Glen Canyon Dam Adaptive Management Program (AMP)
Humpback Chub Comprehensive Plan (HBCCP) Ad Hoc Group
Progress Report to the Technical Work Group (TWG)
Sequencing and Prioritization of HBCCP Projects
January 25, 2006

In March 2005 the Adaptive Management Work Group passed the following motion:

> **Motion**: The AMWG directs the TWG to further develop the humpback chub comprehensive plan, as follows:
>
> 1. Describe linkages, sequences, and feedback loops among projects
> 2. Identify priorities and a timeline for completion of each action within the comprehensive plan.
> 3. Spell out specific steps and criteria for any actions that would be needed if a crisis occurs (e.g., severe population decline).
> 4. Continue to include active participation by GCMRC staff and any additional expertise.
> 5. Incorporate comments from the Science Advisors. The TWG will include a response to comments document in their final draft.

This motion resulted in creation of the HBCCP Ad Hoc, tasked with completing this work. In an effort to help prioritize the HBCCP projects, the HBCCP Ad Hoc performed a ranking exercise on the projects. The current suite of HBCCP Projects are listed below, followed by information about the ranking process used to prioritize projects, and two figures (Figure and Figure 2) to illustrate prioritization, sequencing, and timeframe information. Note that these brief project descriptions and figures provided below are all draft items at this time.

Projects to Facilitate Conservation of the Federally Endangered Humpback Chub (*Gila cypha*) in the Lower Colorado River Basin (January 23, 2006)

1. Genetic Study – TO BE COMPLETED in 2006

Determine genetic relationships within and among populations of the endangered humpback chub (*Gila cypha*) in the Colorado River Basin.

The Conservation Genetics and Larval Fish laboratories at Colorado State University, Fort Collins (CO) are collaborating with researchers at other academic institutions and federal and state agencies to evaluate interrelationships among populations of the endangered *Gila cypha* within Grand Canyon (GC). Five populations from the Upper Colorado River basin also will be included in the study to gain perspective on basin-wide intraspecific relationships. Life history of *G. cypha* in GC is mostly enigmatic and interrelationships among subpopulations are virtually unknown. The most pressing questions pertain to genetic distinctiveness of aggregations in the mainstem Colorado River, the interrelationships among these and tributary populations, and how the sum can be adaptively managed in a dam-perturbed environment. Objectives of the proposed study are therefore to

infer interrelationships among populations of *G. cypha* and to identify (if possible) genetically distinct units.

2. Willow Beach Genetics – TO BE COMPLETED in 2006

Assess genetics of humpback chub being held at Willow Beach National Fish Hatchery for their potential as a refugium stock and as brood stock for captive propagation.

In 1999 the Service removed approximately 200 juvenile HBC from the Little Colorado River and transferred them to the Willow Beach National Fish Hatchery below Hoover Dam. The genetic makeup of these fish relative to the genetics of the species and the LCR population needs to be determined before a decision is made regarding their future use. This project, in conjunction with the basin-wide genetics assessment (project 1), will be used to determine if HBC currently on station at Willow Beach NFH would be suitable as brood stock and as part of a refugium population, or if they should be used for research. Activities include collecting tissues from fish at Willow Beach NFH and any other available archived tissues (approximately 120 from Willow Beach NFH, plus 40-50 reference samples), performing microsatellite DNA analysis using existing loci, and conducting statistical analysis on the data to determine the relatedness of this group of HBC to the LCR population.

3. Genetics Management Plan

Develop and implement a genetics management plan for humpback chub in Grand Canyon.

Propagation and genetics management is one of the seven elements of the Upper Colorado Endangered Fish Recovery Program. Guidance for controlled propagation of federally listed species has been promulgated by the Service. Genetic considerations for recovery of HBC are provided in the Humpback Chub Recovery Goals. A genetics management plan is a necessary precursor to stocking from captive breeding stocks. Such a plan has been developed for populations of HBC and the other three big river endangered fish for use in the Upper Colorado Endangered Fish Recovery Program. A draft genetics management plan for HBC has recently been developed. The genetics management plan for HBC needs to be finalized to guide planning removal of HBC for translocation of individuals to other tributaries in Grand Canyon, for development of a refugium population, and for captive rearing and captive propagation of individuals as a source for restocking.

4. Feasibility Assessment of Augmentation – COMPLETED in 2004

Determine feasibility of developing a program to augment the population of humpback chub (Gila cypha) in Grand Canyon.

There has been concern among biologists and managers regarding the continued downward trend in HBC populations within Grand Canyon. This project will provide a

comprehensive overview of the literature and background associated with three potential methods of augmenting HBC populations: (1) captive propagation of wild caught individuals removed from the LCR to a hatchery facility to produce progeny for restocking (2) removing wild caught young-of-year HBC from the LCR to a grow-out facility, rearing them to a large size in captivity and then restocking them and (3) translocation of wild caught HBC upstream to unoccupied habitat in the LCR and from the LCR to other tributaries.

5. Humpback Chub Hatchery Evaluation – COMPLETED in 2005

Humpback Chub Hatchery Evaluation and Evaluation of Prospective Refuge Facilities.

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. This project was completed by the Arizona Game and Fish Department in 2005.

6. Dam Ops - ONGOING

Use dam operations, or mitigate the effects of dam operations, to benefit humpback chub.

As identified in the 1996 Glen Canyon Dam FEIS and the 1995 FWS Biological Opinion, the operation of Glen Canyon Dam directly and indirectly affects the endangered HBC. There are linkages between such variables as temperature, flow, food base, native/non-native interactions, and water quality. Since1996, the GCDAMP has conducted numerous ecosystem experiments designed to test specific physical and biological hypotheses (1996 Beach/Habitat Building Flow, 1997 and 1999 Habitat Maintenance Flows, 2000 Low Steady Summer Flow, Spring LCR Ponding Flow and Habitat Maintenance Flow, 2003-2005 non-native suppression flows, the 2004 Experimental High Flow, and 2005-2006 Fall Steady Flows). These experiments not only investigated the ecosystem reaction to flow perturbations, but also attempted to determine what habitat conditions are necessary to sustain a recovered population of HBC. The 1994 Biological Opinion on the operation of Glen Canyon Dam contains an element of the reasonable and prudent alternative that addresses dam releases.

7. TCD

Complete feasibility study of selective withdrawal on Glen Canyon Dam and, if feasible, finish compliance, construct, and test the device.

Cold-water releases from Glen Canyon Dam have not been optimal for the existing trout fishery and below those temperatures needed to allow the HBC to thrive in the mainstem

of the Colorado River. Cold-water releases make it easy for trout to prey on young, native, warm-water fish. Thermal shock from cold mainstem temperatures has been recognized as a likely cause of mortality for young endangered fish leaving seasonally warmed tributaries and growth of HBC is markedly decreased in cold mainstream waters. Increasing the temperature of dam releases could be an effective tool to reduce thermal shock and improve growth, survival, and recruitment of HBC that descend to the mainstem.

Warming the Colorado River could have unintended negative consequences by improving conditions for warmwater non-native fish, increasing diseases and parasites, and affecting the cold-adapted foodbase of algae and aquatic invertebrates. The present persistent drought has resulted in the decline of Lake Powell elevation to a level resulting in the warmest documented dam release temperatures since Lake Powell filled in late 1970s. If the reservoir continues to remain low, warmer water will continue to be released with or without a selective withdrawal structure. Recent increases in HBC may be due in part to this warming. A selective withdraw structure could provide the AMP with the ability to control this important physical parameter.

8. Sediment Augmentation – TO BE COMPLETED in 2006

Consider sediment augmentation to benefit native fish (e.g. sediment pipeline from San Juan River), both long-term feasibility and short term experiment.

This project has two components: (1) evaluate the effects of increased turbidity or an extension of the period of turbidity on interactions between native and non-native fish, particularly near the confluence of the Colorado River and LCR (2) evaluate the potential for delivering sufficient amounts of fine sediment to reverse the present decline in Marble Canyon. An experimental test of increased turbidity is proposed to determine the ecological impacts of such augmentation, with particular regard to effects on sight-feeding predators of HBC and effects on fish food resources. Increased turbidity will be facilitated either through use of load-following fluctuations to increase the duration of turbidity, or through additions of fine sediments in the reach below the Paria River. The latter would require a significant compliance effort. A feasibility analysis will be performed to investigate the potential for large-scale sediment augmentation.

9. Improve Rearing Habitats

Improve rearing habitat for early life stage HBC in the LCR to improve growth and survival, particularly of those individuals who would disperse to the mainstream.

Two methods have been suggested that could provide for creation of tributary habitats that more closely resemble those experienced by young native fish prior to emplacement of Glen Canyon Dam. Both methods should be subjected to feasibility assessments prior to implementation. The first is to create ponded habitats in terraces above the LCR by excavation and lining. LCR water would be pumped to the ponds to keep them inundanted. Young HBC would be seined from the LCR, transported to the ponds, and fed either naturally occurring foods or commercial fish food. A second method that

could improve survival of young HBC in the LCR would be to create ponded habitat in the lower reach similar to that in predam days by emplacing an inflatable dam in the stream. This habitat could be created by releasing high steady flows from Glen Canyon Dam for the same period, probably late April to early July, but such releases would conflict with water delivery to the Lower Colorado River Basin and with the production of load-following hydroelectric power during this period. Inflatable rubber dams are being used for several purposes on streams of varying size to create ponded habitats. They have been found to be easy to operate and very resistant to wear and breakage. Such a dam on the LCR could be inflated with the onset of larval native fish drift and deflated when the fish had reached desirable size, but before the onset of summer monsoonal floods.

10. Tributary Nonnative Removal - ONGOING

Evaluate and, if feasible, remove and suppress nonnative fish in selected tributaries of the Colorado River in Grand Canyon National Park and tribal lands.

This project is to explore the feasibility of removing non-native fishes from tributaries of the Colorado River in Grand Canyon that may include the LCR, Bright Angel Creek, Tapeats Creek, Havasu Creek, Shinumo Creek and Kanab Creek. Reduction of non-natives is a necessary precursor for translocation of HBC and for supporting other native fishes in these streams. Non-natives that will be targeted include salmonids, carp, channel catfish, and yellow and black bullhead, but may include other non-natives as well. The level of control necessary to reduce non-natives, including most efficient removal methods, including reduction of by-catch and how long suppression lasts will be investigated. Removal methods will include trammel nets, fyke nets, hoop nets, angling and weirs at the mouth of tributaries. Feasibility of electroshocking using canoes, rafts and backpack units will also be explored as it relates to species-specific capture frequencies and minimization of incidental bycatch. Sample size will be related to initial capture densities and be modified based on success or failure of a particular method.

11. Mainstem Nonnative Removal - ONGOING

Mechanical removal of non-native fishes from the Colorado River near the confluence of the Little Colorado River.

A hypothesized factor in the decline in HBC recruitment in recent years is negative interactions (predation and competition) with non-native fish. Interaction with non-native fish is implicated in the decline and extinction of native fishes throughout the Colorado River Basin. Increased recruitment of rainbow (RBT) and brown trout (BNT) occurred during operation of Glen Canyon Dam under Modified Low Fluctuating Flows, the preferred alternative of the Glen Canyon Dam EIS, and populations in the Colorado River increased dramatically. This project is the continuation of a multi-objective study to evaluate the potential effect of RBT and BNT predation on HBC recruitment and the efficacy of mechanical removal of RBT and BNT from the LCR Inflow reach. Non-native fishes are being removed from a 17-mile stretch of river using boat-mounted electrofishing units. Reduction efforts are scheduled to continue for up to four years and

potentially be repeated as necessary if successful. Results from 3 years indicate that removal is highly effective at removing nonnative fishes, especially RBT, and increases in HBC may be due in part to this removal.

12. Warm Water Nonnative Removal

Removal of Warm Water Nonnative Fishes from Grand Canyon.

Native fishes of the Colorado River Ecosystem appear to have been negatively impacted by flows, cold water nonnative fishes, and perhaps other factors in the Colorado River main stem in the Grand Canyon. Recent natural warming of the CRE as a result of drought conditions appears to have allowed for expansion of the distribution of humpback chub and other native fishes, but the presence of warm water nonnative species, including fishes, crayfish, and parasites, is of concern to native fish managers. If natural warming should continue, or if a Selective Withdrawal Device is added to the Glen Canyon Dam, or both, then warm water nonnative species threats to natives will need to be aggressively addressed if they are to be controlled at levels that allow for the persistence, conservation, and recovery of native fishes. The GCMRC has drafted a warm water nonnative species management plan, with assistance from AMP and other cooperators and advisors, for review by the TWG. This project will include aquatic habitat management elements that need to be addressed, including risk analysis, water quality monitoring, fisheries monitoring, and nonnative control. A preliminary work plan and budget for implementing the warm water nonnative species management plan will be available for implementation in 2006.

13. Effects of Science and Recreation – PARTIALLY COMPLETED

Understand the effect and identify the threats of scientific work and recreational activities on humpback chub populations in the Grand Canyon area (review Upper Basin Recovery Program, etc.).

This project will assess the impacts of repetitive habitat disturbance, recapture, and handling on Grand Canyon HBC populations and develop modified protocols and management policies to maximize recreation opportunity and scientific information collection while minimizing the impacts of these activities on HBC individuals and populations. HBC in Grand Canyon, particularly the Little Colorado River population, have endured significant environmental manipulation and individual physical handling for the last 20 years. PIT tagging efforts alone have resulted in a majority of adult HBC being recognized (handled) individually from multiple recaptures (repeatedly) over time. Other research efforts may also affect HBC indirectly as an unintended consequence. Likewise, the seasonal disturbance associated with recreational activities (boating, swimming, fishing, etc.) in the CRE and especially in the lower portions of the LCR may have similar effects. Repetitive disturbance, recapture, and handling are continual sources of stress, health risk, and potential injury for individuals and the population as a whole. Some research has already completed examining the effects of PIT tagging and hoop net use. Additional efforts are needed to examine the effect of other gear types, as well as the effects of disturbance from recreational and science activities. A study

examining the effects of hoop netting and PIT tagging, using bonytail (*Gila elegans*) as a surrogate, has been completed.

14. Diseases and Parasites - ONGOING

Monitor and investigate control of fish diseases and parasites, Colorado River, Grand Canyon region.

At least four exotic parasites are known to infect fishes of the LCR. Two of these parasites, Asian fish tapeworm Bothriocephalus acheilognathi (Cestoda) and anchor worm Lernaea cyprinacea (Copepoda) infect HBC at a higher rate than any other species in the system. Both B. acheilognathi and L. cyprinacea have been reported as pathogenic and potentially fatal (directly or indirectly) to fish of various age classes. Bothriocephalus acheilognathi has caused high mortality in native fishes that it has infected outside of its native range. These parasites cannot complete their life cycles in the mainstem Colorado River under present, cold water conditions. However, low Lake Powell reservoir levels are resulting in warmer mainstem temperatures that could result in hospitable conditions for these parasites. The project will include two phases: (1) development and implementation of a monitoring plan for fish diseases and parasites in the Colorado River and its tributaries, with emphasis on those infecting HBC and (2) investigation of mechanisms for control and suppression of important diseases and parasites.

15. Translocations to Other Tributaries

The translocation of native fishes to tributaries of the Colorado River, Grand Canyon National Park, and tribal lands.

The goal of this project is to expand the demographic range of HBC and reduce the risk of catastrophic events in the LCR by using other tributaries as growout areas for small HBC. The objective is to transplant young-of-year LCR HBC that likely would be transported to the Colorado River and otherwise not survive to appropriate tributaries within Grand Canyon National Park and adjoining tribal lands to improve their survival. Young HBC translocated to tributaries with suitable juvenile habitat and reduced predator numbers that grow to a size large enough to survive in the mainstream have an opportunity to join existing mainstream aggregations. There they may serve to augment founder populations if mainstream conditions improve sufficiently to allow reproduction and recruitment, e.g. if water temperatures increase from use of a temperature control device. Non-native suppression likely is a necessary prerequisite for translocation of HBC into tributaries having suitable physical habitat for this purpose, thus this project will be implemented in conjunction with Project 10, Removal of Nonnative Fishes from Tributaries in Grand Canyon

16. Translocations above Chute Falls - ONGOING

Translocation of Humpback Chub from the confluence of the Little and Colorado Rivers to the Little Colorado River Above Chute Falls.

Many young HBC that prematurely migrate into the anthropogenically disturbed Colorado River from the LCR are presumed to perish due to cold water temperatures, diel discharge fluctuations, and multitudes of nonindigenous piscine predators. Most HBC that recruit to adulthood are believed to be individuals that remain in the warmer LCR for longer periods of time to grow and become less susceptible to the inhospitable conditions in the mainstem. Endemic speckled dace and a few, primarily small-bodied, nonindigenous fishes have consistently been the only species detected above Chute Falls during ichthyofauna surveys over the last two decades. Translocation of juvenile HBC from near the confluence upstream above Chute Falls might increase the numbers of younger HBC that recruit to adulthood by allowing them an opportunity to exploit the greater food abundance, warmer water temperatures, and reduced competition and predation by fewer large-bodied fishes that are exist in this area. If this experiment is successful, it will supply a viable action to expand suitable HBC rearing habitats within the LCR and may bide additional time until other successful recovery actions can be implemented in the CR or one of its tributaries. Translocation began as a conservation measure in the December 6, 2002 Biological Opinion. Small humpback chub (Gila cypha, HBC , 50-100 mm TL) from the lower Little Colorado River have been moved to above Chute Falls (>14 rkm) in an attempt to improve survival of young of year humpback chub in 2003, 2004, and 2005. To date, approximately 1,200 HBC have been moved. Monitoring has indicated this project is a success. Translocated HBC have persisted above Chute Falls, shown impressive growth rates, and appear to have spawned in 2005. No HBC will translocated in 2006; instead, a population estimate and other research will be conducted to determine if additional translocations are recommended.

17. Monitoring above Chute Falls - ONGOING

Monitoring Humpback Chub in the Little Colorado River Above Chute Falls.

In July of 2003 and 2004, small HBC (HBC, 50-100 mm TL) were captured near the Little Colorado River confluence and translocated to the river corridor above Chute Falls, near river kilometer 16.2. As a result of these translocations, a total of approximately 1,200 HBC have been moved above Chute Falls. It was hoped that these translocations would increase HBC recruitment to adulthood by allowing them an opportunity to exploit the abundant food resources, warm water temperatures, and reduced competition and predation by fewer large-bodied fishes associated with this area. During subsequent monitoring of these translocated HBC, many of the translocated individuals were found to have persisted and grown to adult size. Given this, the need to conduct a stock assessment of the Chute Falls segment of the population became apparent. A stock assessment of the HBC above Chute Falls will result in valuable baseline data of this population for long term monitoring purposes. In addition, the resulting population estimates can be incorporated into ongoing stock assessments occurring below Chute Falls to provide a overall stock assessment of the entire Grand Canyon population as required by the recovery goals.

18. Little Colorado River Monitoring – ONGOING

Maintain a core monitoring effort for the Humpback Chub in the Little Colorado River.

The Grand Canyon Monitoring and Research Center (GCMRC) has identified that a rigorous stock assessment program for the Little Colorado River (LCR) population of humpback chub (HBC) is a priority component, as well as long-term fish monitoring in Grand Canyon. Four monitoring trips will be conducted into the Little Colorado River each year as a continuation of the Little Colorado River HBC stock assessment program initiated in the fall of 2000. These trips will occur in March, April, September, and October. This effort will provide spring and fall abundance estimates of HBC in the Little Colorado River. In concert with the fall 2001-3 LCR HBC abundance estimates, the spring and fall 2004 effort will also provide estimates of: (1) over-winter survival/retention for juvenile HBC in the LCR, (2) year 2004 HBC spawning abundance, (3) post-monsoon survival/retention of juvenile fish in the LCR, and (4) an index of recruitment strength for the year 2001-2003 cohorts. In addition, GCMRC has identified that a continuation of standardized mini-hoopnet efforts in the mainstem (i.e. Hopi-Salt site) will be useful for gauging the survival of young-of-the-year and juvenile HBC. This effort provides information about mainstem over-winter survivorship curves, and is also used to address additional questions about survivorship during studies involving site-specific predator removal and steady flow experiments.

19. LCR Water Quality

Monitoring Hydrology and Water Quality in the Little Colorado River.

While anthropogenic changes in the mainstem Colorado River are often cited as contributing to the decline of HBC, little is known about historical, or even recent, changes in physical and chemical characteristics of the Little Colorado River in Grand Canyon, and how these may have affected the humpback chub. The LCR stream gage was reestablished in 2003, using newer and more effective technologies for measuring river stage (acoustics). Operation of the gage record by the Integrated Downstream Quality of Water Program (DIQWP) is aimed at establishing a continuous stage and discharge record to support ongoing fisheries monitoring and research in the lower 13 km of the Little Colorado River. The gage will also support future monitoring efforts for targeted QW parameters associated with flows in the LCR related to Blue Spring and other sources upstream. Also needed is a monitoring program for basic water quality parameters, contaminants, and review of existing historical hydrological and water quality data. This project will allow for continued operation of the gage and development of a monitoring program for other water quality data in the Lower LCR.

20. Downstream Fish Monitoring – ONGOING

Monitoring the Status and Trends of the Downstream Fish Community in Grand Canyon.

The downstream fish community is an assemblage of native and non-native fish that occur in the Colorado River ecosystem. This assemblage is exclusive of the trout fishery

that is managed in Glen Canyon by the Arizona Game and Fish Department. The constituents include four native fish and introduced competitors/predators like rainbow trout, brown trout, channel catfish, carp, and other non-native forms. The status and trends of the fishery are regulated by biotic and abiotic mechanisms that may in turn be affected by the operations of Glen Canyon Dam. Monitoring basic population statistics including recruitment, abundance, and distribution of native and non-native fishes provide the fundamental information necessary to assess the status of these resources and the attainment of program goals and objectives.

Since 2000, GCMRC and cooperators have been developing a long-term monitoring program for fishes in the CRE. To date, significant progress has been made toward this end such that it is now appropriate for GCMRC to formalize a long-term monitoring program for key non-native fishes (i.e. rainbow trout, brown trout, and common carp). For the immediate future, the project will maintain downstream monitoring in the Little Colorado River and in the mainstem for salmonids, and continue development and implementation of the long-term monitoring program as described in the core monitoring plan.

21. Diamond Down Monitoring - ONGOING

Develop a fish monitoring program for the Colorado River downstream of Diamond Creek to detect changes in habitat and fish communities and complement the monitoring program upstream of Diamond Creek.

Lake Mead's full pool elevation is at 1229 feet. At this elevation, the inflow area of Colorado River is influenced by the reservoir as far upstream as Separation Rapids (River Mile [RM] 239.5 [distance below Lee's Ferry]). This location is about 37 miles upstream of Grand Wash Cliffs (RM 276.5), the western boundary of Grand Canyon National Park and the eastern boundary of Lake Mead National Recreation Area. The 1992 Grand Canyon Protection Act (GCPA) uses Grand Wash Cliffs as the western boundary of the Adaptive Management Program. Under the Act, an Adaptive Management Program (AMP) was set up to provide recommendations to the Bureau of Reclamation on Glen Canyon Dam operations to "protect, mitigate adverse impacts to and improve" downstream National Park Service resources without interfering with the "Law of the River." The Grand Canyon National Park western boundary at Grand Wash Cliffs defines the extent of responsibility for the AMP under the GCPA. Currently there is no monitoring of fishes or fish habitat below the confluence of Diamond Creek with the mainstem Colorado River (RM 226). The area between Separation Rapid and Grand Wash Cliffs overlaps with the area for the Lower Colorado River Multi-Species Conservation Program (MSCP), so this reach is of interest to both programs. This project would develop a monitoring program for the river downstream of Diamond Creek to detect changes in habitat and fish communities resulting from dam operations or other causes. Monitoring of non-native and native fish in this reach may become increasingly important to both the GCDAMP and MSCP, particularly if there is upstream movement of non-native fish out of Lake Mead into Grand Canyon.

22. Concurrent Estimates

Conduct concurrent estimates of HBC in LCR and mainstem to develop/confirm population estimates. Evaluate the age group survivability for all age classes, including recruitment.

Currently population estimates for HBC are conducted in the LCR in the fall of each year to estimate abundance of smaller chub and to get a 'first' signal about the survival and potential recruitment of a given year class. Sampling is also conducted in the spring primarily aimed at marking as large a number of chub as feasible to provide information through capture and subsequent recapture for stock assessment models. Depending on the quality of data with respect to meeting assumptions of mark-recapture population estimation models, these spring data may also be used to generate a point estimate of the population size. There has and continues to be uncertainty regarding how well point estimates derived solely from LCR sampling represent the status and trends of the 'LCR population', which contains individuals that are known move back and forth between the LCR and mainstream, particularly during the spawning period. There is also concern about adopting consistent population estimation procedures for populations of HBC in the Upper and Lower Basin to satisfy criteria identified in the Recovery Goals.

The project would produce estimates of abundance for HBC in the LCR and LCR confluence area of the mainstem in spring. These estimates could be used to compare with estimates obtained using only LCR sampling and using various stock synthesis models. Simulation modeling of population estimates by Dr. Dave Otis at Iowa State University is ongoing, and when completed, will help identify the need to conduct concurrent estimates.

23. LCR Watershed Management Plan

Develop a watershed management plan for the Little Colorado River.

This project focuses on the improvement and protection of the LCR watershed to ensure appropriate habitat conditions downstream on the LCR in the area occupied by the HBC. Potential issues to be addressed include surface and groundwater quantity and quality, pesticides and other hazardous substances, and non-native fish stocking. Several of these issues are addressed in separate projects listed below which should become components the broad LCR watershed management plan.

The LCR watershed is a large area with many political jurisdictions and authorities. For this effort to be successful, these parties must work cooperatively together as they bring their various ideas and responsibilities. The Little Colorado River Watershed Coordination Committee (LCRWCC) group has been organized to facilitate discussions among these various interests. Reclamation, AGFD, and FWS have been involved in recent discussions of the group. This project will review the status of the LCRWCC and its development of a watershed management plan, and then assist in the development and implementation of such a plan. This project will assist in meeting the Recovery Goal of assuring continued protection of conditions needed for HBC recovery. A cooperatively developed watershed-based management plan will provide a strategy for protecting the

endangered HBC and other federally listed species while at the same time continuing with necessary water and resource development, prioritize necessary actions to achieve these goals, identify funding sources, construct management objectives and targets for measuring success, develop the framework for cooperative agreements, and identify a timeline for completion of tasks and measurement of successes.

24. LCR Emergency Hasmat Plan

Develop an emergency response/contingency plan for protection of downstream species from spills into the Little Colorado River at Cameron or other potential sites.

The recently adopted Recovery Goals amend the Humpback chub Recovery Plan and establish "Site-Specific Management Actions to Achieve Recovery." For Grand Canyon, it states the need to: Review and modify, if necessary, state and federal hazardous spills emergency response plans to insure adequate protection from spills, including prevention and quick response to spills; develop and implement a hazardous spills protocol for the Cameron Bridge. This project therefore should undertake to develop a well-designed contingency plan providing details about each step involved in preparing for, and responding to, spills of materials into the Little Colorado River channel at Cameron Bridge on Highway 89 or other potential sites for the express purpose of protecting fish species in the Little Colorado River.

25. LCR Pollution Control Plan

Develop a pollution control plan for Little Colorado River Basin.

The plan would provide a comprehensive evaluation of threats to the HBC and its critical habitat that may arise from pollution generating activities in the LCR basin and suggest potential actions to ameliorate these threats. This would include: 1) a comprehensive review of existing plans and projects of federal, state, tribal, local and private entities as well as adopted and planned water quality standards and objectives for the watershed related specifically to aquatic life; 2) identification of various pollution scenarios related to both point and non-point sources of pollutants; and 3) a list of appropriate response actions that could be employed to deal with the identified pollution scenarios. The project should be implemented in such a manner as to complement and be consistent with the broader LCR Watershed Management Plan. It should provide appropriate background information on watershed activities representing potential pollution threats with particular emphasis on HBC, identify all relevant institutional responsibilities and contact information, and available response capabilities including equipment. The project should also identify existing best management practices, treatment and control practices, likely sources of unintended pollution scenarios, and recommendations regarding response scenarios and responsibilities.

26. Invasive Species Management Plan

Develop an invasive species management plan for the Colorado River ecosystem.

The continued introduction of aquatic invasive species in the Colorado River poses a serious threat to aquatic resources and an already imperiled fauna. These non-native plants and animals are transported into and throughout the Colorado River via recreational boating, fisherman, researchers, through the release of unwanted aquarium contents, or a variety of other transport vectors related to human activities. Because they have few natural controls in their new environments, these species have great potential for rapid colonization and are already having significant impacts on the biodiversity and integrity of aquatic habitats in the Lower Colorado River, e.g. Giant salvinia. Many of the tributaries to the Colorado River in Grand Canyon originate in Grand Canyon National Park, and therefore are under less threat to invasive species introductions. Other tributaries, including the Little Colorado River, traverse large distances before reaching the mainstream and pass through numerous jurisdictions where there is limited coordination in addressing invasive species.

This project would develop a response plan to detect and quickly act should additional nonnative species become established in the CRE as well as develop additional measures as part of the LCR Watershed Management Plan to prevent further introductions. The focus should be to prevent further introductions, yet with potential temperature modification, a coordinated response that acts quickly to contain the nonnative introduction and prevent further spread is necessary. It should also include an evaluation of effective ways to detect new species within CRE, designate an interagency response team to respond to new introductions and develop a response plan that would go into effect if new introductions were detected, including necessary NEPA compliance

27. Nonnative Stocking Procedures

Develop non-native stocking procedures for the Lower Colorado River and tributaries from Glen Canyon Dam to Lake Mead.

Control of the release and escapement of nonnative fishes into the Colorado River in Grand Canyon and its tributaries is a necessary management action to limit the impact of currently present nonnative species, stop the introduction of new fish species into occupied habitats and to thwart periodic escapement of highly predaceous or competitive nonnatives from connected waters throughout the basin. Procedures for the stocking of nonnatives have been developed and associated implementing agreements have been signed among FWS and the States of Colorado, Utah, and Wyoming to review and regulate all stockings within the Upper Colorado River Basin in order to reduce the introduction and expansion of nonnative fishes. Similar procedures need to be developed and implemented to protect the Grand Canyon population of HBC, including all portions of the Lower Colorado River Basin between Glen Canyon Dam and Hoover Dam, including the two mainstem reservoirs.

28. AMP Outreach - COMPLETED

Develop an Adaptive Management Work Group Outreach Program.

The goal of this project is to develop a single, consistent, and coordinated outreach program. There is a clear need for the AMWG to develop a process by which it can agree on the intent and content of all press releases and other outreach mechanisms. AMWG has been established to develop consensus recommendations to the Secretary of the Interior on the operations of Glen Canyon Dam. Direction for AMWG can be found in the Grand Canyon EIS and the Grand Canyon Protection Act. Without an active outreach plan and program AMWG has suffered from "Agency Writers Cramp", with very little information getting to the public and what does reach the public is, normally, only from a single agency's perspective and not AMWG. Because we do not have a coordinated outreach program, we were unable to relay a consistent message to the public. Along with the development of a comprehensive plan for humpback chub, a public outreach plan is necessary to inform the public of our goals and objectives, as well as to inform them of ongoing activities that may impact them.

HBCCP Project Ranking Exercise

In an effort to help meet the AMWG directive to prioritize the HBCCP projects, the HBCCP Ad Hoc conducted a ranking exercise on the projects. Five criteria were used to rank each of the projects. Two additional criteria were used to vote on each of the projects as to their appropriateness in the LTEP process, and for consideration as an "emergency action." The criteria were defined as follows:

Criteria	Definition
Benefit	Benefit to the species, 5 is greatest benefit
Cost	Economic cost, 5 is least expensive
Confidence	How likely the project will be effective, 5 is highest confidence
Learning	How likely a project is to answer science questions, 5 is high likelihood
Timeframe	How quickly will the species benefit, 5 is shortest timeframe
LTEP	LTEP suitability; 1=yes, 0=no; note that by definition, monitoring and planning projects are "0"
Need	How urgently a project is needed (i.e. chronic vs. acute management need), 0=chronic, 1=acute

Five projects were not included in the ranking because they were considered completed (Genetics Study, Willow Beach Genetics, Feasibility Assessment of Augmentation, Sediment Augmentation Feasibility, and AMP Outreach). The 5 ranking criteria were totaled across projects and expressed as a percent of a perfect score of all 5's. No weighting was given to any particular criteria; all were treated equally. Average and variance for each ranking were also calculated. The two voting criteria, "LTEP" and "Need," were totaled across projects and were considered "passed" if they received more than 50 percent of the vote. Ten ad hoc members contributed to the project ranking, 8 contributed to the "LTEP" vote, and 7 contributed to the "Need" vote. Various ad hoc members interpreted the exercise instructions differently, and, as a result, some members did not provide rankings for all criteria and all projects. In cases were an entire criterion was ignored and scored incorrectly, the criteria was dropped from analysis for that member. In cases were a certain project was not ranked in a particular criteria, but other projects were, a "1" was assigned to preserve the other rankings. The results were as follows:

Project Ranking

Project Name	Score	Average	Variance
Genetics management plan	86.5	4.2	1.2
Little Colorado River Monitoring	86.0	4.2	0.9
Downstream Fish Monitoring	80.9	3.9	0.9
Translocations above Chute Falls	80.9	3.9	1.1
Refugium and captive breeding plan	80.5	3.9	1.6
Monitoring above Chute Falls	80.0	3.9	1.0
Translocation plan	76.7	3.7	1.4
Warm water nonnative removal	75.3	3.7	1.1
LCR Water Quality	74.4	3.6	1.2
Mainstem nonnative removal	72.6	3.5	1.7
Diseases and parasites	72.6	3.6	1.2
Translocations to other tributaries	72.6	3.5	1.0
TCD	70.7	3.4	2.4
Dam ops	70.2	3.4	1.5
Effects of science and recreation	70.2	3.4	1.4
Tributary nonnative removal	68.4	3.3	1.4
Invasive species management plan	68.4	3.3	1.5
Diamond down monitoring	67.0	3.3	1.3
Improve rearing habitats	65.1	3.2	1.4
LCR emergency hasmat plan	64.7	3.1	1.3
Nonnative stocking procedures	64.2	3.1	1.4
LCR Pollution control plan	60.5	2.9	1.1
LCR Watershed management plan	60.0	2.9	1.5
Concurrent estimates	52.1	2.6	2.3

LTEP Projects (by vote)

Dam ops
TCD
Tributary nonnative removal
Mainstem nonnative removal
Diseases and parasites
Warm water nonnative removal

Need (emergency actions, by vote)

Genetics management plan
TCD
Mainstem nonnative removal
Little Colorado River Monitoring
Warm water nonnative removal

Note that no criteria were weighted; some Ad Hoc members suggested that "Benefit" or "Need" should be weighted to more strongly contribute to the ranking. Several Ad Hoc members pointed out that some results seemed spurious. For example, most members agreed that the "LCR Hasmat Plan" should have ranked higher and been considered an "emergency action." Others felt that "Diamond Down Monitoring" and "Concurrent Estimates" should have ranked higher, and that we should have ranked "Sediment

Augmentation," because a number of other projects are likewise only in the planning or feasibility stages and yet were still ranked ("Sediment Augmentation" was not ranked because it was considered a completed feasibility project). All members agreed that this effort should be treated as a "work in progress."

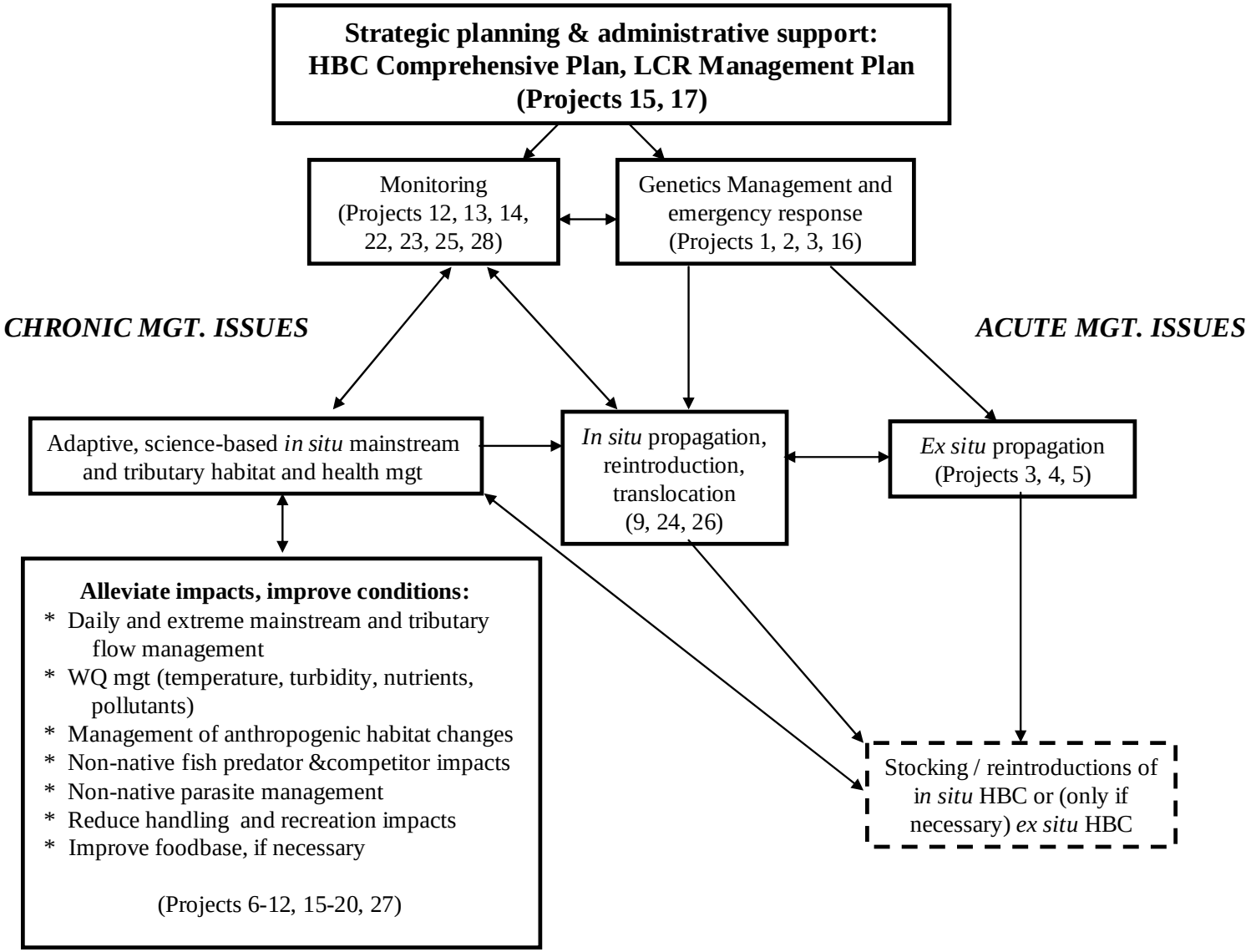

Fig. 1: Linked elements of conservation planning for HBC in Grand Canyon.

Figure 2. Gant chart of HBCCP project implementation.

Number	Project Name	Type	Category	2006			2007			2008			2009			2010		
1	Genetic study	E	R															
2	Willow Beach genetics	E	R															
3	Genetics management plan	E	R															
4	Feasibility assessment of augmentation	E	P															
5	Humpback Chub hatchery evaluation	E	P															
6	Dam ops	I	P															
7	TCD	I	R															
8	Sediment augmentation	I	R															
9	Improve rearing habitats	I	P															
10	Tributary nonnative removal	I	R															
11	Mainstem nonnative removal	I	R															
12	Warm water nonnative removal	I	R															
13	Effects of science and recreation	I	Ma/P															
14	Diseases and parasites	I	R															
15	Translocations to other tributaries	I	Ma															
16	Translocations above Chute Falls	I	Mo															
17	Monitoring above Chute Falls	M	R/Mo															
18	Little Colorado River Monitoring	M	Mo															
19	LCR Water Quality	M	Mo															

Number	Project Name	Type	Category	2006			2007			2008			2009			2010		
20	Downstream Fish Monitoring	M	Mo															
21	Diamond down monitoring	M	R															
22	Concurrent estimates	M	Mo															
23	LCR Watershed management plan	P	R															
24	LCR emergency hasmat plan	P	P															
25	LCR Pollution control plan	P	P															
26	Invasive species management plan	P	P															
27	Nonnative stocking procedures	P	P															
28	AMP Outreach	P	R															

Type: E=Ex Situ, I=In Situ, M=Monitoring, P=Planning
Category: R=Research, Ma=Management, Mo=Monitoring, P=Planning

Funded, near completion.

Partially funded, endpoint not well defined.

Unfunded, possibly outside of AMP.

Unfunded, may be within AMP, urgent need.

Completed.