5 YEAR AGREEMENT FINAL REPORT

2011 - 2016

Central Arizona Project Fund Transfer Program

Cooperative Agreement (F11AC00108) Between
U.S. Fish and Wildlife Service, Region 2
And
New Mexico Department of Game and Fish

SUBMITTED TO
U.S. FISH AND WILDLIFE SERVICE

SUBMITTED BY
FISHERIES MANAGEMENT DIVISION
NEW MEXICO DEPARTMENT OF GAME AND FISH

26 APRIL 2016

Executive Summary:

This report summarizes the Gila River Basin Native Fishes Conservation Program (GRBNFCP) funded projects in New Mexico from 5 April 2011 through 5 April 2016 (Performance Period for Cooperative Agreement F11AC00108)(Figure 1). The bulleted list below summarizes significant findings and accomplishments that occurred during the agreement period.

- The New Mexico Department of Game and Fish (NMDGF) and partners worked on multiple repatriation projects for Gila Topminnow *Poeciliopsis occidentalis*, Gila Chub *Gila intermedia*, Roundtail Chub *Gila robusta*, Spikedace *Meda fulgida* and Loach Minnow *Tiaroga cobitis*.

- The Pitchfork Ranch Gila Topminnow refuge population was surveyed and they were found to be common in six areas of Burro Ciénega.

- The Nature Conservancy Gila Farm pond had nonnative fish present during surveys in 2011 and 2012, but no Roundtail Chub were found. The efficacy of the fish screen at the inlet to the pond needs to be evaluated before renovation and restocking.

- The NMDGF's Redrock Ciénega pond was stocked with Gila Topminnow and Gila Chub multiple times. A 2011 survey found adult and juvenile chub, but no topminnow. After additional stocking of both species a 2012 survey also found Gila Chub but no topminnow.

- The initial repatriation of Spikedace into the San Francisco River occurred prior to this agreement. A survey of the site in 2014 found no Spikedace. This was not a surprise as recent fire effects had impacted fish populations. Stocking was reinitiated in 2014 with Spikedace reared at Arizona's Aquatic Research and Conservation Center (ARCC).

- The NM partners and Arizona Game and Fish Department (AZGFD) stocked Gila chub into Mule Creek for three consecutive years starting in 2012. Surveys in March 2014 found that Gila Chub from previous stocking events successfully overwintered in Mule Creek, but there was no evidence of reproduction.

- The GRBNFCP identified Saliz Canyon as a potential Loach Minnow repatriation site. A 2013 survey found no Loach Minnow, but plans for stocking Loach Minnow were postponed in favor of reestablishing the population near Glenwood after the Whitewater Baldy Fire. Offspring of Loach Minnow salvaged during the fire and held at ARCC were stocked back into that reach in 2014.

- Loach Minnow were stocked into Little Creek for two consecutive years starting in 2014, once from ARCC, and once translocated from the West Fork Gila River.

- The NM partners assessed a portion of the canyon bound reach of the Gila River in 2012. Four fishless tributaries were surveyed. Three mainstem sites were surveyed and seven nonnative species were collected, but no native fish.

- The NM partners surveyed and conducted nonnative removal efforts in Turkey Creek and its tributaries. Gila Chub were found to occupy most of the perennial length of Turkey Creek and Sycamore Canyon. Gila Chub above and below a potential barrier were PIT tagged and samples were collected for genetic analysis.

- The NM partners moved fishes threatened by wildfire from the West Fork Gila River and the San Francisco River to Southwestern Native Aquatic Resources and Recovery Center (SNARRC). Salvaged fish have been returned to their collection sites except for Loach Minnow from the San Francisco River, which were transferred from SNARRC to ARCC to establish a captive population.

- The NM partners removed nonnative fish annually from West Fork Gila River at the Heart Bar Wildlife Management Area. Most native species in the removal reach have rebounded after recent fires and flooding. Multiple removal trips were conducted on Little Creek to remove Brown Trout prior to repatriation efforts. The efficacy of nonnative removal in Little Creek was low, but did not preclude Loach Minnow repatriation.

Unfortunately, the USFWS was unable to provide funding to NMDGF during the last two years of the reporting period, substantially limiting the Department's ability to work under this Cooperative Agreement. Some work was accomplished using alternative funding sources, but other work was postponed or not completed. NMDGF submitted funding requests to USFWS for tasks approved by the GRBNFCP's Technical and Policy committees for 2014 and 2015, but no Financial Assistance Award was executed. In total, the NMDGF was awarded $75,000 in 2011, $10,000 in 2012 (funding was cut due to the increased cost of the Blue River fish barrier), and $75,000 in 2013 (F11AC00740 Amendment 2).

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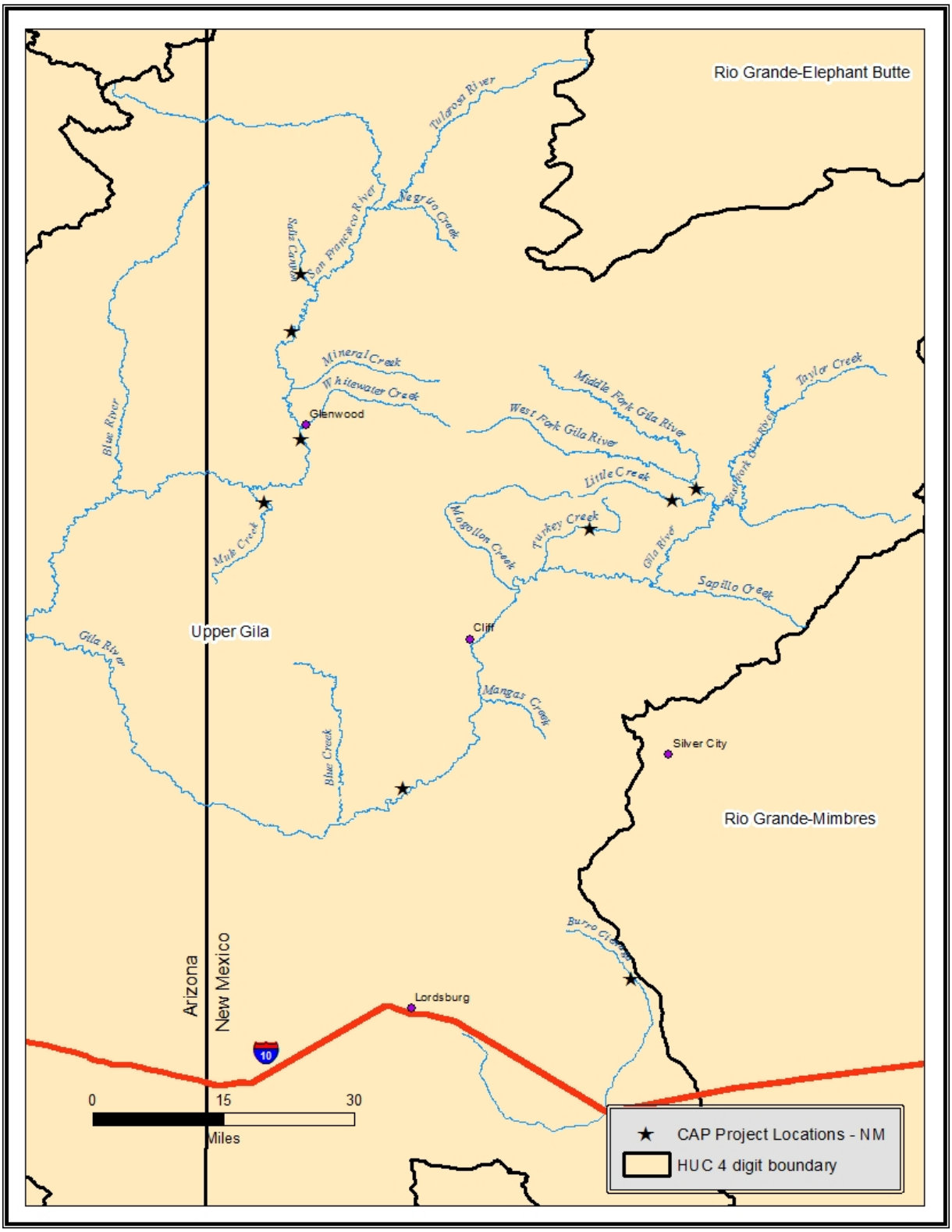

Figure 1. Map of the Upper Gila Basin, New Mexico showing the locations of ongoing Gila River Basin Native Fishes Conservation Program projects.

Native Fishes Recovery & Conservation (RPA 3)

Threatened and Endangered Repatriations and Monitoring:
During the reporting period various similar and related tasks were combined into an inclusive repatriation and monitoring task. This was done to better manage repatriation efforts on a basinwide scale in New Mexico. At the onset of this 5-year agreement the following repatriation tasks were listed under Native Fishes Recovery and Conservation:

- Repatriate native fishes to streams renovated for Gila Trout *Oncorhynchus gilae* in the Gila River Basin, NM.
- Repatriation of Spikedace *Meda fulgida* to the San Francisco River Basin, NM.
- Systematic inventory and assessment of tributaries of San Francisco River for Gila Chub *Gila intermedia*.
- Restoration of native fish to habitats on private lands in the Gila and San Francisco River drainages.

These activities were all continued in the inclusive repatriation and monitoring task. This basinwide approach allows for more opportunities (i.e. assessment of tributaries of the Gila River for Gila Chub) and follow-through (i.e. monitoring after repatriation). The threatened and endangered repatriations and monitoring task included all phases of native fish repatriation efforts (see Appendix A). Repatriation efforts under this task generally followed Childs (2005). This included identifying streams with potential habitat, surveying potential streams, stocking streams, and monitoring repatriated populations. During the 5-year reporting period this work was done in Redrock Cienega, Burro Cienega, Mule Creek, Little Creek, San Francisco River, and Saliz Canyon, and included initial evaluations of additional potential streams using GIS and aerial photography.

Restoration of Native Fishes to Private Lands

New Mexico Department of Game and Fish (NMDGF) worked with two landowners to restore native fishes on private lands during the reporting period. The Pitchfork Ranch, located 24 miles south of Silver City in Grant County, is in the southern portion of the Upper Gila Basin (Figure 1.). In 2008 NMDGF and Arizona Game and Fish Department (AZGFD) stocked Gila Topminnow *Poeciliopsis occidentalis* from Bylas Springs, in Burro Ciénega (Figure 2.) on the Pitchfork Ranch. Despite several high flow events in 2009 and a severe drought from 2011 through 2013, the species persists and the landowners (A.T. & Cinda Cole) report them common in suitable habitats in 2015. Gila Topminnow now occupies six distinct areas at Burro Ciénega. New Mexico Department of Game and Fish visited the site in July 2012. A 1/8-inch mesh minnow trap was set for two hours in the windmill overflow pond and more than 300 Gila Topminnow were captured. Gila Topminnow was common throughout the occupied reach of Burro Ciénega. There is a short reach within the Topminnow habitat that had deeper pools that could be evaluated as a site for future repatriation of Gila Chub *Gila intermedia*.

Figure 2. Gila Topminnow habitat in Burro Ciénega on the Pitchfork Ranch.

The Nature Conservancy owns property on the Gila River four miles upstream of Gila, NM in the Cliff-Gila Valley. The Gila Farm Pond on the property is connected to an irrigation channel, but has no outlet (Figure 3). It had previously been used for agriculture and recreational fishing. After draining and removal of nonnative Largemouth Bass *Micropterus salmoides*, the pond was stocked with 84 Verde River Roundtail Chub *Gila robusta* from the AZGFD Aquatic Research and Conservation Center (ARCC) in February, 2008. The Nature Conservancy installed a fish screen on the inflow structure from the irrigation ditch to the pond in 2009. NMDGF observed Roundtail Chub during snorkel surveys in 2008 and 2009. In June 2011, NMDGF surveyed the pond with a trammel net and captured two Sonora Sucker *Catostomus insignis*. These fish likely entered the pond before the fish screen was installed as they were 235 and 255 millimeters (mm) standard length (SL). In July 2012, NMDGF set two trammel nets in the pond and captured five Bluegill *Lepomis macrochirus* (128 – 146mm total length [TL]), two Yellow Bullhead *Ameiurus natalis* (243 and 268mm TL), two Common Carp *Cyprinus carpio* (304 and 470mm TL) and two Sonora Sucker (268 and 336mm TL). The nets were 50 and 100 feet long and 6 feet deep. The longer net was set deep (sink set) and the shorter net was set at the surface (float set). The combined catch rate was 4.07 fish per 100 feet of net per hour. The water was turbid during the sampling which prohibited snorkel surveys. Western Mosquitofish *Gambusia affinis* were noted along the pond margins. These nonnative fish may have entered the pond before installation of the fish screen. The Nature Conservancy Gila Farm pond should not be considered a Roundtail Chub refuge in its current condition. Nonnative fishes that are large enough to prey on juvenile Roundtail Chub are present. The pond would need to be

drained again before restocking with additional Roundtail Chub and the effectiveness of the fish screen at the inlet would need to be evaluated.

Figure 3. Pond at The Nature Conservancy's Gila Farm.

Restoration of Redrock Ciénega

Redrock Ciénega is an approximately 0.75 acre (0.3 hectare) constructed pond with a central island and variable depth created as a refuge site for Gila Topminnow and Gila Chub. Shortly after completion, Gila Topminnow from Bylas Springs were stocked. In October 2010, numerous Gila Topminnow were observed along the margins. Also in October 2010, 150 Gila Chub *Gila intermedia* from Dix Creek in Arizona (collected and provided by AZGFD) were stocked in Redrock Ciénega.

Figure 4. Redrock Ciénega, New Mexico Department of Game & Fish Redrock Wildlife Management Area, 2009 on the left and 2011 on the right.

Figure 5. Gila Chub stocking, Redrock Ciénega, New Mexico Department of Game & Fish Redrock Wildlife Management Area, October 2011.

In 2011 three Gila Chubs were captured but no Gila Topminnow. Two of the chubs were juveniles (45 mm SL) indicating that chubs reproduced in the pond. An additional 174 Gila Chub and 2,357 Gila Topminnow were stocked by NMDGF and AZGFD personnel in October 2011. Redrock Ciénega pond was sampled on 16 July 2012 and on 19 February 2013 (Figure 6) using minnow traps (Table 1).

Table 1. Fish captured in Redrock Ciénega pond in minnow traps (fish/trap hour).

Date	*Species*	*Size Range (mm TL)*	*Total #*	*CPUE*
July 2012	Gila Chub	81 - 119	2	0.09
Feb 2013	Gila Chub	59 – 98	7	0.07

NMDGF is uncertain why topminnow has not persisted. The record cold temperatures (-18°C) during the winter of 2010/2011 may have been a contributing factor. Also, there was an abundance of filamentous algae during the July 2012 survey, which can result in reduced dissolved oxygen in a pond. Evaluation of the water quality over time is needed to determine what is limiting Gila Topminnow persistence.

Nonnative vegetation, mostly salt cedar, was removed from the pond area during initial construction. At the time of the February 2013 sampling salt cedar was manually removed from the pond's shore and additional willow and seepwillow poles were planted.

Figure 6. Gila Chub, Redrock Ciénega, New Mexico Department of Game & Fish Redrock Wildlife Management Area, February 2013.

Restoration of Spikedace to San Francisco River

Spikedace repatriation in the San Francisco River began in 2008 (Table 2). The location is approximately 10 km upstream of the Hwy 180 crossing near Alma, NM (Figure 7). The effects of the Whitewater Baldy Fire in 2012 apparently negated earlier stocking efforts, as no Spikedace was found at the site in the spring of 2014. Repatriation efforts were reinitiated in autumn 2014. These fish were offspring of individuals captured from the Gila River within Gila National Forest Bird Area, New Mexico and were reared at AZGFD ARCC.

Table 2. Previous Spikedace stocking in the San Francisco upstream of Alma.

Date	Number	Source
Sept 2008	350	ARCC
21 Oct 2009	150	Gila Bird Area
Oct 2010	4,000	ARCC
29 Oct 2014	1,317	ARCC
Autumn 2015-2018	TBD	ARCC or Gila Bird Area

Figure 7. Spikedace repatriation site on San Francisco River upstream of Alma, Catron County, New Mexico.

San Francisco River Tributary Survey for Chub Species and Mule Creek Gila Chub Repatriation

The New Mexico partners identified Mule Creek as an appropriate repatriation site for Gila Chub *Gila intermedia* after a survey of fish and habitat in July 2011. In total about 3.5 km of stream were sampled (Figure 8). Gila Chub are habitat specialists and Mule Creek contained the pool habitats with cover that they require.

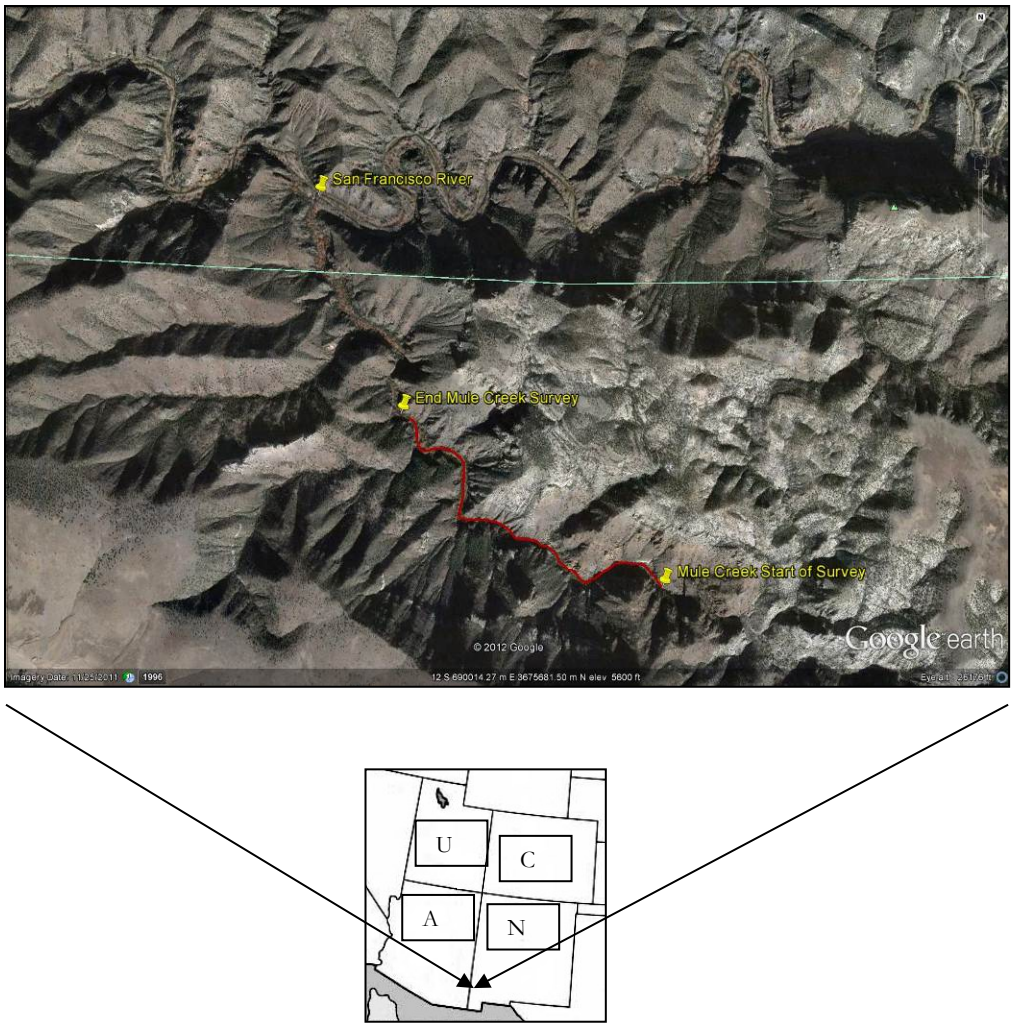

Figure 8. Mule Creek survey location and extent of sampling, 2011.

Desert Sucker *Pantosteus clarkii*, Sonora Sucker, Speckled Dace *Rhinichthys osculus* and Longfin Dace *Agosia chrysogaster*, were collected and common. The last pool, in the lowest portion of Mule Creek sampled, yielded a single Smallmouth Bass *Micropterus dolomieu* (total length 160 mm). This was the only nonnative fish collected in Mule Creek. In total, 520 fish were collected in 970 seconds of sampling (Table 3). Stocking of Harden Cienega Gila Chub into Mule Creek began in 2012.

Table 3. Fish Captured and Catch per Unit Effort (CPUE) Mule Creek, 2011

Species Common Name	*Total Number Collected*	*CPUE (Fish/Second)*
Longfin Dace	248	0.2557
Sonora Sucker	16	0.0165
Desert Sucker	188	0.1938
Speckled Dace	68	0.0701

Each year AZGFD collected Gila Chub from Harden Cienega and held them at ARCC for a quarantine period of approximately 35 days (personal communication, Matt O'Neill, 24 April 2014). Fish were then transferred to NMDGF for repatriation into Mule Creek (Table 4). The stocking method varied from year to year and included atv access down the San Francisco River, hiking fish in buckets (Figure 9), and via helicopter long line (Figure 10). The helicopter delivery is the safest option that is still accessible and will be used for future stockings.

On 6 June 2013, NMDGF, USFWS and USFS conducted a monitoring survey of the stocked reach of Mule Creek. They collected seven species in 1,610 seconds of electrofishing (Table 6). One Channel Catfish *Ictalurus punctatus* (260mm TL) and two Green Sunfish *Lepomis cyanellus* (120mm and 150mm TL) were collected at the lower end of the survey reach and were unlikely to move higher in the system due to boulders in the creek forming small waterfalls.

Table 4. Timeline for repatriation of Gila Chub into Mule Creek.

Date	**Number**	**Source**
27 June 2012	120	Harden Cienega via ARCC
21 November 2013	119	Harden Cienega via ARCC
13 November 2014	60	Harden Cienega via ARCC
Autumn 2015	Target - 100	Harden Cienega via ARCC
Autumn 2016	Target - 100	Harden Cienega via ARCC

Figure 9. November 2013 stocking of Gila Chub into Mule Creek.

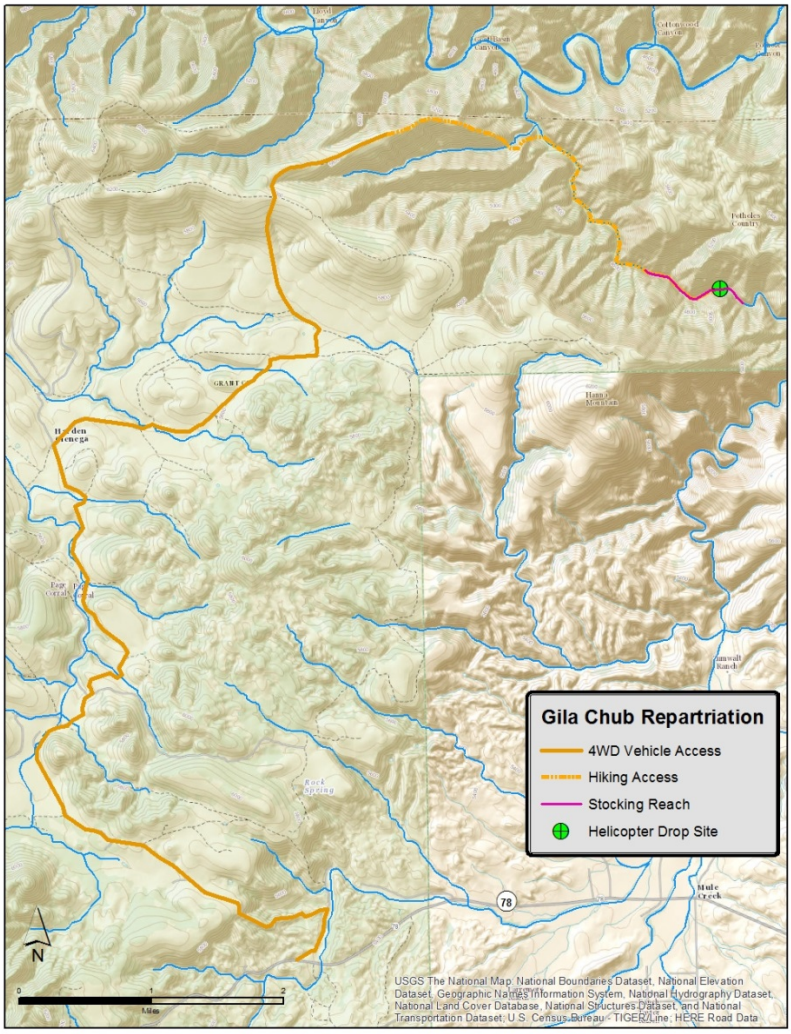

Figure 10. Location of Gila Chub repatriation in Mule Creek, NM.

Table 5. Fish captured and Catch per Unit Effort (CPUE, Fish / Second) Mule Creek, New Mexico, 2013.

Species Common Name	*Total Number Collected*	*CPUE*
Longfin Dace	76	0.0472
Sonora Sucker	113	0.0702
Desert Sucker	131	0.0814
Speckled Dace	46	0.0256
Gila Chub	6	0.0037
Channel Catfish	1	0.0006
Green Sunfish	2	0.0012

Mule Creek was surveyed again on 28 March 2014. Five species were collected from a 2 km reach (Table 6). The Gila Chub that were collected appeared to be from both stocking events (117-222 mm TL), but there was no evidence of reproduction (Figure 11 and Figure 12). Nonnative fish do

not appear to be a threat to Gila Chub in Mule Creek, but future monitoring is necessary, as there is no physical barrier to upstream movement of nonnative fish between the San Francisco River and Mule Creek. Flathead *Pylodictis olivaris* and Channel Catfish are present in the San Francisco River, but as of March 2014, they had not moved up Mule Creek to the Gila Chub stocking reach. Annual stocking of Gila Chub is planned through 2016.

Table 6. Fish captured and Catch per Unit Effort (CPUE, Fish / Second) Mule Creek, New Mexico, March 2014.

Species Common Name	*Total Number Collected*	*CPUE*
Longfin Dace	62	0.0487
Sonora Sucker	78	0.0612
Desert Sucker	118	0.0926
Speckled Dace	29	0.0228
Gila Chub	11	0.0086

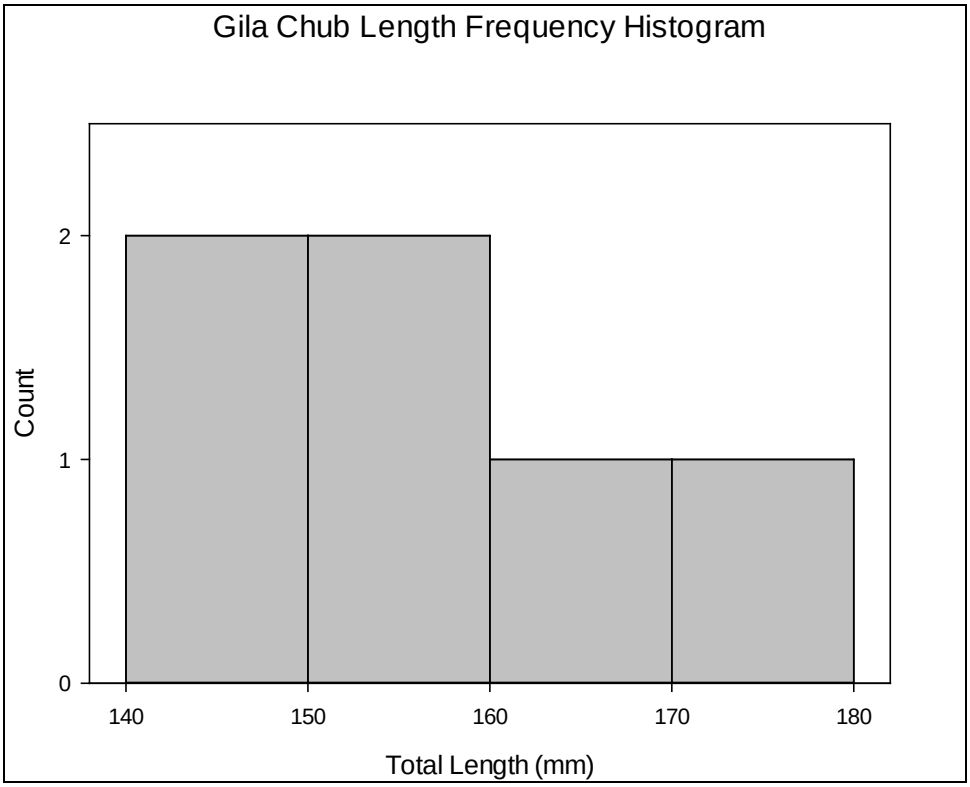

Figure 11. Gila Chub collected during 2013 Mule Creek survey after one stocking (n=6).

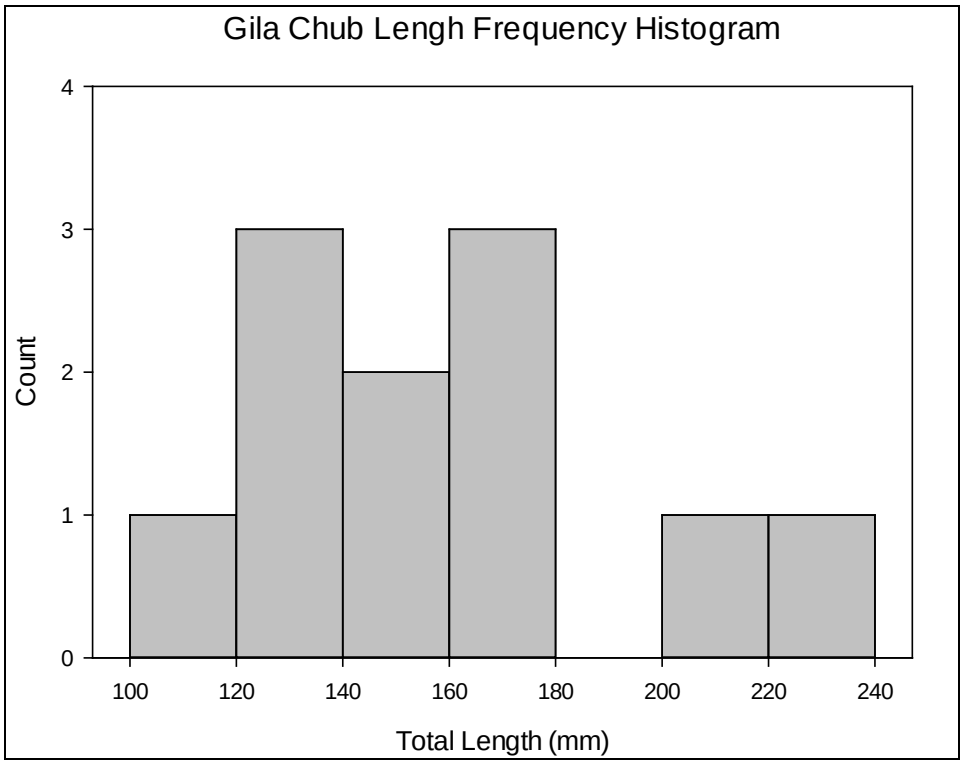

Figure 12. Gila Chub collected during the 2014 Mule Creek survey after two consecutive years of stocking (n=11).

Saliz Canyon Loach Minnow Repatriation

The San Francisco River at its confluence with Saliz Canyon is designated critical habitat for Loach Minnow *Tiaroga cobitis* (Figure 13). Saliz Canyon is ephemeral at the confluence, but there is approximately seven miles of perennial water upstream. The GRBNFCP identified Saliz Canyon as a repatriation site for Loach Minnow. The perennial reaches of Saliz Canyon support a native fish assemblage (Speckled Dace, Longfin Dace, Sonora Sucker, and Desert Sucker). On 5 June 2013, NMDGF and USFWS surveyed three locations on Saliz Canyon. Four species of fish were collected, but no Loach Minnow were collected (Table 7). Due to multiple years of drought, flows in Saliz Canyon were very low during the survey (<2 cfs). Loach Minnow habitat was not extensive but was present. In many of the riffles water flowed through the interstitial spaces of the cobble substrate instead of over it. Saliz Canyon is an ideal location to establish a Loach Minnow population because as a tributary it is protected from impacts in the mainstem San Francisco River. While being geographically separate a Saliz Canyon population would still maintain genetic connectivity when flows are sufficient to establish connectivity to the San Francisco River.

The next step for Saliz Canyon is to stock Loach Minnow from the San Francisco River population. The ARCC houses San Francisco River Loach Minnow salvaged in 2012 after the Whitewater Baldy fire. Stocked Loach Minnow would either be offspring from these fish or wild fish collected upstream in the San Francisco River or its tributaries and transferred to Saliz Canyon.

Table 7. Fish captured and Catch per Unit Effort (CPUE, Number / Second) Saliz Canyon, New Mexico, 2013.

Site	*Species Common Name*	*Total Number Collected*	*CPUE*
Forest Rd. 16	Longfin Dace	90	0.1372
	Sonora Sucker	3	0.0046
	Desert Sucker	19	0.0290
	Speckled Dace	70	0.1067
At Cottonwood Can.	Longfin Dace	75	0.0627
	Desert Sucker	23	0.0192
	Speckled Dace	89	0.0744
At Martinez Canyon	Longfin Dace	77	0.3850
	Sonora Sucker	9	0.0450
	Speckled Dace	27	0.1350

Prior to the Whitewater Baldy Fire of 2012 Loach Minnow occurred in the San Francisco Drainage from just upstream of the San Francisco Box downstream to the Pleasanton Diversion. They were also known to occur in major tributaries including the Tularosa River, Negrito Creek, and Whitewater Creek. Portions of their distribution in the San Francisco Basin were seasonally dry due to surface water diversion making distribution discontinuous. After the Whitewater Baldy Fire sampling by NMDGF did not find Loach Minnow downstream of Reserve, NM. When repatriation of Saliz Canyon was originally conceived there was a healthy population of Loach Minnow in the San Francisco River downstream. The concept was to transfer Loach Minnow from the San Francisco River near Glenwood directly into Saliz Canyon. Individuals from that population were salvaged and moved to ARCC before the population was extirpated by post fire ash flows as a result of the Whitewater Baldy Fire. The offspring of that breeding population were used to repatriate Loach Minnow into the San Francisco at Glenwood. NMDGF began the process of evaluating Loach Minnow from the Tularosa River as a source to supplement the ARCC San Francisco population and to use for wild fish transfers. Once a source is identified those fish could be transferred directly, or ARCC offspring could be stocked into Saliz Canyon.

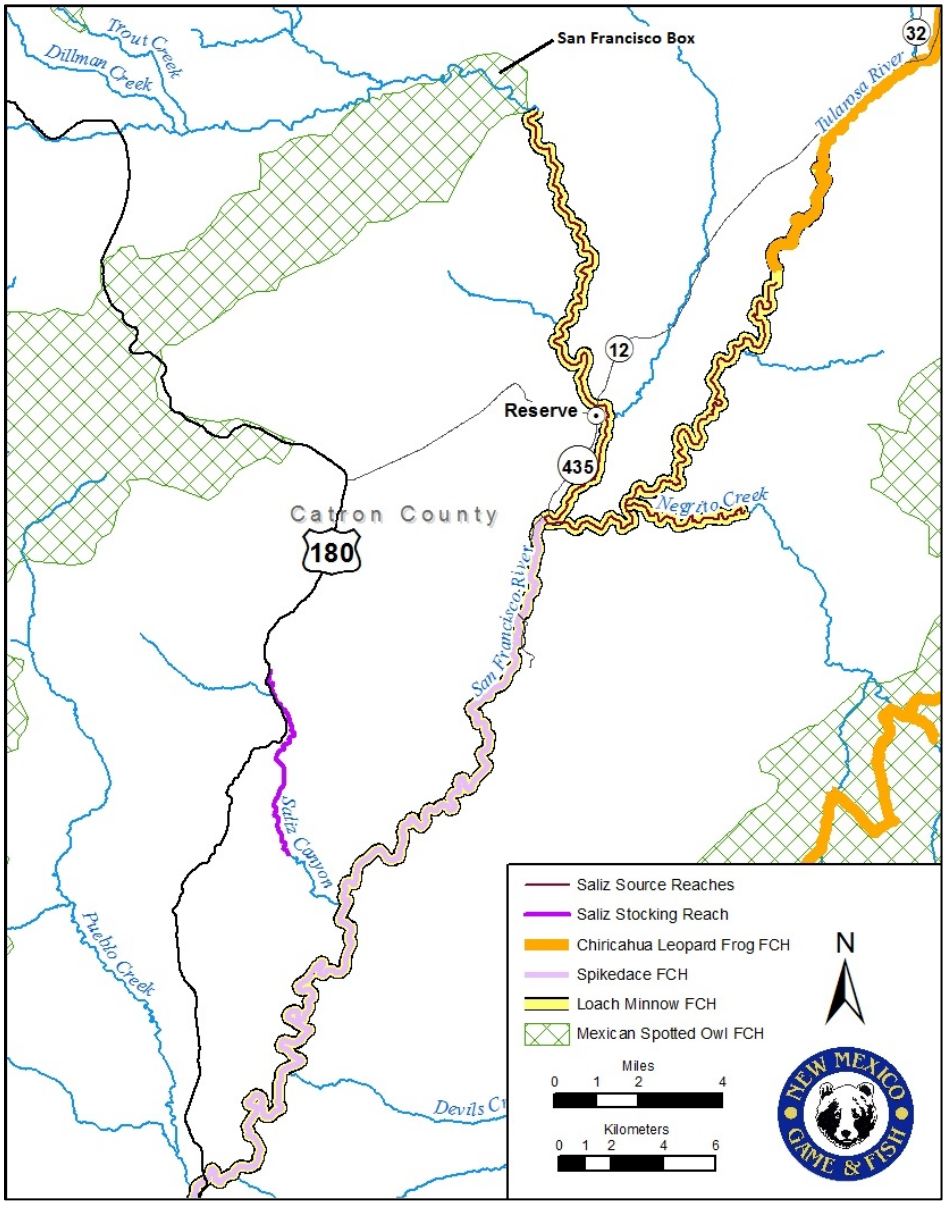

Figure 13. Reaches of Saliz Canyon identified for repatriation of Loach Minnow.

Little Creek Loach Minnow Repatriation

Little Creek is a tributary to the West Fork Gila River. The West Fork Gila River at the confluence of Little Creek is designated critical habitat for Loach Minnow (Figure 14). There is approximately 3 miles of Loach Minnow habitat in Little Creek upstream of its confluence with the West Fork Gila River. Repatriation stocking in Little Creek began in autumn 2014 with 267 Loach Minnow from ARCC. In 2015, 62 Loach Minnow were transferred directly from the West Fork Gila River.

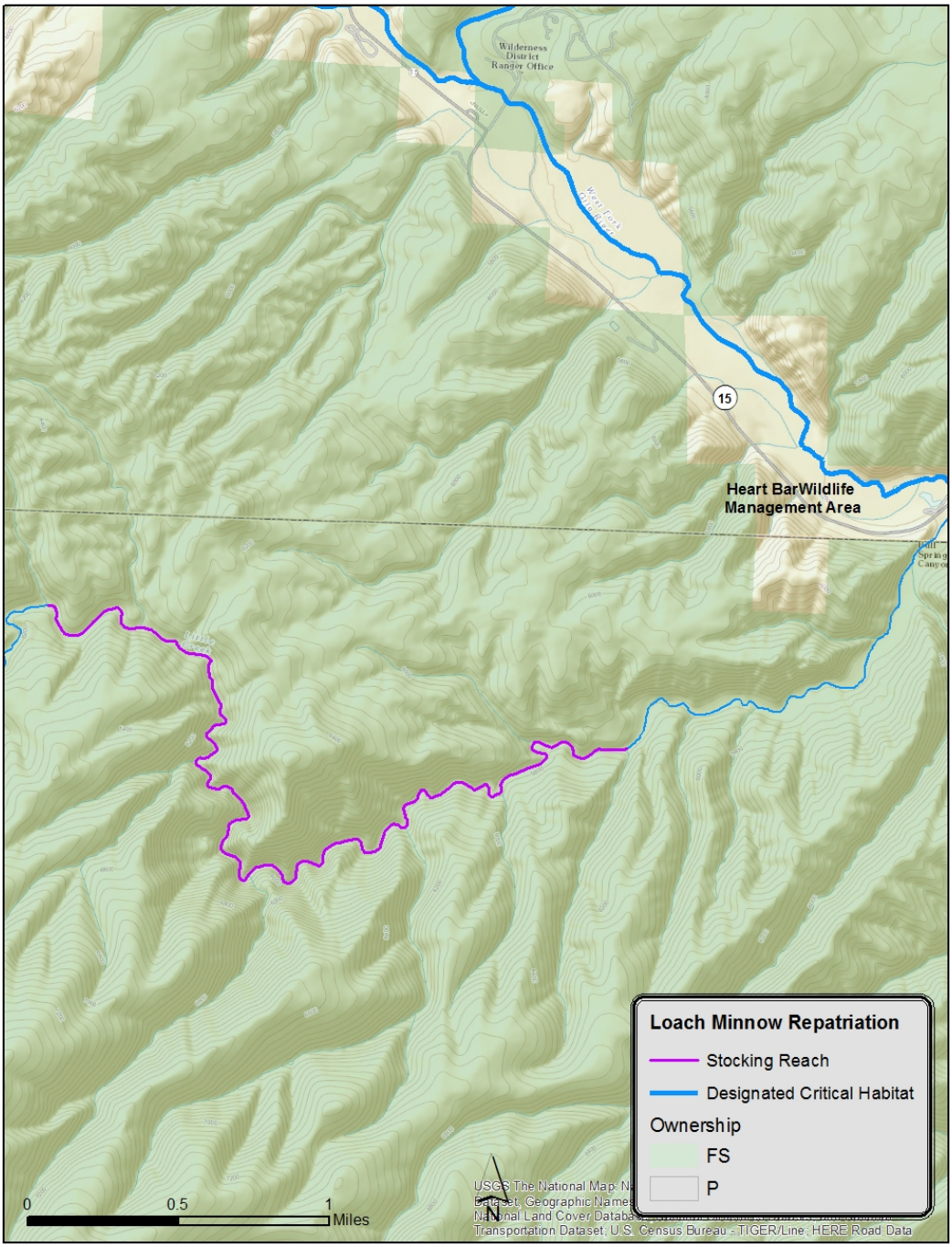

Figure 14. Location of Loach Minnow repatriation in Little Creek, NM.

San Francisco River at Glenwood Loach Minnow Repatriation

The San Francisco River Loach Minnow currently housed at ARCC came from 48 salvaged from the San Francisco near Glenwood after the Whitewater Baldy Fire in June 2012 (Figure 15). Subsequent surveys suggest that Loach Minnow were extirpated from this reach by post-fire effects. Excellent habitat for Loach Minnow remains (D. Propst field notes, 8 October 2013) and re-establishing

Loach Minnow in the Glenwood reach took precedence over establishing a Saliz Canyon population. Repatriation of the Glenwood site began in 2014 with 649 F1 progeny of the salvaged Loach Minnow delivered by ARCC. ARCC retained approximately 200 offspring to augment the aging broodstock. Stocking at Glenwood will continue as needed. The stocking site is also the site of long term annual fish community monitoring.

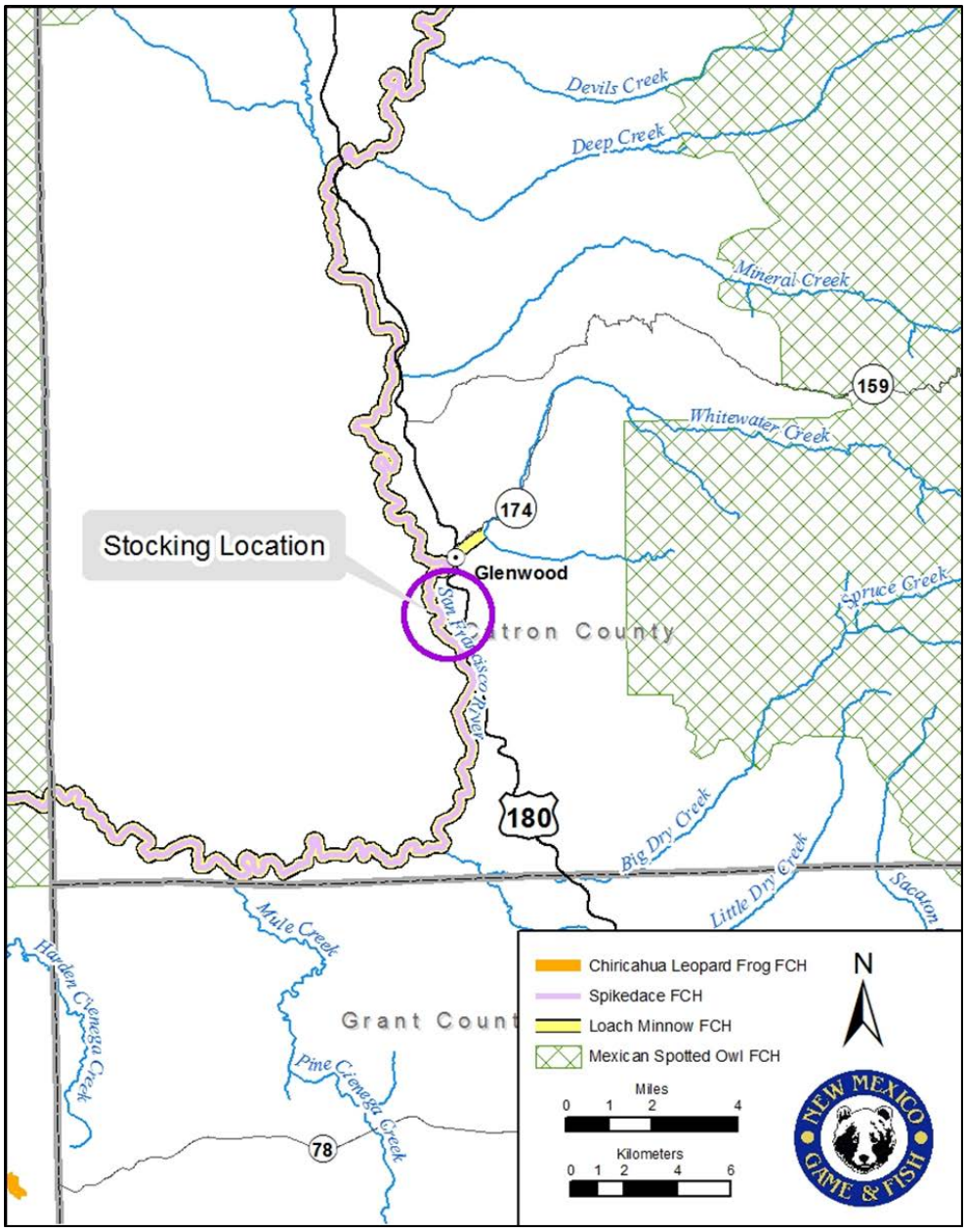

Figure 15. Location of Loach Minnow repatriation in the San Francisco, NM.

Canyon Bound Gila River Assessment:

Surveys of the canyon-bound reach of the Gila River between Alum Camp and the confluence of Turkey Creek were conducted in spring 2012. This stretch of the Gila River had not been sampled by NMDGF since 1983 and has tributaries that have no record of sampling (Figure 16). The 1983 effort focused on the section upstream of Sycamore Canyon and included the lower kilometer of Sapillo Creek. In 2012, three sites were sampled on the mainstem Gila River upstream of Turkey Creek with a backpack electrofisher, seine and gill net. Tributaries that appeared to have perennial water were also surveyed with a backpack electrofisher or visually. These included Hells Canyon, Water Canyon, Wild Cow Canyon and an unnamed canyon on the north side of the Gila River about one mile downstream of Utah Bill Canyon (referred to as Wishbone Canyon in field notes).

In the three mainstem samples we collected seven species (Table 8). These included 5 Flathead Catfish (400 – 700mm TL), 2 Channel Catfish (176 and 420mm TL), 12 sunfish (41 – 124mmTL) and 8 Smallmouth Bass (112 – 226mm TL). The piscivorous community composition helped explain the absence of native fish in our samples. The low overall density suggested there were also other factors involved. Stomach contents were preserved from eight large piscivorous fish for future diet analysis. Species diversity was higher in the 1983 samples and included five native species.

Fish density was low overall in the mainstem samples. Gill net (30 feet x 4 feet) sampling included three sets for a total of 16.82 hours and captured one Channel Catfish. Backpack electrofishing at the three sites totaled 3,570 seconds and captured 92 fish (CPUE = 0.026 fish/sec). Western Mosquitofish represented 75% of the electrofishing catch. Seinable habitat was present at two of the three mainstem sites. Seine hauls covered a total of 370 square meters and captured 114 fish (CPUE = 0.31 fish/square meter). Western Mosquitofish represented 90% of the seine catch.

No fish were found in the tributaries. Habitat in the tributaries consists of high gradient flow with large substrate and a scarcity of pools. All tributaries had perennial sections, but had no surface water connectivity to the Gila River at the time of the survey.

It is not recommended that any of the tributaries sampled in 2012 be considered as repatriation streams for federally listed species due to a lack of habitat. Additional tributaries not sampled in 2012 warrant further investigation, but those surveys would be conducted as part of the repatriation and monitoring task.

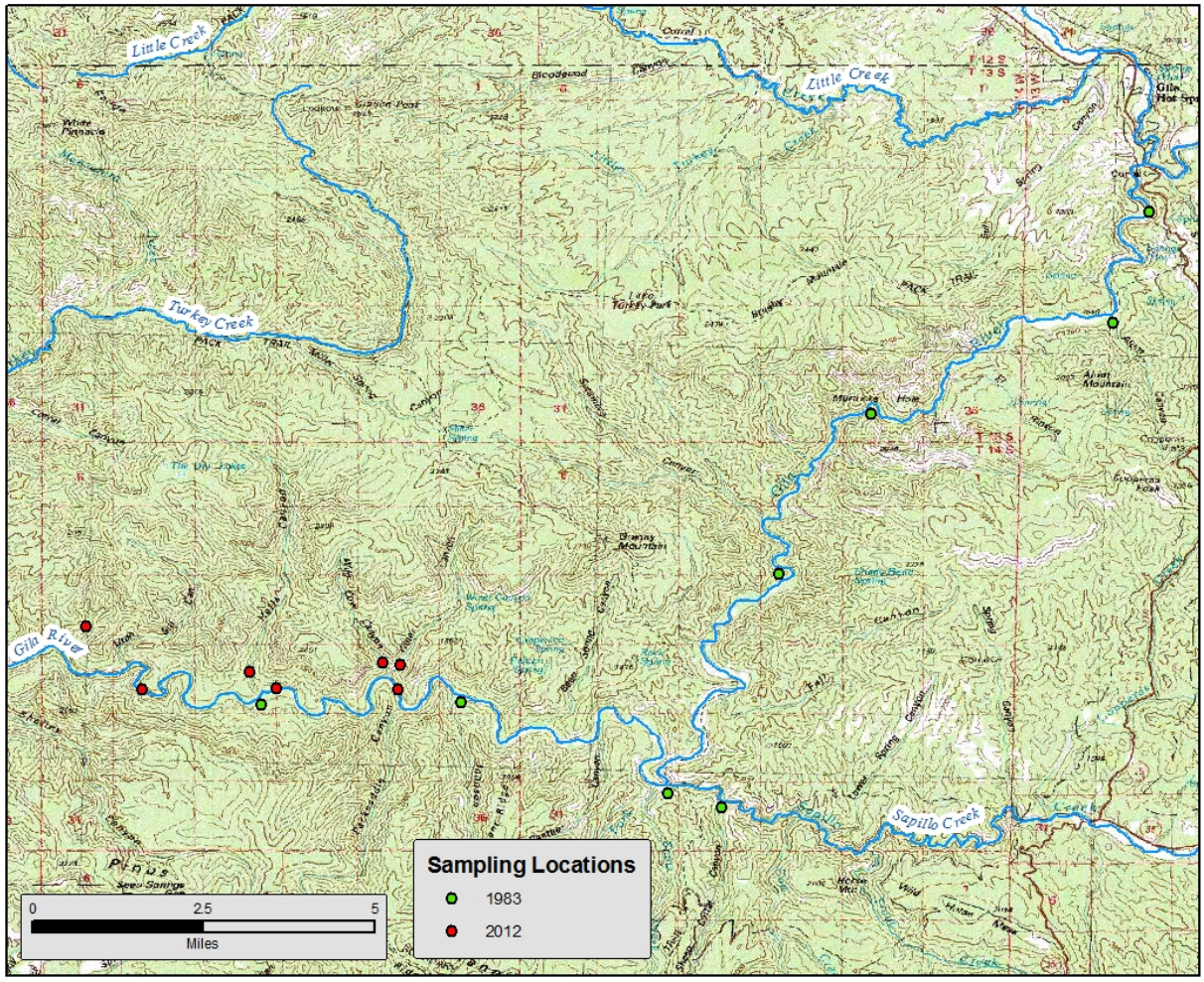

Figure 16. Location of canyon bound Gila River, New Mexico, sampling in 1983 and 2012.

Table 8. Fish species captured during surveys of the Gila River, New Mexico, between Turkey Creek and Alum Camp, including tributaries, 1983 and 2012.

Species Common Name	*1983*	*2012*
Longfin Dace (Native)	X	
Yellow Bullhead (Nonnative)	X	
Black Bullhead (Nonnative)	X	
Sonora Sucker (Native)	X	
Western Mosquitofish (Nonnative)	X	X
Roundtail Chub (Native)	X	
Green Sunfish (Nonnative)	X	X
Smallmouth Bass (Nonnative)	X	X
Desert Sucker (Native)	X	
Rio Grande Sucker (Nonnative)	X	
Fathead Minnow (Nonnative)	X	
Speckled Dace (Native)	X	
Brown Trout (Nonnative)	X	
Flathead Catfish (Nonnative)		X
Red Shiner (Nonnative)		X
Bluegill (Nonnative)		X
Channel Catfish (Nonnative)	X	X

Turkey Creek Inventory, Assessment, Nonnative Removal and Salvage:

From 4 to 6 April 2012, USFWS, NMDGF and USFS surveyed about 4.7 miles of Turkey Creek (Figure 20). From 9 to 11 April 2013, USFWS, NMDGF and USFS surveyed the same section, plus an additional 1.8 miles above the 2012 survey. Nonnative removal was conducted concurrent with both surveys. There is an area of hot springs above and below a small waterfall that likely limits fish movement upstream during base flows (Figure 19). We used the waterfall at the hot springs to delineate between "lower Turkey Creek" and "upper Turkey Creek." The survey of upper Turkey Creek included two tributaries, Brush Canyon (~ 0.2 mi) and Sycamore Canyon (~0.5 mi). Surveys were conducted working upstream with two people dip netting and one person operating the backpack electrofisher. Gila Chub were collected from the confluence with the Gila River up to an elevation of about 1,660 m. In 2012, 412 Gila Chub were captured. In 2013, 209 Gila Chub were captured. In 2012, passive integrated transponder (PIT) tags were implanted in 31 Gila Chub (118 – 280 mm TL), 19 from the lower section and 12 from the upper section. In 2013, 12 Gila Chub (155 – 225 mm TL) were PIT tagged, three from the lower section and nine from the upper section. Additionally in 2013, we recaptured two PIT tagged Gila Chub in the upper reach that were likely fire salvage fish PIT tagged by Southwestern Native Aquatic Resource and Recovery Center (SNARRC). In 2012, fin clip samples were collected from 132 Gila Chub, 88 from the lower section and 44 from the upper section for genetic analysis. In 2013, we collected fin clips from an additional 26 Gila Chub for genetic analysis. Fin clips were delivered to the Museum of Southwestern Biology at the University of New Mexico.

In lower Turkey Creek Gila Chub were collected up to the hot springs just below the waterfall. Water temperature at the collection location closest to the hot springs was 25°C. Some of the Gila Chub captured had tubercles and swollen vents. The smallest Gila Chub collected with tubercles was 121mm (TL).

We found less overall fish density in lower Turkey Creek (0.010 fish/second) than upper Turkey Creek (0.036 fish/second). No nonnative fish were captured in lower Turkey Creek in 2013. These changes are likely due to continued drought and multiple fires in the Turkey Creek watershed. Fires in the Turkey Creek watershed have caused ash flows and increased runoff that transports sediment and debris. Vegetative cover has been reduced in parts of the upper watershed where the fire burned riparian areas along Turkey Creek and its tributaries.

Gila Chub were salvaged in response to the 2011 Miller Fire and the 2012 Whitewater Baldy Fire. In both cases Gila Chub were returned to the creek after the fire. Several canyons in upper Turkey Creek were burned resulting in habitat alteration and ash flows. Despite these changes Gila Chub survived in Turkey Creek and evacuated chub were returned to habitat occupied by remaining Gila Chub.

Turkey Creek contains the sole remnant population of Gila Chub in New Mexico and represents a unique Management Unit identified in the Gila Chub Recovery Plan (USFWS, in preparation). The GRBNFCP identified Turkey Creek as a potential barrier site with the best overall conservation benefit. The hot springs and waterfall are unlikely to act as a barrier at elevated stream flows and they are upstream of occupied Gila Chub habitat. A barrier closer to the mouth of Turkey Creek would be needed to protect the whole Turkey Creek Gila Chub population from nonnative species that are present in the Gila River. The confluence of Turkey Creek and the Gila River is dry at base flows. When flows increase and there is a direct connection there is no barrier to movement of fish from the Gila River into Turkey Creek. Despite this connection with the Gila River, Turkey Creek supports a predominantly native fishery. Green sunfish and Smallmouth Bass are the only nonnatives that were collected in lower Turkey Creek and Rainbow Trout *Oncorhynchus mykiss* the only nonnative present in upper Turkey Creek (Table 5). Additional nonnative piscivorous species that are present in the Gila River and could gain access to Turkey Creek include Channel and Flathead Catfish. Barrier sites have been evaluated by Clarkson and Marsh (2013) and NMDGF contracted Pioneer Technical Services to evaluate two potential sites in the same general area (Pioneer Technical Services, 2013 technical memorandum to J. Wick, NMDGF, on Turkey Creek barrier evaluation). The downstream site is just outside the Wilderness Area boundary and the upstream site just inside the boundary. The downstream site would require a larger structure, but the upstream site would require permission to construct a temporary road and use motorized construction equipment or deliver materials by helicopter.

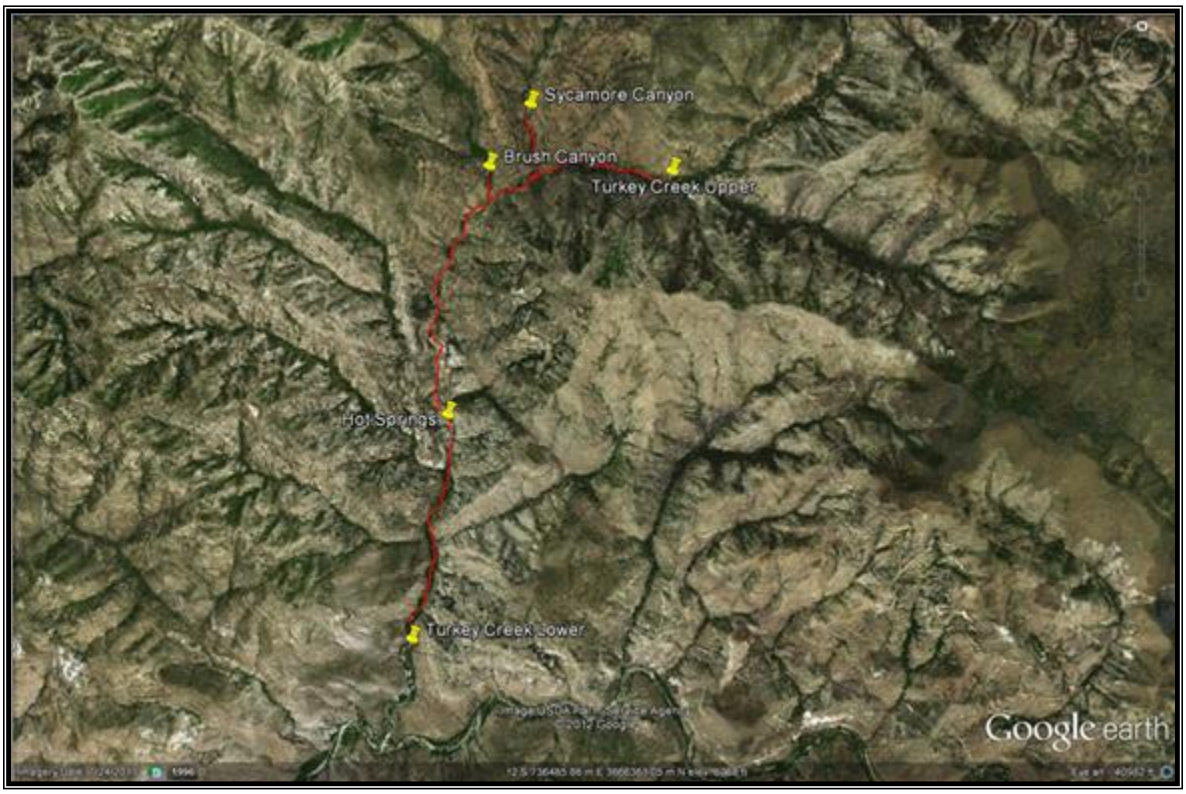

Figure 17. Map of Turkey Creek, New Mexico, and tributaries surveyed in 2012. The 2013 survey included an additional 1.8 miles of Turkey Creek upstream of the 2012 survey.

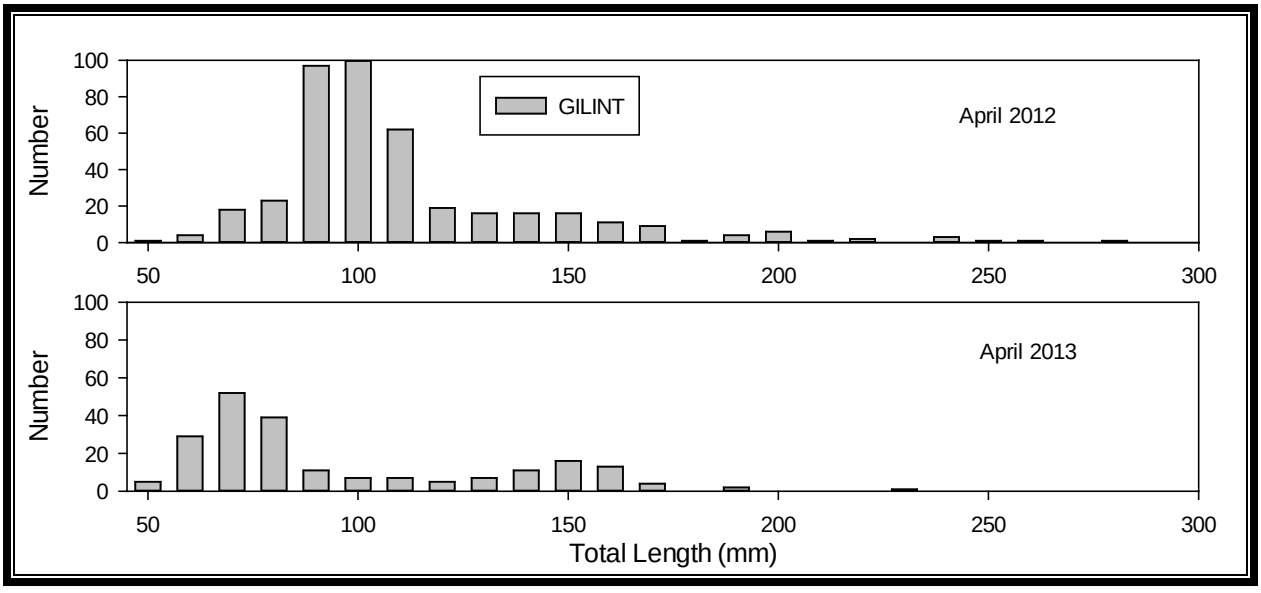

Figure 18. Length-frequency of Gila Chub captured in Turkey Creek, New Mexico.

Table 9. Fish Surveys of Turkey Creek, New Mexico (including Sycamore Canyon). Catch Per Unit Effort (CPUE) is #/second. Size range is total length in millimeters.

Reach	*Species*	*Size 2012*	*# 2012*	*Size 2013*	*# 2013*	*CPUE 2012**	*CPUE 2013***
Upper	Gila Chub	51-258	125	45-194	136	0.007	0.006
	Speckled Dace	31-96	282	25-91	616	0.015	0.029
	Rainbow Trout	107-204	2	109-290	13	<0.001	0.001
Lower	Gila Chub	68-280	287	56-225	73	0.019	0.008
	Longfin Dace	70-82	32	73	1	0.002	<0.001
	Sonora Sucker	87-305	70	132-210	2	0.005	<0.001
	Desert Sucker	72-257	184	65-160	15	0.012	0.002
	Green Sunfish	62-107	5		0	<0.001	0
	Smallmouth Bass	90-117	4		0	<0.001	0

*2012:Shocking time – Lower: 15,286 seconds Upper: 18,926 seconds
**2013:Shocking time - Lower: 8,852 seconds Upper: 21,632 seconds

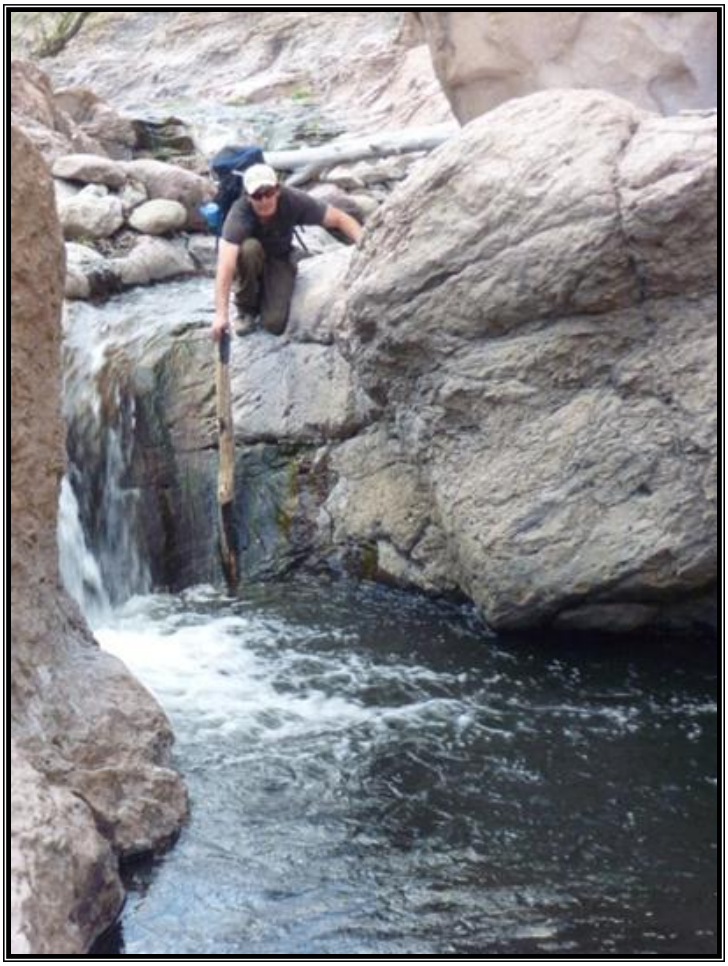

Figure 19. Waterfall at Turkey Creek hot springs, New Mexico.

From 23 to 27 June 2014, USFWS, NMDGF, and USFS surveyed approximately 10.5 kilometers of Turkey Creek (Figure 20). Removal of nonnative Rainbow Trout hybrids was conducted concurrent with the survey. The survey was above the Turkey Creek hot springs waterfall mentioned above (upper Turkey Creek) and overlapped with the upper end of the surveys conducted in 2012 and 2013. Gila Chub were collected in Sycamore Canyon (Figure 21) and the lower half of the surveyed Turkey Creek reach. No fish were found in Manzanita Creek. A total of 203 Gila Chub (CPUE = 0.72/min) were collected representing juveniles to adults. In addition, 191 hybrid trout (CPUE = 0.68/min) were removed, which is the only nonnative species that has been collected in Turkey Creek above the hot springs waterfall. Most of the trout (78%) were young of year.

From 2-4 June 2015, NMDGF, USFWS, and USFS surveyed and conducted nonnative removal on the entire perennial reach of Sycamore Canyon, Miller Spring Canyon, and Turkey Creek above Sycamore Canyon. One trout (CPUE = 0.01/min), 198 Speckled Dace, and 48 Gila Chub (CPUE = 0.69/min) were collected in Sycamore Canyon. Gila Chub ranged from 62-230 mm TL. Only Speckled Dace were collected in Miller Spring Canyon. Fish numbers in Turkey Creek were lower than 2014. Only 13 Gila Chub (CPUE = 0.12/min) were collected in Turkey Creek ranging from 138-240 mm TL. Likewise, hybrid trout numbers were much lower as well, with 15 (CPUE = 0.14/min) collected in the first pass. The removed trout in 2015 did not include any young of year (156-279 mm TL). An additional pass of the highest concentration section resulted in the removal of two additional trout in the same size range.

The results from 2014 and 2015, although funded by an alternate source, are included to provide project reporting continuity going forward. Skeleton Canyon remains to be surveyed for completion of the Turkey Creek inventory and nonnative removal task.

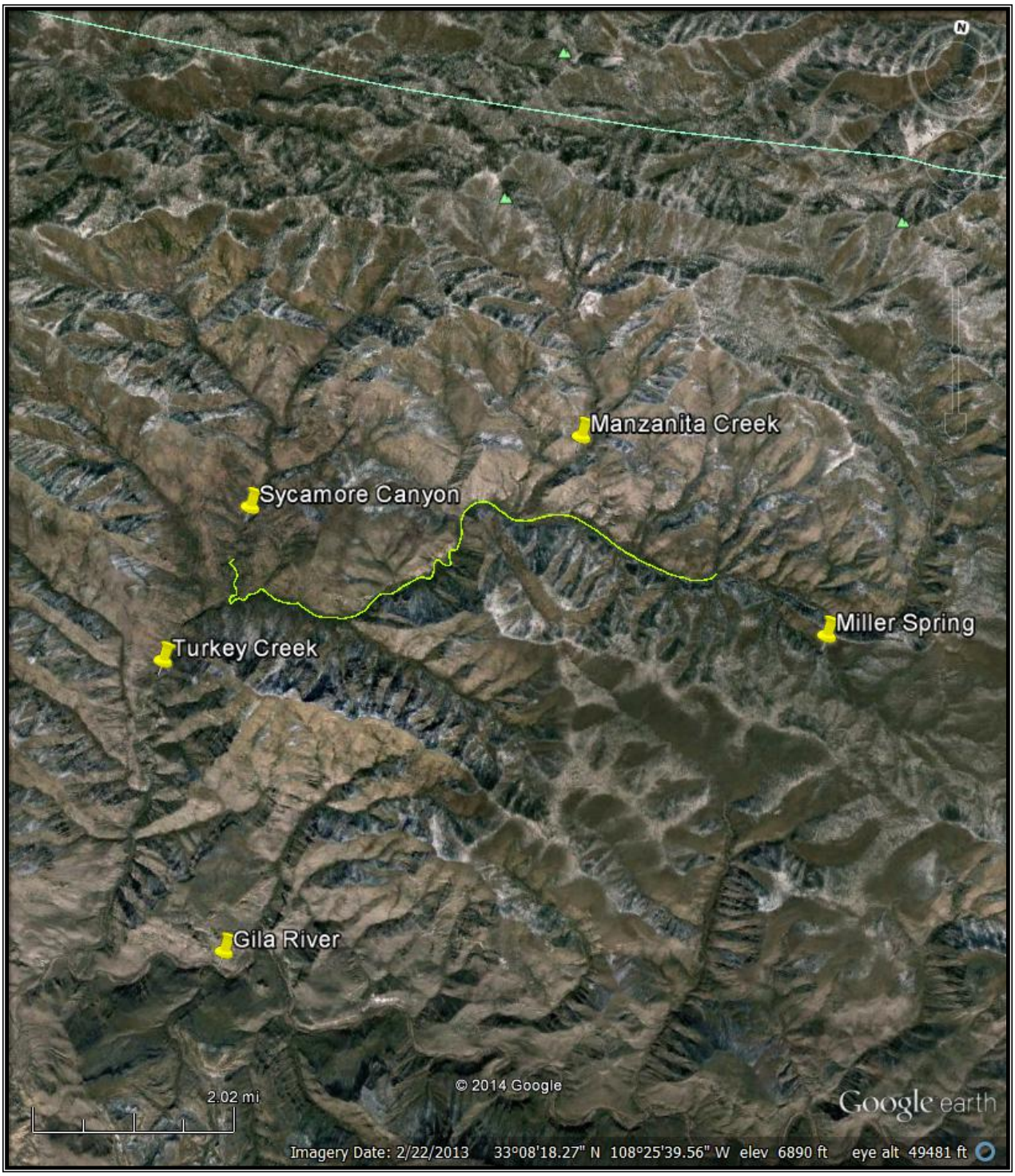

Figure 20. Map of Turkey Creek, New Mexico, and tributaries surveyed in 2014 and 2015.

Figure 21. Gila Chub survey reach of Sycamore Canyon, a tributary of Turkey Creek, June 2014.

Collection of Threatened and Endangered Fish for ARCC captive breeding:

The participating agencies collected fish from the West Fork Gila River in the Heart Bar Wildlife Management Area for a health assessment in April 2011. No significant reportable pathogens were detected by the fish health unit at SNARRC. Subsequently, 148 Spikedace and 434 Loach Minnow were collected and transported to ARCC in Arizona in June 2011. These fish and their offspring will be used for future repatriation efforts.

Spikedace and Loach Minnow Fire Evacuation

In June 2012, the Whitewater Baldy Fire burned in the upper Gila River and San Francisco River watersheds. In anticipation of severe ash and debris flows, Spikedace and Loach Minnow from the West Fork Gila River were evacuated on 15 June 2012. NMDGF and USFWS collected 66 Loach Minnow and 60 Spikedace at the Heart Bar Wildlife Management Area and transferred them to SNARRC for holding. On 10 July, after the first ash flows in West Fork Gila, a second trip was made and 210 Spikedace and 53 Loach Minnow were collected and taken to SNARRC (Figure 22). NMDGF and SNARRC returned 100 Loach Minnow and 239 Spikedace to the West Fork Gila River on 20 June 2013.

On 26 June 2012, NMDGF, USFWS and USFS collected 48 Loach Minnow from the San Francisco River at the Glenwood Ranger Station, which were transported to SNARRC. Loach Minnow from the San Francisco were subsequently transferred from SNARRC to ARCC in summer 2013. The San Francisco River Loach Minnow population had not been represented in captivity and ARCC established a captive breeding population from those that were collected.

Figure 22. Salvaging Spikedace and Loach Minnow from the West Fork Gila River, New Mexico, after the Whitewater-Baldy Fire.

Nonnative Control (RPA 4)

West Fork Gila River:

New Mexico Department of Game and Fish has been conducting annual nonnative fish removal in the West Fork Gila River at the Heart Bar Wildlife Management Area (Heart Bar) since 2006. Each June NMDGF, USFWS and USFS jointly conduct a comprehensive fish survey including removal of nonnative species and enumeration and measurement of native species by habitat from the Little Creek confluence upstream to the NM 15 bridge. The first four years of the effort (2006 - 2009) were evaluated and although the effects of all the variables could not be accounted for (e.g., flow regimes, fine sediment excavation, or unknown factors) the results were positive (see project report submitted in 2009). The GRBNFCP decided to continue the effort based on a demonstrated reduction in piscivorous predators.

The June surveys consisted of single pass electrofishing, seining, and a combination, depending on the most suitable method for each habitat. Fish were collected by habitat type to allow for fish density to be calculated per habitat unit. Morphometric data for all species were collected; native fish were returned to the stream and nonnative fish and bullfrogs were removed. Each habitat was identified by type (pool, run, riffle, glide or shoal) and length, width, depth, substrate and embeddedness was collected for each habitat. Data for the entire project duration are presented here to provide context for the years that were funded under this 5 year agreement (Table 2, Figure 11).

Ash flows as a result of the Whitewater Baldy Fire in 2012 affected habitat present during the 2013 removal by depositing fine sediments and ash, thus decreasing depth and size of pools and

embedding cobble. This was followed by flooding in September 2013 (28,000 cfs at Gila, NM gage) that reconfigured the channel in parts of the removal reach resulting in floodplain avulsion and removal of large amounts of riparian vegetation. In 2015 rather than conduct a second pass of the removal reach, where we had found few nonnative fish, we continued the removal upstream of the NM Hwy 15 bridge although still on the Heart Bar Wildlife Management Area.

Table 10. Number of individuals and relative abundance (%) by year of native and nonnative fishes captured during June in West Fork Gila River Heart Bar reach, New Mexico, 2007-2015. Unidentified larval suckers are not included here.

Species	2007		2008		2009		2010		2011		2012		2013		2014		2015	
	#	*Rel. Ab.*	#	*Rel. Ab.*	#	*Rel. Ab.*	#	*Rel. Ab.*	#	*Rel. Ab.*	#	*Rel. Ab.*	#	*Rel. Ab.*	#	*Rel. Ab.*	#	*Rel. Ab.*
Native	945	81.0	1,361	92.4	11,449	94.1	2,256	96.6	6,887	95.9	2,619	93.3	2,840	98.4	5,152	99.9	11,233	99.5
Longfin Dace	115	9.9	207	14.1	3,444	28.3	712	30.5	2,000	27.8	675	24.1	625	21.6	3,652	70.8	6,712	59.5
Headwater Chub	38	3.3	46	3.1	518	4.3	90	3.9	108	1.5	18	0.6	16	0.6	9	0.2	4	0.0
Spikedace	0	0.0	27	1.8	103	0.8	84	3.6	1,023	14.2	138	4.9	29	1.0	64	1.2	396	3.5
Speckled Dace	17	1.5	59	4.0	566	4.6	153	6.5	1,063	14.8	237	8.4	393	13.6	520	10.1	655	5.8
Loach Minnow	1	0.1	8	0.5	50	0.4	6	0.3	99	1.4	20	0.7	89	3.1	243	4.7	706	6.3
Sonora Sucker	511	43.8	641	43.5	5,328	43.8	1,002	42.9	1,654	23.0	1,231	43.9	1,372	47.5	389	7.5	1,804	16.0
Desert Sucker	263	22.6	360	24.4	1,427	11.7	208	8.9	939	13.1	296	10.5	316	10.9	270	5.2	953	8.4
Gila Trout	0	0.0	13	0.9	13	0.1	1	0.0	1	0.0	4	0.1	0	0.0	5	0.1	3	0.0
Nonnative	221	19.0	112	7.6	724	5.9	80	3.4	297	4.1	187	6.7	47	1.6	7	0.1	53	0.5
Red Shiner	0	0.0	0	0.0	0	0.0	2	0.1	1	0.0	2	0.1	0	0.0	0	0.0	0	0.0
Fathead Minnow	0	0.0	1	0.1	0	0.0	19	0.8	62	0.9	45	1.6	1	0.0	1	0.0	2	0.0
Bullheads	97	8.3	30	2.0	281	2.3	41	1.8	150	2.1	17	0.6	20	0.7	6	0.1	23	0.2
Flathead Catfish	0	0.0	0	0.0	1	0.0	0	0.0	1	0.0	11	0.4	9	0.3	0	0.0	0	0.0
Rainbow Trout	48	4.1	14	1.0	47	0.4	0	0.0	28	0.4	1	0.0	0	0.0	0	0.0	3	0.0
Brown Trout	36	3.1	62	4.2	361	3.0	11	0.5	9	0.1	6	0.2	0	0.0	0	0.0	0	0.0
Western Mosquitofish	15	1.3	0	0.0	4	0.0	0	0.0	6	0.1	90	3.2	11	0.4	0	0.0	24	0.2
Green Sunfish	1	0.1	0	0.0	1	0.0	5	0.2	3	0.0	13	0.4	0	0.0	0	0.0	0	0.0
Smallmouth Bass	24	2.1	5	0.3	29	0.2	2	0.1	37	0.5	2	0.1	0	0.0	0	0.0	0	0.0
Common Carp	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	0.1	6	0.2	0	0.0	1	0.0

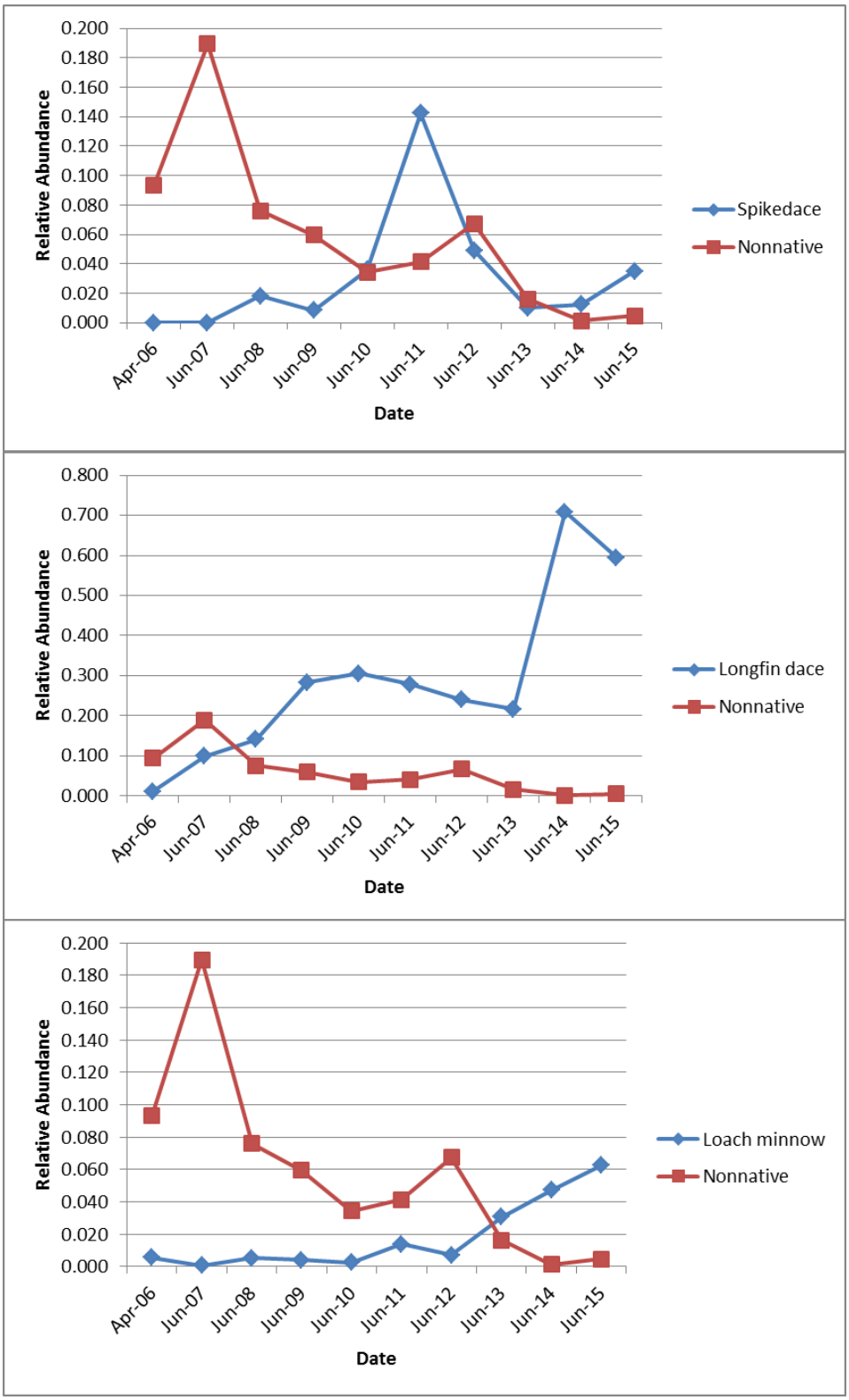

Figure 23. Relative abundance of three minnow species in relation to relative abundance of all nonnative fishes captured in Heart Bar reach of West Fork Gila River, New Mexico. The remainder of the total proportion is made up of native fishes.

Little Creek:

The GRBNFCP initiated nonnative fish removal in Little Creek with the intent of removing Brown Trout to restore Loach Minnow and Headwater Chub *Gila nigra*. The original protocol was for three passes with a backpack electrofisher three times per year, however Little Creek proved to be a difficult stream to work in and each pass of the eight kilometer removal reach took 2 to 3 days (Figure 24). A total of five nonnative removal trips were completed during the reporting period (Table 11). Some of these trips included multiple passes of portions of Little Creek.

Native species found in Little Creek included Longfin Dace, Speckled Dace, Desert Sucker, Sonora Sucker, and Gila Trout. Nonnative species in Little Creek were Rainbow Trout and Brown Trout as well as occasional Smallmouth Bass and Bullhead *Ameiurus spp.* (Table 12). In July 2013 the 78 Brown Trout removed ranged from 68-330 mm TL with a mean of 178. In October 2013 the 83 Brown Trout removed ranged from 93-381 mm TL with a mean of 182. The CPUE and number of Brown Trout per kilometer was not significantly different between the two trips (Figure 25). The size of Brown Trout (Figure 26 and Figure 27) suggests the trout removed in October were from the same cohort and were missed in July. There is also no ingress of Brown Trout to the removal reach because there is a barrier upstream and a warm water reach below. Based on our experience in Little Creek, mechanical removal was inefficient due to the complexity of instream habitat, including an abundance of deeply undercut banks and instream boulder fields. These conditions may preclude the restoration of Headwater Chub, but between kilometer 1 and 5 (as shown in Figure 24) there were few trout and an abundance of cobble riffles that were appropriate Loach Minnow habitat. Loach Minnow repatriation into Little Creek began in 2014 with additional fish stocked in 2015 (see repatriation section of this report). A fish barrier at the downstream end of Little Creek would allow Headwater Chub to be repatriated after piscicide renovation of the stream.

Figure 24. Aerial photograph of Little Creek, New Mexico, showing nonnative removal reach.

Table 11. Number and catch rates (CPUE in fish/minute electrofishing) of nonnative fishes captured in Little Creek, New Mexico.

Trip	*Brown Trout*	*Rainbow Trout*	*NN CPUE*	*NN/km*
Jun-Jul 2010	201	2	0.312	33.7
Jun 2011	92	34	0.466	22.9
Jun 2012	479	0	0.771	79.8
Aug 2012	166	1	0.573	27.8
Apr 2013	30	1	0.125	5.3
Jun 2013	12	0	0.377	N/A*

* Partial pass of nonnative removal reach

Table 12. Number and catch rates (CPUE in fish/minute electrofishing) of nonnative trout captured in Little Creek, New Mexico.

Trip	*Brown Trout*	*Rainbow Trout*	*NN CPUE*	*NN/km*
Jun-Jul 2010	201	2	0.312	33.7
Jun 2011	92	34	0.466	22.9
Jun 2012	479	0	0.771	79.8
Aug 2012	166	1	0.573	27.8
Apr 2013	30	1	0.125	5.3
Jun 2013	12	0	0.377	N/A*
Jul 2013	78	0	0.391	9.8
Oct 2013	83	0	0.360	10.4

* Partial pass of nonnative removal reach

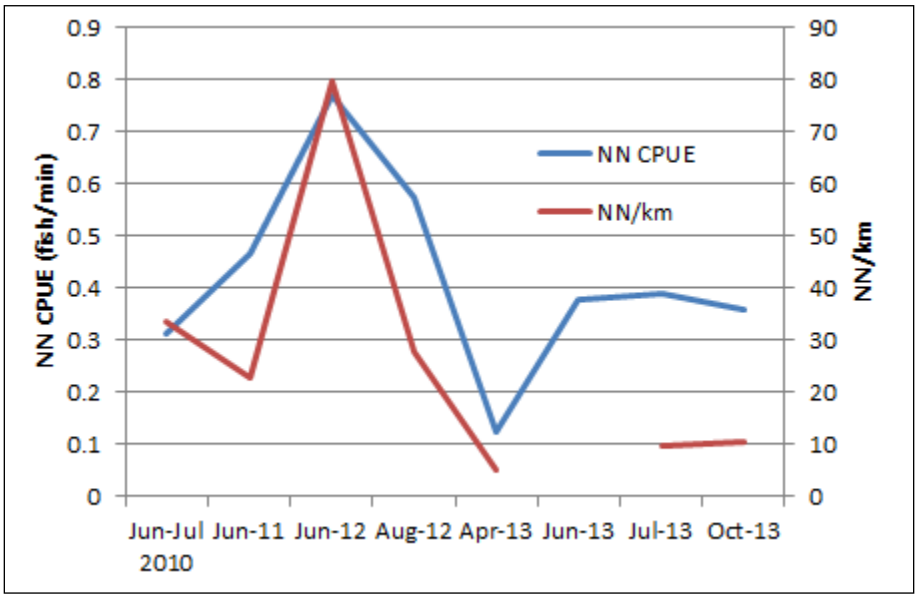

Figure 25. CPUE of trout and trout per kilometer removed from Little Creek, NM since 2010.

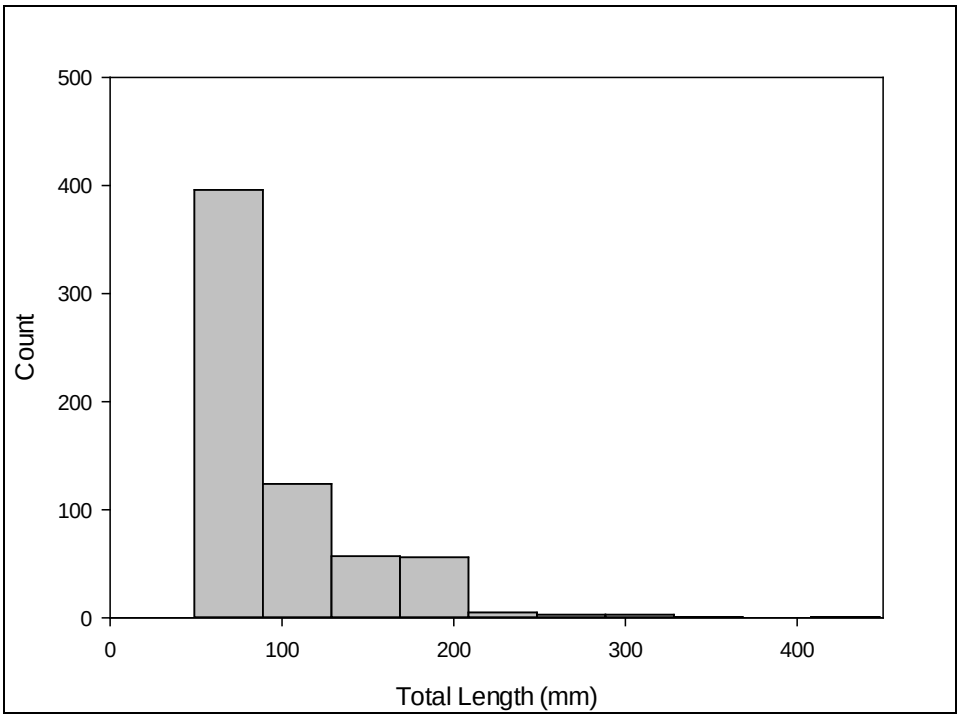

Figure 26. Length frequency histogram of Brown Trout removed from Little Creek, NM in 2012.

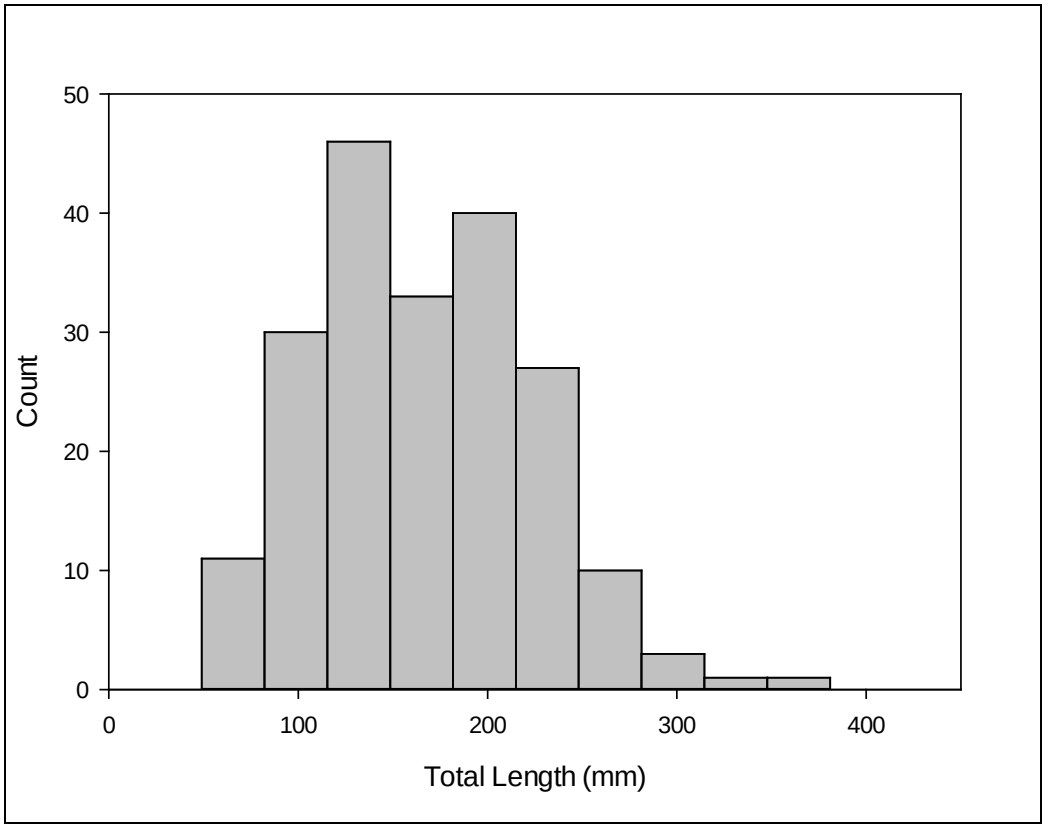

Figure 27. Length frequency histogram of Brown Trout removed from Little Creek, NM in 2013.

Literature Cited:

Childs, M. 2005. Bubbling Ponds Hatchery development for native fishes: protocol for collection, transport, quarantine, maintenance, propagation and repatriation of native fish species. Final Report submitted to U.S. Bureau of Reclamation, Phoenix Area Office, Federal Grant No. 04-FG-32-0310. Arizona Game and Fish Department, Phoenix.

Clarkson R.W., P.C. Marsh. 2013. Preliminary Investigation of Potential Fish Barrier Sites on Middle Fork Gila River and West Fork Gila River, New Mexico, With Notes on the Alma Diversion Dam on San Francisco River and a Summary of All New Mexico Streams Evaluated to Date.

Propst D.L., K.B. Gido, J.E. Whitney, E.I. Gilbert, T.J. Pilger, A.M. Monié, Y.M. Paroz, J.M. Wick, J.A. Monzingo, D.M. Myers. 2015. Efficacy of Mechanically Removing Nonnative Predators from a Desert Stream. River Research and Applications. Vol. 31:692-703.

USFS. 2014. Record of Decision for Travel Management, Gila National Forest. Southwestern Region. Publication No. MB-R3-06-08. May 2014.

USFWS. 2012. Endangered Status and Designations of Critical Habitat for Spikedace and Loach Minnow. Federal Register 77:36(23 Feb 2012): 10809 -10932

Appendix A:

Gila River Basin Native Fishes Conservation Program

New Mexico Repatriation Plan

2016

Introduction:

The repatriation efforts discussed here are funded via U.S. Bureau of Reclamation Central Arizona Project (CAP) funds through the Gila River Basin Native Fishes Conservation Program, which are distributed to U.S. Forest Service, U.S. Fish and Wildlife Service, and New Mexico Department of Game and Fish (NMDGF; Department). These agencies perform the repatriation activities cooperatively. Additionally, Arizona Game and Fish Department's Aquatic Research and Conservation Center (ARCC) receives CAP funding to hold and culture these species. Repatriation activities are currently performed for four species native to the Gila Basin; Loach Minnow, Spikedace, Gila Chub, and Gila Topminnow.

Spikedace (*Meda fulgida*): Spikedace was federally listed as threatened in 1986 (51 FR 23769) and uplisted to endangered in 2014 (77 FR 10810-10932). It is listed as endangered under the New Mexico Wildlife Conservation Act. Spikedace historically occurred in warmwater habitats throughout the Gila basin in New Mexico. It was documented as occurring near Frisco Hot Springs (Minckley 1973) but has not been collected in the San Francisco drainage for over 50 years. Spikedace declined due to loss of habitat and introduction of nonnative species. More recently it has experienced declines related to catastrophic fire in the Gila Basin. It is currently extant in New Mexico from the lower reaches of each fork of the Gila River to the Arizona Border. Its distribution is discontinuous with the highest densities found in the forks and Cliff-Gila Valley (i.e. between the Upper Gila Box and Middle Gila Box). ARCC currently houses a Gila River forks breeding group and a Mainstem Gila River breeding group. These two groups are genetically divergent, but part of the same population (Pilger and Turner 2012). For this reason a repatriation stream may receive fish from both groups.

Loach Minnow (*Tiaroga cobitis*): Loach Minnow was federally listed as threatened in 1986 (51 FR 39468) and uplisted to endangered in 2014 (77 FR 10810-10932). It is listed as endangered under the New Mexico Wildlife Conservation Act. It currently occurs in New Mexico in the San Francisco River including tributaries and the Gila River including tributaries. In the Gila, where populations were impacted, but not extirpated by Whitewater Baldy Fire effects, densities have rebounded. This is likely due to the creation of clean loose cobble riffles from post fire flooding. In the San Francisco, Loach Minnow appear to have been extirpated by Whitewater Baldy Fire effects downstream of Reserve, NM. Offspring of salvaged fish were used to recolonize the San Francisco near Glenwood. ARCC currently houses a Gila River forks breeding group and a Mainstem Gila River breeding group. These two groups have a genetic structure similar to Spikedace (Pilger and Turner 2012).

Gila Chub (*Gila intermedia*): Gila Chub was federally listed as endangered in 2005 (70 FR 66664-66721). It is listed as endangered under the New Mexico Wildlife Conservation Act. Gila Chub is a member of the Roundtail Chub complex, which includes the closely related Headwater and Roundtail chubs. Gila Chub was historically found throughout the Gila River Basin in New Mexico. It is currently limited to Turkey Creek and Mule Creek (a current repatriation project). The Turkey Creek population does not fall clearly into one of the recognized species of the Roundtail Chub complex genetically or morphologically, but appears to overlap among species (Dowling 2004 and 2012, Brandenburg et. al. 2015). It is included in the Gila Chub listing and is being treated as Gila Chub by the Gila Chub Recovery Team. For these reasons it is regarded as Gila Chub in this document. Turkey Creek chubs are not currently replicated in the wild or in captivity. ARCC

currently serves as a quarantine facility for Gila Chub being transferred from Harden Cienega in Arizona to New Mexico for the Mule Creek repatriation. Development of a breeding population at ARCC may increase the number of Gila Chub repatriation streams that could be stocked concurrently.

Gila Topminnow (*Poeciliopsis occidentalis occidentalis*): Gila Topminnow was federally listed as endangered in 1967 (32 FR 4001). It is listed as threatened under the New Mexico Wildlife Conservation Act. Once considered one of the most common species of the lower Colorado River Basin, loss of habitat and interaction with non-native species have contributed to declines. It was extirpated from New Mexico before a repatriated population was established at Burro Cienega in the Lordsburg endorheic sub-basin of the Gila Basin. Gila Topminnow repatriation has been accomplished using direct transfers from Arizona to New Mexico. Attempts to create a refuge population at NMDGF's Redrock Pond have been unsuccessful.

Methods:

This section is an overview of standard methods for repatriation (Figure 1). The specific situation for each repatriation will vary and adjustments to these methods need to be considered on a case by case basis. These methods follow Childs (2005).

Evaluating: NMDGF and partners are continuously working to identify streams that could support populations of threatened or endangered fish species (Table 1). To do this, NMDGF identifies potential streams based on maps, aerial photographs, historic fish records, and on the ground fish and habitat surveys. The next step in evaluating locations is to communicate with people within NMDGF and at other agencies that may be familiar with the site to gather additional information about other threatened and endangered plants and animals that may occur, grazing practices, persistence of perennial water during historic droughts, and any other information that can help determine the suitability of the location for repatriation.

Planning: Once potential streams are identified a series of thorough surveys are done to ensure that there is no remnant population extant in the stream, no nonnative species are present that pose a threat, and quality habitat is present. An ESA Section 7 consultation is completed to identify and evaluate any risks to threatened and endangered species. This is usually an intraservice consultation coordinated between the USFWS Federal Aid and Ecological Services offices. For a Section 7 consultation to be done, the method of stocking, source of fish, and fish health issues need to be addressed. Additional compliance may be necessary if the stream needs to be renovated and/or have a barrier installed. It may also be important to consider other ongoing management actions in the area and additional requirements for wilderness and other special management areas.

The ideal source of stocking is often the nearest geographic neighbor in the same drainage basin. In most situations the nearest neighbor is considered the most similar genetically because proximity increases the probability that historic populations would have exchanged genetic material. Presumably, the nearest neighbor is best adapted to environmental conditions in the area as well. Quarantine of source fish may be necessary depending on differences in pathogens found at the source and stocking locations. The quarantine procedure follows that described in Childs (2005).

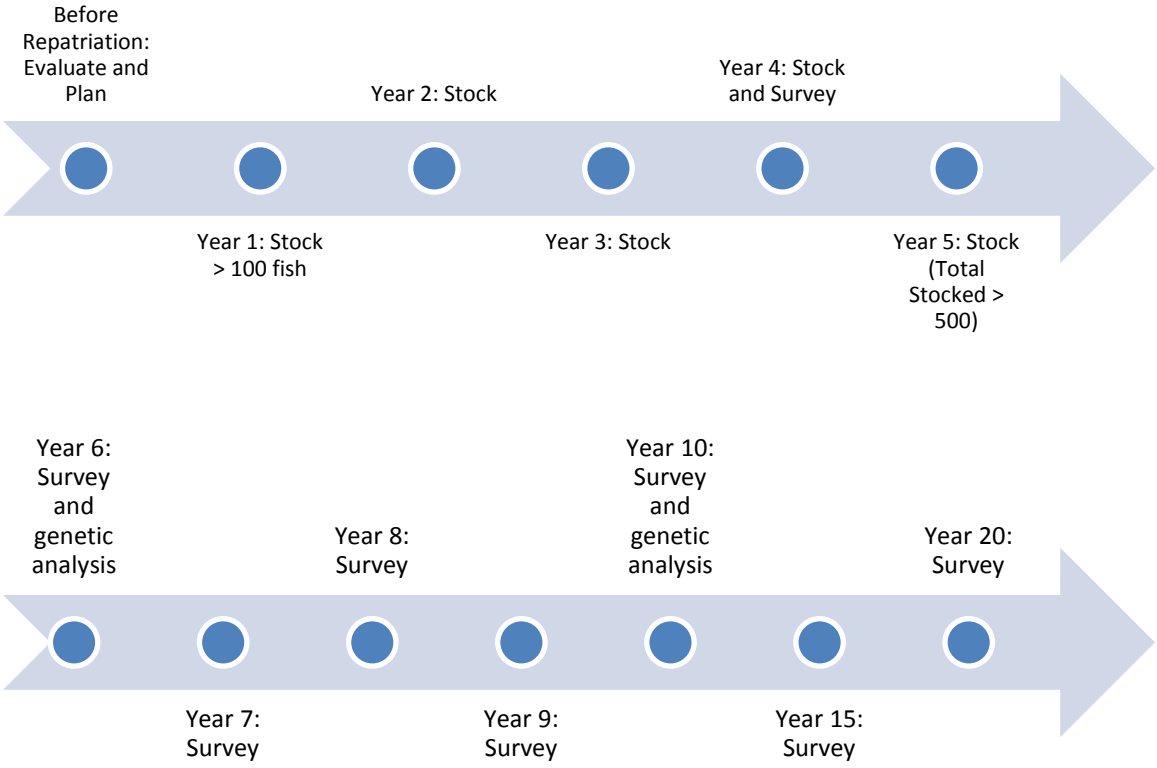

Figure 1. Generic timeline for standard repatriation projects.

Table 1. Repatriation projects in the Gila River Basin.

Species	Location	Action	Current Stage*
Spikedace	San Francisco River	Establish New Population	Stocking
Spikedace	Gila River	Maintain ARCC broodstock	Collect as needed
Loach Minnow	San Francisco River	Establish New Population	Stocking
Loach Minnow	Saliz Canyon	Establish New Population	Stocking
Loach Minnow	Little Creek	Establish New Population	Stocking
Loach Minnow	West Fork Gila River	Maintain ARCC broodstock	Collect as needed
Loach Minnow	Tularosa River	Maintain ARCC broodstock	Planning
Loach Minnow	Pueblo Creek	Establish New Population	Evaluating
Loach Minnow	Frieborn Canyon	Establish New Population	Evaluating
Gila Chub	Mule Creek	Establish New Population	Stocking
Gila Chub	Redrock Cienega	Establish New Population	Stocking
Gila Chub	Pueblo Creek	Establish New Population	Evaluating
Gila Chub	Frieborn Canyon	Establish New Population	Evaluating
Gila Chub	Little Creek	Establish New Population	Evaluating
Gila Chub	Big Dry Canyon	Establish New Population	Evaluating
Gila Topminnow	Redrock Cienega	Establish New Population	Stocking
Gila Topminnow	Burro Cienega	Establish New Population	Monitoring

*Monitoring – Stocking has been completed and population is being surveyed to document changes over time. Surveys are covered under the 10(a)1(A) permit.
Stocking – Project is underway. Any required environmental clearance is complete.
Planning – Initial field reconnaissance has been completed, but project has not been implemented yet. ESA consultation, stream renovation, and barrier construction all fall under planning.
Evaluating – Location has been identified as a possible repatriation/collection site. Field visits are done to determine if the site proceeds to planning stage [conducted under 10(a)1(A) permit].

Stocking: Once the stream is ready for repatriation, fish are stocked for 3-5 consecutive years. The preferred method is translocation from a wild source population. Collection methods employed collect a representative sample of the source population to ensure that the repatriated population does not start with a skewed age or sex ratio. Collections will attempt to include at least 100 fish (50 males and 50 females) without any visible deformities, disease, or infection. If hatchery offspring are used, the initial stocking should be at least 500 F1 progeny. If a year is missed due to reduced source population size or lack of offspring produced at ARCC, the timeline may need to be shifted. If one of five years is missed, but 500 total wild fish are stocked the timeline should not be automatically moved back a year. Timelines presented in this plan are a best case scenario. Best professional judgment should be used to evaluate changes to the schedule. Stocking events should avoid periods of flood flows or high water temperatures.

If fish are collected from the wild the following procedure is used: fish of various age classes (n = 100 to 300 individuals) are collected using drag seines, minnow traps, and/or electrofishing; transported in aerated containers in treated (salt, stresscoat, or MS222) river water; transported via truck, ATV, stock or helicopter; and stocked. Fish collection occurs in autumn and fish are stocked within 12 hours of capture unless a quarantine procedure is necessary. In that case, the quarantine procedure outlined in Childs (2005) is implemented. Fish condition, water temperature, and oxygen

level are checked every two hours while in transport. Temperature acclimation is necessary before stocking if water temperatures differ by more than 3°C.

Monitoring: Monitoring surveys of repatriation sites start after three years of stocking has been completed. After 3-5 years of stocking, post-stocking surveys are conducted every autumn for five years. Post repatriation surveys should consist of a minimum of three 100-200 m sites. These sites should be at the stocking site, upstream, and downstream within the reach that the repatriation species is expected to colonize. Survey methods may vary, but should be appropriate to the habitat (e.g. backpack electrofishing, seining, etc.). Genetic monitoring should be performed every five years to evaluate the need for genetic augmentation to counter any founder effects. It should be noted that additional augmentation to repatriated populations is not covered under previous ESA Section 7 consultations, but should be included in future consultations. Up to 10 fin clips from each site (stocking site, upstream and downstream = 30 fin clips total) should be collected for genetic testing during post repatriation surveys. Survey sites should be added as needed to encompass expanded distributions of repatriated populations. After the initial five years of post-stocking surveys the site should be surveyed at a minimum of five year intervals, after a stochastic environmental event (i.e., flood or fire) or as often as best professional judgment dictates.

Gila River Basin Native Fish Repatriation Projects

Spikedace (*Meda fulgida*)

Spikedace were first stocked in the San Francisco River upstream of Alma in 2008 (Figures 2 and 3). Stocking also occurred in 2009 and 2010 (Table 2). The effects of the Whitewater Baldy Fire in 2012 apparently reset the stocking effort, as no Spikedace was found at the site in the spring of 2014. Repatriation efforts were reinitiated in autumn 2014.

Two sources of Spikedace are approved in the ESA Section 7 consultation (completed in 2008, revised in 2014 for T-53 funding), directly from the Gila River or from the Gila River population at ARCC. If the population can support it, Spikedace from the Gila River can be collected simultaneously to augment broodstock at ARCC. Fish are transported from Highway 180 to the San Francisco River in coolers with oxygen strapped to ATVs. The ATV route to the stocking location requires the use of ramps to descend a bedrock drop in the arroyo. A safer option is to visit the site ahead of time to create an earthen ramp using sand and gravel from the arroyo streambed.

The original plan called for stocking in autumn for at least 3 years, and possibly 5 years, to ensure stocking and survival of a sufficient number of individuals to maintain genetic diversity and reduce founder effect on genetic structure of the restored population. This agrees with the standard repatriation protocol in the Methods section. Post-repatriation monitoring of this population will also follow the steps presented in the Methods section.

Figure 2. San Francisco River stocking location upstream of Alma, NM.

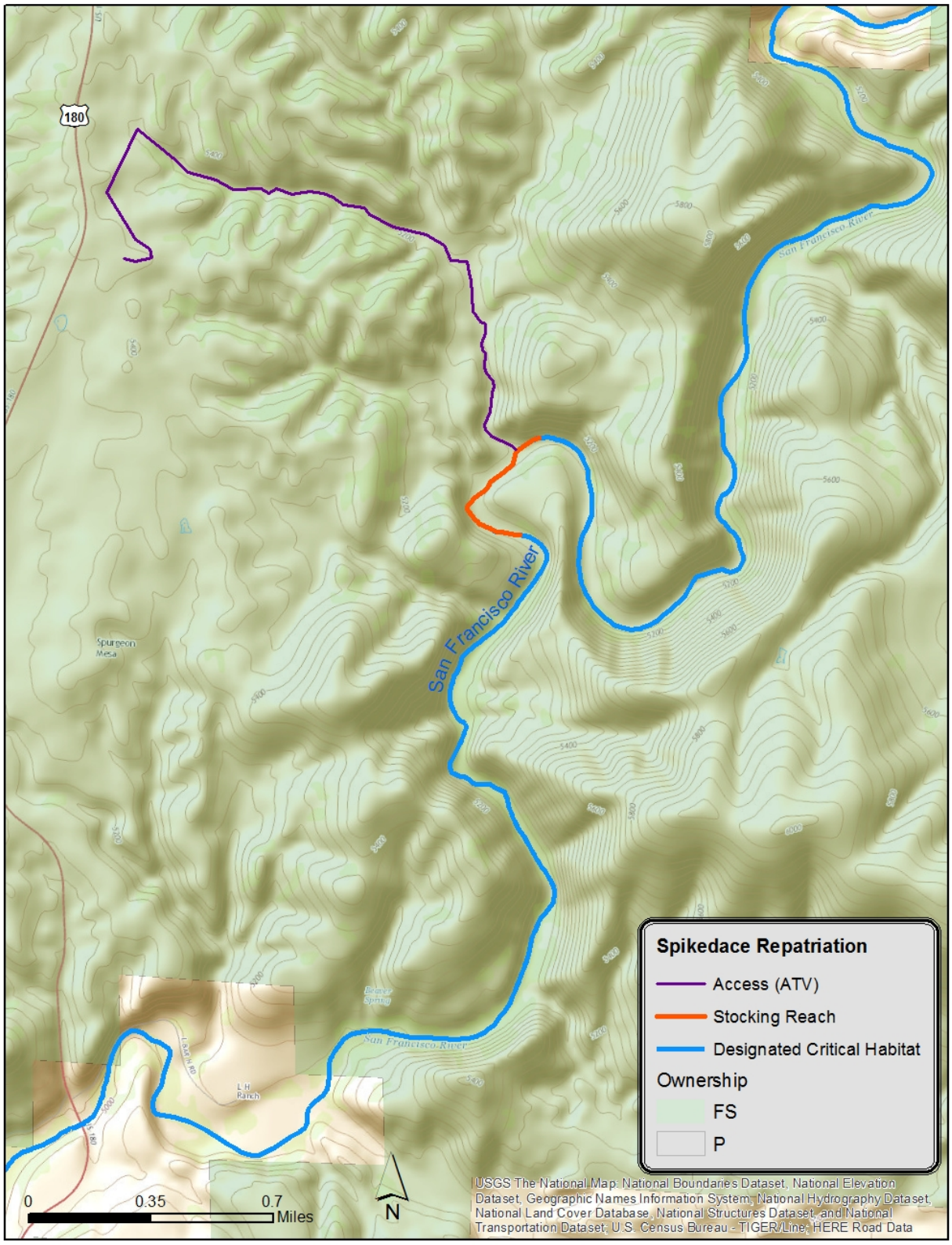

Figure 3. Location of Spikedace repatriation in the San Francisco River, NM.

Table 2. Previous Spikedace stocking in the San Francisco upstream of Alma.

Date	Number	Source
Sept 2008	350	ARCC
21 Oct 2009	150	Gila Bird Area
Oct 2010	4,000	ARCC
29 Oct 2014	1,317	ARCC
2015	N/A	No ARCC production / Gila population depressed
Autumn 2016-2018	TBD	ARCC or Gila Bird Area

Loach Minnow (*Tiaroga cobitis*)

A 2014 ESA Section 7 consultation covered stocking the offspring of Loach Minnow salvaged from the San Francisco River near Glenwood back into the same reach. The same consultation covers stocking Saliz Canyon and Little Creek for five consecutive years. The beginning and ending dates are not specified, but are based on the year of initial stocking.

Saliz Canyon:
Saliz Canyon is a tributary to the San Francisco River. The San Francisco River at its confluence with Saliz Canyon is designated critical habitat for Loach Minnow (Figure 4). Saliz Canyon is ephemeral at the confluence, but there is approximately seven miles of perennial water upstream. USFWS and NMDGF proposed to stock up to 300 San Francisco River Loach Minnow into Saliz Canyon in the first year and then stock the stream in five consecutive years (Table 3). Saliz Canyon was selected as a Loach Minnow repatriation site because, as a tributary, it is protected from impacts in the mainstem San Francisco River (e.g. post-fire ash flows). Although the creek is normally dry between the proposed Loach Minnow repatriation site and the San Francisco River, a Saliz Canyon population could still achieve genetic exchange with the San Francisco River population when flows are sufficient to establish connectivity to the San Francisco River. Stocking will be straightforward because the perennial section has easy access adjacent to U.S. Hwy 180 between Glenwood and Reserve. Monitoring of the repatriated population should begin in 2018 (Table 4).

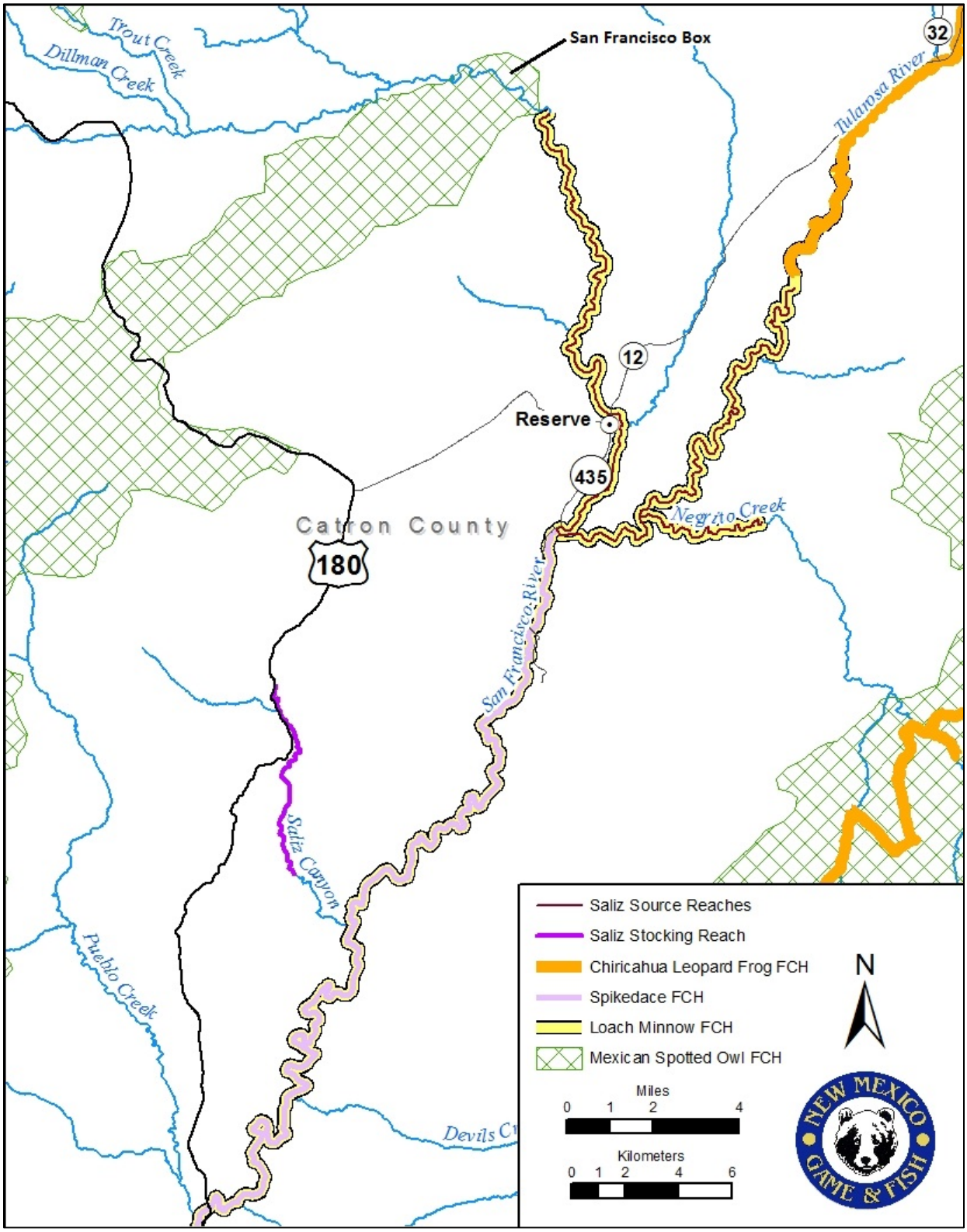

Figure 4. Reaches of Saliz Canyon identified for repatriation of Loach Minnow.

Table 3. Proposed Timeline for repatriation of Loach Minnow into Saliz Canyon.

Date	Planned Number	Source
Autumn 2016	100-300	ARCC or Tularosa River
Autumn 2017	100	ARCC or Tularosa River
Autumn 2018	100	ARCC or Tularosa River
Autumn 2019	100	ARCC or Tularosa River
Autumn 2020	100	ARCC or Tularosa River

Table 4. Proposed Timeline for monitoring of repatriated Loach Minnow in Saliz Canyon

Date	Activity
Autumn 2018	Survey
Autumn 2020	Survey and Genetic Analysis
Autumns 2021 - 2023	Survey
Autumn 2024	Survey and Genetic Analysis
Autumn 2029	Survey

When repatriation of Saliz Canyon was originally conceived there was a healthy population of Loach Minnow in the San Francisco River downstream. The concept was to transfer Loach Minnow from the San Francisco River near Glenwood directly into Saliz Canyon. Individuals from that population were salvaged after the 2012 Whitewater Baldy Fire and moved to ARCC before the population was extirpated by post fire ash flows as a result of the Whitewater Baldy Fire in 2012. The offspring of the salvaged fish were used to repatriate Loach Minnow into the San Francisco River at Glenwood in fall 2014. Loach Minnow from the Tularosa River, a San Francisco River tributary upstream of Saliz Canyon, are being evaluated as a source to supplement the ARCC San Francisco population. Once a source is identified those fish could be transferred directly, or ARCC offspring could be stocked into Saliz Canyon.

Little Creek:

Little Creek is a tributary to the West Fork Gila River. The West Fork Gila River at the confluence of Little Creek is designated critical habitat for Loach Minnow (Figure 5). There is approximately 3 miles of Loach Minnow habitat in Little Creek upstream of its confluence with the West Fork Gila River. The West Fork Gila River and Little Creek are hydrologically connected so introducing novel disease is not a concern. Repatriation stocking in Little Creek began in autumn 2014 and will continue annually through 2018 (Table 5). Monitoring of this population will begin 2017 (Table 6).

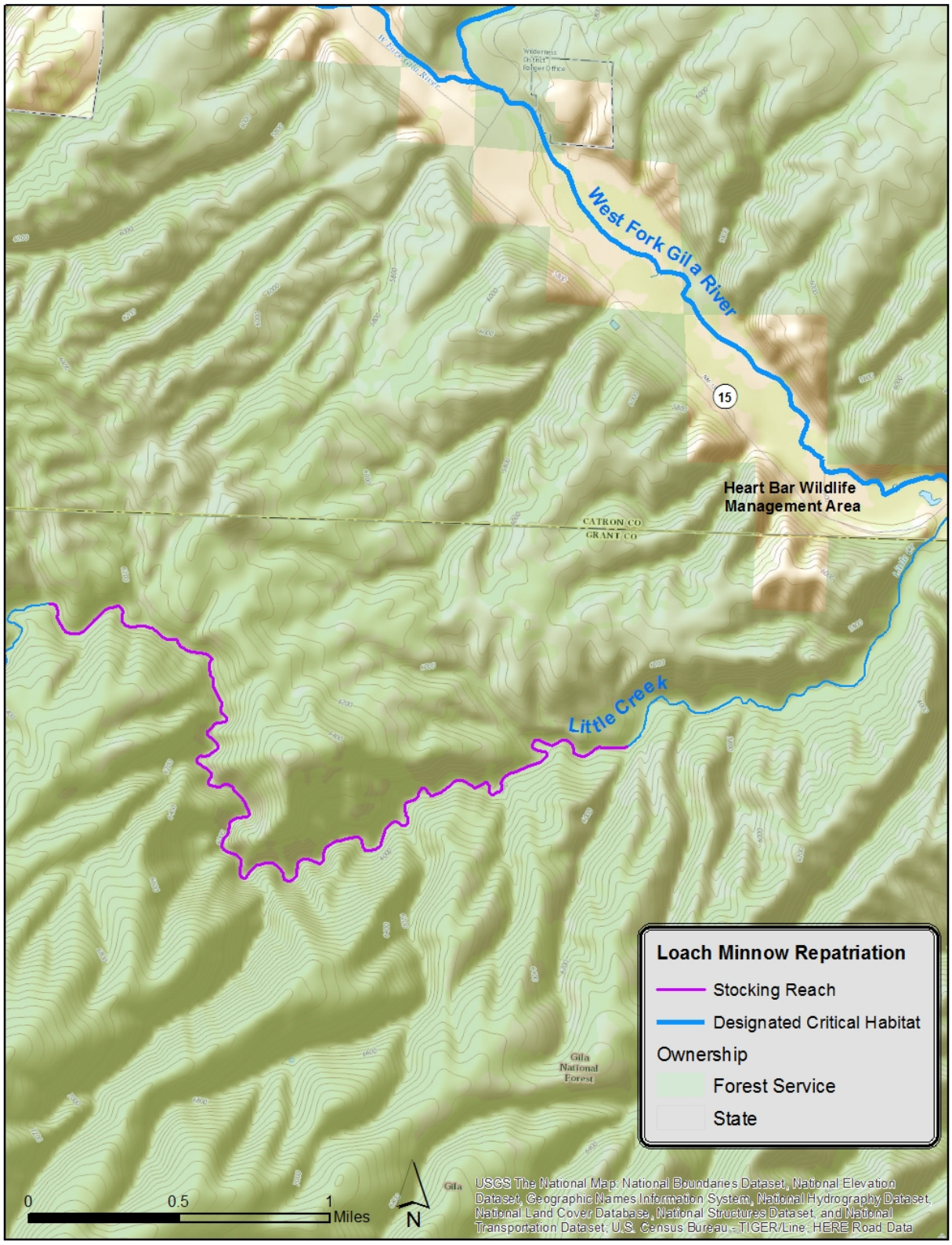

Figure 5. Location of Loach Minnow repatriation in Little Creek, NM.

Table 5. Timeline for repatriation of Loach Minnow into Little Creek.

Date	Number	Source
18 Nov 2014	267	ARCC
3 Sept 2015	62	West Fork Gila River
Autumn 2016	Target - 100	ARCC or WF Gila River
Autumn 2017	Target - 100	ARCC or WF Gila River
Autumn 2018	Target - 100	ARCC or WF Gila River

Table 6. Proposed Timeline for monitoring of repatriated Loach Minnow in Little Creek.

Date	Activity
Autumn 2017	Survey
Autumn 2019	Survey and Genetic Analysis
Autumns 2020 - 2022	Survey
Autumn 2023	Survey and Genetic Analysis
Autumn 2028	Survey

San Francisco River at Glenwood:

The San Francisco River Loach Minnow currently housed at ARCC were salvaged from the San Francisco near Glenwood after the Whitewater Baldy Fire in June 2012. Subsequent surveys suggested that Loach Minnow were extirpated from this reach by post-fire effects. Excellent habitat for Loach Minnow remains (D. Propst field notes, 8 October 2013) and re-establishing Loach Minnow in the Glenwood reach took precedence over establishing the Saliz Canyon population. Stocking of the Glenwood site took place in 2014 (Figure 6, Table 7) with F1 progeny of the salvaged Loach Minnow. ARCC retained approximately two hundred offspring to augment the aging broodstock. The stocking site is also the site of long term annual fish community monitoring which will continue into the future (Table 8).

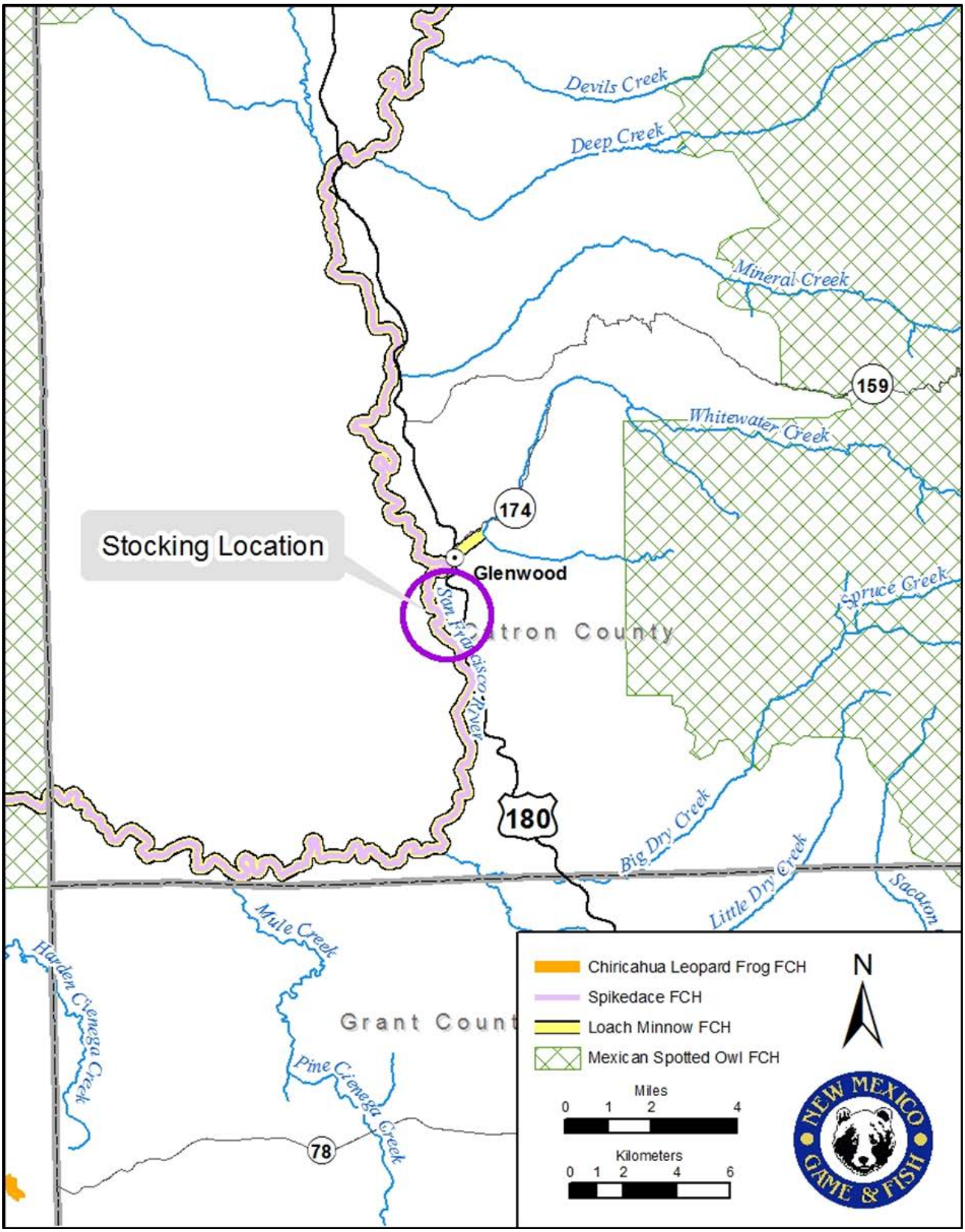

Figure 6. Location of Loach Minnow repatriation in the San Francisco, NM.

Table 7. Timeline for repatriation of Loach Minnow into the San Francisco River.

Date	Number	Source
Autumn 2014	649	ARCC
Autumn 2015	0	N/A
Autumn 2016	Determine if needed	ARCC or Tularosa River
Autumn 2017	Determine if needed	ARCC or Tularosa River
Autumn 2018	Determine if needed	ARCC or Tularosa River

Table 8. Proposed Timeline for monitoring of repatriated Loach Minnow in the San Francisco River.

Date	Activity
Autumn 2016	Survey
Autumn 2017	Survey and Genetic Analysis
Autumns 2018 - 2022	Survey
Autumn 2023	Survey and Genetic Analysis
Autumn 2024	Survey

Future Stream Evaluation:

The streams in Table 9 are prioritized based on estimates of length of perennial water. The streams described below may or may not have habitat and perennial water sufficient to support a population of Loach Minnow, but additional data is needed to complete the evaluation. Frieborn Canyon is also being considered for Gila Chub. If deemed appropriate, repatriation of Loach Minnow into these waterways would proceed in a similar fashion to Saliz Canyon. There would also be a need for additional production of San Francisco and Gila Loach Minnow at ARCC to support additional stocking. This would likely need to be proceeded by establishment of the Tularosa River as a source population for augmentation. Routes for stocking would need to be decided before Section 7 consultation.

Table 9. Proposed priority list of potential Loach Minnow repatriation streams.

Priority	Stream Name	Sub-Basin
1	Frieborn Canyon*	Blue River
2	Rain Creek	Gila River
3	Mogollon Creek	Gila River

*Also being considered for Gila Chub.

Gila Chub (*Gila intermedia*)

Mule Creek:

Mule Creek is a tributary of the San Francisco River upstream of the Arizona border (Figure 7). The Gila Chub Recovery Team identified Harden Cienega and Dix Creek as the best donor populations for Mule Creek. Each year Arizona Game and Fish collects fish from Harden Cienega and holds them at ARCC for a quarantine period of approximately 35 days (personal communication, Matt O'Neill, 24 April 2014). Fish are then transferred to NMDGF for repatriation into Mule Creek. In cooperation with ARCC, 120 Gila Chub were stocked 27 June 2012, 119 on 21 November 2013 and 60 on 13 November 2014. Stocking did not occur in the autumn in 2015 due to weather and helicopter scheduling. A survey of Mule Creek occurred in February 2016 and three nonnative

piscivorous fish species were found in the reach occupied by Gila Chub. Due to this finding stocking should be temporarily suspended while the source of nonnatives is evaluated. The most likely source is the San Francisco River, but waterbodies in the Mule Creek drainage on public and private lands upstream may also be potential sources. Surveys of Mule Creek should continue to verify the persistence of Gila Chub and nonnatives. Thus far, reproduction of Gila Chub has not been conclusively shown in past surveys.

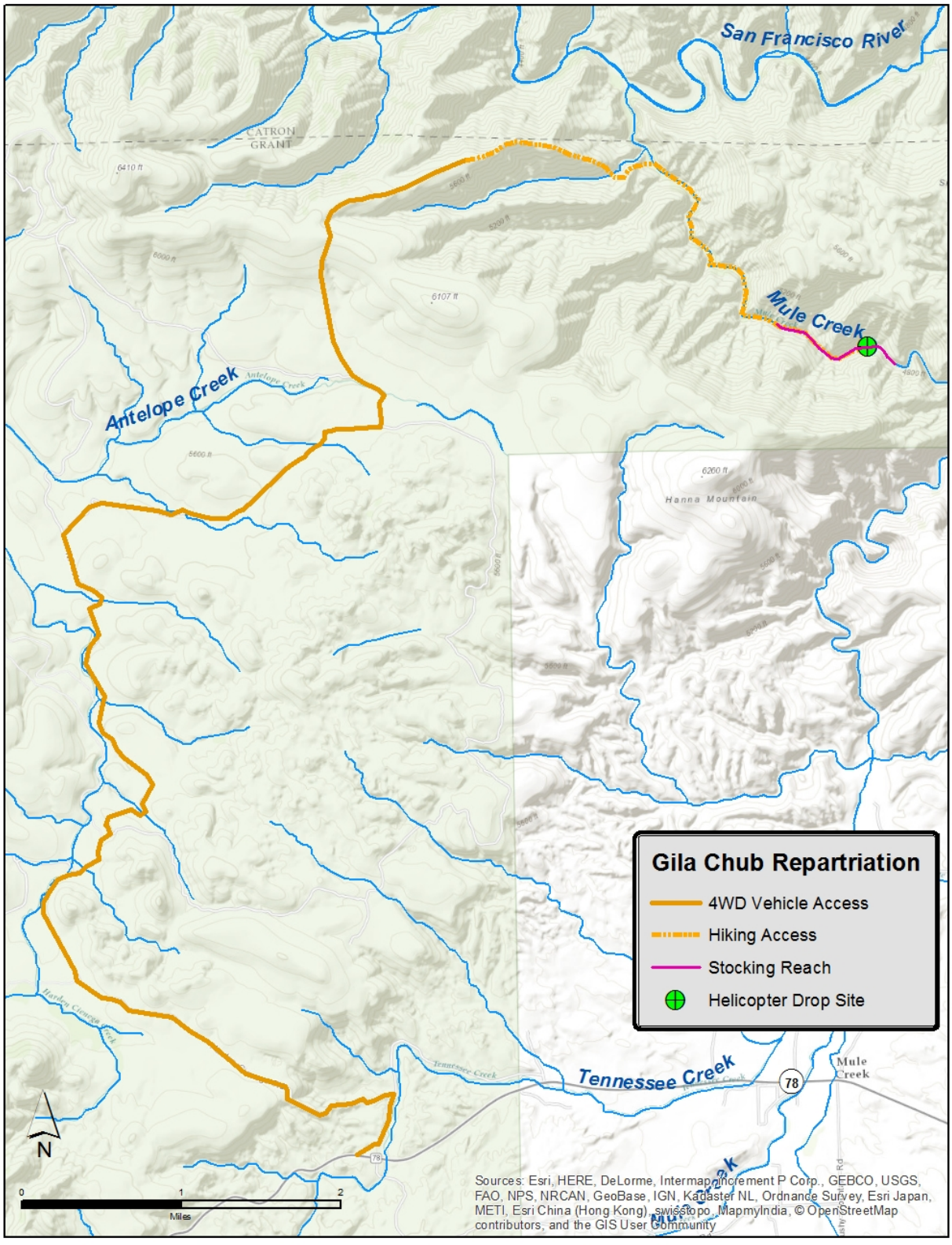

Figure 7. Location of Gila Chub repatriation in Mule Creek, NM.

Table 10. Timeline for repatriation of Gila Chub into Mule Creek.

Date	Number	Source
27 June 2012	120	Harden Cienega via ARCC
21 November 2013	119	Harden Cienega via ARCC
13 November 2014	60	Harden Cienega via ARCC
2015	N/A	No stocking
Spring 2016	Target - 100	Harden Cienega via ARCC
Autumn 2017	Target – 100	Harden Cienega via ARCC

Table 11. Proposed Timeline for monitoring of repatriated Gila Chub in Mule Creek.

Date	Activity
Spring 2013	Survey - Gila Chub detected
Spring 2014	Survey - Gila Chub detected
Spring 2016	Survey – Gila Chub and nonnatives detected.
Autumn 2018	Survey and Genetic Analysis
Autumns 2019 - 2021	Survey
Autumn 2022	Survey and Genetic Analysis
Autumn 2026	Survey

Redrock Cienega Pond:

Redrock Cienega is a constructed off channel refuge site on NMDGF property in Redrock, NM maintained by shallow groundwater and pumped well water as needed. Gila Chub were stocked on 20 Sept 2011 and persist at low density in the pond (Table 12). Gila Chub have spawned in the pond, but the population remains small. Additionally, Gila Topminnow stocked in the pond have not persisted. Prior to additional stocking an assessment of water quality over a year should be conducted (Table 13). It is not clear whether populations are suppressed by water temperature, dissolved oxygen levels, or other issues. Water in the pond is often stagnant with no inflow or outflow. Dense mats of algal growth are present in the pond during warm months which can lead to hypoxic conditions when algae decays. The issue warrants further investigation and possibly installation of a water quality meter that measures dissolved oxygen. If dissolved oxygen is deemed a limiting factor an aerator could be installed to run off the same power supply as the well. The pond may need something as simple as aeration to improve the holding capacity. Stocking of additional Gila Chub could proceed after the improvements are made. If successful, Redrock Cienega pond will be a refuge population for the Dix Creek lineage of Gila Chub. Mule Creek and Turkey Creek are currently hold the only populations of Gila Chub in New Mexico, and the Turkey Creek population is a very unique lineage. Ideally, the pond would produce excess Dix Creek lineage Gila Chub that could be used as a source for a wild repatriated population in Burro Cienega or elsewhere.

Table 12. Timeline for repatriation of Gila Chub into Redrock Cienega Pond.

Date	Number	Source/Survey Method
Oct 2010	150 Stocked	Dix Creek, Arizona
20 Oct 2011	172 Stocked	Dix Creek, Arizona
28 June 2011	2 Captured	Minnow Traps and Seines
16 Jul 2012	2 Captured	Minnow Traps
19 Feb 2013	7 Captured	Minnow Traps
2017	Target – 100	Dix Creek, Arizona
2018	Target – 100	Dix Creek, Arizona

Table 13. Proposed Timeline for monitoring of repatriated Gila Chub in Redrock Cienega Pond.

Date	Activity
2016	Install water quality meter
2017	Address any identified water quality issues
2018	Survey
2019	Survey and Genetic Analysis
2020 – 2023	Survey
2024	Survey and Genetic Analysis
2029	Survey

Future Stream Evaluation:

Twelve streams have been identified for potential Gila Chub repatriation; however, it would not be reasonable to attempt to repatriate all of these waterways concurrently. The streams described here may or may not have habitat and perennial water sufficient to support a population of Gila Chub (Table 14 and Figure 8). Additional data is needed to complete the evaluation. The priority list will likely be reordered based on field evaluations. Recent wildfire has affected Big Dry, Deep, Copper, and Little creeks. Ideally, repatriated populations could be used as sources for future efforts with supplementation from other sources. Some streams would need to be renovated before repatriating Gila Chub. Little Creek, Meadow Creek, or Trout Creek may be a logical place to replicate the Gila Chub from Turkey Creek or Headwater Chub. As previously discussed, ideally Redrock Cienega could be used as a source for future repatriations.

Table 14. Proposed priority list of potential Gila Chub repatriation streams.

Priority	**Stream Name**	**Sub-Basin**
1	Frieborn Canyon	Blue River
2	Tularosa River	San Francisco
3	Little Creek	Upper Gila
4	Meadow Creek	Sapillo
5	Trout Creek	Sapillo
6	Big Dry Creek	San Francisco
7	Snow Creek	Gila
8	Sheep Corral Canyon	Sapillo
9	Cow Creek	Sapillo
10	Deep Creek/Copper Creek	San Francisco
11	Burro Cienega	Lordsburg
12	Pueblo Creek(needs improvements)	San Francisco

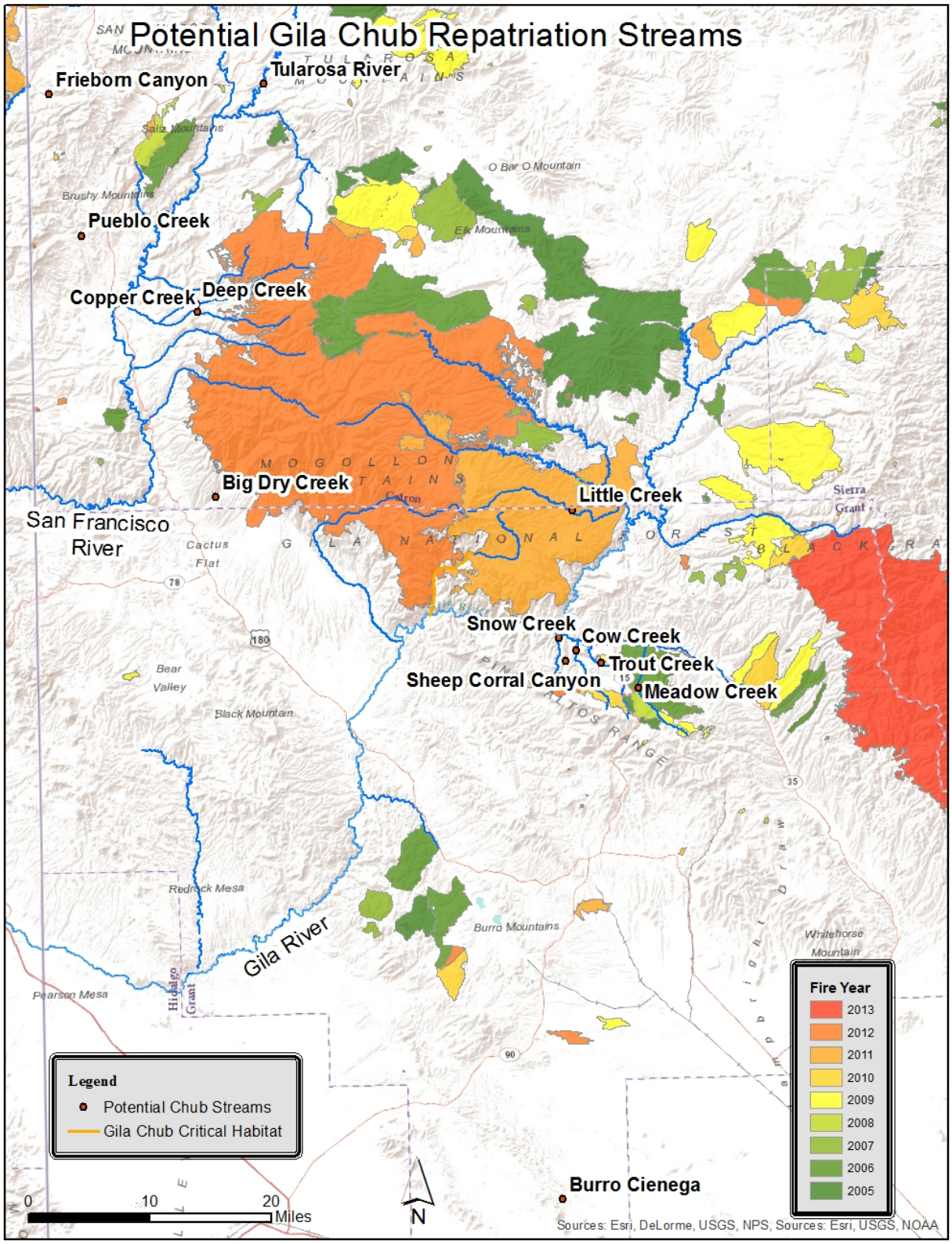

Figure 8. Locations of waterways to be evaluated for Gila Chub repatriation potential.

Gila Topminnow (*Poeciliopsis occidentalis occidentalis*)

Burro Cienega:
Gila Topminnow are established in Burro Cienega in Grant County, NM. Burro Cienega was established from two stockings from Bylas Spring, Arizona (Table 15). This population will require continued monitoring and potentially genetic augmentation (Table 16). If genetic diversity of the Burro Cienega population is representative of the Bylas Springs population, it could be used for future stocking of Redrock Cienega pond.

Table 15. Timeline for repatriation of Gila Topminnow into Burro Cienega.

Date	Number	Source/Survey Method
7 Nov 2007	250 Stocked	Bylas Spring, Arizona
8 Jun 2008	578 Stocked	Bylas Spring, Arizona

Table 16. Proposed Timeline for monitoring of repatriated Gila Topminnow in Burro Cienega.

Date	Activity
2016	Survey and Genetic Analysis
2021	Survey
2026	Survey

Redrock Cienega Pond:
Gila Topminnow from Bylas Spring, AZ were stocked into Redrock Cienega shortly after construction finished in summer 2009. Gila Topminnow were abundant (visual assessment) in October 2010 at the time of Gila Chub stocking, but based on follow-up monitoring it does not appear that they have persisted despite an additional stocking of 2,357 on 24 October 2011. If improvements are made to the Redrock Cienega NMDGF should pursue further stocking, possibly translocations from Burro Cienega.

Future Stream Evaluation:
No locations have been identified at this time, but will be evaluated when they are identified.

Literature Cited:

Brandenburg, W.H., J.L. Kennedy, and M.A. Farrington. 2015. Determining the historical distribution of the *Gila robusta* complex (Gila Chub, *Gila intermedia*, Headwater Chub, *Gila nigra*, and Roundtail Chub, *Gila robusta*) in the Gila River Basin, New Mexico, using morphological analysis. Share with Wildlife report funded by New Mexico Department of Game and Fish.

Childs, M. 2005. Bubbling Ponds Hatchery development for native fishes: protocol for collection, transport, quarantine, maintenance, propagation and repatriation of native fish species. Final Report sumitted to U.S. Bureau of Reclamation, Phoenix Area Office, Federal Grant No. 04-FG-32-0310. Arizona Game and Fish Department, Phoenix.

Dowling, T.E. 2012. Report on molecular characterization of samples of *Gila intermedia* from Turkey Creek, NM. School of Life Sciences, Arizona State University.

Dowling, T.E., P.C. Marsh, C.D. Anderson, M.S. Rosenberg, and A.T. Kelsen. 2004. Population Structure in the Roundtail Chub (*Gila robusta* complex) of the Gila River basin as determined by microsatellites. Report to Arizona Game and Fish Department.

Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department. Pp.293.

Pilger, T and T.Turner. 2012. Baseline genetic studies of fishes native to the Gila River Basin, Phase II. Share with Wildlife report funded by New Mexico Department of Game and Fish.