Supplemental Finding for Sonora Chub Recovery Plan

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BACKGROUND INFORMATION

Section 4(f)(1)(B)(ii) of the Endangered Species Act (Act) 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." It is possible that for some species, however, delisting cannot be foreseen at the time a recovery plan is written. In some rare cases, the best available information is so seriously limited that it is truly not possible to identify delisting criteria. This would be an unusual case, such as one in which the species' threats are not understood well enough to identify priorities and appropriate actions to remove (or offset) the threats. For example, the natural habitat may have been so reduced for an endangered species that captive propagation and active management is necessary for the life of a reasonable recovery plan. In another example, the population of a long-lived, slow growing species may be so depleted that possible recovery may be beyond the life of a reasonable recovery plan.

A 2006 Government Accountability Office (GAO) audit of the National Marine Fisheries Service's (NMFS) and U.S. Fish and Wildlife Service's (USFWS) endangered species recovery programs recommended that the Secretaries of the Department of Commerce and the Interior direct their staff to ensure that all new and revised recovery plans have either recovery criteria evidencing consideration of all five delisting factors or a statement regarding why it is impracticable to do so (GAO 2006). Since the 2006 GAO audit, we have updated our recovery planning and implementation guidance (NMFS and USFWS 2010), and new plans have included determinations regarding the feasibility or possibility of incorporating delisting criteria related to each of the five factors, as recommended by the GAO. Active recovery plans remain, however, that lack delisting criteria and contain either an incomplete determination regarding the practicability of incorporating delisting criteria, or are silent about the absence of delisting criteria in the recovery plan. In this document, we clarify why it remains impracticable to incorporate delisting criteria for Sonora chub (*Gila ditaenia*) in the Sonora Chub Recovery Plan (Recovery Plan).

METHODOLOGY USED TO COMPLETE THE FINDING

The Arizona Ecological Services Office (AESO) staff conducted the review, incorporating information from: (1) the April 30, 1986, Final Rule to Determine the Sonora Chub to be a Threatened Species and to Determine its Critical Habitat (50 FR 16042-16047); (2) the 1992 Recovery Plan (USFWS 1992); (3) the August 2013 Sonora chub/Charalito Sonorense (*Gila ditaenia*) 5-Year Review: Summary and Evaluation (USFWS 2013); and (4) other published and unpublished sources (see References section, below) .

The narrative contained in the Finding section, below, will first address the factors that are affecting Sonora chub and which render it unlikely that the species can be delisted. This is followed by an analysis wherein we conclude that the development of measurable, objective recovery criteria is not practicable.

FINDING

Threats

The 1992 Recovery Plan found that delisting the threatened Sonora chub was unlikely to occur due to presence of: 1) non-native species, 2) degradation of habitat, and 3) continued demand for water for human consumption which, together, are the three primary threats to the species. We have reviewed the available information and have concluded that delisting the Sonora chub remains unlikely due to the ongoing existence of the threats described above as well as the emergence of new threats under the non-native species and degradation of habitat categories. The 2013 5-Year Review (USFWS 2013) reevaluated the aforementioned threats, found that the status of the Sonora chub was unlikely to have measurably declined or improved since 1984, and thus determined that the species should maintain its threatened status.

With respect to the low likelihood that Sonora chub can be delisted, we first make note of the unmet status of Recovery Objectives that pertain to presence of non-native species, degradation of habitat, and continued demand for water for human consumption.

1 – Non-native species: Non-native fishes have not been removed permanently (Objective I, Task B). In Arizona, non-native, predatory and competitive bluegill (*Lepomis macrochirus*) have been found in California Gulch and nearby lakes. The potential sources of these fish are private tanks and ponds in upstream areas. Complete extirpation of these fish has not been successful, but some gains may be realized with ongoing management. In Sonora, Hendrickson and Juarez-Romero (1990) observed bluegill, green sunfish (*Lepomis cyanellus*), and black bullhead (*Ameiurus melas*) with the Sonora chub on the Rio Magdalena, however it is unknown if any non-native species management actions are being implemented in Mexico, but we feel it is unlikely and/or experiencing the same lack of success noted in efforts in the United States.

Asian tapeworm (*Bothriocephalus acheilognathi*) is a parasitic cestode for which fishes are the definitive host. Asian tapeworms are not host-specific and can therefore move between similar and dissimilar taxa. We are not aware of any studies of the effects of Asian tapeworm infestation on Sonora chub. Kline (2007) found that Asian tapeworm infestations of Yaqui chub (*G.*

purpurea, a congener of *G. ditaenia*) can cause intestinal blockage and a reduced growth rate, though infestation did not result in high mortality.

The threat posed by Asian tapeworm manifests through both the presence on non-native and native fishes. One hypothetical vector for the non-host-specific Asian tapeworm to reach the range of Sonora chub is through non-native fish that may be moved between infested and non-infested watersheds in the U.S. and Mexico. For example, bluegill have been reported in California Gulch, yet the origin of these individuals is unknown. Information from Arizona Game and Fish Department (AZGFD) stocking records does not indicate bluegills were ever stocked by AZGFD into either nearby recreational lake (Arivaca or Peña Blanca lakes), but they were reported to be present in those waters (USFWS 2011b). There are tanks and private lakes in the upper portions of the Sycamore Creek and California Gulch watershed that may also be sources of these and other non-native fish found (USFWS 2001, USFWS 2011b). Again, non-native bluegill, green sunfish, and black bullhead fishes co-occur with Sonora chub on the Rio Magdalena in Mexico (Hendrickson and Juarez-Romero 1990). The potential for cestode infestations of Sonora chub by these non-natives of uncertain origin and health is a threat not previously evaluated.

A second hypothetical vector for Asian tapeworm to reach the range of Sonora chub is through other native fishes in Mexico. Asian tapeworm has been found in other fishes in the genus *Gila* throughout the American Southwest (Miller *et al.* 2005); the potential for the Sonora chub to be exposed is high. The presence of Asian tapeworm in fishes of the Río Yaqui watershed, including the Yaqui chub (a congener of Sonora chub), represents new information to the USFWS regarding disease or predation (Miller *et al.* 2005, Kline 2007). Yaqui chub is present only in the headwaters of the Rio Yaqui but is sympatric with desert chub (*G. eremica*) in downstream reaches. Desert chub are also present in the Río Sonora (Miller *et al.* 2005), a watershed in which Sonora chub also occurs.

In terms of competition and predation, non-native and other native fish have been present in the range of the Sonora chub habitat for years (USFWS 2012a). While the presence of non-natives increases competition for resources and possibility of predation, Sonora chub have persisted in numbers great enough to remain present in Sycamore Canyon and California Gulch and survive in an environment where conditions are dynamic (USFWS 2012a). We have no information regarding the current status of Sonora chub's co-occurrence with competitive and predatory non-native fishes in Mexico.

In terms of Asian tapeworm infestation, we concluded in the 2013 5-Year Review (USFWS 2013) that that while the risk of Asian tapeworm infestation is high for Sonora chub, the level of threat is low because mortality in a similar species (Yaqui chub) is low. We have no information regarding the effects of Asian tapeworm infestation on Sonora chub in Mexico.

Sonora chub have persisted with the competition, predation, and increased risk of Asian tapeworm infestation (if such infestation is not already endemic) in a climatically and hydrologically dynamic ecosystem. Climate change impacts are likely to increase the dynamism of Sonora chub habitat (see discussion, below), which could reduce shared resources between non-native fishes and Sonora chub, thus increasing the effects of competition, predation, and/or Asian tapeworm infestation.

2 – Habitat degradation: The second threat identified in the 1992 Recovery Plan that was likely to preclude delisting of Sonora chub is degradation of habitat. Degradation of habitat is a threat of wide scope, and has only been partially addressed. Furthermore, additional threats have emerged since the publication of the 1992 Recovery Plan.

Critical habitat (Objective I, Task A) has been recognized, and designated along Sycamore Creek (USFWS 1986). Sonora chub were not known to be present in California Gulch at the time critical habitat was designated and thus the stream has no critical habitat. The role of critical habitat in protection of habitat degradation is through interagency consultation under section 7 of the Endangered Species Act, during which federally funded or permitted actions are subject to a review to ensure critical habitat is not adversely modified or destroyed (i.e. affected to such a degree that the recovery potential of Sonora chub is appreciably reduced). Federally permitted or funded actions that degrade Sonora chub habitat, but do not rise to the level of destruction or adverse modification of critical habitat, can and do occur.

Objective 1, Task D refers to the incorporation of Sonora chub management needs into the respective management plans for the Goodding Research Natural Area and Pajarita Wilderness. Neither plan contains specific protections for Sonora chub. Broad conservation objectives are included in the Coronado National Forest (CNF) Land and Resource Management Plan (LRMP) and wilderness areas prohibit motorized or mechanized vehicle use. These documents do not directly prevent habitat degradation, but do ensure the needs of Sonora chub are considered during the planning for individual projects conducted under the umbrella of the LRMP.

Ensuring habitat integrity (Objective 1, Task E) is typically implemented by the Coronado National Forest (CNF), which encompasses the entire range of the species in the U.S. The adverse and beneficial effects of the CNF's actions are analyzed in section 7 consultations, as described above. The 5-Year Review (USFWS 2013) discussed the beneficial effects of the elimination of livestock grazing from the riparian corridor of Sycamore Canyon, and in portions of the riparian corridor of California Gulch (USFWS) 2012a]. A bridge has been constructed to replace Ruby Road's low water crossing (a source of direct mortality to Sonora chub and a source of sedimentation in downstream reaches). Roadways in Sycamore Canyon south of Ruby Road have been closed to traffic and off-highway vehicles (OHV) (USFWS 2012a), further minimizing sedimentation of the stream. In addition, CNF and the USFWS agreed to establish a buffer area around waterways to prevent the entry of toxic fire retardant into Sonora chub habitat (USFWS 2011a).

New sources of Sonora chub habitat degradation have emerged since the 1992 Recovery Plan. The 2013 5-Year Review (USFWS 2013) discusses new threats posed by Department of Homeland Security (DHS) activities along the U.S. and Mexico border, but these are typically addressed in interagency consultation under the Endangered Species Act. The deposition of trash, development of new trails from human traffic, soil compaction and erosion, and increased fire risk associated with cross-border activities, which are not subject to consultation, are not minimized in any way.

Climate change represents the most serious, and to date unmitigated threat (and mechanism of habitat degradation) to Sonora chub. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and

variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a).

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (Meehl *et al*. 2007, Ganguly *et al*. 2009, Prinn *et al*. 2011). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2007a, Meehl *et al*. 2007, Ganguly *et al*. 2009, Prinn *et al*. 2011). (See IPCC 2007b and IPCC 2014 for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation. Also see IPCC 2007a and IPCC 2014 for a summary of observations and projections of extreme climate events.)

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007b). Identifying likely effects often involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007a, Glick *et al.* 2011). There is no single method for conducting such analyses that applies to all situations (Glick *et al.* 2011). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. Although many species already listed as endangered or threatened may be particularly vulnerable to negative effects related to changes in climate, we also recognize that, for some listed species, the likely effects may be positive or neutral. In any case, the identification of effective recovery strategies and actions for recovery plans, as well as assessment of their results in 5-year reviews, should include consideration of climate-related changes and interactions of climate and other variables. These analyses also may contribute to evaluating whether an endangered species can be reclassified as threatened, or whether a threatened species can be delisted.

Projections presented for the Southwest speculate warmer, drier, and more drought-like conditions (Hoerling and Eischeid 2007, Seager *et al.* 2007). For example, simulations from the Palmer Drought Severity Index, a calculation of the cumulative effects of precipitation and temperature on surface moisture balance, for the Southwest show an increase in drought severity with surface warming. Furthermore drought severity will increase even under wetter condition simulations because of the effect of heat-related moisture loss through evaporation and evapotranspiration (Hoerling and Eischeid 2007). Tree ring data suggests that the drought over the last decade in the western U.S.

represents the driest conditions in 800 years (Karl *et al*. 2008, Schwalm *et al.* 2012). Overall annual mean precipitation is likely to decrease in the Southwest, as well as the length of the snow season, and the snow depth (IPCC 2007b). Temperatures in the Southwest are projected to rise by 2.5 to 3.9° C (4.5 to 7° F) during this century (IPCC 2007a). This rate of 0.56° C (1.0° F) every 14 years has already been surpassed by Arizona since the 1970s (Lenart *et al*. 2007). Lastly, the magnitude and/or frequency of floods may increase under anticipated changes in climate (Gershunov *et al*. 2013).Changes in temperature (Weiss and Overpeck 2005) and stream flow (Seager *et al*. 2007) are anticipated to reduce the amount of habitat available to the Sonora chub within the United States, worsen habitat conditions throughout the species' range, strengthen effects of other threats, and have both direct and indirect ecological impacts on the species. The effects of climate change, particularly those associated with drought and rising temperatures, have the potential to be a severe threat to the Sonora chub. Moreover, climate change, despite increasing drought conditions, is also anticipated to increase the incidence and/or magnitude of extreme weather events and subsequent flooding (Karl *et al.* 2009, Gershunov *et al*. 2013).

The 1992 Recovery Plan discusses the Sonora chub's persistence during both droughts and extreme floods, but these events were characterized as stochastic (randomly determined). As documented above, drought is now persistent and is no longer a random event. Flooding remains random but is anticipated to increase in magnitude and/or frequency. Sonora chub persisting at lower abundance in habitat reduced by drought will experience larger and/or more frequent floods that may further deplete the species' abundance and/or ability to recolonize upstream habitats after having been displaced to downstream reaches.

3 – Water consumption: The third threat identified in the 1992 Recovery Plan that was likely to preclude delisting of Sonora chub is the continued demand for water for human consumption; this threat has not been minimized and there is unlikely to a be a legal mechanism that would result in permanent protection from this threat.

The determination of water use patterns and protection of water rights (Objective I, Task C) has been implemented only to the extent that Sycamore Canyon and California Gulch were determined to be within the Tucson Active Management Area (AMA), managed by the Arizona Department of Water Resources (ADWR); which may issue permits to appropriate water for instream purposes. Presence of endangered or threatened species "may be a critical consideration in water resource management and supply development" according to ADWR (2012a). No instream flow water rights have been acquired and any such rights acquired in the future would be junior to existing consumptive surface water rights. Moreover, surface water and groundwater are not legally linked under Arizona law; groundwater pumping can therefore deplete surface waters regardless of surface water rights.

The 2013 5-Year Review synthesized the analysis of factors affecting Sonora chub by stating that threats faced by the Sonora chub at the time of listing and during the preparation of the recovery plan including habitat loss, non-native fishes and parasites, and water developments, continue to exist in both Sycamore Canyon and California Gulch. Cross-border incursions and the law enforcement response to them represent a factor that has been present since before the 1986 listing, and which continue to affect the species. Climate change, a threat not identified during listing and recovery planning, along with water development which was previously known, threaten to alter the hydrologic conditions which sustain the streams in which Sonora

chub occurs, potentially reducing the species' resilience and ability to persist through stochastic events such as drought and floods. Drought is becoming prevalent throughout the Southwest; as mean annual temperatures increase precipitation become more variable. As discussed in Section 2.3.1.6, drought conditions are ongoing, with 'severe drought' predicted for the south of Arizona (ADWR 2012b). The degradation, siltation, and water pollution caused primarily by livestock grazing within the riparian corridors, road construction, runoff from roads, construction of infrastructure, and repair of infrastructure, human use, and mining operations are determined to have potential adverse effects on the Sonora chub.

The Sonora chub is a desert fish adapted to the fluctuations of a desert environment; after drought conditions it has been known to rapidly expand and recolonize California Gulch and newly re-wetted reaches. If habitat conditions along water ways can be maintained, then this ability to respond to favorable water conditions is encouraging for the population to avoid the danger of extinction. Construction of roads or bridges as described above might have temporary adverse effects, but long-term effects can be beneficial to the chub if it reduces off road use. The use of fire retardant buffers around habitat will potentially minimize adverse effects from those chemicals, and potentially prevent severe fires from causing adverse habitat modifications. As described above, Sycamore Canyon and California Gulch are not suitable terrain for grazing, but effects have occurred from trespass cattle (USFWS 2012a). If consultations continue to evaluate and minimize the use of allotments upstream from Sonora chub habitat, adverse effects from siltation and water quality degradation can be kept to a minimum. Furthermore, if a catastrophic decline or an adverse take event occurs, the Arizona-Sonora Desert Museum (ASDM) population can serve as a source of fish to repopulate the area once the habitat returns to favorable conditions. Given that there are two known wild populations within the U.S., a captive population, designated critical habitat, and the threats against the population can be managed with possible response procedures, the Sonora chub meets the definition of threatened for the foreseeable future.

The 2013 5-Year Review's (USFWS 2013) underlying conclusion based on the history of survey work, and our understanding of impacts is that the status of the Sonora chub was unlikely to have measurably declined or improved since 1984 and should maintain the designated threatened status, as a species in danger of becoming endangered.

The preceding paragraphs demonstrate why delisting of Sonora chub was unlikely at the time of the 1992 Recovery Plan, and why it remains so today; the three major threats (non-native species, habitat degradation, and continued demand for water for human consumption) have not been adequately mitigated and new threats have emerged. This analysis was undertaken, in part, to frame the subsequent narrative, which will address why we feel that it is impracticable (i.e., not possible or not feasible) to establish delisting criteria relative to the Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms).

<u>Recovery Criteria</u>

Practicability

We reviewed the 1986 Final Rule, the 1992 Recovery Plan, the 2013 5-Year Review, and other available information and determined that it is not presently practicable to develop objective,

quantifiable recovery criteria at this time. Our rationale is based primarily on the lack of data, which, in turn, is a consequence of the incomplete implementation (and in cases, non-implementation) of the Recovery Objectives in the 1992 Recovery Plan. The 1992 Recovery Plan, having determined that delisting of the Sonora chub was unlikely due to unmitigated threats, included Recovery Objectives in lieu of Recovery Criteria. In the 1992 plan, recovery objectives were created to fill in knowledge gaps due to a lack of information concerning: the species range and status of the populations (including the development of a monitoring protocol), overall life history of the species, occurrence of predation or competition, habitat needs, genetic variability, and taxonomy. This indicates that these critical variables to understanding the species were absent when the recovery plan was written. Moreover, we now believe that 95% of the species range occurs in Mexico, and data from Mexico continues to be sparse. The status of implementation of the full suite of the 1992 Recovery Plan's Recovery Objectives appears in the 2013 5-Year Review. Because the majority of the recovery plan objectives have yet to be completed, we continue to lack the information necessary to craft measureable and objective recovery criteria.

The following narrative will focus only on the Recovery Objectives that, if implemented, might generate potentially quantifiable data. Quantifiable data could then conceivably be used to develop objective, quantifiable Recovery Criteria in the future.

Recovery Objective I is to protect remaining populations of Sonora chub, and was proposed to be implemented via the completion of a series of Sub-Tasks.

Recovery Objective I, Task F, is to survey all existing and potential Sonora chub habitat. Implementation of this Task is intermittent and not systematic. The Coronado National Forest (CNF) intermittently completes monitoring in Sycamore Canyon and California Gulch. The surveys are presence- or absence-based; they do not count the individual fish, but do provide general information on population dynamics. In Sonora, the Rio de La Concepcion was last surveyed in 1990, and the Rio Cocospera at Rancho el Aribabi was last surveyed in 2006 (Duncan 2006). Both of these surveys verified the presence of Sonora chub; however, the number of individuals was not known. Additional surveys of these sites are needed to develop an estimate of population size and trends in habitat suitability. There are no available surveys regarding population estimates from the Arizona Game and Fish Department (AZGFD), academic researchers, or consulting biologists. As noted elsewhere in this document, there is a safety concern associated with surveying for Sonora chub in its native range. The canyons where Sonora chub occurs in the U.S. (California Gulch/Warsaw Canyon and Sycamore Creek) are known routes for drug traffickers and undeclared immigrants; therefore, border security issues make it difficult to monitor Sonora chub populations. As a result, recent population surveys in California Gulch have generally been limited to simple inspections for the presence or absence of the species in a major pool near a small dam structure in the upper reaches of the stream and, occasionally, other sites in which water persists (USFWS 2012b). We anticipate that cartel-related smuggling activities present a similar challenge along the border in Sonora, but we do not know if similar safety issues exist further south in the species' range.

The absence of rigorous surveys or demographic data throughout the known (and potential) range of Sonora chub renders it impossible to develop objective, measurable criteria related to

determining the extent of habitat occupied by the species, and whether the species range is contracting, remaining static, or expanding.

Recovery Objective II is to monitor and assess Sonora chub population dynamics. A series of Sub-Tasks, once completed, would result in the implementation of the Recovery Objective.

Recovery Objective II, Task A is to establish standardized monitoring techniques for Sonora chub and its habitat. The absence of standardized protocols for Sonora chub, combined with the intermittent survey frequency noted in the preceding section, have led to a data set that cannot be analyzed to determine the species' status and trends in abundance. Similarly, the absence of a standardized habitat survey technique means that we cannot adequately describe the physical (i.e. hydrologic and geomorphic) and biological characteristics necessary to determine Sonora chub's habitat requirements and subsequently, to determine if habitat is becoming less suitable, is in stasis, or is improving. The cross-border safety issue discussed in the preceding section applies here as well; it may prove difficult to implement standardized monitoring techniques for Sonora chub and its habitat, even if such techniques were to be developed. We are thus presently incapable of developing objective, measurable criteria for this sub-task.

Recovery Objective II, Sub-Task B directs the assessment of Sonora chub population dynamics by conducting research and monitoring in order to understand the biology of the species. Completion of this Sub-Task could result in a data set, the interpretation and modeling of which could result in the development of objective, measurable criteria.

Recovery Objective II, Sub-tasks B1 through B6 are to assess Sonora chub's population dynamics by determining reproductive variables; the effects of predation and competition; survivorship by age group; disease and parasites; diet; seasonal, and annual distribution of life stages; and other factors pertinent to perpetuation of Sonora chub. These sub-tasks require data that could only be collected via the implementation of Recovery Objective I, Sub-task A (the establishment of standardized monitoring techniques for Sonora chub and its habitat). Sub-tasks B1 through B6 are therefore presently impracticable and, absent the data their implementation might provide over multiple years of collection, we cannot presently develop objective, measurable criteria for them.

Recovery Objective II, Task C, is the assessment of Sonora chub habitat dynamics. Sub-tasks C1 through C3 are to assess habitat dynamics by determining fish-habitat relationships, precipitation-runoff relationships, and the relationships of runoff-instream flow needs. Successful implementation of sub-tasks C1 (determination of Sonora chub-habitat relationships) and C3 (evaluation of relationships of runoff to the instream flow needs of Sonora chub) require the implementation of Sub-task A (the establishment of standardized monitoring techniques for Sonora chub and its habitat). Implementation of sub-tasks C1 and C3 are therefore impracticable and, without the data these sub-tasks' implementation might provide over multiple years of collection, we cannot presently develop objective, measurable criteria for them. Sub-task C2, the determination of precipitation-runoff needs, can be implemented absent fish and/or habitat data. Data regarding the manner in which changes in climate affect hydrology are meaningless; however, unless they can be examined for correlation with Sonora chub abundance, distribution, life history and/or the species' physical habitat. Again, absent implementation of Sub-task A

(standardized monitoring techniques for Sonora chub and its habitat), it is not practicable to attempt to determine precipitation-runoff relationships.

Recovery Objective III is the maintenance of captive reserves of Sonora chub, and is to be implemented by two sub-tasks. Sub-Task A directs the establishment of captive reserve populations of Sonora chub and Sub-Task B directs the determination of the genetic variability of the species.

A captive population (Sub-Task A) has been established at the ASDM, and wild fish collected by AGFD periodically supplement this population. The population at Yank's Spring is physically separate from Sycamore Canyon proper and could be supplemented by additional wild fish, but is not truly captive and is not protected from perturbations.

Sub-Task B, the determination of Sonora chub's genetic variability is categorized under the captive reserve Recovery Objective (III), stating that in order to maintain genetic diversity in a captive stock of Sonora chub, it is necessary to first determine the genetic composition of existing wild stocks. The need to determine the genetic composition of wild stocks is also crucial for the species' overall conservation in the wild. In particular, the status of Sonora chub could be affected by the presence of an undescribed *Gila* (previously identified as *G. purpurea*, the Yaqui chub), which is syntopic and hybridizing locally with *G. ditaenia* near La Atascosa, Sonora, Mexico (Miller *et al*. 2005, DeMarais and Minckley 1992, Hendrickson 1983). Absent definitive genetic data, we cannot determine if Sonora chub and the unidentified Gila are distinct species with a genus or sub-genus and if hybridization is occurring and threatening Sonora chub. Moreover, genetic and morphometric data would help elicit if Sonora chub exists as a cryptic species within a large complex of closely-related Gila and/or is a clinal variation based on the increases in watershed area and scale of aquatic habitat between headwater reaches in U.S. versus larger waters in Mexico.

At present, the absence of genetic data renders it impossible to know if the captive population represents the taxon's natural variation. Moreover, without knowing the variation within Sonora chub and the undescribed *Gila* with which it co-occurs in Mexico, we cannot ensure that Recovery Objectives I and II, described above, are conducted in an efficient manner (i.e. Sonora chub should be surveyed without confounding data from other *Gila*). Conversely, the absence of rigorous surveys throughout the known (and potential) range of Sonora chub (see Recovery Objective I, Task F, above) means that the wide-ranging sampling necessary to determine genetic variation is not occurring.

In summary, we have reviewed the present, incomplete implementation of the 1992 Sonora Chub Recovery Plan's Recovery Objectives and have determined that the resultant absence of data regarding the biology and habitat of Sonora chub render it not practicable to develop objective, quantifiable Recovery Criteria at this time.

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