

REASONABLE AND PRUDENT ALTERNATIVE

Regulations implementing section 7 define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that (1) can be implemented in a manner consistent with the intended purpose of the action, (2) can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction, (3) are economically and technologically feasible, and (4) would, the Service believes, avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.

The Service believes that elements of the reasonable and prudent alternative developed for this consultation meet the above four tests due to the following:

(1) There is an unique opportunity to conserve and protect endangered and other native fish fauna in an ecosystem designated as National Park Service lands for the preservation of these and other natural resource protection values from Glen Canyon Dam to Lake Mead. The Grand Canyon Protection Act of 1992 requires the Secretary of the Interior to "... protect, mitigate adverse impacts to, and improve values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established ..."

(2) Providing water storage and annual water releases of at least 8.23 maf to the lower basin States is a primary function of Glen Canyon Dam. The reasonable and prudent alternative will not conflict with this annual delivery of water. All flows requested in the reasonable and prudent alternative that are not part of the proposed action are within powerplant capacity. Lower basin deliveries of water are met from releases from Hoover Dam and, to a lesser extent, from Lake Mead and do not depend on daily or monthly releases from Glen Canyon Dam. Elements previously defined as conservation measures by Reclamation and the Service are presently being conducted within Reclamation's authority. A structure similar to the selective withdrawal structure identified here has been built and is being operated by Reclamation on Flaming Gorge Dam on the Green River.

(3) Elements of the reasonable and prudent alternative that address operations have been reviewed and included in the draft EIS as viable alternatives. Additional NEPA compliance would be necessary for a selective withdrawal structural element.

(4) The Service believes, that to prevent jeopardy to the endangered fish of Grand Canyon, restoration of the aquatic ecosystem by reducing, to the extent possible, known limiting factors and conducting appropriate research to identify and reduce suspected limiting factors will be necessary and can be accomplished with cooperation, innovative approaches, and elements of the following reasonable and prudent alternative.

ELEMENTS OF THE REASONABLE AND PRUDENT ALTERNATIVE

The following reasonable and prudent alternative contains elements that will focus on the community of endangered and native fish present in the Grand Canyon. The Service believes that actions for one native species should be supportive of other native species in the ecosystem. As the trend of more species becoming endangered or threatened continues in the Colorado River, the difficulties of recovering an ecosystem that is losing functional parts may become insurmountable. Therefore, the health of the entire native fish community will be crucial to the removal of jeopardy for the humpback chub and razorback sucker. We realize that not all of the elements can be implemented at once, and an implementation schedule has been noted for some elements. Those elements that can be accomplished without further verification or NEPA compliance should be implemented without delay. For some elements, such as the selective withdrawal structure, a schedule will be determined. Reclamation and the Service will meet at least annually to coordinate reasonable and prudent alternative activities. Such meetings will provide the Service an opportunity to determine whether sufficient progress is being made in accomplishing those actions set forth to remove jeopardy to federally-listed species impacted by operation of Glen Canyon Dam.

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Refinement of specific flows is dependent on continued studies, including a period of experimental flows, that identify mainstem habitats affected by flows and responses by endangered fishes to those habitats. Successful completion of the reasonable and prudent alternative is necessary to remove jeopardy to the humpback chub and razorback sucker from the proposed action. The reasonable and prudent alternative will be accomplished when all elements of the selected alternative have been effected and studies confirm compatibility between these species requirements and the operation of Glen Canyon Dam.

The draft EIS has seven elements common to all but the unrestricted fluctuating flow alternatives. Six of those EIS common elements that would influence native and endangered fish are adaptive management, flood frequency reduction measures, habitat and beach building flows, establishing a new population of humpback chub, further study of selective withdrawal, and emergency operations exception criteria. Three of the EIS common elements that were identified by Reclamation and the Service as conservation measures (see BACKGROUND) are research or long-term monitoring (adaptive management), flood frequency reduction, and the second spawning population of humpback chub. Development of a management plan for the LCR was another conservation measure being conducted by Reclamation through GCES.

Because of the importance of the EIS common elements and conservation measures to the continued existence of the humpback chub, razorback sucker, and other Colorado River native fish, many of the elements and measures are included below as elements of the reasonable and

prudent alternative to assist in identification of actions necessary to be included in any future modification of the preferred alternative.

1. Attainment of riverine conditions that support all life stages of endangered and native fish species is essential to the Colorado River ecosystem. Therefore, Reclamation shall develop an adaptive management program that will include implementation of studies required to determine impact of flows on listed and native fish fauna, recommend actions to further their conservation, and implement those recommendations as necessary to increase the likelihood of both survival and recovery of the listed species.

The Adaptive Management Program, an EIS common element, was still being formulated as we prepared this biological opinion. The Service supports adaptive management as an iterative approach to resource management. We recognize that the aquatic and terrestrial ecosystems below Glen Canyon Dam are still adjusting to impacts from dam operations that will continue into the future. Thus, the need for adaptive management. Actions taken through this approach must be based on integrated resource approach, and, as discussed by Hilborn (1992), an active rather than a passive learning system that includes deliberate experimental design.

- A. A program of experimental flows will be carried out to include high steady flows in the spring and low steady flows in summer and fall during low water years (releases of approximately 8.23 maf) to verify an effective flow regime and to quantify, to the extent possible, effects on endangered and native fish. Studies of high steady flows in the spring may include studies of habitat building and habitat maintenance flows. Research design and hypotheses to be tested will be based on a flow pattern that resembles the natural hydrograph, as described for those seasons in the SASF.

Information from final GCES endangered fish reports, researchers who conducted those studies, and other knowledgeable individuals will be used to assist in determining an experimental flow regime of high spring flow and low summer and fall flow for endangered fishes and to develop hypotheses and studies to accompany those flows with final review and approval by the Service. Reclamation will provide technical assistance and funding.

Design of the experimental flows and associated studies will begin as soon as possible and be targeted for completion by October 1996. Unless the Service determines information provided seriously

questions the validity of experimental designs developed or contribution of the resulting data to remove jeopardy to the federally-listed aquatic fauna of the Grand Canyon, experimental flows will be initiated in April 1997. If sufficient progress and good faith effort is occurring towards initiating experimental flows, implementation of experimental flows may occur later in 1997. If the Service believes there is not sufficient progress, Glen Canyon Dam would be operated as SASF flows during spring through fall (April to October) beginning in 1998. If the Service determines a study design can not be developed that is expected to provide information to support removal of jeopardy to the razorback sucker and humpback chub populations in the Grand Canyon and associated tributaries, such will be considered new information and may be grounds for reinitiating formal consultation.

This element is based on low release years (8.23 maf) occurring approximately 50% of the time. Further improvement of the means for determining a low water year that would initiate the implementation of research flows in a given year will be developed by Reclamation with concurrence by the Service. This may include, for example, methods based on content of water in Lake Powell at a given date. When implemented, experimental flows will be conducted for a sufficient period of time to allow for experimental design, biological processes to function, and for variability inherent in riverine ecosystems to be expressed. The number of years to conduct the experimental flows is, therefore, indeterminate.

During moderate and high release years, Reclamation shall operate Glen Canyon Dam according to requirements of the MLFF. Operations during moderate and high water years would assist in achieving some of the variability that was always present in the historic Colorado River and under which the endangered and other native fish evolved.

Following analysis of the data, appropriate operational flows will be determined by the Service and implemented by Reclamation in compliance with section 7(a)(2), Endangered Species Act.

B. Reclamation shall implement a selective withdrawal program for Lake Powell waters and determine feasibility using the following guidelines.

- i. Review historic information and employ existing modeling with possible updates using alternative reservoir and operating conditions to prepare a set of possible scenarios of temperature changes in the mainstem.
- ii. Determine from the literature, experimentation, and consultation with the AGFD, Native American Tribes, National Park Service, Service, and other native fish species experts the anticipated effects on native fish populations which may result from implementation of temperature changes from a selective withdrawal structure. Determine the range of temperatures for successful larval fish development and recruitment and the relationship between larval/juvenile growth and temperature.
- iii. Assess the temperature induced interactions between native and non-native fish competitors and predators.
- iv. Assess the effects of temperature, including seasonality and degree, on *Cladophora* and associated diatoms, *Gammarus*, aquatic insects, and fish parasites and disease.
- v. Evaluate effects of withdrawing water on the heat budget of Lake Powell, effects of potentially warmer inflow into Lake Mead, and the concomitant effects on the biota within both reservoirs. Evaluate the temperature profiles along with heat budget for both reservoirs.
- vi. Evaluate effects of reservoir withdrawal level on fine particulate organic matter and important plant nutrients to understand the relationship between withdrawal level and reservoir and downstream resources.

Installation of a selective withdrawal structure at Glen Canyon Dam may be essential in order to increase water temperatures downstream. Warmer mainstem temperatures are needed to ensure successful spawning and recruitment of endangered and native fishes in the mainstem. Research identified for this element should be integrated or combined with the research program specified in Element C. A selective withdrawal structure would provide considerable flexibility in managing the aquatic ecosystem downstream of Glen Canyon Dam. Management options, such as when to release warmer temperature water, seasonal pattern of releases to avoid establishment of permanent backwater areas, and use of floods, would all be available to limit expansion or invasion of non-native fish species.

The Service cautions the selective withdrawal structure should not be considered the only action needed to provide successful mainstem spawning and recruitment and ultimate recruitment for the humpback chub and razorback sucker. Aspects of the natural hydrograph, including low, steady releases in the summer, are considered necessary based on our present knowledge of the temperature capabilities of a selective withdrawal structure and habitat requirements of the species. Future studies might identify opportunities to operate Glen Canyon Dam in a manner that would alleviate conditions that jeopardize the continued existence of listed fish in the Grand Canyon and minimize impacts on water utilization for power production and other purposes. This program also is one of the EIS common elements.

C. Determine responses of native fishes in Grand Canyon to various temperature regimes and river flows of the experimental flows and other operations of Glen Canyon Dam. Studies will emphasize collection of information necessary to remove jeopardy to federally-listed species and identify actions necessary to enhance their recovery. Reclamation will provide technical assistance and funding for research to accomplish the following studies.

- i. Determine the effects of water temperature on reproductive success, growth, and survivorship of Grand Canyon fishes.
- ii. Determine relationships among tributary hydrology, reproductive success of fishes, and the abundance of fishes in mainstem rearing habitats.
- iii. Determine the effects of mainstem hydrology on the number of nearshore rearing habitats, environmental conditions in these habitats, and their successful utilization by fishes.
- iv. Assess biotic interactions between native and non-native fishes, particularly those that occur in nearshore rearing habitats affected by dam operations.
- v. Determine humpback chub life history schedule for populations downstream of Glen Canyon Dam.
- vi. Determine origins of fish food resources, energy pathways, and nutrient sources important to their production, and the effects of Glen Canyon Dam operations on these resources.
- vii. Determine the effects of dam operations, including modifications to regulate water temperatures, on the parasites and disease organisms of endangered and native fishes in Grand Canyon.

Emphasis to be placed on experimental approaches using various flow and temperature scenarios to determine cause and effect relationships between dam operations and responses of the community of endangered and native fishes endemic to the Grand Canyon. Efforts should be hypothesis driven and specific in objectives. Explanation of the above research efforts is provided in Appendix 1 along with suggested hypotheses. The success of these research efforts will require sufficient flexibility in operations to design and carry out the experiments. Wherever feasible, off-site experiments should be

considered as a means of generating or supporting the testing of hypotheses to reduce on-site study time and complexity. Long-term measurements should more appropriately be incorporated into the monitoring program, but there must be an active synergism between the two efforts.

The long-term monitoring plan should define objectives and methods for tracking the status of native fishes in Grand Canyon. Relevant indices should be developed and measured in support of the long-term monitoring plan. A major advantage of the current intensive marking studies using passive integrated transponder tags is the ability to measure future movements, growth rates, and population sizes of these fishes. This legacy, and others made available by this period of intensive research effort, should be effectively incorporated into the long-term monitoring program for fishes. Adaptive management, an EIS common element, would likely include a number of the above research objectives.

2. Protect humpback chub spawning population and habitat in the LCR by being instrumental in developing a management plan for this river.

This element remains very important to the survival of the humpback chub in Grand Canyon. Reclamation has, through contracts with the Navajo Nation, developed an extensive database for use in developing the plan. Reclamation will work with the Service, Navajo Nation, Hopi Tribe, National Park Service, Bureau of Indian Affairs, AGFD, and others to develop a management plan that includes actions to avoid possible adverse impacts to humpback chubs and their spawning and rearing habitats in the LCR. The principle objective of this plan shall be the protection of humpback chub habitat in the Colorado River and LCR. A draft plan will be prepared within 2 years from the date of this biological opinion and transmitted to agencies, parties, and others having authority to implement the plan.

3. Develop actions that will help ensure the continued existence of the razorback sucker by first sponsoring a workshop within 1 year following the biological opinion to enlist the advise of species experts, endangered fish researchers in Grand Canyon, Native Fish Work Group biologists, and others, such as Colorado River Recovery Team members, to develop a management plan for the species in the Grand Canyon. Following review of the workshop results, the Service will recommend a course of action and develop a Memorandum of Understanding with Reclamation and other entities who may wish to participate. The memorandum will provide detail on development of the management plan and implementation of actions identified in the plan.

Activities establishing razorback suckers in the Grand Canyon might include development of spawning and rearing areas that would function like flooded river bottom lands. Opportunities for such actions could be at (1) Lee's Ferry in a former gravel storage area along the mainstem and Paria River or (2) near the inflow area of the Colorado River into Lake Mead (Lake Mead National Recreation Area and Hualapai Indian Reservation). Cooperation of land managing agencies, such as the National Park Service and Hualapai Indian Tribe would be necessary.

4. Establish a second spawning aggregation of humpback chub downstream of Glen Canyon Dam.

Baseline information on possible tributary use or suitability for use by spawning humpback chub is being collected. Using that information, information from other Grand Canyon endangered fish research, and information from studies of *Gila* taxonomy, Reclamation, in consultation with the Service, National Park Service, AGFD, and land management agencies such as the Havasupai Tribe, will make every reasonable effort through funding, facilitating, and provide technical assistance to establish a program for additional spawning aggregations (or populations depending on genetic status) in the mainstem or tributaries. This effort has been identified as one of the EIS common elements.

ANALYSIS OF JEOPARDY AND ADVERSE MODIFICATION

The Service's biological opinion on operation of Glen Canyon Dam is based the current status of the species, environmental baseline, effects of the proposed action, and cumulative effects on listed species. To jeopardize the continued existence of a species, as defined in regulations implementing section 7 of the Act, is to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by further reducing the reproduction, numbers, or distribution of that species. Survival is defined as the ability of a species to persist into the future with sufficient resilience to recover from endangerment. Conditions of survival are found in the LCR for the humpback chub: sufficiently large population, represented by all age classes, genetic heterogeneity, and a number of sexually mature individuals producing viable offspring, that exists in an environment providing all requirements for completion of the species' entire life cycle. The concern with the LCR is that all humpback chub use is in the lower 14.5 km of the LCR; thus, the species and its habitat are extremely vulnerable to chronic or catastrophic threats. The 470 km reach of the mainstem Colorado River downstream of Glen Canyon Dam (to upstream boundary of Lake Mead National Recreation Area) apparently does not provide for survival all age classes nor an environment for successful spawning and recruitment of young to adult humpback chub. For the razorback sucker, only minimal support for the adult life stage has been identified in the mainstem reach downstream of Glen Canyon Dam.

Jeopardy also relates to recovery. Recovery is the process by which the quality and quantity of ecosystems are restored so they can support self-sustaining and self-regulating populations of listed species as persistent members of native biotic communities. The proposed action is anticipated to improve conditions over NA for the humpback chub, but the likelihood of recovery in the mainstem Colorado River is still appreciably reduced. While limited evidence of mainstem spawning has occurred during interim flows, survival and recruitment of those larvae is not known. Studies by GCES during NA and interim flow (similar to MLFF) conditions report occurrence of humpback chub in the mainstem is primarily limited to the reach centered on the LCR.

The final analysis of whether an action is likely to jeopardize a species is to consider the aggregate effects of everything that has led to the species' current status, all future non-Federal activities, and the proposed action. Determination if an action is likely to destroy or adversely modify critical habitat is an assessment of whether all the aggregate effects on the critical habitat and its constituent elements will appreciably diminish the value of critical habitat in sustaining its role in the survival and recovery of the species. Thus, while other actions may be responsible for the humpback chub and razorback sucker being in decline before Glen Canyon Dam, or that cold water releases and reduction in sediment further impacted the native fishery, the Department of the Interior, with the Bureau of Reclamation as lead, is still responsible for the impacts of the proposed action of operation of Glen Canyon Dam as MLFF.