961	1105	4400	RHCO, MEFU, GIRO, POOC
04/01/2014	Deadman Creek	Verde	450829	3773116	450780	3772923	1100	600	GIRO, POOC
04/14/2014	Bonita Creek - upper	Upper Gila	637499	3647178	636206	3649943	1160	5875	RHCO, MEFU, POOC
10/16/2014	Copper Creek - upper	Agua Fria	415294	3783300	414957	3784056	1440	500	maybe POOC, GIRO
03/10/2015	Reimer Spring	Agua Fria	410156	3811873	410268	3812368	1350	250	POOC
03/10/2015	Indian Creek	Agua Fria	413535	3798878	413325	3798872	1285	220	POOC
03/17/2015	Seven Springs	Salt	421594	3758300	420324	3758595	1025	1600	MEFU, POOC, GIRO, RHOS, CACL
03/18/2015	Lime Creek - upper	Verde	421976	3771582	423842	3769530	910	1300	POOC, GIRO
03/23/2015	Towel Creek	Verde	434879	3807874	431708	3808163	1060	50	maybe AGCH, RHOS
03/24/2015	Cottonwood Creek	Salt	487568	3723472	487595	3724000	715	600	POOC
03/24/2015	Rock Creek - upper	Salt	471383	3730666	471381	3730670	1160	1300	maybe AGCH, GIRO
03/24/2015	Rock Creek - lower	Salt	475856	3731040	476451	3730776	830	700	AGCH, POOC
04/21/2015	Turkey Creek	Agua Fria	389109	3792493	388400	3790285	1180	4000	AGCH
04/22/2015	Wilson Spring	Agua Fria	415381	3815195	415355	3815206	1560	20	POOC
04/22/2015	Little Ash Creek	Agua Fria	406593	3805271	404663	3805086	1160	>1300	POOC and GIRO
07/27/2015	Copper Creek - lower	Agua Fria	414957	3784056	414324	3784428	1365	32	POOC
02/19/2016	Bishop Creek	Agua Fria	401782	3789224	403890	3788175	1020	30	Maybe POOC

02/27/2016	Grapevine Canyon	Agua Fria	412756	3766285	412770	3766280	1130	500	POOC, GIRO
03/07/2016	Tortilla Creek	Salt	467373	3708578	464233	3710019	550	500	POOC
03/15/2016	South Fork Sheep Creek	Verde	448077	3754778	446914	3756529	940	100	POOC
04/12/2016	Ash Creek	Upper Gila	607829	3632197	607789	3632123	950	?	Maybe AGCH
04/12/2016	Deadman Creek	Upper Gila	611373	3623016	611398	3623118	1390	?	Maybe GIRO
06/05/2016	Home Tank Draw	Verde	452192	3827223	452117	3826994	1695	25	None
06/08/2016	Russell Spring	Verde	430492	3831022	429941	3831305	1060	59	None
06/28/2016	Sabino Canyon	Santa Cruz	520661	3579809	520551	3579167	990	700	GIRO, CACL, RHOS
07/06/2016	Mesquite Spring	Verde	429471	3816410	428902	3815864	925	4	None
07/06/2016	Cottonwood Spring	Verde	429239	3816482	429063	3816016	930	0	None
07/06/2016	Doren's Defeat Spring	Verde	438093	3810597	436636	3811691	1220	15	None
07/06/2016	Willow Spring	Verde	438429	3811400	436636	3811691	1220	10	None
07/06/2016	Big Willow Spring	Verde	437993	3811651	437803	3811414	1255	6	None
07/26/2016	Long Gulch Artesian	Salt	487919	3732399			695	10	None
10/20/2016	West Fork Pinto Creek	Salt	493978	3699996	495059	3700174	1010	1070	POOC, GIRO, CACL
11/2/2016	Reavis Creek	Salt	484483	3710381	484521	3711190	940	500	Maybe POOC, GIRO
02/22/2017	Copper Creek	Agua Fria	414532	3784291	414339	3784419	1365	250	Might dry; Maybe POOC
03/27/2017	West Fork Pinto Creek	Salt	491038	3700111	491607	3700234	1085	700	GIRO if remove sunfish
03/28/2017	Haunted Canyon	Salt	494989	3694636	499072	3695799	1000	100	Mostly dry; maybe POOC
05/25/2017	Mule Spring	Salt	499294	3693737	499384	3693766	1120	100	POOC
06/13/2017	Sabino Canyon-upper	Santa Cruz	519538	3582136	520672	3579822	1050	400	POOC, GIRO, maybe CACL, RHOS

06/13/2017	Double R Canyon	San Pedro	571778	3579977	571730	3579864	1230	120	POOC
07/10/2017	Cave Creek	Upper Gila	666262	3526586	673178	3529739	1525	>100	RHOS
07/10/2017	South Fork Cave Creek	Upper Gila	668492	3524164	671370	3527216	1620	>200	RHOS
07/11/2017	North Fork Cave Creek	Upper Gila	665086	3529901	665185	3529976	2085	>100	Maybe ONGI
07/11/2017	East Turkey Creek	Upper Gila	664767	3531454	668015	3533601	1705	>350	RHOS, maybe GIRO
07/17/2017	Foote Creek	Blue	671461	3723300	671684	3719141	1720	4700	Maybe TICO
07/18/2017	Raspberry Creek	Blue	662652	3710016	664946	3708831	1590	2800	TICO near waterfall
07/27/2017	Bonita Creek	Upper Gila	635217	3653338	635728	3651703	1145	2000	TICO
08/28/2017	Pigeon Creek	Blue	661479	3682954	663116	3683347	1360	2500	TICO
08/29/2017	Turkey Creek (Pigeon)	Blue	662599	3683742	662715	3683641	1370	250	Maybe TICO, GIRO
10/12/2017	Buehman Canyon	San Pedro	543564	3586521	544076	3586841	920	700	POOC, maybe GIRO
10/12/2017	Bullock Canyon	San Pedro	541290	3582592	541463	3582742	1010	250	POOC, maybe GIRO
06/08/2018	Sabino Canyon	Santa Cruz	520841	3581050	520871	3581138	1100	250	GIRO, POOC, CACL, RHOS
07/11/2018	Romero Canyon	Santa Cruz	512923	3585921	511644	3586741	1095	700	GIRO maybe POOC
07/31/2018	Dix Creek	Upper Gila	671783	3673462	671727	3674884	1200	1500	TICO
07/31/2018	Sevenmile Wash	Upper Gila	533278	3716984	532785	3716643	1250	0	None
08/13/2018	Strayhorse Creek	Blue	658093	3705891	661090	3706885	1670	<1000	None
08/13/2018	Little Strayhorse Creek	Blue	656688	3706854	658922	3706360	1730	<500	None
08/28/2018	Thomas Creek	Blue	665388	3696655	668363	3695868	1390	400	None
09/25/2018	Gardner Canyon	Santa Cruz	523036	3508454	523897	3508488	1610	500	Maybe POOC
09/25/2018	Cave Creek	Santa Cruz	523048	3509620	523407	3509240	1580	300	None

09/25/2018	Sweetwater Dam	Santa Cruz	519194	3508774	519194	3508774	1730	100	POOC, GIRO
09/26/2018	Neighbor Spring	Santa Cruz	550916	3474856	550231	3474576	1540	750	POOC
09/26/2018	Temporal Gulch	Santa Cruz	518984	3498903	519186	3498737	1400	500	Maybe GIRO
10/28/2018	Hardscrabble Creek	Verde	442059	3802594	438891	3797423	820	7000	GIRO

Table 13.—Summary of number of broodstock (#B), number of offspring produced (#P), number of offspring stocked (#S) for each species and lineage held at the Aquatic Research and Conservation Center, from 2008 through 2018. Numbers stocked do not include fish transferred to New Mexico.

Taxa	Extant Lineage/Stream		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Spikedace	upper Gila River, NM	#B							380	392	531	267	159
		#P	740	165	2555	539	1300		1000	296	0	384	352
		#S	448	165	545		539			296		327	0
	Gila River Forks	#B		17	267				250	204	138	122	83
		#P	NA	0	379	0	800	700	300		0	1183	195
		#S										1000	0
	Aravaipa Creek	#B							480	412	262	382	331
		#P	1650	410	5993	4663	3471		221	35	120	1347	3214
		#S	1600	386	2954	4663	3471			221	67		2234
Loach Minnow	upper Gila River, NM	#B							NA	NA	NA	NA	NA
		#P											
		#S											
	Gila River Forks	#B							57	81	96	128	97
		#P	NA	0	0	0			250		220	7	1207
		#S										159	0
	San Francisco R., NM	#B							27	119	215	314	318
		#P	NA	NA					500		26	177	1627
		#S										243	0
	Blue River	#B	XX	XX	XX	150		XX	180	245	214	156	117
		#P	670	22	164	722		1500	288		426	47	6
		#S	678		156		217	310	288		390		0
	Aravaipa Creek	#B	XX	XX	XX	XX		XX	340	316	297	490	439
		#P	3250	274	1623	1035		951	0		265	305	1848
		#S	4003	156	1561	527		951					0
Roundtail chub	Eagle Creek	#B				XX			85	85	101	99	99
		#P				149			1500	2000	0	57	0
		#S					221			876	1194	0	0

APPENDICES

Appendix 1.—Summary of native fish stocked in Arizona during 2018 by the Department under the Gila River Basin Native Fishes Conservation Program. Easting and Northing are in UTMs (NAD 83).

Taxa	Water Name	Site Name	Easting	Northing	Date	Lineage	# Stocked	# Mortalities
Desert Pupfish	Crescent Pond		538122	3517839	8/21/2018	Santa Clara Slough	24	0
Desert Pupfish	Egret Pond		538069	3517763	8/21/2018	Santa Clara Slough	173	0
Desert Pupfish	Heart Wildlife Pond		538044	3517854	8/21/2018	Santa Clara Slough	173	0
Gila Topminnow	Bass Canyon	Upper Bass Cyn	572046	3579704	11/20/2018	Bylas Spring	561	8
Gila Topminnow	Bill's Wildlife Pond		546711	3514452	5/10/2018	Cienega Creek	190	6
Gila Topminnow	Black Canyon City Heritage Pond		393797	3770554	6/01/2018	Sharp Spring	734	6
Gila Topminnow	Double R Canyon		571727	3579843	11/20/2018	Bylas Spring	499	0
Gila Topminnow	International Wildlife Museum		493726	3566421	6/20/2018	Peck Canyon	611	111
Gila Topminnow	Mud Spring		558197	3473517	8/29/2018	Sharp Spring	494	6
Gila Topminnow	Pasture 9 Tank		542930	3471369	8/29/2018	Sharp Spring	137	4
Gila Topminnow	Peterson Ranch Pond		557236	3480412	8/8/2018	Sharp Spring	762	142
Gila Topminnow	Sabino Canyon	Above East Fork	520784	3581144	6/21/2018	Cienega Creek	557	54
Roundtail Chub[1]	Harden Cienega Creek	Above barrier	676552	3673550	10/11/2018	Harden Cienega Creek	5	0
Spikedace	Blue River	Cole Flat	667150	3713200	10/3/2018	Gila Mainstem	291	3
Spikedace	Fossil Creek	Irving	443233	3806897	12/5/2018	Aravaipa Creek	1,734	4
Spikedace	Spring Creek	Willow Point Rd	416070	3847214	2/21/2018	Aravaipa Creek	1076	5
Spikedace	Spring Creek	Willow Point Rd	416123	3847254	12/5/2018	Aravaipa Creek	500	0

[1] Roundtail Chub at this location were previously classified as Gila Chub

Appendix 2.—Summary of monitoring results during 2018 for the five priority species and other target native fish species that were previously stocked into various waters in the Gila River Basin Arizona.

Taxa	Location	Date	Gear Type	Sample Size	Statistics	2018
Desert Pupfish	Black Canyon City Heritage Pond	8/23/2018	Minnow Trap	20	#Ind	315
					%YOY	17
					Mean CPUE	3.81
					SE	(1.57)
Desert Pupfish	Black Canyon City Heritage Pond	8/23/2018	Seine	5	#Ind	189
					%YOY	62
					Mean CPUE	4.62
					SE	(1.59)
Desert Pupfish	Bonita Creek	9/26/2017	Minnow Trap	20	#Ind	0
					%YOY	0
					Mean CPUE	0
					SE	0
Desert Pupfish	Las Cienegas-Cottonwood Tank	8/7/2018	Minnow Trap	10	#Ind	47
					%YOY	6
					Mean CPUE	0.98
					SE	(0.34)
Desert Pupfish	Las Cienegas-Crescent Pond	8/7/2018	Minnow Trap	10	#Ind	62
					%YOY	13
					Mean CPUE	2.43
					SE	(1.52)
Desert Pupfish	Las Cienegas-Egret Pond	8/7/2018	Minnow Trap	10	#Ind	39
					%YOY	5
					Mean CPUE	1.0
					SE	(0.39)
Desert Pupfish	Las Cienegas-Gaucho Tank	8/7/2018	Minnow Trap	10	#Ind	129
					%YOY	13
					Mean CPUE	1.67
					SE	(0.56)

Taxa	Location	Date	Gear Type	Sample Size	Statistics	2018
Desert Pupfish	Las Cienegas-Heart Pond	8/7/2018	Minnow Trap	7	#Ind	81
					%YOY	1
					Mean CPUE	2.89
					SE	(1.61)
Desert Pupfish	Muleshoe CMA-Mint Spring	9/17/2018	Seine	6	#Ind	55
					%YOY	0
					Mean CPUE	0.66
					SE	(0.16)
Desert Pupfish	Robbins Butte-Cottonwood Tank	7/3/2018	Minnow Trap	9	#Ind	172
					%YOY	2
					Mean CPUE	3.53
					SE	(1.87)
Desert Pupfish	Robbins Butte-Twin Tanks	7/3/2018	Minnow Trap	10	#Ind	287
					%YOY	8
					Mean CPUE	4.23
					SE	(2.37)
Desert Pupfish	San Pedro Riparian NCA-Murray Spring	8/6/2018	Minnow Trap	13	#Ind	0
					%YOY	0
					Mean CPUE	0.
					SE	0
Desert Pupfish	San Pedro Riparian NCA-Murray Spring	8/6/2018	Dip Net	8	#Ind	0
					%YOY	0
					Mean CPUE	0
					SE	0
Gila Topminnow	Arnett Creek	7/9/2018	Dip Net	9	#Ind	6
					%YOY	100
					Mean CPUE	3.60
					SE	(2.38)
Gila Topminnow	Black Canyon City Heritage Pond	8/23/2018	Minnow Trap	20	#Ind	140

Taxa	Location	Date	Gear Type	Sample Size	Statistics	2018
					%YOY	69
					Mean CPUE	2.28
					SE	(0.47)
Gila Topminnow	Black Canyon City Heritage Pond	8/23/2018	Seine	20	#Ind	1287
					%YOY	14
					Mean CPUE	2.28
					SE	(0.47)
Gila Topminnow	Bass Canyon - upper	9/17/2018	Minnow Trap	10	#Ind	2
					%YOY	0
					Mean CPUE	0.47
					SE	(0.00)
Gila Topminnow	Bonita Creek-Res. Boundary	10/15/2018	Minnow Trap	10	#Ind	96
					%YOY	11
					Mean CPUE	6.50
					SE	(3.22)
Gila Topminnow	Bonita Creek- Midnight Canyon	10/15/2018	Minnow Trap	10	#Ind	338
					%YOY	41
					Mean CPUE	7.91
					SE	(3.57)
Gila Topminnow	Charlebois Spring	10/22/2018	Minnow Trap	11	#Ind	870
					%YOY	15
					Mean CPUE	23.85
					SE	(6.35)
Gila Topminnow	Charlebois Spring	10/22/2018	Dip Net	27	#Ind	54
					%YOY	39
					Mean CPUE	7.99
					SE	(2.93)
Gila Topminnow	Hidden Water Spring	10/17/2018	Minnow Trap	11	#Ind	191
					%YOY	37

Taxa	Location	Date	Gear Type	Sample Size	Statistics	2018
					Mean CPUE	6.67
					SE	(1.68)
Gila Topminnow	Hidden Water Spring	10/17/2018	Dip Net	12	#Ind	62
					%YOY	40
					Mean CPUE	15.40
					SE	(8.03)
Gila Topminnow	Hidden Water Spring	10/17/2018	Seine	6	#Ind	59
					%YOY	31
					Mean CPUE	3.51
					SE	(1.35)
Gila Topminnow	Las Cienegas-Bill's Wildlife pond	8/8/2018	Minnow Trap	10	#Ind	5
					%YOY	20
					Mean CPUE	0.49
					SE	(0.00)
Gila Topminnow	Las Cienegas-Clyne Pond	8/6/2018	Minnow Trap	8	#Ind	12
					%YOY	50
					Mean CPUE	0.85
					SE	(0.14)
Gila Topminnow	Las Cienegas-Crescent Pond	8/7/2018	Minnow Trap	10	#Ind	652
					%YOY	10
					Mean CPUE	12.25
					SE	(6.42)
Gila Topminnow	Las Cienegas-Egret Pond	8/7/2018	Minnow Trap	10	#Ind	1012
					%YOY	32
					Mean CPUE	11.31
					SE	1.67
Gila Topminnow	Las Cienegas-Gaucho Tank	8/7/2018	Minnow Trap	10	#Ind	450
					%YOY	21
					Mean CPUE	5.16

Taxa	Location	Date	Gear Type	Sample Size	Statistics	2018
					SE	(1.83)
Gila Topminnow	Las Cienegas-Nogales Spring	8/8/2018	Dip Net	20	#Ind	0
					%YOY	0
					Mean CPUE	0
					SE	0
Gila Topminnow	San Pedro Riparian NCA-Murray Spring	8/6/2018	Minnow Trap	13	#Ind	54
					%YOY	4
					Mean CPUE	2.49
					SE	0.87
Gila Topminnow	San Pedro Riparian NCA-Murray Spring	8/6/2018	Dip Net	8	#Ind	3
					%YOY	0
					Mean CPUE	1.01
					SE	(1.01)
Gila Topminnow	Robbins Butte Swimming Pool Tank	7/3/2018	Minnow Trap	10	#Ind	1581
					%YOY	12
					Mean CPUE	24.03
					SE	(13.14)
Gila Topminnow	Robbins Butte Stop Sign Tank	7/3/2018	Minnow Trap	10	#Ind	1128
					%YOY	57
					Mean CPUE	16.66
					SE	(3.75)
Gila Topminnow	Rock Spring	7/15/2018	Minnow Trap	10	#Ind	0
					%YOY	0
					Mean CPUE	0
					SE	0
Gila Topminnow	Sabino Canyon	6/7/2018	Minnow Trap	13	#Ind	84
					%YOY	42
					Mean CPUE	2.55
					SE	(0.59)

Taxa	Location	Date	Gear Type	Sample Size	Statistics	2018
Gila Topminnow	Sabino Canyon	6/7/2018	Seine	3	#Ind	192
					%YOY	49
					Mean CPUE	8.00
					SE	(4.08)
Gila Topminnow	Sheepshead Canyon	9/4/2018	Minnow Trap	13	#Ind	1
					%YOY	0
					Mean CPUE	0.51
					SE	(0.00)
Gila Topminnow	Spring Creek	9/4/2018	Minnow Trap	10	#Ind	497
					%YOY	5
					Mean CPUE	14.00
					SE	(6.46)
Gila Topminnow	Tortilla Creek	11/1/2018	Minnow Trap	10	#Ind	1982
					%YOY	19
					Mean CPUE	37.26
					SE	(6.46)
Gila Topminnow	Tortilla Creek	11/1/2017	Dip Net	16	#Ind	38
					%YOY	47
					Mean CPUE	8.24
					SE	(2.70)
Gila Topminnow	West Fork Pinto Creek	7/10/2018	Dip Net	16	#Ind	6
					%YOY	17
					Mean CPUE	1.03
					SE	(0.51)
Gila Topminnow	West Fork Pinto Creek	7/10/2018	Seine	5	#Ind	3
					%YOY	33
					Mean CPUE	0.21
					SE	(0.16)
Loach Minnow	Blue River-lower	10/1/2018	Backpack Electrofisher	12	#Ind	122

Taxa	Location	Date	Gear Type	Sample Size	Statistics	2018
					%YOY	1
					Mean CPUE	35.31
					SE	(5.61)
Loach Minnow	Bonita Creek	10/15/2018	Backpack Electrofisher	3	#Ind	0
					%YOY	0
					Mean CPUE	0
					SE	0
Loach Minnow	Hot Springs Canyon	09/18/2018	Backpack Electrofisher	9	#Ind	30
					%YOY	3
					Mean CPUE	19.80
					SE	(10.39)
Roundtail Chub[1]	Harden Cienega Creek	10/10/2018	Mini-Hoop Net	12	#Ind	304
					%YOY	0
					Mean CPUE	0.15
					SE	(0.03)
Roundtail Chub[1]	Las Cienegas-Clyne Pond	8/6/2018	Mini-Hoop Net	2	#Ind	0
					%YOY	0
					Mean CPUE	0
					SE	0
Roundtail Chub	Blue River-lower	10/1/2018	Hoop Net	24	#Ind	89
					%YOY	0
					Mean CPUE	0.21
					SE	(0.05)
Roundtail Chub	Blue River-lower	10/1/2018	Backpack Electrofisher	12	#Ind	249
					%YOY	2
					Mean CPUE	74.99
					SE	(15.92)
Roundtail Chub	Blue River-middle	09/11/2018	Hoop Net	24	#Ind	17

[1] Roundtail Chub at this location previously classified as Gila Chub

Taxa	Location	Date	Gear Type	Sample Size	Statistics	2018
					%YOY	0
					Mean CPUE	0.05
					SE	(0.14)
Roundtail Chub	Blue River-middle	09/11/2018	Backpack Electrofisher	12	#Ind	23
					%YOY	0
					Mean CPUE	7.05
					SE	(3.13)
Roundtail Chub	Lazy YJ Ranch Pond	09/10/2018	Hoop Net	10	#Ind	145
					%YOY	0
					Mean CPUE	0.08
					SE	(0.02)
Spikedace	Blue River-lower	10/1/2018	Backpack Electrofisher	12	#Ind	295
					%YOY	20
					Mean CPUE	86.21
					SE	(11.13)
Spikedace	Blue River-middle	10/1/2018	Backpack Electrofisher	12	#Ind	6
					%YOY	33
					Mean CPUE	2.28
					SE	(0.92)
Spikedace	Hot Springs Canyon	09/18/2018	Backpack Electrofisher	9	#Ind	1
					%YOY	0
					Mean CPUE	0.25
					SE	(0.22)
Spikedace	Spring Creek	09/05/2018	Backpack Electrofisher	3	#Ind	20
					%YOY	0
					Mean CPUE	19.55
					SE	(2.16)

Appendix 3.—Populations of threatened and endangered species repatriated under the Gila River Basin Native Fishes Conservation Program, 2007 through 2018. Estimated population size is given for those considered established (i.e., reproducing to the point that they are self-sustaining). Topminnow and pupfish begin reproducing during their first year of life, so populations that have increased in numbers and continue to persist for three years after the final stocking are considered established. Spikedace, Loach Minnow, and Longfin Dace begin reproducing at age-1, and have a life span of about three years, so can probably be considered established if there is evidence of reproduction and increase in population over three to four years after the final stocking. Roundtail chub begin reproducing at age-1 or age-2, and live for about eight years, so it is probably necessary to monitor for five years after the final stocking before a relatively confident assessment of establishment can be made. The population size was estimated based catch during the most recent monitoring and size of stream or pond.

Species	Metapopulation	Lineage	Replicated Locations	Year Replicated	Population Status/Size
Gila Topminnow	Bylas Springs	Bylas Springs	Bass Canyon (Muleshoe Ranch CMA)	2014-2018	TBD
			Bonita Creek (lower)	2008	100-499
			Bonita Creek (upper)	2010-2015	>10000
			Burro Cienega, NM	2008	1000-4999
			Double R Canyon (Muleshoe Ranch CMA)	2017-2018	TBD
			Headquarters Spring (Muleshoe Ranch CMA)	2008	1000-4999
			Howard Well	2008	5000-9999
			Kei Sundt pond	2012	1000-4999
			Redfield Canyon (Muleshoe Ranch CMA)	~2009	1000-4999
			Redrock Wildlife Area Pond, NM	2010-2011	Failed
			Secret Spring (Muleshoe Ranch CMA)	2007	1000-4999
			Swamp Spring (Muleshoe Ranch CMA)	2007-2008	1000-4999
			TNC Lower San Pedro Preserve's west pond	2006	>10000
			Wildcat Canyon (Muleshoe Ranch CMA)	2014	500-999
	Upper Santa Cruz	Sharp Spring	Buckhorn Spring	2011	1000-4999
			Black Canyon City Heritage Pond	2018	TBD
			Chalky Spring	2009	0-99
			Fossil Creek	2007-2010	5000-9999
			Morgan City Wash	2009	500-999

Species	Metapopulation	Lineage	Replicated Locations	Year Replicated	Population Status/Size
			Mud Spring (Coronado NF)	2018	TBD
			Page Springs Hatchery SRP Topminnow Pond	2009	100-499
			Robbins Butte Stop Sign Tank	2015	1000-4999
			Robbins Butte Swimming Pool Tank	2015	1000-4999
			Peterson Ranch Pond	2018	TBD
			San Rafael Cattle Company Pasture #2 Pond	2013	0-99
			San Rafael Cattle Company Pasture #9 Pond	2016-2018	TBD
			West Fork Pinto Creek	2017	TBD
	Lower Santa Cruz	Peck Canyon	Hidden Water Spring	2016	TBD
			International Wildlife Museum Pond	2018	TBD
			Phoenix Zoo Ranarium	2012	1000-4999
			Rock Spring	2013-2014	0-99
			Sheepshead Canyon	2014-2016	TBD
			Spring Creek	2015-2016	TBD
			Tortilla Creek (upper)	2017	TBD
		Redrock Canyon	Arnett Creek	2017	TBD
			Walnut Spring (#392)	2012-2013	500-1000
	Monkey&Cottonwood	Cottonwood Spr	Ben Spring (San Pedro Riparian NCA)	2011	Failed
			Horse Thief Draw (San Pedro Riparian NCA)	2011	Failed
			Pemberton Pond (McDowell Mountain Reg. Park)	2009	Failed
			Usery Mountain Regional Park pond	2011	1000-4999
		Monkey Spring	Cottonwood Spring (Goldfield Mountains)	2008	1000-4999
			Mud Spring (#18) augmentation	2008	100-499
			Spur Cross Ranch Cons. Area Solar Oasis Pond	2009	Failed
			Willow Spring (San Pedro Riparian NCA)	2009	Failed
	Cienega Creek	Cienega Creek	Bill's Wildlife Pond (Las Cienegas NCA)	2016-2018	TBD
			Clyne Tank (Las Cienegas NCA)	2015-2016	TBD
			Crescent Pond (Las Cienegas NCA)	2013	1000-4999
			Egret Pond (Las Cienegas NCA)	2013	5000-9999

Species	Metapopulation	Lineage	Replicated Locations	Year Replicated	Population Status/Size
			Empire Tank (Las Cienegas NCA)	2013	1000-4999
			Gaucho Wildlife Pond (Las Cienega NCA)	2014	1000-4999
			Little Nogales Spring (Las Cienegas NCA)	2012	Failed
			Nogales Spring (Las Cienegas NCA)	2012-2015	Failed
			Road Canyon Tank (Las Cienegas NCA)	2012	5000-9999
			Sabino Canyon (lower)	2015-2016	TBD
			Sabino Canyon (upper)	2018	TBD
			Spring Water Wetland (Las Cienegas NCA)	2013	5000-9999
	mixed	mixed	Charlebois Spring	2017	TBD
	mixed	mixed	Murray Spring (San Pedro Riparian NCA)	2011-2017	TBD
Desert Pupfish	Santa Clara/El Doctor		Bonita Creek (lower)	2008	Failed
			Bonita Creek (upper)	2010-2015	Failed
			Cinco Canyon Tank (Las Cienegas NCA)	2013	1000-4999
			Cherry Spring Canyon (Muleshoe Ranch CMA)	2007	Failed
			Cottonwood Pond (Las Cienegas NCA)	2013, 2017	500-999
			Crescent Pond (Las Cienegas NCA)	2013	500-999
			Egret Tank (Las Cienegas NCA)	2015-2016	100-499
			Empire Tank (Las Cienegas NCA)	2013	500-999
			Gaucho Wildlife Pond (Las Cienegas NCA)	2015	100-499
			Headquarters Spring (Muleshoe Ranch CMA)	2008	Failed
			Heart Pond (Las Cienegas NCA)	2013	500-999
			Horse Thief Draw (San Pedro Riparian NCA)	2011	Failed
			Howard Well	2008-2009	100-499
			Kei Sundt Pond	2010	100-499
			Larry & Charlie Tank (Muleshoe Ranch CMA)	2009	100-499
			Little Joe Spring (San Pedro Riparian NCA)	2013	1000-4999
			Mint Spring (Muleshoe Ranch CMA)	2015-2016	TBD
			Mud Spring (#18)	2007-2009	100-499
			Murray Spring (San Pedro Riparian NCA)	2011-2014	TBD

Species	Metapopulation	Lineage	Replicated Locations	Year Replicated	Population Status/Size
			Nursery Tank (McDowell Mnt. Regional Park)	2010	1000-4999
			Pemberton Pond (McDowell Mountain Reg. Park)	2009	100-499
			Road Canyon Tank (Las Cienegas NCA)	2012	500-999
			Robbins Butte Wildlife Area Cottonwood Tank	2010	1000-4999
			Robbins Butte Wildlife Area Twin Tanks	2009	1000-4999
			Secret Spring (Muleshoe Ranch CMA)	2007-2011	100-499
			Spur Cross Ranch Cons. Area Solar Oasis pond	2009	500-999
			Swamp Spring (Muleshoe Ranch CMA)	2007	Failed
			TNC Lower San Pedro Preserve's east pond	2009	5000-9999
			Tule Creek	2007-2009	Failed
			Walnut Spring (#20)	2008	Failed
Longfin Dace		Coal Mine Canyon	Fresno Canyon	2008	1000-4999
		Hassayampa River	Arnett Creek	2007	500-999
		Hassayampa River	Telegraph Canyon	2007	500-999
		Hidden Water Spr	Rock Creek	2016	TBD
		Seven Sprs Wash	Spur Cross Ranch Cons. Area Solar Oasis pond	2008	0-99
		Tangle Creek	Fossil Creek	2008-2009	1000-4999
Loach Minnow		Aravaipa Creek	Hot Springs Canyon (Muleshoe Ranch CMA)	2007-2011	100-499
			Redfield Canyon (Muleshoe Ranch CMA)	2007-2010	Failed
			Fossil Creek	2007-2013	Failed
		Blue River	Bonita Creek (lower)	2008	Failed
			Bonita Creek (upper)	2009-2014	Failed
Spikedace		Aravaipa Creek	Fossil Creek	2007-2018	1000-4999
			Spring Creek	2015-2018	TBD
			Hot Springs Canyon (Muleshoe Ranch CMA)	2007-2011	TBD
			Redfield Canyon (Muleshoe Ranch CMA)	2007-2010	Failed
		Upper Gila River	Blue River	2012	1000-4999
			Blue River (middle)	2017-2018	TBD

Species	Metapopulation	Lineage	Replicated Locations	Year Replicated	Population Status/Size
			Bonita Creek (lower)	2008	Failed
			Bonita Creek (upper)	2009-2010	Failed
Roundtail Chub		Eagle Creek	Blue River	2012-2016	1000-4999
		Cienega Creek[1]	Clyne Pond (Las Cienegas NCA)	2016, 2017	Failed
		Harden Cienega[1]	Harden Cienega (upper)	2015	500-999
		Harden Cienega[1]	Mule Creek NM	2012-2014	TBD
		Redfield Canyon[1]	Redfield Canyon (upper)	2007	500-999
		Dix Creek[1]	Redrock Wildlife Area, NM	2010-2011	Failed
		Cienega Creek[1]	Spring Water Wetland (las Cienegas NCA)	2017	TBD
		Verde River	TNC Gila Riparian Preserve (Farm), NM	2008	Failed
		O'Donnell Creek[1]	TNC Lower San Pedro Preserve's west pond	2010-2011	1000-4999
Razorback Sucker		Lake Mohave	Fossil Creek	2008-2014	Failed

[1] 1 Chub in these locations were previously classified as Gila Chub.