

## RECOVERY PLAN AMENDMENTS FOR NINE SOUTHWEST SPECIES

The U.S. Fish and Wildlife Service identified best available information indicating the need to amend the below species' recovery criteria. Each amendment is recognized as an addendum that supplements the existing recovery plan.

|   |
|---|
| <b>Arizona Cliffrose (<i>Purshia subintegra</i>) Recovery Plan</b><br>Original Recovery Plan Approved: June 16, 1995<br>Page(s) Superseded: 52-73                                       |
| <b>Davis' Green Pitaya Cactus (<i>Echinocereus viridiflorus</i> var. <i>davisii</i>) Recovery Plan</b><br>Original Recovery Plan Approved: September 20, 1984<br>Page(s) Superseded: 11 |
| <b>Desert Pupfish (<i>Cyprinodon macularius</i>) Recovery Plan</b><br>Original Recovery Plan Approved: December 8, 1993<br>Page(s) Superseded: 13-14                                    |
| <b>Fishes of the Rio Yaqui Recovery Plan</b><br>Original Recovery Plan Approved: March 29, 1995<br>Page(s) Superseded: 21-22<br>Species Included: Yaqui chub                            |
| <b>Little Aguja Pondweed (<i>Potamogeton clystocarpus</i>) Recovery Plan</b><br>Original Recovery Plan Approved: June 20, 1994<br>Page(s) Superseded: 21                                |
| <b>Navasota ladies'-tresses (<i>Spiranthes parksii</i>) Recovery Plan</b><br>Original Recovery Plan Approved: September 21, 1984<br>Page(s) Superseded: 21-22                           |
| <b>Nellie Cory Cactus (<i>Coryphantha minima</i>) Recovery Plan</b><br>Original Recovery Plan Approved: September 20, 1984<br>Page(s) Superseded: 11                                    |
| <b>Texas Trailing Phlox (<i>Phlox nivalis</i> ssp. <i>texensis</i>) Recovery Plan</b><br>Original Recovery Plan Approved: March 28, 1995<br>Page(s) Superseded: 13-14                   |
| <b>Walker's Manioc (<i>Manihot walkerae</i>) Recovery Plan</b><br>Original Recovery Plan Approved: December 12, 1993<br>Page(s) Superseded: 16-17                                       |

For

U.S. Fish and Wildlife Service  
Southwest Region  
Albuquerque, New Mexico

September 2019

Approved:

  
Regional Director, U.S. Fish and Wildlife Service

Date:

Sept. 26, 2019

**Fishes of the Rio Yaqui Recovery Plan**

**Amendment 1 for Yaqui Chub (*Gila purpurea*)**

**For  
U.S. Fish and Wildlife Service  
Region-2  
Albuquerque, NM**

**September 2019**

**BACKGROUND INFORMATION**

a. Summary of prior actions.

Listing: 49 FR 34490.  
Date: August 31, 1984.  
Listed status: Endangered.  
Recovery Plan: Fishes of the Rio Yaqui Recovery Plan.  
Prepared by: Kevin S. Cobble, U.S. Fish and Wildlife Service, Douglas,  
Arizona.  
Approved: March 29, 1995.

b. Reason for amendment.

Species recovery plans should be consulted frequently, used to initiate recovery activities, and updated as needed. A review of the recovery plan and its implementation may show that the plan is out of date or its usefulness is limited, and therefore warrants modification. Keeping recovery plans current ensures that the species benefits through timely, partner-coordinated implementation based on the best available information. The need for, and extent of, plan modifications will vary considerably among plans. Maintaining a useful and current recovery plan depends on the scope and complexity of the initial plan, the structure of the document, and the involvement of stakeholders.

An amendment involves a substantial rewrite of a portion of a recovery plan that changes any of the statutory elements. The need for an amendment may be triggered when, among other possibilities: (1) the current recovery plan is out of compliance with regard to statutory requirements; (2) new information has been identified, such as population-level threats to the

species or previously unknown life history traits, that necessitates new or refined recovery actions and/or criteria; or (3) the current recovery plan is not achieving its objectives. The amendment replaces only that specific portion of the recovery plan, supplementing the existing recovery plan, but not completely replacing it. An amendment may be most appropriate if significant plan improvements are needed, but resources are too scarce to accomplish a full recovery plan revision in a short time.

Although it would be inappropriate for an amendment to include changes in the recovery program that contradict the approved recovery plan, it could incorporate study findings that enhance the scientific basis of the plan, or that reduce uncertainties as to the life history, threats, or species' response to management. An amendment could serve a critical function while awaiting a revised recovery plan by: (1) refining and/or prioritizing recovery actions that need to be emphasized, (2) refining recovery criteria, or (3) adding a species to a multispecies or ecosystem plan. An amendment can, therefore, efficiently balance resources spent on modifying a plan against those spent on managing implementation of ongoing recovery actions.

Section 4(f)(1)(B)(ii) of the Endangered Species Act (Act) (USFWS 1973) requires that each recovery plan shall incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination...that the species be removed from the list." Legal challenges to recovery plans (see *Fund for Animals v. Babbitt*, 903 F. Supp. 96 (D.D.C. 1995)) and a Government Accountability Audit (GAO 2006) have also affirmed the need to frame recovery criteria in terms of threats assessed under the five threat factors (ESA 4(a)(1)) (USFWS 1973). In this document, we establish delisting criteria for Yaqui chub (*Gila purpurea*), which supplement the original downlisting criteria included in the Fishes of the Rio Yaqui Recovery Plan (Recovery Plan).

## **METHODOLOGY USED TO COMPLETE THIS AMENDMENT**

U.S. Fish and Wildlife Service (USFWS) personnel associated with San Bernardino National Wildlife Refuge (SBNWR) and with the Regional Biological Science Division completed this finding using best available information from the Recovery Plan (USFWS 1995), pertinent published literature, USFWS files, and personal knowledge of this species. While there is no formal Yaqui Chub Recovery Team, subject matter experts representing Arizona Game and Fish Department, USFWS Region-2 Ecological Services, USFWS Region-2 Fish and Aquatic Conservation Division, San Bernardino National Wildlife Refuge, the Republic of Mexico, academia, and private interests regularly meet and/or correspond and discuss Rio Yaqui fish recovery. All of these parties have provided personal communications and perceptions regarding recovery of the Yaqui chub, and that information was used by the USFWS to develop the information contained in this document.

## SPECIES BACKGROUND

Having the most restricted geographic range of all the Río Yaqui fishes, the Yaqui chub was federally listed as endangered throughout its range, with critical habitat including all aquatic habitats in the main portion of SBNWR, on August 31, 1984. The primary objective of the 1995 Recovery Plan is to restore the endangered Yaqui chub, Yaqui topminnow (*Poeciliopsis occidentalis sonorensis*), the threatened Yaqui catfish (*Ictalurus pricei*) and the beautiful shiner (*Cyprinella formosa*) as secure and self-sustaining members of the indigenous fish fauna of the aquatic ecosystems in which they once occurred (USFWS 1995). While the Recovery Plan covers all four fish in a single document, the information identified in this supplemental finding pertains only to the Yaqui chub. The Recovery Plan defines “secure” as inclusive of legal protection and protection from natural (physical, chemical, or biological) catastrophes as technologically and economically possible; “reestablished” as maintaining a self-sustaining population, with no or minimal human intervention; “self-sustaining” as populations that are reproducing naturally and maintaining sizes and structures indicative of persistence for a reasonable period; and “reasonable” in this context as through tens to hundreds of generations.

Recovery objectives and downlisting criteria for Yaqui chub were established in the original Recovery Plan (USFWS 1995); however, delisting criteria were not established at that time. Our knowledge of the species has increased since it was originally listed. As a member of the community of organisms utilizing critical aquatic habitats on SBNWR, Yaqui chub would benefit from the continued conservation and management of these habitats despite any potential downlisting of this species in the future.

For many years, the Yaqui chub was confused with the similar desert chub (*Gila eremica*) described by DeMarais (1991), which ranges from the westernmost tributaries of the upper Río Yaqui basin west and southward to the upper Río Sonora and Río Matape (Minckley and Marsh 2009). Before genetic work was conducted to examine the fish species, the range of the Yaqui chub was incorrectly thought to include a much larger portion of the Río Yaqui watershed and about 98 percent of the range of the Yaqui chub was wrongly thought to exist only in Mexico. The Recovery Plan for this species (USFWS 1995) was completed based on this information, which was the best available information at the time. We now recognize that the range of the Yaqui chub is restricted to the Río San Bernardino system in Arizona and Sonora. It was historically and still remains known in Mexico only from a <3.0 km perennial reach of Río San Bernardino, immediately south of the international border in Sonora (Varela-Romero et al. 1992). Most of its range is therefore in the U.S., and the majority of that is directly protected on SBNWR.

The Yaqui chub live in springs, spring-fed ditches, creeks, (and has adapted favorably to ponds) over substrates of silt, clay, sand, and gravel. Water may be clear or muddy, with associated vegetation including watercress, cattail, sedges, and willows. Depths of capture vary to >1.5 m;

and currents are none to moderate (Minckley and Marsh 2009; Stewart et al. 2017; Stewart et al. 2019). Spawning occurs mostly during spring – early summer and has been recorded in all but midwinter months. The reproductive potential of this fish is very high, with large populations able to quickly develop from only a few adults when habitat conditions are favorable (DeMarais and Minckley 1993; Kline and Bonar 2009). The species feeds mostly on algae, invertebrates, and detritus (Galat and Gerhardt 1987).

Continuing threats to this fish include: very limited range, making potential loss from catastrophic events more likely; loss, alteration, and degradation of suitable wetland habitat; competition with, and/or depredation by, non-native species; and long-term drought combined with expanding human populations, which are creating increased demand for water for human consumption (Minckley and Marsh 2009). Yaqui chub populations in the San Bernardino Valley, Douglas High School, and Bar-Boot Ranch continue to be threatened due to infestations by the non-native Asian tapeworm (*Bothriocephalus acheilognathi*), while those on El Coronado Ranch and Coronado National Forest currently remain free of this parasite. However, Kline et al. (2007) determined that Asian tapeworm infestations of Yaqui chub can cause intestinal blockage and a reduced growth rate, but that infestation by this tapeworm did not result in an overall threat to the Yaqui chub population. While this parasite may impact Yaqui chub, it does not appear to kill or threaten the fecundity of the chub, which has adapted to the occurrence of the tapeworm (Kline et al. 2007).

Since the development of the 1995 Recovery Plan, populations of Yaqui chub have responded well to conservation efforts and intensive management, and have established large and viable populations in diverse habitats (Hendrickson and Brooks 1991; USFWS 1994a). Approximately 35 managed populations of Yaqui chub currently occur across the known range. Yaqui chub are living in nearly all wetlands on SBNWR (16 separated ponds, San Bernardino River, also known as Black Draw, and Hay Hollow Wash). Additionally, the species has been established in Leslie Creek on Leslie Canyon National Wildlife Refuge (LCNWR), in West Turkey Creek on the Coronado National Forest, and at the following locations on private property: in House Pond on Slaughter Ranch (covered by a conservation easement and a warranty deed), in two ponds on the 99-Bar Ranch, in two ponds on the Bar-Boot Ranch (where it is covered by separate conservation easements and a Safe Harbor Agreement), in one pond at Douglas High School, in eight ponds at El Coronado Ranch (where it is covered by a Habitat Conservation Plan). In Mexico, Yaqui chub have been found in Rio San Bernardino, three adjacent ponds, two springs on Ciénega de San Bernardino, and the spring Los Ojitos.

Since the Recovery Plan was developed, much work has been done to establish the above populations by including understanding and managing water capacity, controlling non-native, harmful species, and protecting habitats from human impacts. Additional data provided from

research and management has improved our knowledge base. The 1995 Recovery Plan provides the following conditions/objectives for recovery of the four Yaqui fishes:

“All the following conditions must be met within currently occupied habitat for a period of 10 years before consideration of delisting for beautiful shiner and Yaqui catfish or downlisting for Yaqui chub and topminnow:”

*Secure and protect San Bernardino Valley aquifers so that all artesian and other flows from subsurface sources are perennial. Secure and protect Leslie Creek, San Bernardino River and Mimbres River, NM watersheds to ensure adequate, perennial flow.*

Earman et al. (2003) delineated catchment area, recharge and flow rates, storage volumes and other attributes of the underground aquifers for portions of the watershed that included San Bernardino/ Leslie Canyon. Since the mid-1990's, identifying and quantifying the volume of water required to sustain the existing wetland ponds found throughout the refuge has been a priority. The impact to the aquifer appears to be minimal and the aquifer has demonstrated a pattern of natural recharge.

*Eradicate all non-indigenous fish species and other undesirable organisms such as bullfrogs from critical habitat.*

Non-indigenous fish species have been successfully eradicated on SBNWR, LCNWR, and Slaughter Ranch (private property) since the 1990's. Additionally, all non-indigenous fish were removed from ponds on El Coronado Ranch (private property) that supported Yaqui chub during 2015 (although green sunfish (*Lepomis cyanella*) still exist adjacent to West Turkey Creek). U.S. Fish and Wildlife Service personnel have surveyed annually and occasionally biannually and no longer observe any non-indigenous fish species at SBNWR, LCNWR, House Pond on Slaughter Ranch, and Big Tank on El Coronado Ranch.

Non-native green sunfish are known to occur throughout portions of West Turkey Creek in Cochise County, AZ where they are sympatric with Yaqui chub. Sunfish may feed upon the eggs and young of Yaqui chub and may limit recovery of Yaqui chub in this stream system. Permanent removal of sunfish downstream from these stream reaches is currently impractical as infested impoundments on adjacent private lands support green sunfish and landowners are not receptive to elimination of this fish. However, over the course of Yaqui chub monitoring, green sunfish have been removed from West Turkey Creek by USFWS personnel (see refuge annual reports, example USFWS 1994b). These efforts have depleted green sunfish from stream reaches known to support Yaqui chub and allow for continued suppression of populations.

American bullfrogs (*Lithobates catesbeiana*), a non-native amphibian, remain on SBNWR, Slaughter Ranch, El Coronado Ranch, and in adjacent wetlands. We believe this species poses little direct risk to Yaqui chub though it may compete for limited food resources. For example, Liu et al. (2017) reported on the analysis and composition of bullfrog (native and nonnative) diets around the world and found that their diets primarily consisted of insects and anurans, including aquatic algal foods. Fish comprised a smaller portion of their diet and was found to not be significant in their model-based exercise (Liu et al. 2017). Other studies corroborate these findings and report that non-indigenous bullfrogs did not typically affect small-bodied fishes, though some have found that the presence of Mosquitofish may negatively affect amphibians (Blaustein and Kiesecker 2002; Kats and Ferrer 2003; Liu et al. 2017). Still, adult Yaqui chub (*Gila purpurea*) have been found in the stomachs of bullfrogs collected at SBNWR and El Coronado Ranch, documenting that this fish does represent a food source for bullfrogs. Therefore, we cannot exclude the occurrence of predation by bullfrogs on any of the smaller-bodied Rio Yaqui fishes (Beautiful Shiner, Yaqui Chub, and Yaqui Topminnow), individuals of these species number in the hundreds to thousands (the Yaqui Topminnow numbers in the hundreds of thousands) in a single pond and have been self-sustaining since non-indigenous bullfrogs invaded the SBNWR and associated waters. Since the initial invasion of bullfrogs, the numbers of Yaqui chub have continued to remain stable and self-sustaining, indicating that bullfrogs do not pose a threat to the persistence of the Yaqui chub.

A non-indigenous parasitic cestode species, the Asian tapeworm also occurs throughout much, but not all, of the habitat occupied by Yaqui chub in Cochise County, AZ. The presence of Asian tapeworm in fishes of the Rio Yaqui watershed represents new information to the USFWS regarding disease and predation on the Yaqui chub (Miller et al. 2005, Kline 2007). Asian tapeworm are not host-specific and can therefore move between similar and dissimilar taxa. Kline (2007) determined that Asian tapeworm infestations of Yaqui chub can cause intestinal blockage and a reduced growth rate, but that infestation by this tapeworm did not result in an overall threat to the Yaqui chub population. While this parasite may impact Yaqui chub, it does not kill or threaten the fecundity of the chub, which has adapted well to the occurrence of the tapeworm.

Non-native grass carp (*Ctenopharyngodon idella*) were introduced to ponds on El Coronado Ranch and the Slaughter Ranch pond for parrotfeather watermilfoil (*Myriophyllum aquaticum*) control by USFWS staff. The use of grass carp as a biological control, presents a new ecological condition since the 1995 Recovery Plan. This exotic species was first reported on the USFWS Fish Monitoring Report in 2003 (Brouder 2003). Grass carp is native to Eastern Asia (Lee et al. 1980) and has been introduced to control aquatic vegetation (Courtenay et al. 1984). Chilton and Muoneke (1992) stated that grass carp indirectly affect other species by modifying habitat, although when resources are limited grass carp may directly affect species through predation and competition. Grass carp potentially change trophic structures and community structure by

modifying the aquatic plant community (Bain 1993). The effects of grass carp on Yaqui chub is unknown, although population monitoring has not detected any population reductions in areas containing grass carp.

Yaqui chub found in Mexico co-occur with Western mosquitofish (*Gambusia affinis*), a southwestern native fish. Although not an exotic, western mosquitofish directly impact native fish species, for example Mills et al. (2004) demonstrated negative interactions between western mosquitofish and least chub (*Iotichthys phlegethontis*), where the native chub species showed higher mortality and behavioral changes in the presence of the mosquitofish. As the Mexican populations of Yaqui chub are not monitored by the USFWS, the effects of the presence of Western mosquitofish is yet to be determined.

*Protect critical habitat and other habitats where species of concern occur or are reestablished from human disturbances including excessive grazing, irrigated agriculture, introductions of non-indigenous species and water diversion or removal.*

Critical habitat for the Yaqui chub is designated for all aquatic habitat on SBNWR in the U.S. Livestock grazing has been eliminated on the refuge since establishment in 1982, and adjacent lands are not impacted by excessive grazing in the U.S. or in Mexico, as U.S. landowners are members of the Malpai Borderlands Group (MBG). The MBG is an alliance of stakeholders invested in the conservation of the Malpai Borderlands, of which SBNWR is a part. The Malpai Borderlands multi-species Habitat Conservation Plan provides a framework from which the MBG consults for land use and management decisions. In Mexico, Yaqui chub only occur on Rancho San Bernardino, whose owner is a member of the MBG. Irrigated agriculture does not occur on surrounding private lands in the U.S. as well as immediately south of the refuge in Mexico. Water use also occurs on private land (Slaughter Ranch) adjacent to SBNWR, where it is used to maintain a park-like atmosphere to encourage public use. The effects of these small-scale irrigation activities upon Yaqui chub populations are poorly known. Water diversion is not an immediate threat to Yaqui chub habitat in the U.S. or in Mexico, but the future consequences of groundwater withdrawal in this area is unknown. These potential threats to Yaqui chub can be monitored for compliance by USFWS personnel as all occupied land in the U.S. is covered under agreements with landowners via Habitat Conservation Plans (El Coronado Ranch), Safe Harbor Agreements (Bar Boot), or Conservation Easements (Slaughter Ranch).

## **RECOVERY CRITERIA**

The 1995 Recovery Plan identifies conditions for delisting the beautiful shiner and Yaqui catfish, and downlisting Yaqui chub and Yaqui (Gila) topminnow. However, no delisting criteria were identified for the Yaqui chub or the Yaqui topminnow. The current recovery criteria can be found on pages 21-22 in the 1995 Recovery Plan.

### **Amended Recovery Criteria**

The original Recovery Plan (USFWS 1995) does not identify delisting criteria for the Yaqui chub. The range of this species was not accurately defined at the time the Recovery Plan was written, and was anticipated to be much broader throughout the Rio Yaqui watershed in Mexico. Because fish biologists considered a wide distribution, they therefore anticipated the insurmountable threats to the species that are widespread throughout the entire Rio Yaqui watershed. Such threats included habitat loss, predation, competition with non-native species, increasing human development and demand for water, and the predicted trends of warmer, drier, and more extreme hydrological conditions associated with climate change throughout the expected Mexican range of the Yaqui chub. Most of these threats were technically or politically unfeasible to address in Mexico. For example, addressing the widespread proliferation of non-native fish (including species considered to be valuable sport fish) within the Rio Yaqui in Mexico and eliminating the potential for continual contamination and/or recontamination of these exotic species into sensitive habitats in order to promote recovery of Yaqui chub remains undeterminable but seem unlikely to occur. Additionally, restoring chub habitat by reversing the desiccation of springs or removing existing agricultural or municipal dams in Mexico are not likely to have support. The 1995 Recovery Plan identified that Yaqui chub could be downlisted to threatened status when self-sustaining populations are established and secure on SBNWR, LCNWR, and West Turkey Creek; when San Bernardino Valley aquifers are secure and protected; when non-indigenous fish and other undesirable organisms have been eradicated from critical habitat; and when critical habitat is protected from human disturbances, water diversion, or water removal (USFWS 1995). About 35 managed populations of Yaqui chub currently occur across the known range, where they have been self-sustaining for 10-36 years.

Yaqui chub in Mexico, are found in Rio San Bernardino, which today has been separated into sections by large gabions. The subpopulations in those sections persist and are presumable mixed during extremely high flows. There are three to four ponds associated with the river, that on a given year may or may not be dry, that represent habitat, where Yaqui chub are generally not found, unless introduced. Additionally, during spring outflow, a small spring flows across Ciénega de San Bernardino eventually reaching the ponds, providing some supplementary habitat. An artesian well near the border also hosts a small population. Further, past Highway 2, a large downstream relict population persists, with little access to Rio San Bernardino as the reduced flow does not allow movement back to the river except during rare high flow storm events. Four miles downstream of this population, the river is usually dry. No other favorable sites occur for Yaqui chub on Rancho San Bernardino, where the fish exist in large numbers, but only locally and seldom mix. The dynamic conditions shaping the availability of Yaqui chub habitat necessarily requires fluctuating subpopulations that may or may not be present at a given point in time. These subpopulations comprise two self-sustaining local populations in Mexico.

We now recognize that the range of the Yaqui chub is restricted to a much smaller portion of the Rio San Bernardino system in Arizona and Sonora, where it historically and currently remains known in Mexico only from a <3.0 km perennial reach of Rio San Bernardino, immediately south of the international border in Sonora (Varela-Romero et al. 1992). Because most of its range is directly protected in the U.S. on SBNWR and LCNWR, delisting criteria can be determined for the Yaqui chub. Since the Recovery Plan was written in 1995, our knowledge base for the species has significantly increased, our understanding of the species' status, threats, and recovery needs has changed, and data gaps and uncertainties that once existed have been resolved to the degree that they no longer impede recovery progress. We establish delisting criteria for Yaqui chub as follows:

The Yaqui chub will be considered for delisting when:

- 1) The Arizona population of Yaqui chub is secure and viable, demonstrated by the perpetuation of dozens of reproductive cohorts in a total of  $\geq 50$  distinct (unconnected) local populations inhabiting suitable wetlands over multiple locations. Suitable locations include at least 16 on SBNWR, 1 on LCNWR, 2 at El Coronado Ranch, 2 at Bar-Boot Ranch, 1 on Slaughter Ranch, and other suitable sites within the U.S. These self-sustained local populations are comprised of any number of fluctuating subpopulations, which are dependent upon the amount of available habitat at any given time. As environmental conditions favorable to habitat creation are dynamic, no definitive number of subpopulations are required as they will occasionally be extirpated then reestablish. The required number of local populations is at least twenty-five times larger than what is identified to have occurred historically for the Yaqui chub in Arizona (2 local populations in 1982), and should serve to adequately mitigate anticipated threats to the species. These local populations should be self-sustaining within 50 years of initiation of monitoring and management (1982) to demonstrate the dynamic ecology associated with these desert fishes. Should local populations be extirpated from areas, such that the overall numbers is  $< 50$ , the species is still to be considered recovered as long as these areas are restocked and become self-sustaining within 5 years (so that local populations numbers at least 50).
- 2) The Sonora population of Yaqui chub is secure, reestablished, and self-sustaining (allowing and documenting populations supported by the perpetuation of dozens of reproductive cohorts) in a total of  $\geq 5$  (unconnected) suitable wetland local populations within a combination of locations that include Rancho San Bernardino and other favorable sites. This number of local populations is also about five times greater than what was known historically for the Yaqui chub in Sonora, and should serve to adequately mitigate anticipated threats to the species. Local populations in this area

should demonstrate 10 years of self-sustained population persistence and include varying numbers of subpopulations dependent upon environmental conditions.

**Justification for Delisting Criteria 1 and 2:**

We conclude that the criteria described above are sufficient based on 36 years of annual monitoring as part of the Service's adaptive management of the species. This period has encompassed a wide range of climatic conditions, from extreme drought (2012) to extreme flooding (2014), and across a range of population sizes (estimated as 2 in 1982 to 35 today). The choice of 50 local populations is enough to represent the species as it allows for the species to be present in the multiple remaining systems where it historically occurred (SBNWR to Turkey Creek). Additionally, this number is redundant enough such that multiple sites can be occupied in multiple areas, decreasing the likelihood of loss at all sites from a single or even multiple events. Resiliency is achieved with the use of 50 local populations because it maximizes the spatial extent of the species as well as the habitat extent (stream + pond), such that diversity and population size are maximized to the fullest extent possible.

Maintaining several populations with relatively independent susceptibility to threats is an important consideration for the long-term viability of Yaqui Chub. Considering the wide-scale flooding throughout the Refuge in 2014 due to a hurricane, it was of interest to continue establishing multiple local populations to provide continued security in case of another catastrophic event, disease outbreaks, or repeated year-class failures. Currently, about 35 managed populations of Yaqui Chub occur on the landscape. The positive effect of creating additional independent populations can be demonstrated by the following examples. Given that this species is considered a boom or bust species, imagine that a single population has a probability of extinction from an unforeseen event of 50% in 200 years. If we establish 13 independent populations, the risk of extinction is 0.01% ( $0.50^{13}$ ) (Casagrandi and Gatto 1999). Even with an extinction probability of 90% for one population, the probability of extinction for 43 and 50 local populations reduces to 1.08% ( $0.90^{43}$ ) and <1% ( $0.90^{50}$ ) (Casagrandi and Gatto 1999). Thus, our management approach to introduce this species into additional suitable habitats to reach a total of 50 local populations in the United States ensures that even under the high scenario (90% local population extinction risk) these species remain secure now and into the future. This is also the case in Mexico, where establishing up to 10 additional local populations, decreases the extinction risk from 0.51% to 0.18%. Since, introducing new populations to suitable habitats increases the likelihood of prolonged survival, it is the major component of our delisting criteria.

### **Rationale for Amended Recovery Criteria**

Populations of Yaqui chub have been monitored annually since establishment of SBNWR in 1982. Since then, Yaqui chub of multiple size classes are routinely captured in these habitats, indicating that the areas are suitable for recruitment and recovery, which demonstrates the potential for recovery if aquatic habitats are maintained. While overall annual numbers of fish vary widely (this is a boom or bust species, quick to take advantage of favorable habitat conditions), monitoring supports that the species has been secure and reestablished in locations on SBNWR in Arizona and Rancho San Bernardino in Sonora for over 36 years, meeting the purpose of the Endangered Species Act.

Continued long-term monitoring of Yaqui chub populations allows for the documentation of self-sustaining populations within the greatest number of wetlands (SBNWR, LCNWR, El Coronado Ranch, Bar-Boot Ranch, and Slaughter Ranch in Cochise County, Arizona, and at Rancho San Bernardino in Sonora, Mexico) and assessing species security. Furthermore, recently updated monitoring protocols are being implemented that will account for the effects of decreased capture efficiency due to environmental factors such as submergent aquatic vegetation (Stewart et al. 2017; Stewart et al. 2019) and improve the objectivity and accuracy of monitoring estimates. Research continues to clarify important species-habitat relationships (habitat requirements) and potential inter-specific interactions that will help to inform management plans in the future.

Per Endangered Species Act requirements in section 4(a)(1), the following five general factors that frame recovery criteria for the Yaqui chub have been addressed, or are being addressed, to help justify the rationale that supports the amended recovery criteria for this species to include delisting criteria. Further, the following factors provide a framework for initiating delisting discussions for future species status reviews.

#### **A. Present or threatened destruction, modification, or curtailment of its habitat or range.**

Yaqui chub face two main threats related from habitat modification: decreased prevalence in appropriate habitat and habitat degradation, both linked to surface water availability. Habitat loss poses a challenge to species recovery; few sites exist that provide the suitable habitat required by the species and is directly related to the amount of surface water present in the landscape. Furthermore, the availability of surface water directly impacts the quality of Yaqui chub habitat, as factors such as water quality, temperature, and community structure are linked to the amount of water at these sites. To mitigate these threats, San Bernardino Valley aquifers are secure and protected such that all artesian-well and other flows from subsurface sources are perennial. SBNWR was acquired in 1982, and helps assure surface water on the landscape for the Yaqui chub. To guarantee adequate, perennial flow in the San Bernardino River watershed that supports SBNWR and Rancho San Bernardino in Mexico, a variety of hydrologic studies have been conducted on and adjacent to SBNWR. An extensive hydrologic study, based on carbon-14 analysis and tritium activity, was conducted by New Mexico Institute of Mining and Technology (Earman, et al. 2003). Additionally, an aquifer

test was performed by the USFWS on SBNWR during 2002 to determine hydraulic properties such as transmissivity and storativity of the deep, confined aquifer that supports the rare fish protected on the refuge. It concluded that the water yielded by wells on SBNWR is connected and transmitted by preferential flowpaths consisting of fractures in well-cemented alluvium and/or channel deposits (Broska 2002). Additionally, from 2010 to 2012, refuge staff seasonally collected water samples at locations on Slaughter Ranch and SBNWR to help determine hydrologic relationships between individual springs, ponds, and wells. Finally, during 2012, U.S. Geological Survey personnel collected water samples from sites on Slaughter Ranch and SBNWR for isotopic testing (USFWS 2012).

Flow in Leslie Creek has been secured and protected through acquisition of LCNWR in 1988, acquisition of in-stream flow state water rights in 1993, purchase of upstream conservation easements to prevent development and additional water use on private land in 2011, establishment of the Leslie Canyon Watershed Safe Harbor Agreement in 2008 to facilitate Yaqui chub reintroduction, and ongoing monitoring to document perpetuation of surface water.

- B. Over-utilization for commercial, recreational, scientific, or educational purposes.** The Yaqui chub is not utilized commercially, recreationally, scientifically, or for educational purposes, and none of these uses poses a threat to recovery of the species.
- C. Disease or predation.** All non-indigenous fish species and other undesirable organisms that negatively impact Yaqui chub have been eradicated from critical habitat in Arizona. Asian tapeworm is present but does not threaten the perpetuation or recovery of Yaqui chub (Kline et al. 2007). American bullfrog is present but does not threaten the perpetuation or recovery of Yaqui chub (Blaustein and Kiesecker 2002; Kats and Ferrer 2003; Liu et al. 2017). In select El Coronado Ranch ponds and Slaughter Ranch House pond Grass Carp may be present, the effects of grass carp on Yaqui chub are unknown, although population monitoring has not detected any population reductions in areas containing grass carp.
- D. The inadequacy of existing regulatory mechanisms.** The Yaqui chub was listed as endangered under the Endangered Species Act on August 31, 1984. The acquisition of SBNWR on April 1, 1982 and LCNWR on May 31, 1988 has protected the species from extinction. While evaluating recovery, state laws and Mexican federal laws pertinent to the species should be considered.
- E. Other natural or manmade factors affecting its continued existence.** Self-sustaining populations of Yaqui chub are protected on SBNWR and LCNWR, and critical habitat for the Yaqui chub is formally designated to include all aquatic habitat on SBNWR (USFWS 1995). Off refuge wetland habitats also help protect this species. The El Coronado Ranch Habitat Conservation Plan helps protect this fish within the West Turkey Creek watershed draining the Chiricahua Mountains (Minckley and Duncan 1997). The Malpai Borderlands multi-species Habitat Conservation Plan (Lehman et al. 2008) helps protect this fish in the San Bernardino watershed. Both of these planning documents provide an innovative framework for creative partnerships with the ultimate goal of reducing conflicts between listed species and planned activities by the landowners. Habitats where Yaqui chub occur in

the U.S. are therefore protected from human disturbances such as excessive grazing, irrigated agriculture, introductions of non-indigenous species, and water diversion or removal.

## REFERENCES

- Bain, M. 1993. Assessing impacts of introduced aquatic species: grass carp in large systems. *Environmental Management* 17:211-224.
- Blaustein, A.R., and J.M. Kiesecker. 2002. Complexity in conservation: lessons from the global decline of amphibian populations. *Ecology Letters* 5:597-608.
- Broska, J. 2002. Aquifer Test at San Bernardino National Wildlife Refuge, December 2-5, 2002. 20 p.
- Brouder, M.J. 2003. El Coronado Ranch Habitat Conservation Plan: 2003 Fish Monitoring Report. U.S. Fish and Wildlife Service, Arizona Fisheries Resources Office. USFWS-AZFRO-SC-04-001.
- Casagrandi, R., and M. Gatto. 1999. A mesoscale approach to extinction risk in fragmented habitats. *Nature* 400: 560-562.
- Chilton, III, E.W. and M.I. Muoneke. 1992. Biology and management of grass carp (*Ctenopharyngodon idella*, *Cyprinidae*) for vegetation control: a North American perspective. *Reviews in Fish Biology and Fisheries* 2:283-320.
- Courtenay, W.R., Jr., D.A. Hensley, J.N. Taylor, and J.A. McCann. 1984. Distribution of exotic fishes in the continental United States. Pages 41-77 in W.R. Courtenay, Jr., and J.R. Stauffer, Jr., eds. *Distribution, biology and management of exotic fishes*. Johns Hopkins University Press, Baltimore, MD.
- DeMarais, B.D. 1991. *Gila eremica*, a new cyprinid fish from northeastern Sonora, Mexico. *Copeia* 1991:178-189.
- DeMarais, B.D., and W.L. Minckley. 1993. Genetics and morphology of Yaqui chub, *Gila purpurea*, an endangered cyprinid fish subject to recovery efforts. *Biological Conservation* 66:195-206.
- Earman, S., B.J.O.L. McPherson, F.M. Phillips, S. Ralser, and J. M. Herrin. 2003. An investigation of the properties of the San Bernardino Groundwater Basin, Arizona and Sonora, Mexico. New Mexico Institute of Mining and Technology. 283 p.

Galat, D.L., and D. Gerhardt. 1987. Preliminary evaluation of *Gila purpurea* food habits at San Bernardino National Wildlife Refuge, Cochise County, Arizona. Report to U.S. Fish & Wildlife Service, Albuquerque, NM, Arizona State University, Tempe.

Hendrickson, D.A., and J.E. Brooks. 1991. Transplanting short-lived fishes in North American deserts: review, assessment and recommendations. Pp 283-298 in W.L. Minckley and J.E. Deacon (eds.), *Battle Against Extinction: Native Fish Management in the American West*. Univ. AZ Press, Tucson.

Kats, L.B., and R.P. Ferrer. 2003. Alien predators and amphibian declines: review of two decades of science and the transition to conservation. *Diversity and Distributions* 9:99-110.

Kline, J., T. Archdeacon, A.C. Iles, and S.A. Bonar. 2007. Factors influencing distribution of introduced Asian tapeworm and effects on selected Southwestern fishes (Yaqui topminnow and Yaqui chub). Fisheries Research Report 01-07. Heritage Project 104010. University of Arizona, Tucson. 55 p.

Kline, S.J., and S.A. Bonar. 2009. Captive breeding of endangered Yaqui topminnow and Yaqui chub for recovery purposes. *North American Journal of Aquaculture* 71:73-78.

Lee, D.S., C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr. 1980. *Atlas of North American freshwater fishes*. North Carolina State Museum of Natural History, Raleigh, NC.

Lehman, W., and Malpai Borderlands Habitat Conservation Plan Technical Working Group. 2008. *Malpai Borderlands Habitat Conservation Plan*. USFWS. 248 p.

Liu, X., S. Wang, Z. Ke, C. Cheng, Y. Wang, F. Zhang, F. Xu, X. Li, X. Gao, C. Jin, W. Zhu, S. Yan, and Y. Li. 2017. More invaders do not result in heavier impacts: the effects of non-native bullfrogs on native anurans are mitigated by high densities of non-native crayfish. *Journal of Animal Ecology* 87:850-862.

Miller, R.R., W.L. Minckley, and S.M. Norris. 2005. *Freshwater Fishes of Mexico*. Univ. Chicago Press. Chicago, Illinois. 490 p.

Mills, M.D., R.B. Rader, and M.C. Belk. 2004. Complex interactions between native and invasive fish: the simultaneous effects of multiple negative reactions. *Oecologia* 141:713-721.

Minckley, W. L., and D.K. Duncan. 1997. Environmental Assessment and Habitat Conservation Plan for issuance of an Endangered Species Act Section 10(a)(10(B) Permit for incidental take of

Yaqui chub (*Gila purpurea*) and other Rio Yaqui fishes for ranching and related activities on El Coronado Ranch and associated grazing allotments on West Turkey Creek, Cochise County, Arizona. Dep. Of Zool., Ariz. State Univ., Tempe; and Ecological Services, U.S. Fish and Wildlife Service, Phoenix. 33 p.

Minckley, W.L., and P.C. Marsh. 2009. Inland fishes of the Greater Southwest; chronicle of a vanishing biota. The University of Arizona Press. Tucson, Arizona. 426 p.

Stewart, D.R., M.J. Butler, G.M. Harris, L.A. Johnson, and W.R. Radke. 2017. Estimating abundance of endangered fish by eliminating bias from non-constant detectability. *Endangered Species Research* 32:187-201.

Stewart, D.R., M.J. Butler, L.A. Johnson, A. Cajero, A. N. Young, G.M. Harris. 2019. Efficacy of depletion models for estimating abundance of endangered fishes in streams. *Fisheries Research* 209: 208-217.

U.S. Fish and Wildlife Service. 1973. Endangered Species Act.

U.S. Fish and Wildlife Service. 1994a. Comprehensive management plan for San Bernardino National Wildlife Refuge and Leslie Canyon National Wildlife Refuge. U.S.D.I. Fish and Wildlife Service, Albuquerque, NM.

U.S. Fish and Wildlife Service. 1994b. Annual Narrative Report: Calendar Year 1994. San Bernardino and Leslie Canyon National Wildlife Refuges, Douglas, AZ.

U.S. Fish and Wildlife Service. 1995. Yaqui Fishes Recovery Plan. U.S.D.I. Fish and Wildlife Service, Albuquerque, New Mexico. 48 p.

U.S. Fish and Wildlife Service. 2012. Summary of Water Quality and Spring Connectivity for San Bernardino National Wildlife Refuge, Arizona. 5 p.

Varela-Romero, A., J. Campoy-Favela, and L. Juarez-Romero. 1992. Fishes of the rios Mayo and Fuerte basins, Sonora and Sinaloa, Mexico. *Proc. Desert Fishes Council* 22(1990):70-71 (abstr.).

## **APPENDIX A – SUMMARY OF PUBLIC, PARTNER, AND PEER REVIEW COMMENTS RECEIVED**

### **Summary of Public Comments**

We published a notice of availability in the *Federal Register* on June 27, 2019 (84 FR 30764-30768) to announce that the draft amendment for the Fishes of the Rio Yaqui Recovery Plan (Recovery Plan), specific to the Yaqui chub (*Gila ourporea*), was available for public review, and to solicit comments by the scientific community, State and Federal agencies, Tribal governments, and other interested parties on the general information base, assumptions, and conclusions presented in the draft amendment. An electronic version of the draft recovery plan amendment was also posted on the Service's Species Profile website: <https://ecos.fws.gov/ecp0/profile/speciesProfile?slId=3414#recovery>

The Service received one response to the request for public comments from the Western Watershed Project.

Public comments ranged from providing minor editorial suggestions to specific recommendations on the amendment content. We have considered all substantive comments; we thank the reviewers for these comments. In general, these comments suggested moderate revisions to the Recovery Plan amendment, leading to increased utility and clarity of the recommendations. These comments that we incorporated as changes into the final Recovery Plan amendment did not warrant an explicit response and, thus, are not presented here.

### **Summary of Peer and Partner Review Comments**

In accordance with the Act, we solicited independent peer review of the draft amendment from qualified representatives from academic and scientific groups. Criteria used for selecting peer reviewers included their demonstrated expertise and specialized knowledge related to Yaqui chub, desert stream ecology, endangered species management, and threats facing desert wetland ecosystems. The qualifications of the peer reviewers are in the decision file and the administrative record for this Recovery Plan amendment.

We received comments from two peer reviewers, a retired USFWS biologist and a representative from Defenders of Wildlife. In general, the draft amendment was well-received by the reviewers and garnered positive constructive comments. Reviewers provided additional specific information, including information on the status of Yaqui chub in Mexico; we thank the reviewers for these data and we have added the information where appropriate.

We considered all substantive comments, and to the extent appropriate, we incorporated the applicable information or suggested changes into the final Recovery Plan amendment. Below, we provide a summary of specific comments received from peer reviewers with our responses;

however, we addressed many of the reviewers' specific critiques and incorporated their suggestions as changes to the final amendment. Such comments did not warrant an explicit response, and as such, are not addressed here. We appreciate the input from all commenters, which helped us to consider and incorporate the best available scientific and commercial information during development and approval of the final Recovery Plan amendment.

*Peer Review Comment (1):* The commenter suggested clarifying stream names within the Rio Yaqui watershed and provided information about the status of Yaqui chub in Sonora, Mexico.

*Response:* We incorporated consistency in river and stream names, as some have both official and local names that were used interchangeably within the document. Additionally, we included information about Yaqui chub local population locations and status in Mexico. Although we have no jurisdiction over the management of these population, including this information allowed for a more comprehensive account of the species status.

*Peer Review Comment (2):* The commenter suggested adding information about the number of years that the local Yaqui chub populations should be self-sustaining and the occurrence of temporary extirpations, and also suggested that lands and water rights of the upper Rio Yaqui of the San Bernardino Valley be permanently protected by some legal mechanism

*Response:* We revised the delisting criteria in the final amendment to include the number of years populations should be self-sustaining and we better explained the dynamic nature of the populations by adding a condition to address temporary extirpations that occur frequently with Yaqui chub. We did not include the suggested criteria of requiring all lands and water rights to be permanently protected as this criteria is already required for downlisting the Yaqui chub.

*Peer Review Comment (3):* The commenter expressed concern about the extent of livestock overgrazing and the security of Sonoran Yaqui chub populations.

*Response:* We added information in the final amendment about the Malpai Borderlands Group (MBG) which includes the landowners adjacent to San Bernardino NWR, and discussed how land management decisions are based on the Malpai Borderlands Group Habitat Conservation Plan (MBGHCP) created by this group with Service personnel involvement. No overgrazing occurs because the MBGHCP does not allow for this practice. Further, lands adjacent to the San Bernardino NWR have habitat protection in place (i.e. conservation easements, safe harbor agreements, etc.). We also included a statement that the Rancho San Bernardino is the only location in Mexico where populations of Yaqui chub occur, and this landowner is also a member of the MBG.