# HUMPBACK CHUB HATCHERY EVALUATION: PROSPECTIVE REFUGE FACILITIES

Mike Childs
Arizona Game and Fish Department
Research Branch

May 2005

Heritage Program
Arizona Game and Fish Department

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Cover Photo: Humpback chub by Matt Lauretta, SWCA, Flagstaff.

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## INTRODUCTION

The purpose of this project is to evaluate hatcheries, aquariums, and established refuge facilities within the United States as potential refuge locations for humpback chub (*Gila cypha*) from Grand Canyon. This is not to be considered an evaluation of potential broodstock facilities, and any recommendation contained within this report for use of a given facility as a refuge for humpback chub should not be considered as an endorsement for developing a broodstock program, or for reintroduction of incidental progeny into the wild. Moreover, the Arizona Game and Fish Department (AGFD) does not endorse initiating any form of captive or controlled propagation of Grand Canyon humpback chub at this time. Thus, the proposed work should be considered exempt from U. S. Fish and Wildlife Service "Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act" (USFWS 2000). Regardless, all of the safeguards recommended in that Policy should be followed, so as to protect the genetic integrity of wild humpback chub.

If catastrophic loss of the wild humpback chub population in Grand Canyon were to occur, a detailed broodstock management plan would have to be developed, and compliance with the aforementioned federal Policy would have to be documented, in order to make use of the proposed refuge population for production and repatriation into the wild.

The U.S. Fish and Wildlife Service (Van Haverbeke and Simmonds Jr. 2004) evaluated several options for protecting and/or enhancing the wild population of humpback chub in Grand Canyon. Options considered include 1) establishing a captive broodstock program, 2) captive grow-out of wild caught age-0 humpback chub to release into the wild, and 3) augmenting the wild population via translocation. So far, the only option acted upon is translocation of humpback chub within the Little Colorado River (LCR) (above a purported natural barrier). All considered options pose some genetic risk to the wild population, either through genetic drift, inbreeding, or artificial selection within a hatchery facility, each of which could cause a reduction of genetic effective population size. The translocation of humpback chub upstream within the LCR should be genetically monitored to ensure that this newly established population does not adversely affect the genetic structure of the wild population downstream.

Given the genetic risks mentioned above, the option least likely to cause detrimental impacts to the wild population would be the establishment of a captive refuge population. The Arizona Game and Fish Department proposes to capture one hundred age-0 fish from the LCR in Grand Canyon during Summer/Fall 2005. The fish will be transported to a facility that has demonstrated an ability to manage refuge populations, and that agrees not to reintroduce incidental F1 progeny produced by the captive population into the wild. As mentioned above, catastrophic loss of the wild population would open the door to discussions regarding use of the captive population as broodstock.

Evaluation of facilities across the country for use as potential humpback chub refuge facilities follows. Subjective evaluations of each facility are presented in Table 1, and Appendices 1-9 include responses provided by persons of authority from each facility.

## RESULTS AND DISCUSSION

The following facilities are discussed in descending order, from best available facilities to those least likely to be useful for protecting a refuge population of humpback chub.

### Mora National Fish Hatchery
### (Score 133)

Mora National Fish Hatchery (Figure 1) is a federal hatchery located 30 miles north of Las Vegas, NM. It is an indoor recirculating system, and all tanks and raceways are filled

**Figure 1. Mora National Fish Hatchery, indoor recirculating facility, Mora, New Mexico.**

with well water. Only two species are currently housed on station: Gila trout and rainbow trout. The facility is presently disease-free, and a good deal of space is available, both in circular tanks (10' dia X 5' depth; Figure 2) that can be operated


**Figure 2. Circular tank at Mora facility.**

independently from the rest of the recirculating system, and in 10' X 50' fiberglass raceways (Figure 3). The facility

**Figure 3. Linear raceways at Mora facility.**

is not in a floodplain, it is secure from wildlife and the public, and enough space is available for replication of a captive humpback chub population. Mora has a quarantine facility (Figure 4) available for treating wild fish, there are no congeners of

**Figure 4. Quarantine tanks at Mora facility.**

humpback chub present, and the staff is experienced handling endangered species. Water quality is excellent, and the entire facility is monitored by sensors 24 hours/day that are connected to a computer software system (Figure 5). An alarm system exists that will notify employees if power is lost to the facility, and employees live on station

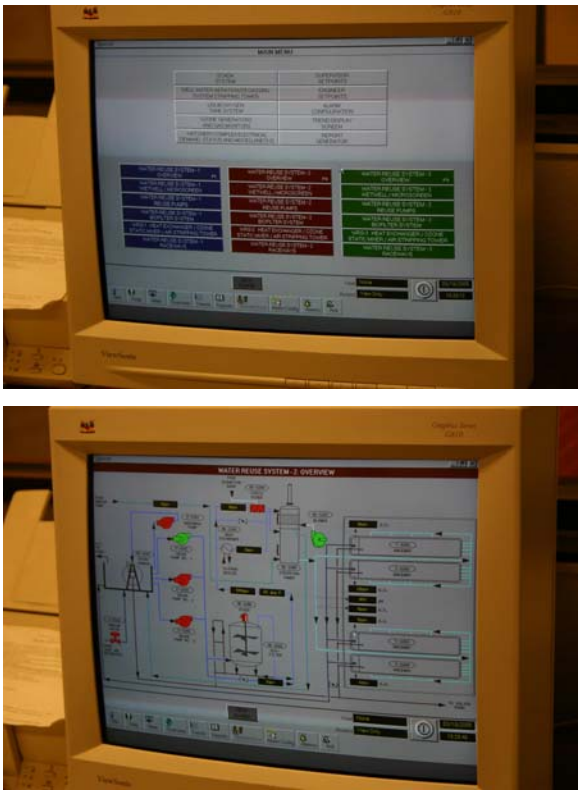

**Figure 5. Monitoring software at Mora facility.**

for added security and safety. The only contingency regarding use of this facility as a humpback chub refuge is lack of funding for labor, food, utilities, and chemical treatments (if necessary). The cost of housing humpback chub (minimum 100 adults) will have to be negotiated with the Fish and Wildlife Service, Region II (Albuquerque).

**Hualapai Tribe, Peach Springs, Arizona (Score 128)**

The Peach Springs Facility (Figure 6) is located on Hualapai land near Peach Springs, Arizona. The facility can be run as flow-through or reuse, and ponds can be

**Figure 6. Hualapai facility, Peach Springs, Arizona.**

isolated from one another. Ponds (Figure 7) and raceways are filled with well water, and source water is therefore pathogen-free. In addition, ponds are lined with 20-mil polyethylene to conserve water. Unlike Mora, the facility is outdoors and therefore susceptible to some predators. Operators of the facility, however, are planning to install bird netting to keep bird predators away from fish. At present, the facility does not include any form of quarantine for wild fish or climate control for storage of food or chemicals, but additions are being made. One drawback to the facility is the potential to hold congeners of humpback chub in the future (roundtail chub). This could allow for

**Figure 7. Outdoor ponds at Hualapai facility.**

potential hybridization between these species. In addition, because the facility is still under construction, there are presently no employees living on-station. The operators of the facility, however, show interest in cost sharing, regarding providing refuge for humpback chub.

**Bubbling Ponds Refuge Facility (Score 124)**

The Central Arizona Project Fund Transfer Program has provided funding to AGFD for the design and construction of a new refuge facility at Bubbling Ponds Hatchery. The facility will use a newly drilled artesian well (80 gpm), will be run primarily as a flow-through system with 24 500 gal tanks, and will house threatened and endangered species from the Gila River basin. Although the facility will provide refuge for species

such as Gila topminnow, desert pupfish, spikedace, and loach minnow, some space should be available for additional species, such as humpback chub. The source well water is pathogen-free and the facility will be secure from the public and from wildlife. However, since the facility will be located adjacent to Oak Creek, in the Verde River drainage, there is some concern about potential for escape of larvae, and eventual hybridization with roundtail chub in Oak Creek and Verde River. In addition, roundtail chub propagation may someday occur at Bubbling Ponds Hatchery, increasing the risk of genetic contamination. Power outages occur on occasion, and at present, there is no alarm system in place to alert hatchery personal. The site, however, has an adequate quarantine facility, and food and chemical storage is climate controlled.

**Wahweap Hatchery, Utah**

**(Score 116)**

Wahweap Hatchery (Figure 8) is located in southern Utah, near the town of Big Water. Located about 20 miles NW of Page, AZ, the hatchery ponds sit within the 25-year flood plain of Wahweap Creek (pers. comm.., Q. Bradwisch, Utah Division of Wildlife). This fact alone undermines use of the facility as a long-term refuge for humpback chub, despite relatively high scores for other aspects of the facility. One other drawback to use of Wahweap hatchery is the fact that it is located in the upper basin (above Glen Canyon Dam) and escape from the hatchery is possible, even without the occurrence of a 25-year flood. Other features of the facility can be reviewed in Appendix 8.

**Figure 8. Wahweap Hatchery, Big Water, Utah.**

**University of Arizona**

**(Score 108)**

The University of Arizona (Tucson Arizona) operates a small facility that uses well water in a reuse system. At present, the reuse water can be treated for pathogens with ultraviolet radiation and/or chemical treatments, but both solutions will require additional funding. Water quality is somewhat in question; if space is not available indoors (an option that depends both on building space and funding for

indoor tanks and plumbing), then fish would have to be held outdoors, where temperatures, pH, and dissolved oxygen levels could reach extremes. Costs for providing necessary indoor amenities could prove excessive. Finally, congeners are present, and will be present in the future. This would not likely pose a problem if humpback chub were held indoors, but if fish were moved outdoors, there would be the potential for predators to possibly mix congeners, resulting in unwanted hybridization.

**Willow Beach National Fish Hatchery (Score 107)**

Willow Beach National Fish Hatchery is located about 60 miles NW of Kingman, AZ, on the Colorado River. The facility pumps water directly from the Colorado River, and thus the source water is a potential source of pathogens. Furthermore, the facility uses reuse water, which adds to the potential for pathogen transfer. Escape of humpback chub from the hatchery, if it occurred, would pose minimal risk to the genetic integrity of wild humpback chub populations (as long as the number of escaped individuals was low) because the hatchery is located within the lower Colorado River basin. However, the hatchery currently has bonytail chub on station, so any fish held outdoors would be somewhat susceptible to transfer from pond to pond by predators, and thus some risk of hybridization might exist. Humpback chub are already being held indoors at Willow Beach Hatchery, and pending genetic characterization, this group of adult fish might be considered useful as an existing refuge population of humpback chub. If that turns out to be the case, it would be wise to add wild fish (perhaps 5% of the total number of adults) on an annual basis to increase the genetic diversity of the refuge population, and to replace adults as they become senescent. A 5% annual addition of adults would allow for a complete replacement of adults every 20 years, which is less than the total lifespan of this species.

**Dexter National Fish Hatchery (Score 106)**

The Dexter facility (Figure 9) is located approximately 20 miles SE of Roswell, NM, adjacent to the Pecos River. At present, there are 17 threatened and endangered species on station, including several congeners (bonytail chub, Chihuahua chub, Pahranagat roundtail chub, and Virgin River chub). Some humpback chub (F1 progeny produced at Willow Beach) are also being

held indoors at Dexter, along with some experimental hybrids between humpback

**Figure 9. Typical outdoor pond at Dexter facility.**

and bonytail chub. Thus, use of Dexter as a refuge facility for humpback chub is probably not wise. Regardless, even though Dexter has 72 outdoor ponds, no space is presently available for addition of another listed species.

### Bubbling Ponds Hatchery
### (Score 91)

Bubbling Ponds Hatchery is located about 5 miles north of Cornville, AZ. The facility consists of open ponds, some of which are lined, and a hatchery building that contains 5 linear raceways. The ponds are filled by means of flow-through water from artesian springs, located about ½ mile upstream. Water is channeled to the facility by means of an open ditch, which holds an abundant supply of mosquitofish, and which is therefore susceptible to pathogen transfer, particularly "Ich." The hatchery building is fed by a separate artesian spring that is isolated from the rest of the hatchery, and is therefore relatively pathogen-free. Unfortunately, both the ponds and the hatchery building empty directly into Oak Creek, where roundtail chub are present. The risk of escape and hybridization with roundtail chub is relatively high. In addition, roundtail chub may be held on station in the future and propagated, thus increasing the risk of unwanted hybridization between species. The facility is old and in relatively poor condition. Thus, unless a major renovation of Bubbling Ponds Hatchery occurs, the facility is not appropriate as a humpback chub refuge.

### Ouray National Wildlife Refuge
### (Score 91)

The Ouray facility is located in the upper Colorado River basin adjacent to the Green River. The facility is near a flood plain, and is fed by shallow, somewhat unreliable wells. Drains from ponds and tanks are interconnected (providing for possible mixing of species), and effluent is not screened to prevent escape of larval fish. No mechanism is currently in place to prevent pathogen transfer among tanks and ponds. Although no other chub species are

currently present on station, the potential exists for addition of congeners in the future. In addition, no staff live on station to handle emergency situations. Overall, the facility is probably not a good choice as a refuge for humpback chub, especially humpback chub from Grand Canyon (lower Colorado River basin).

**Silver Creek Hatchery**

**(Score 88)**

Silver Creek Hatchery is located in the LCR drainage, about 15 miles east of Show Low, Arizona. The hatchery is used primarily for trout production, but one pond exists for the purpose of holding and rearing threatened Little Colorado River spinedace. Although Silver Creek is part of the LCR drainage, there are no records of humpback chub from the upper portions of the LCR. The main factor weighing against use of Silver Creek Hatchery as a refuge for humpback chub is simply lack of space. Like several other prospective facilities, if funding becomes available to install ponds or tanks, then the feasibility of using this site would increase dramatically. However, the water source is not pathogen-free, so water quality would have to be remedied as well.

**Alchesay-Williams Creek National Fish Hatchery (Score 79)**

The Alchesay and Williams Creek facilities are located adjacent to the White River in eastern Arizona. Source water for the hatcheries comes directly from the river, and thus is not pathogen-free. In addition, the White River is in the Black/Salt River drainage, and thus escape from the hatchery would likely result in hybridization between humpback chub and other *Gila* species. Since both hatcheries are located within the White River flood plain, escape of any long-term refuge population would likely be inevitable. In addition, space is limiting, there is no mechanism at either site to prevent pathogen transfer, and no quarantine facility exists for bringing wild fish on station. Finally, the White Mountain Apache Tribe owns both the land and the water rights, and it is very unlikely that the Tribe would be willing to sign a legal agreement with the Arizona Game and Fish Commission. This site should therefore be rejected as a potential humpback chub refuge facility.

**Sipes Wildlife Area**

**(Score 66)**

The Sipes Wildlife Area is located approximately 5 miles SE of Springerville,

AZ, on land that is owned by the Arizona Game and Fish Commission. Rudd Creek flows through the property, and a series of ponds exist that catch and hold snowmelt runoff, when available. Flooding of the wetland areas is possible during high flows, but flow rates are unpredictable, as is the annual snowfall and subsequent runoff. Ponds occasionally become desiccated due to lack of precipitation. Like Silver Creek Hatchery, the Sipes Wildlife Area is located within the LCR drainage. However, the ponds are not built for fish culture, and the potential for escape during flooding is possible. Therefore, this site should be rejected as a potential humpback chub refuge.

**Achii Hanyo**

**(Score 61)**

Achii Hanyo is a remote and primitive fish culture area located on Colorado River Indian Tribes Land near Parker, AZ. The site suffers from poor drainage, it is not secure from the public or from wildlife, there is no mechanism to prevent pathogen transfer, and drain lines from tanks (indoor) are interconnected. There is no maintenance plan for the facility. Bonytail are already on station, so the potential for hybridization exists. Effluent from the facility is not screened to prevent escape of larval fish. Only one person runs the facility, and that person has less than ½ year of experience conducting fish culture. The source water for the facility comes from a canal (Colorado River water). Temperature fluctuations are extreme, and dissolved oxygen can be as low as 3.0 ppm. Known pathogens at Achii Hanyo include Columnaris, Ich, *Costia* and learnea. Due to the potential for hybridization, as well as environmental concerns, Achii Hanyo should not be considered appropriate as a refuge facility for humpback chub.

**SUMMARY**

The best available locations for establishing refuge populations of humpback chub appear to be the Mora National Fish Hatchery and the Hualapai Indian Peach Springs facility. In addition to providing 100 adult fish to the chosen facility(ies), at least 5 (5%) wild fish should be added to the captive refuge population on an annual basis, both to increase genetic diversity of the captive population, and to provide enough wild fish to completely replace the captive population every 20 years. In this way, the captive population can exist and be replenished for generations to come. It would also be wise to establish more than

one refuge population, to ensure the continued existence of humpback chub in captivity.

## LITERATURE CITED

United States Fish and Wildlife Service (USFWS). 2000. Policy regarding controlled propagation of species listed under the Endangered Species Act. Federal Register 65(183): 56916-56922.

Van Haverbeke, D. R. and R. L. Simmonds Jr. 2004. The feasibility of developing a program to augment the population of humpback chub (*Gila cypha*) in Grand Canyon. Final Report by the U.S. Fish and Wildlife Arizona Fishery Resources Office, Flagstaff. 64 pp.

Table. Score sheet for prospective humpback chub refuge facilities.

| Questions<br>Score = 0-4<br>4 = best<br>0 = worst<br>2 = neutral | Achii Hanyo (CRIT) | Alchesay | Bubbling Ponds* | Bubbling Ponds Refuge* | Dexter | Hualapai, Peach Springs | Mora Natl. Fish Hatchery | Ouray Natl. Fish Hatchery | Silver Creek Hatchery** | Sipes Wildlife Area** | University of Arizona | Wahweap Hatchery | Williams Creek | Willow Beach |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Land Ownership (long term) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Land size (protect water supply and treatment of effluent) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 3 |
| Gravity flow and aeration | 4 | 3 | 3 | 4 | 4 | 4 | 4 | 1 | 2 | 3 | 4 | 2 | 3 | 1 |
| Drainage from facility | 0 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 2 | 3 | 4 | 4 | 4 | 4 |
| Flood Plain | 4 | 0 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 4 | 0 | 0 | 4 |
| Lower Colorado River Basin | 4 | 0 | 2 | 2 | 2 | 4 | 2 | 0 | 4 | 4 | 4 | 1 | 0 | 4 |
| Adequate space (tanks, ponds) | 2 | 0 | 2 | 2 | 0 | 4 | 4 | 4 | 1 | 2 | 2 | 4 | 0 | 3 |
| Facility in good condition with maintenance plan and budget | 0 | 4 | 1 | 4 | 3 | 4 | 4 | 4 | 1 | 1 | 2 | 4 | 4 | 4 |
| Secure from public | 0 | 3 | 1 | 4 | 1 | 4 | 4 | 4 | 4 | 0 | 4 | 4 | 3 | 4 |
| Secure from predators | 0 | 2 | 1 | 4 | 1 | 3 | 4 | 1 | 2 | 1 | 4 | 3 | 2 | 4 |
| Reuse | 0 | 3 | 3 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 4 | 3 | 0 |
| Pathogen transfer protection | 0 | 0 | 0 | 4 | 4 | 3 | 2 | 0 | 0 | 0 | 2 | 4 | 0 | 4 |
| Replication (multiple ponds or tanks) | 0 | 0 | 2 | 4 | 4 | 4 | 4 | 2 | 0 | 4 | 4 | 4 | 0 | 3 |
| Easy access to ponds/tanks | 0 | 2 | 3 | 4 | 3 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 2 | 3 |
| Quarantine | 0 | 0 | 2 | 4 | 0 | 2 | 4 | 4 | 0 | 0 | 4 | 3 | 0 | 4 |
| Climate-controlled storage (food, chemicals) | 4 | 0 | 4 | 4 | 4 | 1 | 4 | 4 | 2 | 0 | 4 | 3 | 0 | 4 |
| Effluent treatment | 1 | 0 | 0 | 4 | 4 | 4 | 4 | 0 | 2 | 0 | 4 | 1 | 0 | 0 |
| Separate drain lines from tanks | 1 | 1 | 1 | 4 | 1 | 4 | 1 | 1 | 2 | 2 | 4 | 1 | 1 | 1 |
| Permits in hand for effluent | 2 | 4 | 4 | 4 | 2 | 3 | 4 | 3 | 2 | 1 | 4 | 4 | 4 | 2 |
| NEPA compliance needed | 2 | 1 | 1 | 1 | 3 | 4 | 4 | 4 | 2 | 2 | 3 | 3 | 1 | 3 |
| Congeners present | 0 | 2 | 0 | 2 | 0 | 4 | 4 | 4 | 4 | 4 | 0 | 0 | 2 | 0 |
| Congeners in future | 2 | 2 | 0 | 0 | 0 | 1 | 4 | 2 | 4 | 4 | 0 | 0 | 2 | 0 |
| Other refuge species present | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 4 | 4 | 4 |
| Staff on-station (housing) | 4 | 4 | 3 | 3 | 4 | 2 | 4 | 1 | 4 | 1 | 4 | 4 | 4 | 4 |
| 24 hour employees | 4 | 4 | 2 | 2 | 4 | 2 | 4 | 4 | 2 | 1 | 4 | 4 | 4 | 4 |
| Employees adequately trained (fish culture, pathogens) | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 0 | 4 | 4 | 4 | 4 |
| Water ownership (long term) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Pathogen-free water source | 0 | 0 | 0 | 4 | 4 | 4 | 4 | 2 | 0 | 0 | 4 | 4 | 0 | 0 |
| Water quantity sufficient | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 2 | 0 | 4 | 4 | 4 | 4 |

| Questions<br>Score = 0-4<br>4 = best<br>0 = worst<br>2 = neutral | Achii Hanyo (CRIT) | Alchesay | Bubbling Ponds* | Bubbling Ponds Refuge* | Dexter | Hualapai, Peach Springs | Mora Natl. Fish Hatchery | Ouray Natl. Fish Hatchery | Silver Creek Hatchery** | Sipes Wildlife Area** | University of Arizona | Wahweap Hatchery | Williams Creek | Willow Beach |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water reliability | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 0 | 4 | 4 | 4 | 4 |
| Water temperature (45-80F) | 0 | 2 | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 2 | 1 | 4 | 2 | 4 |
| Water pH (6.5-9.0) | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 1 | 4 | 4 | 4 |
| Water dissolved oxygen | 1 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 1 | 4 | 4 | 4 |
| Water dissolved nitrogen (100% saturation or less) | 2 | 2 | 4 | 4 | 2 | 4 | 4 | 2 | 4 | 2 | 1 | 4 | 2 | 4 |
| Funding available for meeting all minimum requirements | 1 | 0 | 2 | 2 | 0 | 3 | 2 | 0 | 2 | 0 | 0 | 3 | 0 | 0 |
| Will sign legal agreement | 0 | 0 | 4 | 4 | 4 | 4 | 4 | 0 | 4 | 3 | 3 | 4 | 0 | 4 |
| TOTALS | **61** | **79** | **91** | **124** | **106** | **128** | **133** | **91** | **88** | **66** | **108** | **116** | **79** | **107** |

* Personal observation

** Based on telephone interview.

Contacts

1. Achii Hanyo (CRIT): Chester Figiel; chester_figiel@fws.gov; (928)-767-3456
2. Alchesay Natl Fish Hatchery: Bob David; bob_david@fws.gov; (928)-338-4901
3. Bubbling Ponds Hatchery: Frank Agyagos; fagyagos@sedona.net; (928)-634-4466
4. Bubbling Ponds Refuge: Mike Childs; mchilds@sedona.net; (928)-639-1346
5. Dexter Natl Fish Hatchery: Manuel Ulibarri; manuel_ulibarri@fws.gov; (505)-734-5910
6. Hualapai (Peach Springs): Kerry Christensen; cuszhman@yahoo.com; (928)-769-2254
7. Mora Natl Fish Hatchery: John Seals; john_seals@fws.gov; (505)-387-6022 x13
8. Ouray Natl Fish Hatchery: Dave Irving; dave_irving@fws.gov; (435)-789-4078 x17
9. Silver Creek Hatchery: Mark Seversen; (928)-537-7513
10. Sipes Wildlife Area: Brian Crawford; (928)-587-2269
11. University of Arizona: Scott Bonar; sbonar@Ag.Arizona.Edu; (520)-621-1959
12. Wahweap Hatchery: Quent Bradwisch; quentbradwisch@utah.gov; (435)-675-3714
13. Williams Creek Natl Fish Hatchery: Bob David; bob_david@fws.gov; (928)-338-4901
14. Willow Beach Natl Fish Hatchery: Chester Figiel; chester_figiel@fws.gov; (928)-767-3456

Facilities already rejected:

1. Glen Canyon Dam; no space, poor access, cold water
2. Monterey Bay Aquarium; salt water only
3. Shedd Aquarium; renovating
4. Tennessee Aquarium; SE U.S. fish only
5. National Aquarium; no room at this time
6. Aquarium of Niagara Falls; some interest shown, but now unresponsive. Glenn Knowles (716)-285-3575 x 211
7. New Mexico silvery minnow facility. Capacity for 35-40 adult HBC. Dave Propst (505)-476-8103.
8. New Mexico, Glenwood Hatchery. Earthen ponds/raceways, escape likely. Dave Propst

**Appendix 1. Achii Hanyo response to questionnaire for prospective humpback chub refuge facilities.**

Please place answers in boxes. This is not a legally binding agreement. This questionnaire is designed to aid the Arizona Game and Fish Department in selecting a refuge facility for humpback chub from the LCR in Grand Canyon.

**Land**

Ownership

Who owns the land?

***Colorado River Indian Tribes***

Do you anticipate any changes in land ownership in the foreseeable future (50+ years)?

***No***

Is there enough land available for all facilities, protection of water supply, and treatment of effluent?

***yes***

Topography

Is there sufficient elevation between water source and holding facilities for aeration and gravity flow?

***yes***

If no, what is the means of water delivery, how is water aerated, and is the supply of water and aeration guaranteed?

Does the holding facility provide adequate drainage?

***no***

Is the land located in a flood plain, or other locality that could be flooded?

***no***

If yes, is it in the Colorado River basin where humpback chub occur?

If yes, is it in the upper or lower Colorado River basin?

**Existing Hatchery Facilities**

What is the existing space (number and volume) **available** as ponds, raceways, or tanks? Are they earthen, plastic-lined, fiberglass, or concrete?

***None – would need to be created***

What is the condition of the existing facility? How old are the holding ponds/tanks? How old is the plumbing? Do you have a maintenance plan and budget in place for the existing facility?

***Condition is primitive. No maintenance plan, budget is fluctuating***

Is the existing facility secure from the public? From livestock? From predators? If not, what control measures can be implemented?

***No, no, no, rear fish indoors at the facility***

Is the existing facility a recirculating or reuse system? If recirculating, is the facility equipped with biological, chemical, physical, and/or ultraviolet filtration? If reuse, is there any way to prevent pathogen transfer between ponds, tanks, or raceways?

***No***

Is replication available. In other words, can captive fish be held in separate, secure ponds or raceways, to avoid catastrophic loss of the species at the facility?

***No***

Can fish (larvae and adults) easily be retrieved from ponds, tanks, or raceways? By what means?

***No***

Do you have a quarantine facility, where wild fish and/or sick fish can be excluded from other fish and treated for external and internal pathogens?

***No***

Do you have a climate-controlled storage facility for fish food and therapeutic chemicals?

***Yes***

Effluent

Is effluent from existing facility screened to prevent both escape and entry of fish and pathogens? If no, can this be done expeditiously?

***No, yes***

Are drains from each pond, tank, or raceway interconnected?

***Yes***

Will permits be required for dealing with the effluent? If so, from whom? Do you foresee any problems obtaining permits, if necessary?

***No***

Do you anticipate the need for NEPA compliance? If so, how long will this process take?

***No***

Other Species

What other species are already being held/propagated at the facility?

***Bonytail***

If other species are present, are any being held for refuge purposes?

***No***

Do you anticipate adding other species in the future? If so, which species?

***Razorback suckers***

Is there any potential for accidental hybridization between HBC and any of these species?

***Yes***

Personnel

How many people are employed to operate and maintain the facility?

***1***

Do you have staff living on station, in case of emergencies?

***1***

How many years of experience do employees have working with captive populations of threatened or endangered fish?

***3 months***

How many years of experience do employees have treating internal and external fish pathogens (e.g. bacterial, viral, parasitic)?

***3 months***

**Water**

Ownership

Who owns the water rights for the facility?

***CRIT***

Do you anticipate any changes in ownership of water rights in the foreseeable future (50+ years)?

***No***

Source

Is the water source a spring, well, stream, river, lake or reservoir? Please specify.

***Canal – river water***

Quantity

Do you have enough water to supply 3 changes per hour through each available unit (pond, raceway, tank), and 1 change per hour through the entire system? If no, what are your exchange rates?

***No, three days***

How reliable is the your water supply? Do you anticipate any changes in the foreseeable future (50+ years)?

***Good no***

Quality

Temperature. Please provide seasonal information regarding maximum, minimum, and average water temperature of source water and for water at your facility.

***11 C – winter 32 - summer***

pH. Please provide seasonal information regarding maximum, minimum, and average pH of source water and for water at your facility.

***7 to 8***

Dissolved oxygen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***Down to 3.0 in summer***

Dissolved nitrogen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***Unknown***

Pathogens. What, if any, pathogens exist in the source water for your facility? What is the source of pathogens, and can it be eliminated? What is the pathogen load? Do you have mechanisms in place to eliminate pathogens from source water?

***Columnaris, ich, costia, learnaea***

**Funding**

Do you presently have adequate resources to provide a refuge facility for humpback chub that meets the following minimum requirements (Table)? If not, what is the estimated annual cost for providing such a refuge facility?

***No, a lot***

**Table.** Minimum criteria for eligibility as a possible humpback chub refuge facility.

Land must be owned by the facility operator, and ownership will not change for the foreseeable future (50+ years).
Water rights must be owned by the facility, and ownership will not change for the foreseeable future (50+ years).
The facility must be large enough to hold a minimum of 100 adult humpback chub.
The facility should allow fish to be held in multiple ponds, tanks, or raceways.
The facility cannot be located in a flood plain, unless it is within the native range of humpback chub.
The facility must be secure from the public and from predators (e.g. birds, mammals).
Quarantine of wild fish, as well as sick captive fish, must be possible.
Fish food must be climate-controlled and secure from pests.
The facility must provide for complete effluent treatment, including the prevention of escape and entry fish and pathogens.
All permits for holding endangered fish and treating/releasing effluent must be obtained by the facility operator prior to delivery of fish.
No congeners of humpback chub are or will be held at the same facility.
Staff must either live at the facility, or at least one person must be on duty 24 h/day.
Water source should be either pathogen-free or treated to remove all known pathogens.
Water source should consist of sufficient volume to safely accommodate 100 adult humpback chub, and this volume should be reliable for the foreseeable future (50+ years).
Water quality parameters must be within the following range (from Piper et al. 1982):

| | |
|---|---|
| Temperature: | 45-80 F (7-27 C) |
| Oxygen: | >= 5 ppm |
| Nitrogen: | 100% saturation or less |
| pH: | 6.5-9.0 |

**Legal Agreement**

The facility chosen to house a captive population of humpback chub must be willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service stating that:

- Humpback chub will not be propagated at the facility
- Any F1 progeny found at the facility will be separated from adult fish, and either accessioned into a museum or used for research purposes, pending written approval by both the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service.
- No F1 progeny will ever be released into the wild.
- Any mortality(ies) of adult captive fish, when found, will be preserved in alcohol, and date and apparent cause of death will be documented.
- In the event of catastrophic loss of the wild population of humpback chub in the Little Colorado River in Grand Canyon, negotiations will begin immediately with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to initiate captive propagation of humpback chub at the facility.

Is your facility willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U. S. Fish and Wildlife Service stating that you will comply with these terms?

| |
|---|

**Appendix 2. Alchesay-Williams Creek National Fish Hatchery response to questionnaire for prospective humpback chub refuge facilities.**

Please place answers in boxes. This is not a legally binding agreement. This questionnaire is designed to aid the Arizona Game and Fish Department in selecting a refuge facility for humpback chub from the LCR in Grand Canyon.

**Land**

Ownership

Who owns the land?

***White Mountain Apache Tribe***

Do you anticipate any changes in land ownership in the foreseeable future (50+ years)?

***No***

Is there enough land available for all facilities, protection of water supply, and treatment of effluent?

***Yes***

Topography

Is there sufficient elevation between water source and holding facilities for aeration and gravity flow?

***Yes***

If no, what is the means of water delivery, how is water aerated, and is the supply of water and aeration guaranteed?

Does the holding facility provide adequate drainage?

***Yes***

Is the land located in a flood plain, or other locality that could be flooded?

***Yes***

If yes, is it in the Colorado River basin where humpback chub occur?

***No***

If yes, is it in the upper or lower Colorado River basin?

***No***

**Existing Hatchery Facilities**

What is the existing space (number and volume) **available** as ponds, raceways, or tanks? Are they earthen, plastic-lined, fiberglass, or concrete?

***None available***

What is the condition of the existing facility? How old are the holding ponds/tanks? How old is the plumbing? Do you have a maintenance plan and budget in place for the existing facility?

***Contructed 1962 – Good condition – Annual Maint Budget***

Is the existing facility secure from the public? From livestock? From predators? If not, what control measures can be implemented?

***Reasonably secure – predator problem with great blue herons***

Is the existing facility a recirculating or reuse system? If recirculating, is the facility equipped with biological, chemical, physical, and/or ultraviolet filtration? If reuse, is there any way to prevent pathogen transfer between ponds, tanks, or raceways?

***No***

Is replication available. In other words, can captive fish be held in separate, secure ponds or raceways, to avoid catastrophic loss of the species at the facility?

***Currently no space available***

Can fish (larvae and adults) easily be retrieved from ponds, tanks, or raceways? By what means?

***Fish currently seined from ponds***

Do you have a quarantine facility, where wild fish and/or sick fish can be excluded from other fish and treated for external and internal pathogens?

***No***

Do you have a climate-controlled storage facility for fish food and therapeutic chemicals?

***No***

Effluent

Is effluent from existing facility screened to prevent both escape and entry of fish and pathogens? If no, can this be done expeditiously?

***No***

Are drains from each pond, tank, or raceway interconnected?

***Yes***

Will permits be required for dealing with the effluent? If so, from whom? Do you foresee any problems obtaining permits, if necessary?

***Would fall under current NPDES permit***

Do you anticipate the need for NEPA compliance? If so, how long will this process take?

***Uncertain***

Other Species

What other species are already being held/propagated at the facility?

***Rainbow, brown, and Apache trout***

If other species are present, are any being held for refuge purposes?

***No***

Do you anticipate adding other species in the future? If so, which species?

***No***

Is there any potential for accidental hybridization between HBC and any of these species?

***No***

Personnel

How many people are employed to operate and maintain the facility?

***4***

Do you have staff living on station, in case of emergencies?

***Yes***

How many years of experience do employees have working with captive populations of threatened or endangered fish?

***15***

How many years of experience do employees have treating internal and external fish pathogens (e.g. bacterial, viral, parasitic)?

***15***

**Water**

Ownership

Who owns the water rights for the facility?

***White Mountain Apache Tribe***

Do you anticipate any changes in ownership of water rights in the foreseeable future (50+ years)?

***No***

Source

Is the water source a spring, well, stream, river, lake or reservoir? Please specify.

***River***

Quantity

Do you have enough water to supply 3 changes per hour through each available unit (pond, raceway, tank), and 1 change per hour through the entire system? If no, what are your exchange rates?

***Yes***

How reliable is the your water supply? Do you anticipate any changes in the foreseeable future (50+ years)?

***No***

Quality

Temperature. Please provide seasonal information regarding maximum, minimum, and average water temperature of source water and for water at your facility.

***34-70 deg F seasonally***

pH. Please provide seasonal information regarding maximum, minimum, and average pH of source water and for water at your facility.

***Ave 7.3***

Dissolved oxygen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***Elevation 5400 ' normally at saturation given above temps***

Dissolved nitrogen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***Unknown***

Pathogens. What, if any, pathogens exist in the source water for your facility? What is the source of pathogens, and can it be eliminated? What is the pathogen load? Do you have mechanisms in place to eliminate pathogens from source water?

***Normal parasite loads, no specific pathogen present***

**Funding**

Do you presently have adequate resources to provide a refuge facility for humpback chub that meets the following minimum requirements (Table)? If not, what is the estimated annual cost for providing such a refuge facility?

***No***

**Table.** Minimum criteria for eligibility as a possible humpback chub refuge facility.

Land must be owned by the facility operator, and ownership will not change for the foreseeable future (50+ years).
Water rights must be owned by the facility, and ownership will not change for the foreseeable future (50+ years).
The facility must be large enough to hold a minimum of 100 adult humpback chub.
The facility should allow fish to be held in multiple ponds, tanks, or raceways.
The facility cannot be located in a flood plain, unless it is within the native range of humpback chub.
The facility must be secure from the public and from predators (e.g. birds, mammals).
Quarantine of wild fish, as well as sick captive fish, must be possible.
Fish food must be climate-controlled and secure from pests.
The facility must provide for complete effluent treatment, including the prevention of escape and entry fish and pathogens.
All permits for holding endangered fish and treating/releasing effluent must be obtained by the facility operator prior to delivery of fish.
No congeners of humpback chub are or will be held at the same facility.
Staff must either live at the facility, or at least one person must be on duty 24 h/day.
Water source should be either pathogen-free or treated to remove all known pathogens.
Water source should consist of sufficient volume to safely accommodate 100 adult humpback chub, and this volume should be reliable for the foreseeable future (50+ years).
Water quality parameters must be within the following range (from Piper et al. 1982):

| | |
|---|---|
| Temperature: | 45-80 F (7-27 C) |
| Oxygen: | >= 5 ppm |
| Nitrogen: | 100% saturation or less |
| pH: | 6.5-9.0 |

**Legal Agreement**

The facility chosen to house a captive population of humpback chub must be willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service stating that:

Humpback chub will not be propagated at the facility

Any F1 progeny found at the facility will be separated from adult fish, and either accessioned into a museum or used for research purposes, pending written approval by both the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service.

No F1 progeny will ever be released into the wild.

Any mortality(ies) of adult captive fish, when found, will be preserved in alcohol, and date and apparent cause of death will be documented.

In the event of catastrophic loss of the wild population of humpback chub in the Little Colorado River in Grand Canyon, negotiations will begin immediately with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to initiate captive propagation of humpback chub at the facility.

Is your facility willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U. S. Fish and Wildlife Service stating that you will comply with these terms?

***No – Tribal ownership of land and water prevents USFWS from entering into this type of agreement without written Tribal approval which is doubtful.***

**Appendix 3. Dexter National Fish Hatchery response to questionnaire for prospective humpback chub refuge facilities.**

Please place answers in boxes. This is not a legally binding agreement. This questionnaire is designed to aid the Arizona Game and Fish Department in selecting a refuge facility for humpback chub from the LCR in Grand Canyon.

**Land**

Ownership

Who owns the land?

***U.S. Fish and Wildlife Service***

Do you anticipate any changes in land ownership in the foreseeable future (50+ years)?

***No***

Is there enough land available for all facilities, protection of water supply, and treatment of effluent?

***Yes***

Topography

Is there sufficient elevation between water source and holding facilities for aeration and gravity flow?

***Well water***

If no, what is the means of water delivery, how is water aerated, and is the supply of water and aeration guaranteed?

***Water is pumped to rearing units. Splashed into ponds to aerate, 5 wells on station for a combined total of 2000 acre ft. year.***

Does the holding facility provide adequate drainage?

***Yes***

Is the land located in a flood plain, or other locality that could be flooded?

***No***

If yes, is it in the Colorado River basin where humpback chub occur?

If yes, is it in the upper or lower Colorado River basin?

**Existing Hatchery Facilities**

What is the existing space (number and volume) **available** as ponds, raceways, or tanks? Are they earthen, plastic-lined, fiberglass, or concrete?

***None available***

What is the condition of the existing facility? How old are the holding ponds/tanks? How old is the plumbing? Do you have a maintenance plan and budget in place for the existing facility?

***Most ponds and associated water supply and drain lines are in good shape. All buildings have been rebuilt over the past 9 years.***

Is the existing facility secure from the public? From livestock? From predators? If not, what control measures can be implemented?

***Not secure from all predators, such as birds, turtles and raccoons. Bird***

***netting is installed over select ponds and stocks are brought indoor for over wintering.***

Is the existing facility a recirculating or reuse system? If recirculating, is the facility equipped with biological, chemical, physical, and/or ultraviolet filtration? If reuse, is there any way to prevent pathogen transfer between ponds, tanks, or raceways?

***Both.***

Is replication available. In other words, can captive fish be held in separate, secure ponds or raceways, to avoid catastrophic loss of the species at the facility?

***Yes.***

Can fish (larvae and adults) easily be retrieved from ponds, tanks, or raceways? By what means?

***Yes. Sein or draining pond***

Do you have a quarantine facility, where wild fish and/or sick fish can be excluded from other fish and treated for external and internal pathogens?

***No.***

Do you have a climate-controlled storage facility for fish food and therapeutic chemicals?

***Yes***

Effluent

Is effluent from existing facility screened to prevent both escape and entry of fish and pathogens? If no, can this be done expeditiously?

***Yes***

Are drains from each pond, tank, or raceway interconnected?

***Yes***

Will permits be required for dealing with the effluent? If so, from whom? Do you foresee any problems obtaining permits, if necessary?

***No***

Do you anticipate the need for NEPA compliance? If so, how long will this process take?

***No***

Other Species

What other species are already being held/propagated at the facility?

***17 T& E listed species***

If other species are present, are any being held for refuge purposes?

***Refuge and production***

Do you anticipate adding other species in the future? If so, which species?

***No***

Is there any potential for accidental hybridization between HBC and any of these species?

***No. Stock management plans in place.***

Personnel

How many people are employed to operate and maintain the facility?

***12***

Do you have staff living on station, in case of emergencies?

***Yes***

How many years of experience do employees have working with captive populations of threatened or endangered fish?

***10 to 23 years each***

How many years of experience do employees have treating internal and external fish pathogens (e.g. bacterial, viral, parasitic)?

***20+***

**Water**

Ownership

Who owns the water rights for the facility?

***U.S. Fish and Wildlife Service***

Do you anticipate any changes in ownership of water rights in the foreseeable future (50+ years)?

***No***

Source

Is the water source a spring, well, stream, river, lake or reservoir? Please specify.

***Wells***

Quantity

Do you have enough water to supply 3 changes per hour through each available unit (pond, raceway, tank), and 1 change per hour through the entire system? If no, what are your exchange rates?

***We do not do water changes through ponds, we maintain water levels mainly.***

How reliable is the your water supply? Do you anticipate any changes in the foreseeable future (50+ years)?

***Reliable water supply and do not foresee changes in the foreseeable future.***

Quality

Temperature. Please provide seasonal information regarding maximum, minimum, and average water temperature of source water and for water at your facility.

***Winter – 40 F to 70 F, Summer 65 F to 85 F***

pH. Please provide seasonal information regarding maximum, minimum, and average pH of source water and for water at your facility.

***Neutral***

Dissolved oxygen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***4.6 ppm source water. Following aeration = 6.0 ppm to 12.0 ppm***

Dissolved nitrogen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

Pathogens. What, if any, pathogens exist in the source water for your facility? What is the source of pathogens, and can it be eliminated? What is the pathogen load? Do you have mechanisms in place to eliminate pathogens from source water?

***No source pathogens***

**Funding**

Do you presently have adequate resources to provide a refuge facility for humpback chub that meets the following minimum requirements (Table)? If not, what is the estimated annual cost for providing such a refuge facility?

***No. Establishing this program would require the construction of a quarantine facility and pond lining. Estimated cost would be $800,000 capital and $45,000 annually for operations.***

**Table.** Minimum criteria for eligibility as a possible humpback chub refuge facility.

| |
|---|
| Land must be owned by the facility operator, and ownership will not change for the foreseeable future (50+ years). |
| Water rights must be owned by the facility, and ownership will not change for the foreseeable future (50+ years). |
| The facility must be large enough to hold a minimum of 100 adult humpback chub. |
| The facility should allow fish to be held in multiple ponds, tanks, or raceways. |
| The facility cannot be located in a flood plain, unless it is within the native range of humpback chub. |
| The facility must be secure from the public and from predators (e.g. birds, mammals). |
| Quarantine of wild fish, as well as sick captive fish, must be possible. |
| Fish food must be climate-controlled and secure from pests. |
| The facility must provide for complete effluent treatment, including the prevention of escape and entry fish and pathogens. |
| All permits for holding endangered fish and treating/releasing effluent must be obtained by the facility operator prior to delivery of fish. |
| No congeners of humpback chub are or will be held at the same facility. |
| Staff must either live at the facility, or at least one person must be on duty 24 h/day. |
| Water source should be either pathogen-free or treated to remove all known pathogens. |
| Water source should consist of sufficient volume to safely accommodate 100 adult humpback chub, and this volume should be reliable for the foreseeable future (50+ years). |
| Water quality parameters must be within the following range (from Piper et al. 1982): |
| Temperature: 45-80 F (7-27 C) |
| Oxygen: >= 5 ppm |
| Nitrogen: 100% saturation or less |
| pH: 6.5-9.0 |

**Legal Agreement**

The facility chosen to house a captive population of humpback chub must be willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service stating that:

Humpback chub will not be propagated at the facility

Any F1 progeny found at the facility will be separated from adult fish, and either accessioned into a museum or used for research purposes, pending written approval by both the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service.

No F1 progeny will ever be released into the wild.

Any mortality(ies) of adult captive fish, when found, will be preserved in alcohol, and date and apparent cause of death will be documented.

In the event of catastrophic loss of the wild population of humpback chub in the Little Colorado River in Grand Canyon, negotiations will begin immediately with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to initiate captive propagation of humpback chub at the facility.

Is your facility willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U. S. Fish and Wildlife Service stating that you will comply with these terms?

| |
|---|

**Appendix 4. Hualapai Tribe, Peach Springs Facility response to questionnaire for prospective humpback chub refuge facilities.**

Please place answers in boxes. This is not a legally binding agreement. This questionnaire is designed to aid the Arizona Game and Fish Department in selecting a refuge facility for humpback chub from the LCR in Grand Canyon.

**Land**

Ownership

Who owns the land?

***Hualapai Tribe***

Do you anticipate any changes in land ownership in the foreseeable future (50+ years)?

***No***

Is there enough land available for all facilities, protection of water supply, and treatment of effluent?

***Yes. There is 80 acres***

Topography

Is there sufficient elevation between water source and holding facilities for aeration and gravity flow?

***Yes***

If no, what is the means of water delivery, how is water aerated, and is the supply of water and aeration guaranteed?

***Each pond and raceway has aeration installed***

Does the holding facility provide adequate drainage?

***Yes***

Is the land located in a flood plain, or other locality that could be flooded?

***No***

If yes, is it in the Colorado River basin where humpback chub occur?

***It is located within the Colorado River Basin***

If yes, is it in the upper or lower Colorado River basin?

***Lower Colorado River Basin***

**Existing Hatchery Facilities**

What is the existing space (number and volume) **available** as ponds, raceways, or tanks? Are they earthen, plastic-lined, fiberglass, or concrete?

***1-2.5 acre water treatment pond, 8-1/2 acre ponds, 1 (150' X 4' X 4') raceway available. 4-1/2 acre ponds and 2 raceways are currently under construction. Ponds are lined with 20 mil polyethelene.***

What is the condition of the existing facility? How old are the holding ponds/tanks? How old is the plumbing? Do you have a maintenance plan and budget in place for the existing facility?

***Condition of facility is excellent. Holding ponds, tanks, plumbing are <5 yrs old. We are working on a maintenance plan and budget for the future.***

Is the existing facility secure from the public? From livestock? From predators? If not, what control measures can be implemented?

***Yes. Yes. No – Bald eagles and hawks frequent the area. We are working with USFWS in getting netting to cover the ponds.***

Is the existing facility a recirculating or reuse system? If recirculating, is the facility equipped with biological, chemical, physical, and/or ultraviolet filtration? If reuse, is there any way to prevent pathogen transfer between ponds, tanks, or raceways?

***Recirculating system with physical settling of solids in a 2.5 acre treatment pond and anaerobic decomposition. A UV filtration could be installed if found necessary. All ponds can be set independently of each other, so if the recirc. System is in use, a pond can be shut off from the circuit.***

Is replication available. In other words, can captive fish be held in separate, secure ponds or raceways, to avoid catastrophic loss of the species at the facility?

***Yes***

Can fish (larvae and adults) easily be retrieved from ponds, tanks, or raceways? By what means?

***Adults can easily be retrieved by draining a pond into the raceway for collection.***

Do you have a quarantine facility, where wild fish and/or sick fish can be excluded from other fish and treated for external and internal pathogens?

***Not yet, still under final construction of holding facility.***

Do you have a climate-controlled storage facility for fish food and therapeutic chemicals?

***The storage facility is not climate controlled yet.***

Effluent

Is effluent from existing facility screened to prevent both escape and entry of fish and pathogens? If no, can this be done expeditiously?

***Screened to prevent fish loss.***

Are drains from each pond, tank, or raceway interconnected?

***No.***

Will permits be required for dealing with the effluent? If so, from whom? Do you foresee any problems obtaining permits, if necessary?

***No. Effluent waters currently discharge into native tree nursery.***

Do you anticipate the need for NEPA compliance? If so, how long will this process take?

***No. NEPA has already been done.***

Other Species

What other species are already being held/propagated at the facility?

***Razorback suckers are being grown out. Currently no propagation occurs.***

If other species are present, are any being held for refuge purposes?

***Refuge purposes.***

Do you anticipate adding other species in the future? If so, which species?

***Humpback chub and possibly roundtail chub. Maybe some sportfish.***

Is there any potential for accidental hybridization between HBC and any of these species?

***No potential.***

Personnel

How many people are employed to operate and maintain the facility?

***No FTE's just contractors for construction. Non-intensive care currently for the Razorbacks.***

Do you have staff living on station, in case of emergencies?

***Housing unit will be provided when the need arises.***

How many years of experience do employees have working with captive populations of threatened or endangered fish?

***25 yrs***

How many years of experience do employees have treating internal and external fish pathogens (e.g. bacterial, viral, parasitic)?

***15 yrs***

**Water**

Ownership

Who owns the water rights for the facility?

***Hualapai Tribe***

Do you anticipate any changes in ownership of water rights in the foreseeable future (50+ years)?

***No***

Source

Is the water source a spring, well, stream, river, lake or reservoir? Please specify.

***Well – drilled down to 500' and a 72 hr pump test was conducted***

Quantity

Do you have enough water to supply 3 changes per hour through each available unit (pond, raceway, tank), and 1 change per hour through the entire system? If no, what are your exchange rates?

***Yes.***

How reliable is the your water supply? Do you anticipate any changes in the foreseeable future (50+ years)?

***Reliable. NO foreseeable change in the future.***

Quality

Temperature. Please provide seasonal information regarding maximum, minimum, and average water temperature of source water and for water at your facility.

***54 F year round***

pH. Please provide seasonal information regarding maximum, minimum, and average pH of source water and for water at your facility.

***6-8 year round***

Dissolved oxygen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***Avg. 7***

Dissolved nitrogen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***Acceptable for fish rearing per Hach Kit Testing through the years.***

Pathogens. What, if any, pathogens exist in the source water for your facility? What is the source of pathogens, and can it be eliminated? What is the pathogen load? Do you have mechanisms in place to eliminate pathogens from source water?

***None known.***

**Funding**

Do you presently have adequate resources to provide a refuge facility for humpback chub that meets the following minimum requirements (Table)? If not, what is the estimated annual cost for providing such a refuge facility?

***Yes but feel the USFWS and AG&F could help with partial funding and labor.***

**Table.** Minimum criteria for eligibility as a possible humpback chub refuge facility.

Land must be owned by the facility operator, and ownership will not change for the foreseeable future (50+ years).

Water rights must be owned by the facility, and ownership will not change for the foreseeable future (50+ years).

The facility must be large enough to hold a minimum of 100 adult humpback chub.

The facility should allow fish to be held in multiple ponds, tanks, or raceways.

The facility cannot be located in a flood plain, unless it is within the native range of humpback chub.

The facility must be secure from the public and from predators (e.g. birds, mammals).

Quarantine of wild fish, as well as sick captive fish, must be possible.

Fish food must be climate-controlled and secure from pests.

The facility must provide for complete effluent treatment, including the prevention of escape and entry fish and pathogens.

All permits for holding endangered fish and treating/releasing effluent must be obtained by the facility operator prior to delivery of fish.

No congeners of humpback chub are or will be held at the same facility.

Staff must either live at the facility, or at least one person must be on duty 24 h/day.

Water source should be either pathogen-free or treated to remove all known pathogens.

Water source should consist of sufficient volume to safely accommodate 100 adult humpback chub, and this volume should be reliable for the foreseeable future (50+ years).

Water quality parameters must be within the following range (from Piper et al. 1982):

| | |
|---|---|
| Temperature: | 45-80 F (7-27 C) |
| Oxygen: | >= 5 ppm |
| Nitrogen: | 100% saturation or less |
| pH: | 6.5-9.0 |

**Legal Agreement**

The facility chosen to house a captive population of humpback chub must be willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service stating that:

Humpback chub will not be propagated at the facility

Any F1 progeny found at the facility will be separated from adult fish, and either accessioned into a museum or used for research purposes, pending written approval by both the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service.

No F1 progeny will ever be released into the wild.

Any mortality(ies) of adult captive fish, when found, will be preserved in alcohol, and date and apparent cause of death will be documented.

In the event of catastrophic loss of the wild population of humpback chub in the Little Colorado River in Grand Canyon, negotiations will begin immediately with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to initiate captive propagation of humpback chub at the facility.

Is your facility willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U. S. Fish and Wildlife Service stating that you will comply with these terms?

***We already have an MOU with AZGFD and could work to include USFWS.***

**Appendix 5. Mora National Fish Hatchery response to questionnaire for prospective humpback chub refuge facilities.**

Please place answers in boxes. This is not a legally binding agreement. This questionnaire is designed to aid the Arizona Game and Fish Department in selecting a refuge facility for humpback chub from the LCR in Grand Canyon.

**Land**

Ownership

Who owns the land?

***US Fish and Wildlife Service-Mora National Fish Hatchery & Technology Center***

Do you anticipate any changes in land ownership in the foreseeable future (50+ years)?

***No***

Is there enough land available for all facilities, protection of water supply, and treatment of effluent?

***Yes***

Topography

Is there sufficient elevation between water source and holding facilities for aeration and gravity flow?

***NA***

If no, what is the means of water delivery, how is water aerated, and is the supply of water and aeration guaranteed?

***Recirc System, Regenerative blowers, Emergency Generator***

Does the holding facility provide adequate drainage?

***NA***

Is the land located in a flood plain, or other locality that could be flooded?

***No, Facility located well above river flood plain***

If yes, is it in the Colorado River basin where humpback chub occur?

***NA (Mora River on the Arkansas/Red River Drainage)***

If yes, is it in the upper or lower Colorado River basin?

***NA***

**Existing Hatchery Facilities**

What is the existing space (number and volume) **available** as ponds, raceways, or tanks? Are they earthen, plastic-lined, fiberglass, or concrete?

***Fiberglass raceways and circular tanks located inside large metal building. Natural light from clerestory windows.***

What is the condition of the existing facility? How old are the holding ponds/tanks? How old is the plumbing? Do you have a maintenance plan and budget in place for the existing facility?

***Facility less than ten-years old. Maintenance budget of $65K/year***

Is the existing facility secure from the public? From livestock? From predators? If not, what control measures can be implemented?

***Hatchery facility locked 24/7, gated at night, all indoors***

Is the existing facility a recirculating or reuse system? If recirculating, is the facility equipped with biological, chemical, physical, and/or ultraviolet filtration? If reuse, is there any way to prevent pathogen transfer between ponds, tanks, or raceways?

***Recirculating/re-use system. Bio-filters and drum filters. Ozone capability and UV on some systems. Pathogen transfer is possible.***

Is replication available. In other words, can captive fish be held in separate, secure ponds or raceways, to avoid catastrophic loss of the species at the facility?

***Yes. Especially if the use is a refugia and no propagation is proposed.***

Can fish (larvae and adults) easily be retrieved from ponds, tanks, or raceways? By what means?

***Crowding and netting in raceways, and netting in circular tanks.***

Do you have a quarantine facility, where wild fish and/or sick fish can be excluded from other fish and treated for external and internal pathogens?

***Yes***

Do you have a climate-controlled storage facility for fish food and therapeutic chemicals?

***Yes***

Effluent

Is effluent from existing facility screened to prevent both escape and entry of fish and pathogens? If no, can this be done expeditiously?

***A series of settling ponds prevent escapement.***

Are drains from each pond, tank, or raceway interconnected?

***Yes***

Will permits be required for dealing with the effluent? If so, from whom? Do you foresee any problems obtaining permits, if necessary?

***Permits are in place***

Do you anticipate the need for NEPA compliance? If so, how long will this process take?

***Facility already permitted by New Mexico and FWS to hold, propagate and rear endangered species. Should not be a hurdle.***

Other Species

What other species are already being held/propagated at the facility?

***Gila trout and razorback suckers***

If other species are present, are any being held for refuge purposes?

***Razorback suckers and Gila trout***

Do you anticipate adding other species in the future? If so, which species?

***No***

Is there any potential for accidental hybridization between HBC and any of these species?

***No. Bonytail were all transferred to other facilities.***

Personnel

How many people are employed to operate and maintain the facility?

***Six***

Do you have staff living on station, in case of emergencies?

***Yes. Two biologists. Also the maintenance worker can respond to mechanical/electrical/water emergencies in short order. Alarm system and dialers are operational.***

How many years of experience do employees have working with captive populations of threatened or endangered fish?

***21***

How many years of experience do employees have treating internal and external fish pathogens (e.g. bacterial, viral, parasitic)?

***21***

**Water**

Ownership

Who owns the water rights for the facility?

***US Fish and Wildlife Service***

Do you anticipate any changes in ownership of water rights in the foreseeable future (50+ years)?

***No***

Source

Is the water source a spring, well, stream, river, lake or reservoir? Please specify.

***Wells. We are permitted nearly 1000 acre/feet year. Currently using less than 1/3 available.***

Quantity

Do you have enough water to supply 3 changes per hour through each available unit (pond, raceway, tank), and 1 change per hour through the entire system? If no, what are your exchange rates?

***Yes***

How reliable is the your water supply? Do you anticipate any changes in the foreseeable future (50+ years)?

***No***

Quality

Temperature. Please provide seasonal information regarding maximum, minimum, and average water temperature of source water and for water at your facility.

***Low of 48 and high of 60 degrees F. We can heat water but use makeup water to cool rearing units.***

pH. Please provide seasonal information regarding maximum, minimum, and average pH of source water and for water at your facility.

***Ranges between 7.5 and 8.8***

Dissolved oxygen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***Saturation due to regenerative blowers***

Dissolved nitrogen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***95-98% for Nitrogen. Oxygen at saturation.***

Pathogens. What, if any, pathogens exist in the source water for your facility? What is the source of pathogens, and can it be eliminated? What is the pathogen load? Do you have mechanisms in place to eliminate pathogens from source water?

***Source water free from pathogens. However, we have experienced Gyrodactylus, and Ichtyobodo as external parasites, and Hexamita for internal parasites in the recirculation systems. Proper hatchery management practices have greatly reduced incidences and therefore treatments. Suspect Asian tapeworm also.***

**Funding**

Do you presently have adequate resources to provide a refuge facility for humpback chub that meets the following minimum requirements (Table)? If not, what is the estimated annual cost for providing such a refuge facility?

***Mora has the physical facilities and expertise. Costs can be negotiated.***

**Table.** Minimum criteria for eligibility as a possible humpback chub refuge facility.

Land must be owned by the facility operator, and ownership will not change for the foreseeable future (50+ years).
Water rights must be owned by the facility, and ownership will not change for the foreseeable future (50+ years).
The facility must be large enough to hold a minimum of 100 adult humpback chub.
The facility should allow fish to be held in multiple ponds, tanks, or raceways.
The facility cannot be located in a flood plain, unless it is within the native range of humpback chub.
The facility must be secure from the public and from predators (e.g. birds, mammals).
Quarantine of wild fish, as well as sick captive fish, must be possible.
Fish food must be climate-controlled and secure from pests.
The facility must provide for complete effluent treatment, including the prevention of escape and entry fish and pathogens.
All permits for holding endangered fish and treating/releasing effluent must be obtained by the facility operator prior to delivery of fish.
No congeners of humpback chub are or will be held at the same facility.
Staff must either live at the facility, or at least one person must be on duty 24 h/day.
Water source should be either pathogen-free or treated to remove all known pathogens.
Water source should consist of sufficient volume to safely accommodate 100 adult humpback chub, and this volume should be reliable for the foreseeable future (50+ years).
Water quality parameters must be within the following range (from Piper et al. 1982):

| | |
|---|---|
| Temperature: | 45-80 F (7-27 C) |
| Oxygen: | >= 5 ppm |
| Nitrogen: | 100% saturation or less |
| pH: | 6.5-9.0 |

**Legal Agreement**

The facility chosen to house a captive population of humpback chub must be willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service stating that:

Humpback chub will not be propagated at the facility

Any F1 progeny found at the facility will be separated from adult fish, and either accessioned into a museum or used for research purposes, pending written approval by both the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service.

No F1 progeny will ever be released into the wild.

Any mortality(ies) of adult captive fish, when found, will be preserved in alcohol, and date and apparent cause of death will be documented.

In the event of catastrophic loss of the wild population of humpback chub in the Little Colorado River in Grand Canyon, negotiations will begin immediately with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to initiate captive propagation of humpback chub at the facility.

Is your facility willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U. S. Fish and Wildlife Service stating that you will comply with these terms?

**Appendix 6. Ouray National Wildlife Refuge response to questionnaire for prospective humpback chub refuge facilities.**

Please place answers in boxes. This is not a legally binding agreement. This questionnaire is designed to aid the Arizona Game and Fish Department in selecting a refuge facility for humpback chub from the LCR in Grand Canyon.

**Land**

Ownership

Who owns the land?

***U.S. Fish and Wildlife Service***

Do you anticipate any changes in land ownership in the foreseeable future (50+ years)?

***No***

Is there enough land available for all facilities, protection of water supply, and treatment of effluent?

***Yes***

Topography

Is there sufficient elevation between water source and holding facilities for aeration and gravity flow?

***No***

If no, what is the means of water delivery, how is water aerated, and is the supply of water and aeration guaranteed?

***Pumped, packed columns and no guarantees***

Does the holding facility provide adequate drainage?

***Yes***

Is the land located in a flood plain, or other locality that could be flooded?

***Hatchery is near flood plain***

If yes, is it in the Colorado River basin where humpback chub occur?

***Yes***

If yes, is it in the upper or lower Colorado River basin?

***Upper***

**Existing Hatchery Facilities**

What is the existing space (number and volume) **available** as ponds, raceways, or tanks? Are they earthen, plastic-lined, fiberglass, or concrete?

***12, 0.5 acre & 24, 0.2 acre ponds; 30, 4 foot & 21, 8 foot tanks.***

What is the condition of the existing facility? How old are the holding ponds/tanks? How old is the plumbing? Do you have a maintenance plan and budget in place for the existing facility?

***Good condition, 7-8 years old, have maintenance plans and a budget.***

Is the existing facility secure from the public? From livestock? From predators? If not, what control measures can be implemented?

***Yes, public, yes, livestock and no, predators (not much in line of control)***

Is the existing facility a recirculating or reuse system? If recirculating, is the facility equipped with biological, chemical, physical, and/or ultraviolet filtration? If reuse, is there any way to prevent pathogen transfer between ponds, tanks, or raceways?

***Intensive culture is reuse, extensive is single-pass and no.***

Is replication available. In other words, can captive fish be held in separate, secure ponds or raceways, to avoid catastrophic loss of the species at the facility?

***Perhaps***

Can fish (larvae and adults) easily be retrieved from ponds, tanks, or raceways? By what means?

***Yes, by draining and collecting fish with nets in individual tanks or kettles.***

Do you have a quarantine facility, where wild fish and/or sick fish can be excluded from other fish and treated for external and internal pathogens?

***We have an isolation tank room***

Do you have a climate-controlled storage facility for fish food and therapeutic chemicals?

***Yes***

Effluent

Is effluent from existing facility screened to prevent both escape and entry of fish and pathogens? If no, can this be done expeditiously?

***No and No***

Are drains from each pond, tank, or raceway interconnected?

***Yes***

Will permits be required for dealing with the effluent? If so, from whom? Do you foresee any problems obtaining permits, if necessary?

***Yes, state of Utah, unsure***

Do you anticipate the need for NEPA compliance? If so, how long will this process take?

***No***

Other Species

What other species are already being held/propagated at the facility?

***Razorback sucker***

If other species are present, are any being held for refuge purposes?

***Yes***

Do you anticipate adding other species in the future? If so, which species?

***Possible, Colorado River basin fishes***

Is there any potential for accidental hybridization between HBC and any of these species?

***Yes***

Personnel

How many people are employed to operate and maintain the facility?

***Four***

Do you have staff living on station, in case of emergencies?

***No***

How many years of experience do employees have working with captive populations of threatened or endangered fish?

***32 years***

How many years of experience do employees have treating internal and external fish pathogens (e.g. bacterial, viral, parasitic)?

***28 years***

**Water**

Ownership

Who owns the water rights for the facility?

***Ouray National Wildlife Refuge***

Do you anticipate any changes in ownership of water rights in the foreseeable future (50+ years)?

***No***

Source

Is the water source a spring, well, stream, river, lake or reservoir? Please specify.

***Shallow wells***

Quantity

Do you have enough water to supply 3 changes per hour through each available unit (pond, raceway, tank), and 1 change per hour through the entire system? If no, what are your exchange rates?

***No, 8 foot tanks (1 per hour), ponds (1 change every 30 days)***

How reliable is the your water supply? Do you anticipate any changes in the foreseeable future (50+ years)?

***Somewhat unreliable and Yes***

Quality

Temperature. Please provide seasonal information regarding maximum, minimum, and average water temperature of source water and for water at your facility.

***Temperature is constant from the wells at approximately 11 C***

pH. Please provide seasonal information regarding maximum, minimum, and average pH of source water and for water at your facility.

***7.7-8***

Dissolved oxygen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***5mg/L – 10 mg/L***

Dissolved nitrogen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***Ponds (Less than 100%) Intensive (101-103%)***

Pathogens. What, if any, pathogens exist in the source water for your facility? What is the source of pathogens, and can it be eliminated? What is the pathogen load? Do you have mechanisms in place to eliminate pathogens from source water?

***Costia, UV Filtration***

**Funding**

Do you presently have adequate resources to provide a refuge facility for humpback chub that meets the following minimum requirements (Table)? If not, what is the estimated annual cost for providing such a refuge facility?

***No. Unsure.***

**Table.** Minimum criteria for eligibility as a possible humpback chub refuge facility.

Land must be owned by the facility operator, and ownership will not change for the foreseeable future (50+ years).
Water rights must be owned by the facility, and ownership will not change for the foreseeable future (50+ years).
The facility must be large enough to hold a minimum of 100 adult humpback chub.
The facility should allow fish to be held in multiple ponds, tanks, or raceways.
The facility cannot be located in a flood plain, unless it is within the native range of humpback chub.
The facility must be secure from the public and from predators (e.g. birds, mammals).
Quarantine of wild fish, as well as sick captive fish, must be possible.
Fish food must be climate-controlled and secure from pests.
The facility must provide for complete effluent treatment, including the prevention of escape and entry fish and pathogens.
All permits for holding endangered fish and treating/releasing effluent must be obtained by the facility operator prior to delivery of fish.
No congeners of humpback chub are or will be held at the same facility.
Staff must either live at the facility, or at least one person must be on duty 24 h/day.
Water source should be either pathogen-free or treated to remove all known pathogens.
Water source should consist of sufficient volume to safely accommodate 100 adult humpback chub, and this volume should be reliable for the foreseeable future (50+ years).
Water quality parameters must be within the following range (from Piper et al. 1982):

| | |
|---|---|
| Temperature: | 45-80 F (7-27 C) |
| Oxygen: | >= 5 ppm |
| Nitrogen: | 100% saturation or less |
| pH: | 6.5-9.0 |

**Legal Agreement**

The facility chosen to house a captive population of humpback chub must be willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service stating that:

Humpback chub will not be propagated at the facility

Any F1 progeny found at the facility will be separated from adult fish, and either accessioned into a museum or used for research purposes, pending written approval by both the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service.

No F1 progeny will ever be released into the wild.

Any mortality(ies) of adult captive fish, when found, will be preserved in alcohol, and date and apparent cause of death will be documented.

In the event of catastrophic loss of the wild population of humpback chub in the Little Colorado River in Grand Canyon, negotiations will begin immediately with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to initiate captive propagation of humpback chub at the facility.

Is your facility willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U. S. Fish and Wildlife Service stating that you will comply with these terms?

| |
|---|
| ***No.*** |

**Appendix 7. University of Arizona response to questionnaire for prospective humpback chub refuge facilities.**

Please place answers in boxes. This is not a legally binding agreement. This questionnaire is designed to aid the Arizona Game and Fish Department in selecting a refuge facility for humpback chub from the LCR in Grand Canyon.

**Land**

Ownership

Who owns the land?

***UA***

Do you anticipate any changes in land ownership in the foreseeable future (50+ years)?

***NO***

Is there enough land available for all facilities, protection of water supply, and treatment of effluent?

***Yes***

Topography

Is there sufficient elevation between water source and holding facilities for aeration and gravity flow?

***These are recirculating tanks with biofilters, aeration and water flow ok.***

If no, what is the means of water delivery, how is water aerated, and is the supply of water and aeration guaranteed?

***N/a***

Does the holding facility provide adequate drainage?

***Yes***

Is the land located in a flood plain, or other locality that could be flooded?

***No***

If yes, is it in the Colorado River basin where humpback chub occur?

***N/a***

If yes, is it in the upper or lower Colorado River basin?

***N/a***

**Existing Hatchery Facilities**

What is the existing space (number and volume) **available** as ponds, raceways, or tanks? Are they earthen, plastic-lined, fiberglass, or concrete?

***Fiberglass tanks, number available contingent on funding***

What is the condition of the existing facility? How old are the holding ponds/tanks? How old is the plumbing? Do you have a maintenance plan and budget in place for the existing facility?

***Land available and indoor space available. Budget needed to supply tanks, food, and salary for maintenance staff.***

Is the existing facility secure from the public? From livestock? From predators? If not, what control measures can be implemented?

***Yes, could be locked inside of compound potentially.***

Is the existing facility a recirculating or reuse system? If recirculating, is the facility equipped with biological, chemical, physical, and/or ultraviolet filtration? If reuse, is there any way to prevent pathogen transfer between ponds, tanks, or raceways?

***Yes, individually recirculating tanks***

Is replication available. In other words, can captive fish be held in separate, secure ponds or raceways, to avoid catastrophic loss of the species at the facility?

***Yes, we could hold them in separate tanks, again depending on funding available***

Can fish (larvae and adults) easily be retrieved from ponds, tanks, or raceways? By what means?

***Yes, by crowding screens and nets***

Do you have a quarantine facility, where wild fish and/or sick fish can be excluded from other fish and treated for external and internal pathogens?

***Yes***

Do you have a climate-controlled storage facility for fish food and therapeutic chemicals?

***Yes***

Effluent

Is effluent from existing facility screened to prevent both escape and entry of fish and pathogens? If no, can this be done expeditiously?

***Yes***

Are drains from each pond, tank, or raceway interconnected?

***No***

Will permits be required for dealing with the effluent? If so, from whom? Do you foresee any problems obtaining permits, if necessary?

***No***

Do you anticipate the need for NEPA compliance? If so, how long will this process take?

***No***

Other Species

What other species are already being held/propagated at the facility?

***Gila chub, Yaqui chub, roundtail chub, headwater chub, Yaqui topminnow, Mohave tui chub***

If other species are present, are any being held for refuge purposes?

***No, experiments***

Do you anticipate adding other species in the future? If so, which species?

***Potentially other desert fishes***

Is there any potential for accidental hybridization between HBC and any of these species?

***No***

Personnel

How many people are employed to operate and maintain the facility?

***Approx 4***

Do you have staff living on station, in case of emergencies?

***Yes***

How many years of experience do employees have working with captive populations of threatened or endangered fish?

***Graduate students, techs and professor. Ranging from 3 mo to 20 yrs***

How many years of experience do employees have treating internal and external fish pathogens (e.g. bacterial, viral, parasitic)?

***See question 3, same answer***

**Water**

Ownership

Who owns the water rights for the facility?

***UA***

Do you anticipate any changes in ownership of water rights in the foreseeable future (50+ years)?

***No***

Source

Is the water source a spring, well, stream, river, lake or reservoir? Please specify.

***Well***

Quantity

Do you have enough water to supply 3 changes per hour through each available unit (pond, raceway, tank), and 1 change per hour through the entire system? If no, what are your exchange rates?

***Not flowthrough***

How reliable is the your water supply? Do you anticipate any changes in the foreseeable future (50+ years)?

***Good, no problem – Agricultural center well***

Quality

Temperature. Please provide seasonal information regarding maximum, minimum, and average water temperature of source water and for water at your facility.

***Depending on the size of tanks needed could put them in a room indoors. Then we could hold fish at the temperatures needed below. If we had to hold outside, we could not meet these temperature requirements.***

pH. Please provide seasonal information regarding maximum, minimum, and average pH of source water and for water at your facility.

***“”***

Dissolved oxygen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***“”***

Dissolved nitrogen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***“”***

Pathogens. What, if any, pathogens exist in the source water for your facility? What is the source of pathogens, and can it be eliminated? What is the pathogen load? Do you have mechanisms in place to eliminate pathogens from source water?

***No***

**Funding**

Do you presently have adequate resources to provide a refuge facility for humpback chub that meets the following minimum requirements (Table)? If not, what is the estimated annual cost for providing such a refuge facility?

***Approx $6,000 for tanks (one time purchase), $20,000 for tech time annually, approx $3,600 for year utilities/rent, $5,000 per year supplies and food. We could work up a more accurate cost estimate if you decide our facility might meet your needs.***

**Table.** Minimum criteria for eligibility as a possible humpback chub refuge facility.

Land must be owned by the facility operator, and ownership will not change for the foreseeable future (50+ years).
Water rights must be owned by the facility, and ownership will not change for the foreseeable future (50+ years).
The facility must be large enough to hold a minimum of 100 adult humpback chub.
The facility should allow fish to be held in multiple ponds, tanks, or raceways.
The facility cannot be located in a flood plain, unless it is within the native range of humpback chub.
The facility must be secure from the public and from predators (e.g. birds, mammals).
Quarantine of wild fish, as well as sick captive fish, must be possible.
Fish food must be climate-controlled and secure from pests.
The facility must provide for complete effluent treatment, including the prevention of escape and entry fish and pathogens.
All permits for holding endangered fish and treating/releasing effluent must be obtained by the facility operator prior to delivery of fish.
No congeners of humpback chub are or will be held at the same facility.
Staff must either live at the facility, or at least one person must be on duty 24 h/day.
Water source should be either pathogen-free or treated to remove all known pathogens.
Water source should consist of sufficient volume to safely accommodate 100 adult humpback chub, and this volume should be reliable for the foreseeable future (50+ years).
Water quality parameters must be within the following range (from Piper et al. 1982):

| | |
|---|---|
| Temperature: | 45-80 F (7-27 C) |
| Oxygen: | >= 5 ppm |
| Nitrogen: | 100% saturation or less |
| pH: | 6.5-9.0 |

**Legal Agreement**

The facility chosen to house a captive population of humpback chub must be willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service stating that:

Humpback chub will not be propagated at the facility

Any F1 progeny found at the facility will be separated from adult fish, and either accessioned into a museum or used for research purposes, pending written approval by both the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service.

No F1 progeny will ever be released into the wild.

Any mortality(ies) of adult captive fish, when found, will be preserved in alcohol, and date and apparent cause of death will be documented.

In the event of catastrophic loss of the wild population of humpback chub in the Little Colorado River in Grand Canyon, negotiations will begin immediately with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to initiate captive propagation of humpback chub at the facility.

Is your facility willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U. S. Fish and Wildlife Service stating that you will comply with these terms?

***Yes, probably would. Need to discuss with legal staff if you are interested in using this facility.***

**Appendix 8. Wahweap Hatchery response to questionnaire for prospective humpback chub refuge facilities.**

Please place answers in boxes. This is not a legally binding agreement. This questionnaire is designed to aid the Arizona Game and Fish Department in selecting a refuge facility for humpback chub from the LCR in Grand Canyon.

**Land**

Ownership

Who owns the land?

***State of Utah owns the 265 acres the Hatchery is on***

Do you anticipate any changes in land ownership in the foreseeable future (50+ years)?

***No changes***

Is there enough land available for all facilities, protection of water supply, and treatment of effluent?

***Yes, the whole 265 acres can be used for Hatchery related activities***

Topography

Is there sufficient elevation between water source and holding facilities for aeration and gravity flow?

***The water is pumped out of a well for all hatchery activities***

If no, what is the means of water delivery, how is water aerated, and is the supply of water and aeration guaranteed?

***Pumped, plans have been made to build a modern Hatchery building with aeration tower but because of lack of money it has been put on hold.***

Does the holding facility provide adequate drainage?

***Yes***

Is the land located in a flood plain, or other locality that could be flooded?

***Yes, Whole Hatchery sits in a 75 year flood plain***

If yes, is it in the Colorado River basin where humpback chub occur?

***Yes, Hatchery sits on Wahweap Creek by the town of Big Water Utah***

If yes, is it in the upper or lower Colorado River basin?

***Located in the Upper Basin***

**Existing Hatchery Facilities**

What is the existing space (number and volume) **available** as ponds, raceways, or tanks? Are they earthen, plastic-lined, fiberglass, or concrete?

***Wahweap Hatchery has 35 ponds, 11 of them are for sportfish production. There are 24 lined ponds for native fish production that are 0.4 surface acre and 14 ft deep. All ponds have drain kettles for harvesting.***

What is the condition of the existing facility? How old are the holding ponds/tanks? How old is the plumbing? Do you have a maintenance plan and budget in place for the existing facility?

***5 ponds are 10 years old, 6 ponds are 8 years old, 14 are 4 years old, all***

***other ponds are older than 10 years and are used only for sportfish production.***

***Funding for the hatchery is being provided for by the Upper Colorado River Recovery Program, Virgin River Recovery Program, State Wildlife Grant, and Sport fish money.***

Is the existing facility secure from the public? From livestock? From predators? If not, what control measures can be implemented?

***All of the ponds are secured with a 6 ft chain link fence topped with 3 strands of barb wire. The station also has a house where the Hatchery manager lives in site of all ponds.***

***Livestock graze the area but are kept out of the main area. The hatchery does have some fish losses due to ducks but they are addressed when they show up in the early spring.***

Is the existing facility a recirculating or reuse system? If recirculating, is the facility equipped with biological, chemical, physical, and/or ultraviolet filtration? If reuse, is there any way to prevent pathogen transfer between ponds, tanks, or raceways?

***Wahweap Hatchery is a one time use hatchery and passes all waste water into the creek.***

Is replication available. In other words, can captive fish be held in separate, secure ponds or raceways, to avoid catastrophic loss of the species at the facility?

***Yes, the hatchery has two different fenced areas and also one area that is broken up into 4 different groups of ponds. Native fish currently on station are being held in different areas to address genetic/population concerns.***

Can fish (larvae and adults) easily be retrieved from ponds, tanks, or raceways? By what means?

***Ponds all have kettles for draining and harvest. Ponds holding large fish can be drained in 2-6 hours. Since the ponds all have 1/8 screen we take 2-3 days if fry need to be harvested.***

Do you have a quarantine facility, where wild fish and/or sick fish can be excluded from other fish and treated for external and internal pathogens?

***We have a small area with 3 four foot tanks that can hold fish for 2-4 weeks of a quarantine but this area needs to be addressed better***

Do you have a climate-controlled storage facility for fish food and therapeutic chemicals?

***No for fish food but we do have a refrigerator for treatment chemicals***

Effluent

Is effluent from existing facility screened to prevent both escape and entry of fish and pathogens? If no, can this be done expeditiously?

***No, Wahweap Creek doesn't have year around flow so discharge and fish escape are not a problem. If fish escape they may end up in Lake Powell if conditions are perfect which at high lake level is 4-5 miles. Small flood events and summer heat keep any escaped fish located in***

***drain line plunge pools.***

Are drains from each pond, tank, or raceway interconnected?

***Yes, Hatchery has 5 different drain lines that all dump into the wash at different locations but all ponds on each line can be considered connected.***

Will permits be required for dealing with the effluent? If so, from whom? Do you foresee any problems obtaining permits, if necessary?

***No, Hatchery doesn't discharge enough water daily to need permits in Utah.***

Do you anticipate the need for NEPA compliance? If so, how long will this process take?

***NO***

Other Species

What other species are already being held/propagated at the facility?

***Bonytail, razorback sucker, least chub, woundfin, smallmouth bass, wipers, tiger muskie. All species are received as fry and grownout on station to required size.***

If other species are present, are any being held for refuge purposes?

***Least chub (2 genetic different populations in two ponds), Razorback sucker are being held as backup brood fish for the population found at Ouray National Fish Hatchery, Woundfin will be in the fall of 2005***

Do you anticipate adding other species in the future? If so, which species?

***No***

Is there any potential for accidental hybridization between HBC and any of these species?

***There could be some problems with hybridization with bonytail but currently all chub offspring produced at Wahweap are killed because of genetic questions.***

Personnel

How many people are employed to operate and maintain the facility?

***Hatchery Manager, Wildlife Tech II, and at least one summer tech***

Do you have staff living on station, in case of emergencies?

***Hatchery manager lives on station***

How many years of experience do employees have working with captive populations of threatened or endangered fish?

***Manager 11 years culture, Tech II 1 year culture***

How many years of experience do employees have treating internal and external fish pathogens (e.g. bacterial, viral, parasitic)?

***Manager 11 years but we have direct access with our fisheries disease lab staffed with two PhD vets and support staff of 5 and they can be called 24 hours a day to address problems.***

***Wahweap hatchery goes through a state fish health inspection every spring and maintains disease free status. This is required by the Utah Department of AG to transport and stock fish within the state of Utah.***

**Water**

Ownership

Who owns the water rights for the facility?

***Utah Division of Wildlife***

Do you anticipate any changes in ownership of water rights in the foreseeable future (50+ years)?

***No***

Source

Is the water source a spring, well, stream, river, lake or reservoir? Please specify.

***Well, drilled 800 feet but pumped at 260 ft. Back up well has been drilled and pumping designs are pending to provide a redundant water supply.***

Quantity

Do you have enough water to supply 3 changes per hour through each available unit (pond, raceway, tank), and 1 change per hour through the entire system? If no, what are your exchange rates?

***No, we only pump to keep our ponds full and topped off***

How reliable is the your water supply? Do you anticipate any changes in the foreseeable future (50+ years)?

***Main well has been in use for 30+ years and has showed no changes in the entire time it has been used for the hatchery. Drought has not caused any reduced flow in the last five years.***

Quality

Temperature. Please provide seasonal information regarding maximum, minimum, and average water temperature of source water and for water at your facility.

***Well water is 65 but pond temps range from 32 in the winter to 80 in the summer***

pH. Please provide seasonal information regarding maximum, minimum, and average pH of source water and for water at your facility.

***7.8***

Dissolved oxygen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***Well water is 4 but ponds hold at 10-16***

Dissolved nitrogen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***No concerns as of yet as fish loads are not maxed. Less than 100***

Pathogens. What, if any, pathogens exist in the source water for your facility? What is the source of pathogens, and can it be eliminated? What is the pathogen load? Do you have mechanisms in place to eliminate pathogens from source water?

***None, well water meets State drinking water standards***

**Funding**

Do you presently have adequate resources to provide a refuge facility for humpback chub that meets the following minimum requirements (Table)? If not, what is the estimated annual cost for providing such a refuge facility?

***Yes, There would be a few issues with some of the criteria (7,8,9,11) Most of these issues have been addressed dealing with bonytail and other species on station and have proved to meet the needs of the fish and address concerns.***

**Table.** Minimum criteria for eligibility as a possible humpback chub refuge facility.

Land must be owned by the facility operator, and ownership will not change for the foreseeable future (50+ years).

Water rights must be owned by the facility, and ownership will not change for the foreseeable future (50+ years).

The facility must be large enough to hold a minimum of 100 adult humpback chub.

The facility should allow fish to be held in multiple ponds, tanks, or raceways.

The facility cannot be located in a flood plain, unless it is within the native range of humpback chub.

The facility must be secure from the public and from predators (e.g. birds, mammals).

Quarantine of wild fish, as well as sick captive fish, must be possible.

Fish food must be climate-controlled and secure from pests.

The facility must provide for complete effluent treatment, including the prevention of escape and entry fish and pathogens.

All permits for holding endangered fish and treating/releasing effluent must be obtained by the facility operator prior to delivery of fish.

No congeners of humpback chub are or will be held at the same facility.

Staff must either live at the facility, or at least one person must be on duty 24 h/day.

Water source should be either pathogen-free or treated to remove all known pathogens.

Water source should consist of sufficient volume to safely accommodate 100 adult humpback chub, and this volume should be reliable for the foreseeable future (50+ years).

Water quality parameters must be within the following range (from Piper et al. 1982):

| | |
|---|---|
| Temperature: | 45-80 F (7-27 C) |
| Oxygen: | >= 5 ppm |
| Nitrogen: | 100% saturation or less |
| pH: | 6.5-9.0 |

**Legal Agreement**

The facility chosen to house a captive population of humpback chub must be willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service stating that:

Humpback chub will not be propagated at the facility

Any F1 progeny found at the facility will be separated from adult fish, and either accessioned into a museum or used for research purposes, pending written approval by both the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service.

No F1 progeny will ever be released into the wild.

Any mortality(ies) of adult captive fish, when found, will be preserved in alcohol, and date and apparent cause of death will be documented.

In the event of catastrophic loss of the wild population of humpback chub in the Little Colorado River in Grand Canyon, negotiations will begin immediately with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to initiate captive propagation of humpback chub at the facility.

Is your facility willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U. S. Fish and Wildlife Service stating that you will comply with these terms?

***Utah would be willing to discuss the option but would need to run it through the Fisheries section and reviewed by other agencies that the hatchery receives money from.***

**Appendix 9. Willow Beach Hatchery response to questionnaire for prospective humpback chub refuge facilities.**

Please place answers in boxes. This is not a legally binding agreement. This questionnaire is designed to aid the Arizona Game and Fish Department in selecting a refuge facility for humpback chub from the LCR in Grand Canyon.

**Land**

Ownership

Who owns the land?

***U. S. Fish and Wildlife Service***

Do you anticipate any changes in land ownership in the foreseeable future (50+ years)?

***No***

Is there enough land available for all facilities, protection of water supply, and treatment of effluent?

***Yes***

Topography

Is there sufficient elevation between water source and holding facilities for aeration and gravity flow?

***Electrical pump flows Colorado River water to raceways and hatchery.***

If no, what is the means of water delivery, how is water aerated, and is the supply of water and aeration guaranteed?

Does the holding facility provide adequate drainage?

***Yes***

Is the land located in a flood plain, or other locality that could be flooded?

***No***

If yes, is it in the Colorado River basin where humpback chub occur?

If yes, is it in the upper or lower Colorado River basin?

**Existing Hatchery Facilities**

What is the existing space (number and volume) **available** as ponds, raceways, or tanks? Are they earthen, plastic-lined, fiberglass, or concrete?

***12 circular fiberglass tanks, potentially more tanks***

What is the condition of the existing facility? How old are the holding ponds/tanks? How old is the plumbing? Do you have a maintenance plan and budget in place for the existing facility?

***45 years old, 5 years, 5 years, yes***

Is the existing facility secure from the public? From livestock? From predators? If not, what control measures can be implemented?

***Yes from all***

Is the existing facility a recirculating or reuse system? If recirculating, is the facility equipped with biological, chemical, physical, and/or ultraviolet filtration? If reuse, is there any way to prevent pathogen transfer between ponds, tanks, or raceways?

***Recirculating systems, yes.***

Is replication available. In other words, can captive fish be held in separate, secure ponds or raceways, to avoid catastrophic loss of the species at the facility?

***Yes***

Can fish (larvae and adults) easily be retrieved from ponds, tanks, or raceways? By what means?

***Yes, nets***

Do you have a quarantine facility, where wild fish and/or sick fish can be excluded from other fish and treated for external and internal pathogens?

***Yes***

Do you have a climate-controlled storage facility for fish food and therapeutic chemicals?

***Yes***

Effluent

Is effluent from existing facility screened to prevent both escape and entry of fish and pathogens? If no, can this be done expeditiously?

***Yes for the wetlab area***

Are drains from each pond, tank, or raceway interconnected?

***Some are some are not***

Will permits be required for dealing with the effluent? If so, from whom? Do you foresee any problems obtaining permits, if necessary?

***We obtain permits from AZDEQ***

Do you anticipate the need for NEPA compliance? If so, how long will this process take?

***No***

Other Species

What other species are already being held/propagated at the facility?

***Humpback chub, bonytail chub, razorback suckers, rainbow trout, relict leopard frog***

If other species are present, are any being held for refuge purposes?

***Humpback chub***

Do you anticipate adding other species in the future? If so, which species?

***No, but would like Virgin River chub and woundfin***

Is there any potential for accidental hybridization between HBC and any of these species?

***Yes, bonytail***

Personnel

How many people are employed to operate and maintain the facility?

***6***

Do you have staff living on station, in case of emergencies?

***Yes***

How many years of experience do employees have working with captive populations of threatened or endangered fish?

***14***

How many years of experience do employees have treating internal and external fish pathogens (e.g. bacterial, viral, parasitic)?

***25***

**Water**

Ownership

Who owns the water rights for the facility?

***Federal***

Do you anticipate any changes in ownership of water rights in the foreseeable future (50+ years)?

***No***

Source

Is the water source a spring, well, stream, river, lake or reservoir? Please specify.

***River and well***

Quantity

Do you have enough water to supply 3 changes per hour through each available unit (pond, raceway, tank), and 1 change per hour through the entire system? If no, what are your exchange rates?

***Yes***

How reliable is the your water supply? Do you anticipate any changes in the foreseeable future (50+ years)?

***Good, no***

Quality

Temperature. Please provide seasonal information regarding maximum, minimum, and average water temperature of source water and for water at your facility.

***12 to 16 C river water, 16 C well water, solar-heated water available***

pH. Please provide seasonal information regarding maximum, minimum, and average pH of source water and for water at your facility.

***6.5 to 7.5, average 7.0***

Dissolved oxygen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***River water => 8.0 ppm. Well water = < 2.0 ppm with use regenerate aeration to > 7.0 ppm***

Dissolved nitrogen. Please provide seasonal information regarding maximum, minimum, and average dissolved oxygen concentration of source water and for water at your facility.

***97 to 100%***

Pathogens. What, if any, pathogens exist in the source water for your facility? What is the source of pathogens, and can it be eliminated? What is the pathogen load? Do you have mechanisms in place to eliminate pathogens from source water?

***Ich, costia, columnaris, river, controllable, treat with chemicals. No known pathogens in well water.***

**Funding**

Do you presently have adequate resources to provide a refuge facility for humpback chub that meets the following minimum requirements (Table)? If not, what is the estimated annual cost for providing such a refuge facility?

***No, $10,000***

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Fish food must be climate-controlled and secure from pests.
The facility must provide for complete effluent treatment, including the prevention of escape and entry fish and pathogens.
All permits for holding endangered fish and treating/releasing effluent must be obtained by the facility operator prior to delivery of fish.
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Staff must either live at the facility, or at least one person must be on duty 24 h/day.
Water source should be either pathogen-free or treated to remove all known pathogens.
Water source should consist of sufficient volume to safely accommodate 100 adult humpback chub, and this volume should be reliable for the foreseeable future (50+ years).
Water quality parameters must be within the following range (from Piper et al. 1982):

| | |
|---|---|
| Temperature: | 45-80 F (7-27 C) |
| Oxygen: | >= 5 ppm |
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| pH: | 6.5-9.0 |

**Legal Agreement**

The facility chosen to house a captive population of humpback chub must be willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service stating that:

Humpback chub will not be propagated at the facility

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No F1 progeny will ever be released into the wild.

Any mortality(ies) of adult captive fish, when found, will be preserved in alcohol, and date and apparent cause of death will be documented.

In the event of catastrophic loss of the wild population of humpback chub in the Little Colorado River in Grand Canyon, negotiations will begin immediately with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to initiate captive propagation of humpback chub at the facility.

Is your facility willing to sign a legally binding agreement with the Arizona Game and Fish Department and the U. S. Fish and Wildlife Service stating that you will comply with these terms?

| |
|---|
| ***Yes*** |