

## **PART II** **RECOVERY**

### **Objective**

To recover the Colorado squawfish in three major recovery areas: the Green River/Upper Colorado River subbasins; the San Juan River subbasin; and the Lower Basin by establishing naturally self-sustaining populations in each of these areas. Quantitative criteria for defining self-sustaining populations will be determined in the future pending evaluation of information on population viability.

It is important to the recovery and long-term survival of the Colorado squawfish to maintain and protect sufficient numbers in enough areas to protect against catastrophic loss (disease, pollution, etc.) that could occur in any one area or affect any one population. Inclusion of the San Juan River subbasin as a Recovery Area is considered necessary because it provides an additional population that will help prevent extinction of the species given a catastrophic loss of the Green River/Upper Colorado River subbasin and because it may represent a separate genetic stock. Inclusion of streams in the Lower Basin also will provide protection against catastrophic loss if it is determined feasible to reestablish populations there.

The Colorado squawfish can be downlisted or delisted by population or Recovery Area. Reclassifying a population or Recovery Area in this way means that the species will be treated as threatened (in the case of downlisting) or will no longer be considered a listed species (in the case of delisting) only within the reclassified Recovery Area; other Recovery Areas are unaffected.

If one or more populations remain listed as endangered or threatened any other delisted populations may be identified as being protected under Similarity of Appearance rules. Similarity of Appearance means that take of individuals from delisted populations may still be regulated, in order to protect individuals of the same or similar species occurring in populations that are still listed as endangered or threatened. Other requirements of the Endangered Species Act do not apply to delisted populations under Similarity of Appearance rules, therefore, proposed actions affecting delisted populations under Similarity of Appearance rules are not required to undergo Section 7 consultations.

For the purposes of these recovery objectives, Colorado squawfish inhabiting the Green River subbasin and the Upper Colorado River subbasin will be treated as one population and one recovery area because of the potential for fish interchange between the two subbasins and the potential value of either subbasin serving to augment the populations in the other. Therefore, any reclassification actions (downlisting or delisting) will be done simultaneously on these two subbasins.

At present, there is no information indicating a possible link between Colorado squawfish inhabiting the San Juan subbasin and Colorado squawfish inhabiting the Upper Colorado/Green River subbasin; therefore, downlisting and delisting actions in these subbasins are not linked. Such actions may proceed independently as appropriate criteria are met in either of the subbasins.

Currently, any populations of the Colorado squawfish occurring in the Lower Basin (in the Salt or Verde Rivers) have been designated as nonessential experimental populations and are by regulation treated as threatened.

#### Downlisting Criteria

1. Green River/Upper Colorado River subbasins.

Colorado squawfish in the Green River/Upper Colorado River subbasins will be considered eligible for reclassification to threatened when naturally self-sustaining populations are maintained in:

- (a) the Green River subbasin including the Green River from its confluence with the Colorado River upstream to its confluence with the Yampa River, the lower 220 km (137.5 miles) of the Yampa River, and the lower 240 km (150 miles) of the White River; and
- (b) the Colorado River from Lake Powell upstream to Palisade, Colorado.

2. San Juan River subbasin.

Colorado squawfish in the San Juan River subbasin will be considered eligible for reclassification to threatened when;

- (a) a naturally self-sustaining population is maintained in the San Juan River from Lake Powell upstream to the confluence of the Animas River near Farmington, New Mexico.

#### Delisting Criteria

1. Green River/Upper Colorado River subbasins.

Colorado squawfish will be considered eligible for delisting in the Green River/Upper Colorado River subbasins when:

- (a) downlisting criteria have been met in the Green River/Upper Colorado River subbasins;

- (b) the threat of significant fragmentation (e.g., fragmentation that would impair the reproductive success of the population or limit/impact the adult population size) is removed or alleviated;
- (c) essential habitats, primary migration routes, required streamflows, and necessary water quality are legally protected; and
- (d) other identifiable threats, if any, which may significantly affect the population are removed.

2. San Juan River subbasin.

Colorado squawfish in the San Juan River subbasin will be considered eligible for delisting when:

- (a) downlisting criteria have been met in the San Juan River subbasin; and
- (b) the criteria listed in (b) through (d) for the Green River/Upper Colorado River subbasins also have been met in the San Juan River subbasin.

3. Lower Basin.

The population of Colorado squawfish in the Lower Basin will be considered eligible for delisting when:

- (a) the populations in the Green River/Upper Colorado River subbasins and the San Juan River subbasin have been delisted;
- (b) a population in either the Salt River from a diversion dam upstream of Roosevelt Lake to Apache Falls or in the Verde River from Horseshoe Reservoir upstream to Paulden, Arizona, is reestablished and habitats and streamflows are legally protected. Feasibility of this effort will be reevaluated at the conclusion of the 1995 Lower Basin agreement. At that time the need for inclusion of these areas in the delisting criteria will be reconsidered; and
- (c) the criteria listed in (b) through (d) of the Green River/Upper Colorado River subbasins have been met in the Lower Basin.

The estimated date for achieving recovery in the Green River/Upper Colorado River subbasins, as identified in the Upper Basin Recovery Implementation Program, is 2003. A recovery date for the San Juan River subbasin and the Lower Basin will be established during the development of recovery programs for those basins.

These recovery criteria are preliminary and may be revised on the basis of new information from population viability analyses or information on population or habitat status in either the Upper Basin or Lower Basin. Radiotelemetry studies of Colorado squawfish are continuing, and if additional information indicates a link between Colorado squawfish inhabiting the San Juan River with Colorado squawfish inhabiting the Upper Colorado, then revision of these recovery criteria will likely be needed.

### Stepdown Outline

1. Monitor population status and define the life history requirements of the Colorado squawfish.
  11. Monitor Colorado squawfish populations.
    111. Compile and analyze population data.
    112. Develop standardized monitoring procedures.
    113. Determine population status and trends.
  12. Research and expand the life history information.
    121. Refine information related to life history/spawning and recruitment requirements.
    122. Assess inter-/intraspecific interactions.
    123. Develop aging techniques and determine age distribution and growth rates.
    124. Identify cues for and importance of migration.
  13. Develop and implement standardized procedures for data collection, management, and analysis.
  14. Develop annual work plans for high priority research and monitoring activities for interagency review.
2. Develop and implement management plans to protect and maintain Colorado squawfish populations and their habitat.
  21. Determine threats to and protect Colorado squawfish populations and their habitat.
    211. Monitor and assess the impact of proposed development projects.
    212. Identify and assess the impacts of introduced nonnative species which compete with or impact the Colorado squawfish.
    213. Monitor the extent of parasitism and disease in the Colorado squawfish.

214. Determine effects of environmental contaminants on Colorado squawfish and their habitat.
22. Refine and enforce existing laws and regulations protecting the Colorado squawfish.
  221. Inform appropriate agencies of their enforcement responsibilities.
  222. Ensure compliance with Section 7 of the Endangered Species Act by all Federal Agencies.
  223. Assess effectiveness of current regulations/management and draft additional regulations or increase protection and enforcement as needed.
  224. Discontinue or prevent introductions of nonnative fish species which have a negative impact on the Colorado squawfish.
  225. Minimize incidental take of all life stages of Colorado squawfish, especially that associated with sportfishing, seining for bait, and stranding in irrigation ditches.
23. Identify and monitor all essential habitat.
  231. Conduct field investigations to locate and further define sensitive habitat (i.e., spawning and rearing areas, etc.).
  232. Determine biological, chemical, and physical components for critical habitat type.
  233. Define flow, temperature, and substrate requirements.
  234. Establish criteria to identify suitable habitat (i.e., timing, duration, and microhabitat).
24. Manage and restore primary Colorado squawfish habitat.
  241. Assess impacts of existing water development projects and make recommendations to improve habitat conditions for Colorado squawfish.
  242. Evaluate fish passage as a method to restore use by and movement of Colorado squawfish within their former range where dams now restrict movement.
  243. Determine effectiveness of enhancing Colorado squawfish spawning and rearing success through habitat improvement.
  244. Ensure that essential habitats, migration routes, streamflow, and adequate water quality are legally protected.

25. Develop and implement cooperative interagency programs to protect and recover the Colorado squawfish.
3. Reintroduce Colorado squawfish into their historic range.
31. Develop capabilities to produce adequate numbers of Colorado squawfish for research and management.
311. Develop or improve propagation, holding, and rearing techniques to optimize production.
312. Maintain a diversified gene pool.
32. Conduct reintroduction programs in Lower Basin.
321. Identify areas for reintroduction/augmentation.
322. Restore or prepare stocking sites as needed.
323. Stock and monitor reintroduced/stocked populations.
33. Conduct augmentation/reintroduction program in the Upper basin.
331. Assess the role of artificial propagation of Colorado squawfish in providing fish for research and for augmentation stocking.
332. Conduct reintroduction/augmentation programs.
4. Promote and encourage improved communication and information dissemination.
41. Conduct nationwide and basinwide information and education programs.
42. Conduct local information and education programs.
421. Minimize incidental take of squawfish through information and education programs.
422. Assess the sportfishery potential for Colorado squawfish.
43. Promote information and education programs within management agencies.
44. Encourage and support publication of research and other recovery results in the technical literature.

5. Determine biological criteria/objectives for downlisting/delisting the Colorado squawfish.

51. Define naturally self-sustaining populations.

52. Establish quantifiable objectives for downlisting and delisting.

## Narrative

### 1. Monitor population status and define the life history requirements of the Colorado squawfish.

#### 11. Monitor Colorado squawfish populations.

Intensive field investigations have been conducted to locate Colorado squawfish populations in most of the known occupied habitat. Reaches should be identified for long-term monitoring of important life stages of Colorado squawfish.

##### 111. Compile and analyze population data.

Information on population abundance, distribution, migration, and other general biological information should be compiled and evaluated to: (a) identify index monitoring sites; and (b) determine baseline population status and trends at the index monitoring sites.

##### 112. Develop standardized monitoring procedures.

Standardized procedures should be developed by an interagency group to ensure that efficient and compatible monitoring procedures are used throughout the Colorado River basin. Monitoring procedures including electrofishing, handling, tagging, and larval fish sampling should be evaluated for impacts to squawfish populations.

##### 113. Determine population status and trends.

An intensive monitoring program using procedures developed in Task 112 should be conducted to determine population status over time (i.e., identify age classes, hatching and rearing success, relative abundance, etc.).

#### 12. Research and expand the life history information.

Important aspects of the life history of the Colorado squawfish will be described. Efforts should be made to maximize scientific use of fish. All fish mortalities will be sent to the Service facility at Fort Collins, Colorado; Arizona State University; or other suitable facility as determined by the Service for cataloging and storage.

##### 121. Refine information related to life history/spawning and recruitment requirements.

Additional life history information should be collected to determine critical or limiting life stages of the Colorado squawfish. Major emphasis should focus on better understanding the factors affecting spawning, larval and young-of-the-year transport, and recruitment success. Priority studies include:

(a) determining the relationship between larval abundance and young-of-the-year abundance and recruitment; (b) determining the effects of streamflow, water temperature, and predation on recruitment; and (c) roles of chemoreception and imprinting on recruitment; and (d) use and movement of Colorado squawfish in the inflow regions of the Colorado and San Juan river arms of Lake Powell.

In addition, the sensitive areas for the Upper Basin should be refined periodically to reflect important habitats for Colorado squawfish. The sensitive area concept also should be expanded to the Lower Basin using new or refined criteria.

122. Assess inter-/intraspecific interactions.

Determine the interaction between individual Colorado squawfish and between Colorado squawfish and other species which may lead to competition, displacement, and predation.

123. Develop aging techniques and determine age distribution and growth rates.

Techniques for aging specimens are being developed. Reliable aging techniques for live fish are needed and should be developed. Total length and weight records should be maintained by all monitoring agencies.

124. Identify cues for and importance of migration.

Migration routes and patterns have been determined through radiotelemetry and by monitoring tag returns in the Green and Upper Colorado Rivers. Additional work to determine migration and movements in the San Juan River are needed. Cues affecting migration should be identified and their relative importance estimated.

13. Develop and implement standardized procedures for data collection, management, and analysis.

To ensure that data collected by all cooperating management agencies are comparable and accessible, a standardized program for data collection, management, analysis, and dissemination is required.

14. Develop annual work plans for high priority research and monitoring activities for interagency review.

Annual meetings should be conducted to review the overall status of recovery efforts in both Upper and Lower Basins. Each agency should prepare a report of its recovery efforts for the annual meeting. For effective implementation of recovery activities, work plans need to be developed and revised annually by involved agencies.

2. Develop and implement management plans to protect and maintain Colorado squawfish populations and their habitat.

Areas supporting existing populations should be protected under the Endangered Species Act. Federal and State agencies should ensure that existing sensitive Colorado squawfish habitats are maintained. This includes legal provision for adequate streamflow and temperature regimes, water quality, and physical characteristics. Primary habitats will be selectively monitored until the species is delisted. Monitoring should continue after delisting to ensure habitat and population stability.

21. Determine threats to and protect Colorado squawfish populations and their habitat.

An assessment of threats facing Colorado squawfish and their potential impacts on the species and its habitat should be made. Once this information is known, management and protective regulations can be revised or applied as needed.

211. Monitor and assess the impact of development projects.

Ongoing or proposed water development or related projects should be monitored/evaluated to determine their effects on squawfish populations and their habitat in terms of flow, temperature, and water quality changes (e.g., turbidity, salinity, environmental contaminants).

212. Identify and assess the impacts of introduced nonnative species which compete with or impact the Colorado squawfish.

Studies should be conducted in conjunction with Task 122 to determine the impact of competition, predation, and displacement by nonnative species on the Colorado squawfish and the extent to which this is influencing Colorado squawfish distribution and abundance. Potential beneficial effects of nonnative species as forage also should be determined.

213. Monitor the extent of parasitism and disease in the Colorado squawfish.

Although cursory investigations have not indicated that disease or parasitism presently pose a serious threat to Colorado squawfish populations, information obtained through monitoring of wild populations should be evaluated to determine if additional study is needed.

214. Determine effects of environmental contaminants on Colorado squawfish and their habitat.

Identify point and nonpoint sources of environmental contaminants/pollutants that may affect Colorado squawfish and

their habitat. Determine concentration levels of environmental contaminants in Colorado squawfish and their effect on growth, reproduction, and survival. Take appropriate action to eliminate sources of environmental contaminants that pose a threat to the recovery of the Colorado squawfish.

22. Refine and enforce existing laws and regulations protecting the Colorado squawfish.

The purpose of this task is to maintain Colorado squawfish populations by preventing any further degradation of essential habitat.

221. Inform appropriate agencies of their enforcement responsibilities.

All agencies should be made aware of their responsibilities regarding the laws protecting listed species and their habitats (e.g., Endangered Species Act, Fish and Wildlife Coordination Act, or Lacey Act). Agencies should be kept current on all laws and regulations or revisions that would change agency responsibility.

222. Ensure compliance with Section 7 of the Endangered Species Act by all Federal Agencies.

Federal Agencies should comply with Section 7 of the Endangered Species Act and consult with the Service on any project involving Federal permits, monies, etc., which may affect the Colorado squawfish. Section 7 consultation on such projects should help in ensuring that the ecological requirements of the squawfish are maintained and further impacts minimized.

223. Assess effectiveness of current regulations/management and draft additional regulations or increase protection and enforcement as needed.

Current management practices and protection or enforcement activities should be monitored to determine their effectiveness in conserving the species.

224. Discontinue or prevent introductions of nonnative fish species which have a negative impact on the Colorado squawfish.

Stocking of nonnative species which compete with the Colorado squawfish should be discontinued until it is demonstrated that such introductions will not have a negative impact on the Colorado squawfish (see Task 212). A cooperative agreement should be initiated by the Service and the States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming to prohibit introduction of nonnative fishes that might further endanger the Colorado squawfish or jeopardize its recovery.

225. Minimize incidental take of all life stages of Colorado squawfish, especially that associated with sportfishing, seining for bait, and stranding in irrigation ditches.

Recent evidence suggests that angling and the use of live resident fishes as bait may promote the "take" of Colorado squawfish or expand the range of nonnative species. State laws and regulations related to the use of live fish as bait, bait seining, and angling should be reviewed and changed to minimize the incidental take of Colorado squawfish. Fishing regulations, tackle restrictions, and seasonal temporary and permanent angling closures should be implemented as appropriate by State wildlife management agencies. Fishing, with appropriate restrictions, also may be useful as a monitoring tool and should be evaluated as needed. The diversion of Colorado squawfish into irrigation ditches and their subsequent stranding contributes to overall plight of the species. Although the extent of such loss is not known, investigations should be carried out into methods that might assess and minimize such impact.

23. Identify and monitor all sensitive habitat.

Although sensitive areas have been identified in portions of the Upper Basin, investigations should be conducted to determine the critical components of sensitive habitat. State or Federal agencies, including the Arizona Game and Fish Department, the Colorado Division of Wildlife, the New Mexico Department of Game and Fish, the Service, and the Utah Division of Wildlife Resources, should participate in or supervise habitat monitoring.

231. Conduct field investigations to locate and further define sensitive habitat (i.e., spawning and rearing areas, etc.).

Field investigations must be continued to refine information on spawning areas, migration routes, etc., so that information on ecological requirements can be obtained. Primary emphasis should be directed toward areas that have not been intensely studied in the past (e.g., San Juan River, Lower Basin).

232. Determine biological, chemical, and physical components for sensitive habitat types.

Continue studies to refine the ecological requirements for the different life stages of the Colorado squawfish. This would include the collection of data on substrate, hydraulic characteristics, water temperatures, isolating factors, salinity and environmental contaminant levels, and other essential components of the habitat.

233. Define flow, temperature, and substrate requirements.

Collect and evaluate microhabitat data to refine depth, velocity, substrate, cover, temperature, and other important requirements of Colorado squawfish. Develop quantitative relationships between flow and habitat at important sensitive areas. Relate changes in flow and habitat to changes in populations of Colorado squawfish.

234. Establish criteria to identify suitable habitat (i.e., timing, duration, and microhabitat).

Using information gained through implementation of Tasks 231, 232, and 233, a set of criteria should be developed for use in identifying suitable potential habitat. The criteria should be developed based on a comparative analysis of important habitat features in the San Juan, Green, and Upper Colorado River subbasins, including water quality, gradient, availability of backwaters, spatial distribution of key habitat types, water volume, exotic fish abundance/composition, shape of the hydrograph, etc.

24. Manage and restore primary Colorado squawfish habitat.

Techniques for restoring historic migratory and primary habitat must be developed which would include restoration of water flows and physical requirements for squawfish. Once such restoration methods are developed, they can be implemented as needed.

241. Assess impacts of existing water development projects and make recommendations to improve habitat conditions for Colorado squawfish.

Continued monitoring of ongoing water development projects is essential to accurately evaluate cumulative effects of habitat degradation and to apply effective management techniques. Operating plans should be developed for the Flaming Gorge, Blue Mesa, and Navajo projects to protect and recover Colorado squawfish in the Green, Colorado, and San Juan Rivers.

242. Evaluate fish passage as a method to restore use by and movement of Colorado squawfish within their former range where dams now restrict movement.

Through the use of radiotelemetry and other techniques, the migration of Colorado squawfish and some of the factors influencing their migration patterns in the Upper Basin have been determined. The biological merits of providing unrestricted passage to historic habitats in the Upper Basin (e.g., the White River above Taylor Draw Dam, the Gunnison River above the Redlands diversion, etc.) should be evaluated.

In addition, tests should be conducted to determine the ability of Colorado squawfish to negotiate various fish passage devices (e.g., ladders or elevators). The feasibility of providing passage around low or moderately high dams should be determined.

243. Determine effectiveness of enhancing Colorado squawfish spawning and rearing success through habitat improvement.

Studies need to be conducted to determine if alteration or improvement of physical habitat, streamflows, or water quality and other important parameters of squawfish habitat will enhance recovery.

244. Ensure that essential habitats, migration routes, streamflow, and adequate water quality are legally protected.

Through the application of appropriate State and Federal laws, purchase of water rights, formal agreements, Memorandums of Agreement, and the provisions of the Endangered Species Act, ensure that essential habitats, migration routes, and physical habitat characteristics for Colorado squawfish are legally protected. All strategies to protect the species' habitat should be investigated. Private conservation groups as well as State and Federal agencies should direct their efforts toward this goal. Quantification of the amount and timing of flows will depend on identifying the species' habitat requirements. Adequate streamflows to provide habitat for the Colorado squawfish will have to be protected on a long-term basis.

25. Develop and implement cooperative interagency programs to protect and recover the Colorado squawfish.

A major cooperative effort to recover endangered fish species in the Upper Basin (excluding the San Juan River drainage) was initiated in August 1984. This resulted in the establishment of the "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin." A cooperative agreement signed in January 1988 by the Governors of Colorado, Wyoming, and Utah; the Secretary of the Interior; and the Administrator of the Western Area Power Administration formally implemented the program and created a 10-member committee to oversee it. Five basic recovery elements are identified: (1) provision for instream flows; (2) habitat development and maintenance; (3) rearing and stocking of native fish; (4) management of nonnative species and sportfishing; and (5) research, monitoring, and data management. The projected annual budget for the Recovery Program is \$2.3 million, and sources of funds will include Federal and State governments, power and water users, and private donations. A \$10 million fund will be requested of Congress for purchase of water rights to acquire and/or protect instream flows, and another \$5 million will be requested for

construction of facilities such as a hatchery, fish passageways, etc. Private entities proposing water projects will support the program by providing a one-time contribution of \$10 per acre-foot of the average annual depletion of the project.

The Recovery Program (U.S. Fish and Wildlife Service 1987) is intended to provide for the coordinated implementation of the Service's recovery plans for the endangered bonytail chub, humpback chub, Colorado squawfish, and the proposed endangered razorback sucker in the Upper Basin (excluding the San Juan River). Therefore, the Recovery Program will be considered a stepdown effort of this recovery plan and become the primary mechanism for implementing the recovery plan in the Upper Basin.

A recovery implementation program for the Colorado squawfish and the razorback sucker is currently being developed for the San Juan River by the Service in coordination with appropriate Federal and State agencies, Indian tribes, environmental groups, and water development interests. This will be the primary mechanism for implementing this recovery plan in the San Juan River.

An additional cooperative interagency plan for recovery actions for these endangered fish in the Lower Basin is being planned. When completed, this Lower Basin Recovery Action Plan will be considered the Lower Basin stepdown effort of this recovery plan and will be the primary mechanism for implementing this recovery plan in the Lower Basin. The Service should ensure that the Upper Basin Recovery Program, the San Juan Recovery Program, and the Lower Basin Recovery Action Plan currently being developed are fully coordinated.

### 3. Reintroduce Colorado squawfish into their historic range.

Colorado squawfish are now being reintroduced into unoccupied habitat areas in the Lower Basin with highest recovery potential (i.e., the Salt River, the Verde River, and the Lower Colorado River). Based on research accomplished in Task 331, augmentation of Colorado squawfish in the upper Colorado River and San Juan River subbasins may be needed to support research and recovery activities. Studies on age class structure, distribution, and creel census will determine success of the stocking program. Results of these studies will help to determine future stocking requirements.

All fish stocked in the Upper Basin will be marked before release into the wild, consistent with ongoing efforts. Restocked areas will be sampled by standard fishery techniques to assess survival, growth, etc. Followup stockings in reintroduction sites should be based on monitoring results to determine if initial stocking is contributing to the reestablishment of a self-sustaining population.

31. Develop capabilities to produce adequate numbers of Colorado squawfish for research and management.

Produce an adequate supply of genetically diverse and disease-free Colorado squawfish to support research, recovery, and reintroduction efforts and to maintain a refugium population.

311. Develop or improve propagation, holding, and rearing techniques to optimize production.

Additional information on propagation, rearing, and holding techniques must be developed to optimize production. Methods to induce maturation of gonads have been developed. However, there is a need to determine optimum loading capacities of holding/rearing facilities for different sizes of fish. Additional production and rearing capability should be developed to meet anticipated needs, but emphasis should be placed on maximizing the use of existing capabilities (e.g., Dexter and Willow Beach National Fish Hatcheries, State facilities).

312. Maintain a diversified gene pool.

Studies should be undertaken to determine whether significant genetic differences exist among fish from different subbasins and to determine the number of brood fish needed to provide natural genetic diversity for at least 20 generations. If little or no genetic impact is indicated, hatchery broodstock will be supplemented as necessary with wild fish or gametes from wild fish of different rivers to maintain genetic diversity.

32. Conduct reintroduction programs in the Lower Basin.

Reintroduction programs have been initiated in the Lower Basin. Because there are no existing populations in the Lower Basin, reintroduction is the only potential method for reestablishing Colorado Squawfish populations.

321. Identify areas for reintroduction/augmentation.

An evaluation of each potential reintroduction site will be conducted based on information gathered in Tasks 231, 232, and 233. Primary candidate sites for reintroduction are in the Lower Basin. Fish stocked in the Lower Basin in the Salt and Verde Rivers have been designated as nonessential experimental populations.

322. Restore or prepare stocking sites as needed.

Habitat enhancement should be considered based on the results of Task 243. Improvements could include physical habitat modifications such as addition of large boulders for cover or the creation of side channels and backwaters, as well as biological modifications such as eradication of nonnative species or a moratorium on stocking nonnative species where Colorado squawfish recovery activities will be initiated.

323. Stock and monitor reintroduced/stocked populations.

Stock specific reintroduction sites identified in Task 321. Stocking is planned to continue in the Salt and Verde Rivers through 1995. At least annual monitoring of stocked areas should be conducted to determine survival, movement, and habitat selection of the stocked fish, plus other attributes of the ecosystem such as relative abundance of fish species encountered. After the stocking period, the success of the program will be evaluated and recommendations for further recovery efforts in the Lower Basin may be formulated. Regular monitoring will determine if it is contributing to the establishment of a self-sustaining population.

33. Conduct augmentation/reintroduction program in the Upper Basin.

Colorado squawfish populations occur in several reaches of Upper Basin rivers. Stocking programs will need to be evaluated to determine if they will contribute to reproduction and establishment of self-sustaining populations. If so, programs will be initiated to augment existing populations and reestablish populations in reaches where Colorado squawfish are absent.

331. Assess the role of artificial propagation of Colorado squawfish in providing fish for research and for augmentation stocking.

Some basic questions about size at stocking, habitat use, interspecific competition, olfactory cues and imprinting, and reproductive success must be answered to determine the feasibility of stocking artificially propagated Colorado squawfish. This may require carefully planned experimental stocking. Questions associated with artificial propagation include size, capacity, location, etc., of facilities needed to rear Colorado squawfish for research and for stocking.

332. Conduct reintroduction/augmentation programs.

If stocking of captive-reared Colorado squawfish is determined to be feasible in successfully restoring or augmenting self-sustaining populations of Colorado squawfish, then efforts to initiate stocking programs will begin. This will include

identification of appropriate stocking sites, development of stocking plans at each site, restoration or preparation of stocking sites, and implementation of monitoring of stocking programs.

4. Promote and encourage improved communication and information dissemination.

Information and education programs should be implemented at local, regional, and national levels to focus on the value of the Colorado squawfish as an endemic natural resource. An active effort will be made by the Service and State agencies to inform the public of recovery activities and the eventual sportfishing potential of Colorado squawfish.

Inter- and intra-agency communications, the sharing of information, and the education of the public about the goals, objectives, methods, and benefits of the recovery program are essential for a successful program.

41. Conduct nationwide information and education programs.

Conduct a national campaign to inform the public of the need to recover the Colorado squawfish. News of restoration efforts should be published in the Service's Endangered Species Technical Bulletin. Also, national environmental groups, newspapers, and the media should be contacted and encouraged to promote the value of recovering the Colorado squawfish.

42. Conduct local information and education programs.

All State wildlife agencies should continue to develop and provide leaflets for use by the local chapters of sportsmen and environmental groups, river runners, newspapers, and the media. Efforts should focus on recent investigations, problems facing the squawfish, and recovery efforts. The ecological value of the Colorado squawfish as an endemic species should be emphasized.

421. Minimize incidental take of squawfish through information and education programs.

Specific measures to minimize take may include: (a) education at the time of license purchase, including identification of the species and information on penalties for taking Colorado squawfish; (b) increased contact of anglers by Federal and State enforcement and management personnel; or (c) posting of signs at high concentration angler use areas.

422. Assess the sportfishery potential for Colorado squawfish.

One way to gain support for recovery programs would be generating interest in and support for a Colorado squawfish sportfishery. An assessment of the squawfish as a sport fish

and the public's potential acceptance of the program should be determined. The Service, in cooperation with State agencies, has attempted to establish experimental Colorado squawfish sportfisheries in Kenney Reservoir on the White River and the Colorado River below Headgate Rock Dam. If feasible, additional locations for establishing sportfisheries, such as in National Recreation Areas, may be evaluated.

43. Promote information and education programs within management agencies.

Increase awareness among agency personnel regarding squawfish identification, importance, role in the ecosystem, etc., and the agency responsibility to aid in the recovery effort.

44. Encourage and support publication of research and other recovery results in the technical literature.

All participating agencies and their contractors should encourage publication of research findings in technical literature. These agencies should provide support by funding printing or other necessary logistical support.

5. Determine biological criteria/objectives for downlisting/delisting the Colorado squawfish.

Objective and measurable criteria must be developed by Federal and State conservation agencies to determine when Colorado squawfish populations/recruitment are sufficiently high and habitat sufficiently protected to permit downlisting or delisting the species. Monitoring activities (Task 1) should be designed and results evaluated to define when Colorado squawfish populations have become self-sustaining. Criteria addressing population size and demography needed for sufficient recruitment to offset losses from mortality must be determined to ensure that the populations can persist through natural reproduction. The Recovery Program for the Upper Basin (U.S. Fish and Wildlife Service 1987) has a goal of recovering and delisting the Colorado squawfish by the year 2003.

51. Define naturally self-sustaining populations.

Various ideas exist for what constitutes a self-sustaining population. Criteria addressing population size needed for sufficient recruitment to offset losses from mortality must be determined to ensure that the populations can persist through natural reproduction. Monitoring activities (Task 1) should be designed and results evaluated to define when various Colorado squawfish populations are self-sustaining.

52. Establish quantifiable objectives for downlisting and delisting.

Objectives for downlisting and delisting must be further quantified so that it can be determined when recovery (i.e., self-sustaining populations) has progressed to the point where recommendations can be made to downlist or delist the Colorado squawfish. Information from the population viability analyses will be utilized to quantify recovery objectives. The information from genetics studies, discussed under Task 3, should be evaluated to assess populations interchange and inter-relatedness between the various subbasins.

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