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CONSULTATION REPORT ON FISH GENETIC RESOURCE CONSERVATION AND MANAGEMENT OF THE INDIGENOUS FISHERY RESOURCES OF INDIA WITH AN EMPHASIS ON THREATENED AND ENDANGERED SPECIES

MAIN PROJECT: AGRICULTURE RESEARCH

SUBPROJECT: ANIMAL GENETIC RESOURCE CONSERVATION

Buddy L. Jensen
Dexter National Fish Hatchery and Technology Center
U.S. Fish and Wildlife Service
P.O. Box 219
Dexter, New Mexico 88230
United States of America

Submitted to

Winrock International
[USAID Agriculture Research Project]
7, Poorvi Marg, Vasant Vihar
New Delhi, 110 057
India

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I thank all of the many ICAR personnel in New Delhi, Cochin, Bombay and Allahabad who were so kind and interested in meeting my requests for interviews and exchange of ideas and information. Particular thanks go to Dr. P.V. Dehadrai at ICAR headquarters, New Delhi; Drs. M.S. Rajagopalan and M.K. George at CMFRI, Cochin, KE; Prof. Y. Sreekrisna and Ms. R. Tewari at CIFE, Bombay, MA; and in addition to Dr. P. Das, Drs. A.G. Ponniah and D. Kapoor at NBFGR, Allahabad, UP.

While at Allahabad, I fell ill and was treated by two physicians, one in particular. Dr. R.R. Singh came to my bedside numerous times to check on my well being in addition to prescribing appropriate medication and dietary considerations. His assistance and concern for my personal welfare were greatly appreciated. Dr. Sharad Kumar also examined me and his services were also gratefully acknowledged.

I thank Ms. Surbhi Bhatt, Winrock International, Arlington, VA, USA, and Mr. P.S. Srinivasan and Dr. Harold Kauffman, Winrock International, New Dehi, India, for their kind attention to administrative details as well as my personal welfare.

ACRONYMS USED IN AGRC - FISHERIES REPORT

ICAR = Indian Council of Agricultural Research

NBFGR = The National Bureau of Fish Genetic Resources, Allahabad, UP

CMFRI = The Central Marine Fisheries Reserach Institute, Cohin, KE

CIFE = The Central Institute for Fisheries Education, Bombay, MA

CICFRI = The Central Inland Capture Fisheries Research Institute, Barrackpore, WB

DNFH & TC = Dexter National Fish Hatchery and Technology Center, Dexter, NM, USA

AGRC - FISHERIES CONSULTANTING ASSIGNMENT

TRAVEL ITINERARY

18 April	Arrival in Delhi, India, 0100 hours Met with P.S. Srinivasan, WI
19 April	In Delhi; Worked on paper for End. Sp. Seminar
20 April	In Delhi; Met with officials at WI & ICAR Offices
21 April	Lv Delhi 0520; Arr Cochin 0940; Met with and interviewed Senior Scientists at CMFRI offices and visited Cochin Harbour Marine Fisheries Landing Site with CMFRI personnel
22 April	Revisited Cochin Harbour MFLS with CMFRI personnel; Toured CMFRI facilities and interviewed key senior scientists
23 April	Lv Cochin 0740; Arr Bombay 0925; met with and interviewed scientists at CIFE; Lv Bombay 2130; Arr Delhi 2330
24 April	AM at WI offices; Lv Delhi 1300; Arr Varanasi 1430; Arr Allahabad 1730
25 April	National Seminar on Endangered Fishes of India, Allahabad
26 April	National Seminar on Endangeerd Fishes of India, Allahabad
27 April	Visit NBFGR, Allahabad; Discussions with scientists
28 April	Sick in bed, Allahabad
29 April	Sick in bed, Allahabad
30 April	Consultation with Dr. P. Das, Director, NBFGR, Allahabad
01 May	Visit NBFGR, Allahabad; Discussions with scientists
02 May	Work on consultation report; Lv Allahabad 1650; Arr Delhi 1750
03 May	Work on consultation report
04 May	Work on consultation report
05 May	Work on consultation report
06 May	Complete report; Meet with officials at WI
07 May	Depart India 0230 hours

SITE VISIT TO CMFRI - COCHIN, KERALA

FACILITY: Central Marine Fisheries Research Institute

DATES VISITED: 21-22 April, 1992

INDIVIDUAL IN CHARGE OF VISIT: Dr. M.S. Rajagopalan

SCIENTISTS INTERVIEWED:

1) Dr. M.S. Rajagopalan, Principal Scientist
   Fishery Environmental Monitoring Division

2) Dr. K. Alagaraja, Head
   Fishery Resources Assessment Division

3) Dr. I.D. Gupta, Scientist
   Animal Genetics & Breeding Division

4) Dr. P.C. Thomas, Senior Scientist
   Animal Genetics & Breeding/PNP Division

5) Dr, N. Neelakanta Pillaai, Head
   Crustacean Fisheries Division

6) Dr. C. Susulan, Senior Scientist
   Crustacean Fisheries Division

7) Dr. A. Knoble, Principal Scientist/Officer in Charge
   Post Graduate Teaching Programme

8) Dr. N.G. Menon, Senior Scientist
   Demersal Fisheries Division

9) Dr. M.K. George, Senior Scientist
   Pathology, Nutrition, & Physiology Division

SITE VISIT TO CIFE - BOMBAY, MAHARASHTRA

FACILITY: Central Institute of Fisheries Education

DATE VISITED: 23 April 1992

INDIVIDUAL IN CHARGE OF VISIT: Professor Y. Sreekrishna

SCIENTISTS INTERVIEWED:

1) Professor Y. Sreekrishna, Principal Scientist/Head
   Craft and Gear Division

2) Dr. Kiran Dube, Scientist/Head
   Reproductive Physiology, Genetics and Breeding Division

3) Dr. Gopalkrishna, Scientist
   Reproductive Physiology, Genetics and Breeding Division

4) Ms. R. Tewari, Scientist
   Fisheries Extension Division

SITE VISIT TO NBFGR - ALLAHABAD, UTTAR PRADESH

FACILITY: National Bureau of Fish Genetics Resources

DATES VISITED: 27 April - 1 May, 1992

INDIVIDUAL IN CHARGE OF VISIT: Dr. P. Das

SCIENTISTS INTERVIEWED:

1) Dr. P. Das, Director
   Senior Scientist

2) Dr. A.G. Ponniah, Scientist
   Cryopreservation & Biochemical Genetics Division

3) Dr. D. Kapoor, Scientist
   Conservation of Endangered Fish Germplasm Division

4) Sri P.C. Mahanta, Scientist
   Conservation of Endangered Fish Germplasm Division

5) Sri S.P. Singh, Scientist
   Conservation of Endangered Fish Germplasm Division

6) Sri A. Gopalakrishnan, Scientist
   Cryopreservation & Biochemical Genetics Division

7) Dr. A.K. Singh, Fish Farm Manager
   Cryopreservation Division

BOOKS, LITERATURE & BLUEPRINTS DONATED TO NBFGR LIBRARY, ALLAHABAD, U.P.

I. HARDBOUND BOOKS:

1) "Battle Against Extinction - Native Fish Management in the American West". W.L. Minckley and J.E. Deacon, Editors. 517 pp.

2) "Electrophoretic and Isoelectric Focusing Techniques in Fisheries Management". Donald H. Whitmore, Editor. 350 pp.

3) "Population Genetics & Fishery Management". Nils Ryman and Fred Utter, Editors. 420 pp.

II. BINDER NOTEBOOK:

4) U.S. Fish and Wildlife Service "Field Guide to Broodstock Management". David A. Erdhal. 267 pp.

III. PAPERBACK PUBLICATIONS:

5) "Native Fishes of Arid Lands: A dwindling Resource of the Desert Southwest". J.N. Rinne and W.L. Minckley. 45 pp.

6) "Aquaculture Genetics and Breeding: National Research Priorities":
   a) Volume 1 - 56 pp.
   b) Volume 2 - 61 pp.

7) "Captive Propagation and Reintroduction: A Strategy for Preserving Endangered Species?" Endangered Species Update Special Issue. 88 pp.

8) "Review of Genic Diversity and Conservation Genetics in Fishes of U.S. Fish and Wildlife Service Region II, With a Suggested Program of Conservation Genetics". Anthony A. Echelle. 42 pp.

9) "Conservation of Fish Genetic Resources". Bill Herschberger. 19 pp.

10) "Dexter NFH & TC Advance Project Planning". Buddy Jensen. 12 pp.

IV. PUBLISHED SCIENTIFIC PAPERS:

11) "Fish Cytogenetics Symposium". American Fisheries Society. 150 pp.

12) "Conservation Genetics: Techniques and Fundamentals". P.W. Hedrick and P.S. Miller. 17 pp.

13) "Potential Application of Cryobiology to Aquaculture". D. Erdahl. 6 pp.

14) "Cryopreservation of Sperm as a Means to Store Salmonid Germ Plasm and to Transfer Genes from Wild Fish to Hatchery Populations". J.G. Cloud, W.H. Miller, and M.J. Levanduski. 3 pp.

V. BLUEPRINTS:

16) "Mora NFH & TC" blueprints on building design

17) "Dexter NFH & TC" blueprints on pond lining project

18) "Inks Dam NFH" blueprint on fish collection kettle design

INTRODUCTION

The aquatic ecosystems of India are vast and consist of the following four major habitat components: upland coldwater fisheries, plains warmwater fisheries, brackish water fisheries, and marine fisheries. This diversity of habitats supports a broad array of fish species, many of which are important both socially and economically. The wise use of animal genetic resources, including fish, is imperative for the continued improvement of socioeconomic conditions of this populous country. In recognition and response to this need, the Indian Council of Agricultural Research (ICAR) established a broad array of research institutes to address the needs inherent in studying and managing these highly important fishery resources. Institutes addressing the biological parameters of the various aquatic ecosystems included coldwater, warmwater, brackish water and marine ecosystem institutions. The central institutes were set up on a regional basis to address the various types of fisheries being exploited, with additional suboffices located at other strategic points to address local needs and to feed data to the main institutions. Although significant amounts of data relative to fishery harvest and problems associated with possible over exploitation were being compiled, it was only in the last decade that the urgent need for fisheries genetic resources conservation and categorization was brought forward since much remained to be learned about the exceptionally rich fisheries fauna of the country.

Marine, brackish, and fresh water fisheries harvests are integral parts of the daily economic infrastructure of India as well as providing one of the main staples in the diet of the Indian people. Beyond the commercially important species, however, their lies a great diversity of fishes of which little is

presently known. ICAR scientists have recognized, with some concern, the decline in harvest of many species, particularly those associated with fresh water ecosystems. This legitimate concern for declining harvests and obvious reduction in biodiversity of individual species brought about the need for taking a more holistic approach to fisheries management relative to both exploitation and conservation. In view of a national emphasis on improvement and expansion of both inland and marine fisheries, ICAR recognized that enhancement of fish production alone was not enough and that conservation of the diversity of fishery resources in a natural state was desirable. In response to this growing concern and apparent need, the Government of India created in 1983, under ICAR, the National Bureau of Fish Genetic Resources (NBFGR).

NBFGR's mandates include 1) collection, classification and evaluation of information on fish genetic resources of the country, 2) cataloguing of genotypes, 3) maintenance and preservation of fish genetic materials, 4) study of introduction of exotic species in Indian waters, and 5) conservation of endangered species.

While gradually building an adequate staff to address it's declared mandates, NBFGR's existing staff have concentrated their immediate attention on the following programs: 1) Cataloguing of fish genetic resources and ascertaining their present status, 2) Study of genetic variation in natural populations, 3) In situ conservation of fishery resources, 4) Identification of endangered, threatened, and rare fishes and their ex situ conservation, and 5) Cryopreservation of gametes for Gene Banking.

The NBFGR's staff have made significant progress in their effort to address the mandates given to them. They have made progress in each of the five areas listed immediately above and all information is not repeated here since it is available in their own publications. However, I deem it important to point out

the current status of cataloging and identifying the diversity of species occurring in Indian waters and they are listed below, categorically, by ecosystem occurrence.

IDENTIFIED FISHERY RESOURCES OF INDIA TO DATE*

ECOSYSTEM	NO. OF SPECIES	% OF TOTAL
1) Upland Coldwater	73	3.32
2) Plains Warmwater	544	24.73
3) Brackish Water	143	6.50
4) Marine	1,440	65.45
TOTAL	2,200	100.00

*As of May, 1992

Even with this impressive assemblage of species, it was obvious to me in discussions with numerous scientists that there are still many more undescribed species present in Indian waters that little or nothing is understood about their life history or extent of occurrence. Just since the establishment of NBFGR, some 500 species have been added to the fauna list. Therefore the task that lies ahead for NBFGR is monumental and will require significant commitments of funds, facilities, manpower, and equipment.

DISCUSSION AND RECOMMENDATIONS

The Indian Council on Agriculture Research can be proud of the quality of scientists working in it's various fishery programs throughout the country. I was thoroughly impressed with not only the ability of scientists at the various institutes which I visited, but also with their interest, enthusiasm and dedication to the resources with which they work. With this assemblage of quality personnel, good science and biology can be moved along as has been demonstrated in the past. All that is needed is additional direction and guidance from the central government, along with needed funding to jump-start the new program on endangered species to get it moving along a charted course.

Proper management of India's fishery resources requires not just institutional research but good, biologically sound field data on which to make management decisions and recommendations. Primary objectives should be to optimize the productivity of commercial and sport fisheries while protecting both the habitats and fishery stocks that support and sustain these important fisheries. This can be accomplished through developing, coordinating and implementing fishery resource plans that address specific fishery resource issues. Coordination with other federal and state resource managing agencies must be developed and fostered in order to achieve success. All successful resource management programs are met primarily by building partnerships and providing leadership in an atmosphere of cooperation of all resource managers, including user groups, i.e., commercial fishermen, sport fishermen, conservation groups, etc. By taking the lead, ICAR can set the pace and the example that will lead to the identification and restoration of significantly important commercial or sport fish species as well as threatened and endangered species.

RECOMMENDATION - SET OUT IMMEDIATELY TO ESTABLISH WRITTEN COOPERATIVE AGREEMENTS WITH ALL FEDERAL AND STATE AGENCIES AND INSTITUTIONS THAT DEAL WITH NATURAL RESOURCES AND WHICH HAVE ANY IMPACT ON NATIVE INDIAN FISHERY RESOURCES OR THEIR HABITATS.

Federal legislation can also play a key role in the development of fishery management strategies and protective measures that will lead to constructive programs of fishery stock and habitat protection and maintenance. In addition to the "Indian Fisheries Act", other existing legislation should be reviewed to determine what may already be in place to help mandate and give authority to the efforts to protect fishery stocks and their habitats. If needed, additional legislation should be drafted and put in force to ensure proper protection of the fountain of productivity for the fishery resources of India - the spawning stocks and their habitat. A common consensus amongst scientists that I interviewed at all locations, was 1) existing regulations are not enforced, and 2) recommendations to implement new regulations have not been acted upon. Regulations that are in place must be enforced and where inadequate protective measures do not exist they must be established! Catch limits, mesh size restrictions, closed seasons (to protect spawners, etc.) must be put in place and then enforced. Additionally, if endangered species are to be listed, as recommended at the Seminar, it seems to me that legislation similar to the "Endangered Species Act" in the United States, should be passed in order to give mandate and force to the listing process. Independent states should also draft legislation for the conservation and protection of fishery resources and their habitats within their sphere of jurisdiction. This would be in addition to federal legislation.

RECOMMENDATION - REVIEW ALL EXISTING STATUTORY MANDATES AND LEGISLATIVE AUTHORITY THAT WOULD BE USEFUL IN PROVIDING PROTECTION OF EXISTING FISHERY STOCKS AND THEIR HABITATS. DUST THEM OFF AND IMPLEMENT THEM FULLY! WHERE AND WHEN NECESSARY, DRAFT AND GET PASSED, NEW LEGISLATION WHICH WILL FILL IN ANY NEEDED GAPS IN EXISTING LEGISLATION.

RECOMMENDATION - ENSURE THAT EXISTING OR NEWLY PASSED LEGISLATION HAS SUFFICIENT AND ADEQUATE PENALTIES ASSOCIATED WITH IT TO BE A SERIOUS DETERRENT TO BREAKING THE LAW. UNENFORCED LAWS AND LAWS WITH NO PENALTY ASSOCIATED WITH THEM, OR ONLY ONE THAT CONSISTS OF A 'SLAP ON THE HAND', WILL DO LITTLE TO PROTECT THE RESOURCE AS INTENDED. LAWS MUST HAVE TEETH (= PENALTIES) THAT ARE A SIGNIFICANT DETERRENT TO COMMITTING THE CRIME. SOCIETY MUST ALSO RECOGNIZE THAT STEALING FISH AND WILDLIFE RESOURCES BY OVER OR ILLEGAL HARVEST IS A CRIME, THE SAME AS STEALING LIVESTOCK OR OTHER POSSESSIONS.

RECOMMENDATION - ESTABLISH A FEDERAL LAW ENFORCEMENT BRANCH WITHIN ICAR WHICH CAN ENFORCE LEGISLATIVE MANDATES ON THE BOOKS. THESE "FEDERAL FISH AND GAME AGENTS" WOULD BE STATIONED THROUGHOUT THE COUNTRY WHERE NEEDED TO ENFORCE THE LAWS WHICH PROTECT FISH AND WILDLIFE RESOURCES AND THEIR HABITATS. STATES SHOULD ALSO IMPLEMENT OR ADD TO A SIMILAR LAW ENFORCEMENT BRANCH, "STATE FISH AND GAME AGENTS", THAT CAN BE THE MOST EFFECTIVE GROUP IN MANAGING FISH AND WILDLIFE RESOURCES ON A LOCAL BASIS. DEPENDING UPON THE SIZE OF THE STATE AND THE AMOUNT AND TYPE OF RESOURCE THAT NEEDS PROTECTION, THERE COULD BE UP TO 100 SUCH INDIVIDUALS ON A STATE BY STATE BASIS.

TERMS OF REFERENCE

Fish genetic resources conservation is neither a new science nor a new approach to fishery conservation and management. More and more, however, good genetic planning is considered by most fishery managers and administrators to be an essential part of any good fishery management program. Good genetic planning, combined with other fish culture and fishery management practices, fits hand-in-glove for conservation of all fishery stocks, regardless of abundance or status. With these types of goals in mind, the terms of reference for this consulting assignment are listed below.

1) Suggestion of methodology for making an inventory of existing fish genetic resources of India.
2) Assessing the types and kinds of fish genetic resources to be conserved along with their domesticated varieties.
3) Workable suggestions for identification of Endangered, Vulnerable and Rare fishes since data on previous abundance is not readily available.
4) Methodology for identification of causative factors leading some fishes to endangered status.
5) Reviewing of existing conservation measures in India and suggest further pragmatic ex situ and in situ techniques.
6) Recommendation for a fish farm-cum-hatchery for conservation of endangered fishes in particular and other in general.

I will now attempt to address each of the terms of reference (TOR) that are the basis for undertaking this consulting assignment:

TOR No. 1 - **Suggestion of methodology for making an inventory of existing fish genetic resources of India.**

This task will require work, work, work! Literature must first be compiled and summarized for individual river systems and then by species. Exhaustive field surveys must then be carried out in all aquatic habitats to ascertain the information needed to fill in existing data gaps.

RECOMMENDATIONS:

(1) Assign existing central institutes the responsibility of compiling all existing literature (published and unpublished) on each river system and on each species. Synthesize this information into a single document with a priority to those species considered to be threatened or endangered.

(2) Establish regional "fishery field crews" who have expertise in carrying out fishery management field surveys so that all missing data points on species biology, habitat preferences, and distribution can be collected. This would be their primary responsibility - to collect field data, analyze and compile it, and provide information to research institutes for further synthesis and study.

(3) Field surveys should concentrate on collecting pertinent data relative to distribution and abundance, habitat preference, temperature range and preference, reproduction, possible migration, growth, food habits, microhabitat requirements of early life stages, possible predators, harvest information, etc. Sampling should also include physical and chemical parameters, benthic organisms, aquatic vegetation associated with various life stages, etc. Sampling gear should include, depending upon habitat type: gill and trammel nets, hoop or frame nets, seining, electrofishing, cast nets if desirable, and passive (trot line) or active (rod & reel) angling. There is abundant written literature on carrying

out appropriate fishery management field surveys and data collection. I will send a few of these documents to Dr. P. Das upon my return to the U.S.

(4) USAID should fund collaboration of Indian and American field scientists. I recommend that at least four Indian scientists (two one trip and two another) spend a two month assignment in the United States working with U.S. Fish and Wildlife Service field crews doing fishery surveys in the outdoors on streams, rivers and lakes. This is the best manner to get Indian field crews on-the-job experience in field work assessments.

TOR No. 2 -- Assessing the types and kinds of fish genetic resources to be conserved along with their domesticated and wild varieties.

I believe that an attempt should be made to protect and conserve all species of fishes. There should be a prioritized system to first address those with the most important economic considerations and those truly endangered, but the ultimate goal should be to protect all species, regardless of status. Thus, through proper application of management techniques, some species decline may be reversed or stabilized prior to reaching the point that they would need to be listed as an endangered species.

RECOMMENDATION:

(1) Follow or modify the prioritization system used by the U.S. Fish and Wildlife Service to determine which species have listing priority in the U.S. Some elements of the system are included here and the entire document is included as Appendix No. 3! First, recovery potential of a species needs to be determined based on biological data, degree of threat, taxonomy, etc. The following tables demonstrate how this can be done:

Table No. 1 - RECOVERY POTENTIAL

Factors	High Recovery Potential	Low Recovery Potential
Biological & Ecological Limiting Factors	----Well Understood----	---Poorly Understood---
Threats to Species Existence	Well Underestood/Easily Alleviated	Poorly Understood/pervasive & Difficult to Alleviate
Management Needed?	Intensive Management Not Needed or Techniques Well Documented With High Probability of Success	Intensive Management With Uncertain probability of Success or Techniques unknown or Experimental

Table No. 2

PRIORITIES FOR LISTING OR RECLSSIFICATION FROM THREATENED TO ENDANGERED

Threat		Taxonomy	Priority
Magnitude	Immediacy		
High	Imminent	Monotypic Genus	1
		Species	2
		Subspecies	3
	Non-imminent	Monotypic Genus	4
		Species	5
		Subspecies	6
Moderate to Low	Imminent	Monotypic Genus	7
		Species	8
		Subspecies	9
	Non-imminent	Monotypic Genus	10
		Species	11
		Subspecies	12

The tables above are two examples of how species listing can be priortized. The U.S. Fish and Wildlife Service docment (Appendix No. 3) pertaining to listing priorities contains additional tables and written criteria developed for this purpose. ICAR and NBFGR will find this information highly useful as listing of Indian species gets underway. It can be used directly, or a new document pr[illegible] using this one as a prototype.

I am concerned that many stocks of fish that may not really be endangered at this point in time are being considered for endangered status. Just because harvest of a species has declined by 50% or perhaps more, does not mean that the species is in danger of extinction. Such data should be a warning that the fish might be in trouble if remedial action is not taken, and that it warrants intensive management and extra protective measures, but not necessarily endangered status.

In the United States, the U.S. Fish and Wildlife Service is engaged in many "Restoration" programs for important commercial and sport fishes whose numbers have declined significantly. These species are protected by special harvest regulations as well as being cultured in federal and state hatcheries and reintroduced to augment natural reproduction. However, these species are not presently endangered and the objective through proper management is to prevent them from declining to the point that listing becomes necessary.

Another item that frequently came up in my discussions with ICAR scientists was what I term "local endangerment". The concern expressed involved what to do about a species that is greatly reduced in a certain area or river system, but is abundant elsewhere. In the United States, these situations are handled by State Game and Fish agencies who have autonomy to manage all species of fish and wildlife within their jurisdictional boundaries. When a species becomes locally endangered within a state, the legislature will proceed to list it as Threatened or Endangered, depending on it's status and the degree of threat, even though in neighboring state, the species may be highly abundant and legal take actively employed. Therefore, "local endangerment" = state responsibility and "species endangerment" = federal responsibility. Actually a species can be listed by both the state and the federal government, but the practice as described basically holds true regardless.

TOR No. 3 - Workable suggestions for identification of Endangered, Vulnerable and Rare fishes since data on previous abundance is not readily available.

This term of reference has been answered under Term of Reference No. 1 above - literature compilation and field surveys. In light of this, I suggest a rewording of this term of reference as follows:

TOR No. 3 - Workable suggestions for addressing recovery of species once they have been identified and listed as endangered.

"Recovery Plans" should be prepared for all listed species. A recovery plan is a documentation of existing information, identification and recommendation for needed research or remedial actions on the species, and an action plan for implementing recovery recommendations with assignment of responsibilities and time schedules to accomplish work.

A recovery plan should have a table of contents similar to the following:

- -History and Description of Species
- -Historic Distribution and Abundance
- -Present Distribution and Abundance
- -Life History
  - -Habitat and temperature Preferences
  - -Reproduction and migration
  - -Growth
  - -Food Habits
  - -Possible Predators
- -Cultural, Economic, and Biological Importance
- -Reasons For Decline
- -Recovery Actions

Research needed to fill in gaps in existing data both for in situ and ex situ situations is addressed in the recovery portion of a recovery plan. Attachment No. 4 documents the type of items that have been included in recovery actions for the woundfin, Plagopterus argentissimus, an endangered American cyprinid.

To protect a declining species in the wild takes corrective action to eliminate or alter the causative factors which have contributed to the problem. Therefore, proper legislative mandates if needed are brought into force, law enforcement, habitat reclamation where needed, harvest regulations and possible restrictions contribute to a united effort to stem the decline of a species. In order to protect the gene pool of a given species while remedial in situ actions are implemented, both captive holding of genetically diverse group of live fish and additional gene banking of spermatozoa should be carried out to ensure maintenance of the species.

Numerous recovery plans for U.S. fishes are available and I will send several plans for different species to Dr. P. Das upon my return to Dexter.

RECOMMENDATION - I recommend that ICAR hold an annual "Endangered Species Coordination Meeting" that the top two or three staff from each central institute attend to bring everything up to current status and plan the next years' activities.

RECOMMENDATION - I recommend the formation of "Recovery Teams" to address regional endangered fish issues and write "Recovery Plans"for the species under there jurisdiction. These "teams" should be made up of leading scientists within the geographic area of coverage and be "well rounded" with personnel from federal government, state, academic and conservation groups represented on the team. In this manner a great amount of expertise is brought together in one body and different agencies are represented on the team so that everyone is kept informed. Personnel assigned to the team should be trained biologists, not political

appointments. The team develops a "biologically oriented recovery plan" that addresses biological factors for the species and does not let political or monetary considerations influence biological recommendations.

RECOMMENDATION - I recommend calling for an International Endangered Fishes Workshop/Symposium on Endangered Fishes Conservation. USAID should help by funding attendance of Indian scientists at such a workshop. This forum should bring together into a single locality, many of the worlds premier scientists that are dealing with endangered fish issues on a daily basis. Scientists within ICAR responsible for endangered species issues should be required to attend this proposed symposium.

RECOMMENDATION - USAID or the Government of India should fund travel for selected ICAR scientists to attend formal training programs on endangered fish culture practices, genetic workshops, etc. which are routinely held in the U.S.

RECOMMENDATION - Establish "critical habitat" where needed. This would be done during the "listing process" for a species and would include all habitat totally essential to survival of the species.

TOR No 4 - Methodology for identification of causative factors leading to endangered status.

From my discussions with ICAR and other scientists at the various institutes and at the seminar, it was immediately apparent to me that Indian fishes are declining for the same reasons as American fishes - habitat degradation and over exploitation - interference with aquatic ecosystems by technological man. For causative factors of decline of American fishes, and to avoid repeating them here, see the section titled "Reasons For Decline" in Appendix No. 1, where these factors are discussed in detail.

What can be done about these problems? Nothing will come easily in this area and most alternatives are costly. Never-the-less, if corrective actions are not taken, fish stocks will continue to decline unabated. Point source pollution, whether industrial, municipal or agricultural, must be addressed through appropriate legislation and enforcement. The "Clean Water Act" in the United States was a big help in turning around gross pollution problems in U.S. waters. Existing dam operations should be examined for two purposes: 1) to see if fish ladders that would permit migrating fish a passageway around structures could be constructed, and 2) release of "Minimum flows" to protect all aquatic fauna in river segments between or below dam sites. New dam construction should be closely reviewed and potential impacts on fishery resources "mitigated" prior to start of construction. Mitigation attempts to prevent, minimize, and compensate for adverse resource impacts that are related to specific construction activities or long term alteration of preexisting natural conditions. Existing harvest regulations should be enforced and new ones put into force where the resource and its protection demands such.

NBFGR should take the lead responsibility they have been given to keep the program moving. Close coordination and collaboration with all other lead institutes should be an integral part of the program since there are excellent scientists with good data and ideas present at all facilities.

TOR No. 5 - Reviewing of existing conservation measures in India and suggest further pragmatic ex situ and in situ techniques.

First, existing laws that protect aquatic resources must be enforced! Secondly, additional strong legislation must be drafted and passed, giving additional protection beyond existing legislation. Any such law that is passed must also be enforced. Laws on the books are meaningless without appropriate

penalties and enforcement. This was discussed in detail under TOR No. 1.

Looking beyond legislation there are additional things which can be done. Collaboration and coordination with other federal Indian resource managing agencies is absolutely essential. The same applies to collaboration and cooperation with State resource managing agencies. Without a good, coordinated program involving all resource managers and users, ICAR efforts will only be partially successful at best. Lay out a program that can be sold to all other managers and get them to come aboard in a coordinated program that will be able to address the real issues that are the crux of the problem with resource decline. This was also discussed earlier under my first recommendation prior to specifically discussing the terms of reference.

In situ measures include establishing harvest limits where none exist, closing harvest when brood animals are on spawning grounds, implementing mesh size regulations to limit by-catch of smaller target species or non-target species, controlling point source pollution contaminants, and setting aside certain critical fish habitats as sanctuaries or seasonal conservation areas. Perhaps the whole upper end of a watershed could be set aside to protect the entire ecosystem, taking a holistic conservation approach. Taking a 10 to 20 kilometer stretch of river will probably not be adequate to do anything significant unless it was the very upper reaches of a system.

Ex situ measures include continued genetic monitoring to establish genetic fingerprints of all species, to continue testing cryopreservation and gene banking opportunities, establishment of a fish hatchery-cum-farm that is dedicated to threatened and endangered species (see TOR No. 6), and contaminant studies. Many of these efforts are in progress and should be continued.

RECOMMENDATION - A dedicated effort to examine the effect of industrial, municipal and agricultural pollutants on all aquatic fauna should be initiated.

Fish and other organisms are known to accumulate toxic pesticides and other pollutants and store them in adipose and gonadal tissues. Such pollutants could therefore, have a detrimental effect on spawning success, gamete viability, embryo development and larval fish survival. Biomagnification of pesticides could also be occurring with an eventual threat to predatory bird populations as well as human health.

TOR No. 6 - Recommendation for a fish farm-cum-hatchery for conservation of endangered fishes in particular and others in general.

The U.S. Fish and Wildlife Service endangered fish facility at Dexter, New Mexico, USA in described in some detail in Appendix No.1. It has served a crucial role in the conservation of fishes indigenous to Southwestern America.

RECOMMENDATION - Construct one or more such facilities to deal with declining and endangered fish resources of India. Two fresh water facilities are needed, one for cold water species and one for warm water species. The need for facilities to work with brackish water and marine species I am unable to address. However, if the documentation is available to show serious problems with some stocks, then *ex situ* work should be looked at. Perhaps there are current brackish water and marine facilities which could take on this work along with their current responsibilities.

I have provided Dr. P. Das with several different blueprints that deal with various fish culture and administrative buildings, pond liners (to prevent seepage), and fish catchment basins (kettles) for earthen ponds. The freshwater facilities should be multipurpose and overseen by the Director, NBFGR. It should have, as a minimum, the same mandates that currently guide work at NBFGR's. I also recommend the following goals/objectives:

1) Maintain living, captive gene pools of the more critically endangered warm water species.

2) Purchase PIT tagging equipment (minimum of 2 scanners/readers) and PIT tags so that all individual fish can be identified for any purpose any time they are being handled.

3) Maintain pure lines of economically important species being cultured in other Indian facilities.

4) Carry out needed life history and biochemical genetic studies to advance knowledge on each species.

5) Develop culture techniques so that fish can be produced for restoration or reintroduction purposes.

The warmwater facility should be constructed in conjunction with the new NBFGR facilities. I recommend immediate initiation of this project, i.e., new NBFGR facilities-cum-endangered fish farm-cum-hatchery, in order for the NBFGR staff to have appropriate work facilities and move forward with the mandates that they have been given. In Attachment No. 2, my keynote speech at the Endangered Species Seminar, I refer to a 10 year lag that occurred in the American program. I encourage you to make an immediate commitment to move on with your program so that DR. Das and his staff can carry out the mandates relegated to them.

If additional blueprints, i.e., pond construction and configuration, I can provide this information from the U.S. Dr. Das need only get in touch with me for this purpose.

The next subject consists of the "Scientific Recommendations" made during the plenary session of the Endangered Species Seminar in Allahabad, 25-26 April 1992. I have provided comments following each recommendation.

DRAFT RECOMMENDATIONS OF THE NATIONAL SEMINAR

ON THE ENDANGERED FISH SPECIES OF INDIA

25-26 APRIL 1992

ALLAHHABAD, U/P, INDIA

The following scientific recommendations were prepared and presented by a special committee assigned to develop such. The recommendations were then placed on the floor for discussion, amendment, general approval or rejection by the body of the seminar participants. No legal or authoritative action was taken, just the general consensus of the group of assembled scientists.

1) Immediate efforts should be made to list the threatened species of fishes and other aquatic organisms from available information and further survey. Periodical updating of the same need also be done. Initially, priority should be given to commercially important species. APPROVED.

   COMMENT - Agree. Once a system is in place to actually determine endangered status, and legal authority has been put in place to allow listing, the listing process should proceed. Periodic review of status of species, both listed and unlisted is an essential part of the program.

2) Urgent steps are needed for preservation and protection of the germplasm of all presently threatened species on a regional basis. APPROVED.

   COMMENT - Agree. Enforcement of existing regulations is a must, NOW! Other portions of this work should move forward as quickly as facilities can be completed.

3) Efforts should be made for effective restoration of habitats through:

a) Minimum water levels in the natural water bodies should be maintained in order to maintain the proper ecosystem necessary for the preservation of fish species.

b) To enforce implementation of anti-pollutional laws.

c) To control other human interferences. ALL THREE APPROVED.

COMMENT - a) Agree. Enact legislation that will establish "minimum flows" to protect aquatic resources. b) Agree. Precisely, and implement new laws if present ones are inadequate. c) Agree. Difficult to do but easier if planning for such eventualities ahead of time.

4) Pre-impoundment and post-impoundment studies of the reservoirs need be undertaken as a part of any construction. APPROVED.

COMMENT - Agree. Carry on with this effort. Bring "mitigation" into force in the pre-construction phases of the program.

5) The model revised Indian Fisheries Act may be immediately prepared by Central Government and circulated to all State Governments for their enactment. This should especially incorporate provisions for protection and conservation of threatened species. Efforts need be made by the State Governments to strictly enforce and monitor the same. APPROVED.

COMMENT - Agree. Go for it!

6) Steps need to be taken to breed and produce seed of threatened species on a mass scale for ranching of streams/rivers. APPROVED.

COMMENT - Be careful! For those species that might fit into a "restoration" vs "endangered" category, I agree, IF a broad, genetically diverse broodstock is use to produce these "mass

numbers". For truly endangered forms, you must be careful about introducing too many hatchery produced fish on top of the wild genome. Numbers used to augment wild populations should be carefully planned.

7) It is necessary to revive the existing fish sanctuaries as far as possible and to identify possible additional sanctuaries. Known deep pools in river beds harboring mature fishes need also be protected. APPROVED.

   COMMENT - Agree. Go for it!

8) It is suggested that National Standing Committee and Regional Sub-Committees be constituted. These would evolve strategies for protection and conservation of threatened species. NOT APPROVED.

   COMMENT - I'm not sure I understand what was proposed here and eventually not approved. However, I strongly recommend the establishment of regional "Recovery Teams" that have the responsibility to prepare "Recovery Plans" for listed species.

9) It is essential to create a mass awareness regarding threatened fish species all over the country through all types of media. Strengthening of extension wings of State Fisheries Departments will be essential to achieve this goal. APPROVED.

   COMMENT - Strongly agree. Go for it!

GENETICS CONSIDERATIONS

A major goal in recovery and management of threatened and endangered fishes is genetics conservation. This requires the identification, characterization, protection, and conservation of unique and valuable genetic resources inherent within the extant populations. Effective genetics management and recovery relies

n accurate genetic data derived from the target species. Results of initial genetics studies provide baseline data required for identification, characterization and future management of wild populations. This data can also be important in understanding important life history and population interactions in the wild. An attempt at genetics management is best based on solid baseline genetic data as previously mentioned. Evaluating intra- and inter-population genetic structure, variability and relationships may be essential to long term recovery and survival of threatened and endangered species.

ICAR has assembled an excellent genetics staff at NBFGR and they are well on their way to establishing excellent genetic data bases for Indian fishes.

CONCLUDING REMARKS/RECOMMENDATIONS

1) Take action! Philosophy and concern will do nothing for the resource in and of itself alone. Neither will planning alone. So take action - go for it!

2) In the U.S., Section 7 of the Endangered Species Act requires all other federal agencies or anyone carrying out a project in which federal funding is involved, to first consult with the Fish and Wildlife Service, in writing, regarding any possible impacts the project would have on endangered species. India should incorporate such language into upcoming endangered species legislation.

3) In partnership with other federal agencies, the States and the private sector, develop and achieve common management goals and objectives.

4) Develop formal agreements and processes with other federal and state agencies that will reduce degradation of riparian, freshwater, brackish water and marine aquatic ecosystems.

5) Coordinate and cooperate with other resource managing agencies to protect both the quality and quantity of water available for fishery resources.

6) Ensure that existing fish hatchery operation are compatible with the

preservation and management of existing stocks of native fishes and use expertise to stem decline of important stocks of fishes.

7) Establish at NBFGR's new facilities, a national repository for fisheries data and gene banking for threatened and endangered freshwater species.

8) Increase investigations to better understand fish genetics, diseases, nutrition, impact of contaminants, habitat loss, etc.

9) When reintroduction start, initiate comprehensive follow up monitoring and evaluation of stocking programs to determine effectiveness of management practices.

10) Establish an environmental outreach program to inform the public of the plight of and recovery efforts for endangered species.

11) Enforce existing laws and press for additional legislation where needed.

12) Make significant attempts at holistic management to protect entire ecosystems where possible.

13) Promote environmentally and economically sound construction design and planning to avoid or minimize human conflict with aquatic resources.

14) Initiate sound on-the-job and classroom training programs to ensure that scientists receive the best training opportunities possible.

15) Provide employees with the best quality work environments and equipment so that they can effectively and efficiently carry out their mandated responsibilities.

APPENDIX I

FISH REFUGIA AND CAPTIVE PROPAGATION
A Viable Aid To Conservation And Restoration

by

Buddy L. Jensen
Director

Dexter National Fish Hatchery and Technology Center
United States Fish and Wildlife Service
P.O. Box 219
Dexter, New Mexico 88230
United States of America

Abstract

History documents man's desire to protect living organisms by placing them into controlled environments, i.e., captive facilities. Today, many zoological and botanical organizations continue to bring wild animals into captivity for educational, economic, and ecological purposes. Protecting species that are threatened with extinction by placing them into refugia is a logical course of action for both short term and long term management and preservation. However, captive propagation is not an end in itself and entails some risk to the species involved. Evaluating these risks and proper planning to safeguard captive species is essential to success of any such effort. With careful, coordinated planning, loss of valuable natural resources, including the elimination of species, need not be the price of modern progress.

INTRODUCTION

Man's impact on the environment, particularly following the Industrial Revolution, is today both obvious and well documented, and is generally understood by most. In his book titled "Conserving Life on Earth", David Ehrenfeld made the following profound statement:

> "Not all the winds and storms and earthquakes and seas and seasons of the world have done so much to revolutionize the earth as Man...has done since the day he came forth upon it and received dominion over it." (Ehrenfeld, 1972).

Refuges or parks consisting of large tracts of land that provide protection for and also permit natural reproduction of rare animals has long been recognized as a viable means of perpetuating species in a natural to semi-natural state. However, as man continued to encroach upon and alter the habitats that wild animals required for self maintenance, it was recognized that even traditional refuges were sometimes no longer adequate for maintaining some species.

Captive propagation and management has long played a role in maintaining domesticated species of animals for the benefit of the human family. Increasingly, however, it has become obvious to those concerned with biodiversity and species maintenance that captive propagation and reintroduction may be required in order to ensure perpetuation of wild species as well (David, 1990; Jensen, 1990; Johnson and Jensen, 1991). Some species driven to near extinction within historic times survive today because man has brought them into captivity and subjected them to captive propagation. Although some have been saved in this manner, many more probably have vanished without man's knowledge of their existence or possible contribution to science.

With increased public awareness about staggering environmental degradation around the world and the consequential impact on diversity of species, conservation biologists today receive greater support than ever in their search to find and develop management techniques or tools that will help ensure survival of our vast and biologically diverse array of species. Captive propagation and reintroduction are such tools, but there are still those who remain skeptical that such

"artificial means" can play a substantial role in maintaining or perpetuating biodiversity. It was with both interest and reservations about the increased use of captive propagation and reintroduction that one author stated:

> "On the one hand, I am excited about this rapidly growing body of management knowledge -- such as that concerning genetics, population viability analysis, and captive breeding protocols -- and the options that such new skills may offer to snatch back species teetering on the brink of extinction. Yet, on the other hand, I am wary of this human tendency of ours to try to solve environmental problems like habitat degradation and loss of biodiversity -- which are ultimately caused by human technology and disruption of ecological systems -- with increased human technology and even more 'invasive' management methods. Thus, even while I applaud the management progress being made with endangered species, I wonder to what avail is the perfection of captive breeding techniques if we still are unable to find workable resource use solutions to the problems which caused most species to become endangered in the first place." (Jones, 1990)

Such concerns are valid and we should not be content with the success of captive propagation programs alone. However, if many species are to be saved, let alone perpetuated, action must be taken before it is too late. Through captive propagation and reintroduction, a species cannot only be saved, but wild populations which have been greatly diminished or extirpated may be reestablished, even in the face of unstable habitat conditions.

Those who oppose the role of captive propagation and reintroduction in the conservation or preservation of biodiversity stress the larger picture, the need to save large areas of habitat and biologically diverse ecosystems. While their vision of the ideal scenario is praiseworthy, only rarely can this goal of ecosystem protection and holistic management be achieved today. That should be a clear objective where possible, but when it is not, contingency plans must be in place and the means to implement them established. An old cliche - "to fail to plan is to plan to fail" - sums up the situation well.

Therefore, from a practical, realistic point of view, we, as scientists, must be prepared to press forward diligently, pursuing all avenues of conservation biology, including habitat preservation, captive propagation and reintroduction. Therein lies the challenge - to best "determine how, where and when captive propagation and reintroduction" fit into a plan that attempts "a holistic approach to conservation biology and management" (Constant, 1990).

The frequently quoted statement by American Conservationist Aldo Leopold -"The first prerequisite of any intelligent tinkering is to save all the pieces" (Leopold, 1949) - states well the role that captive propagation and reintroduction can play in preserving biodiversity. We must indeed attempt to save all the pieces (= species), utilizing captive maintenance and artificial propagation when necessary, and reintroduction when ecologically feasible.

DEXTER NATIONAL FISH HATCHERY AND TECHNOLOGY CENTER

Dexter National Fish Hatchery and Technology Center, Dexter, New Mexico, USA, is a refuge and development facility for endangered fishes of southwestern America. The natural waters of the American Southwest have changed dramatically in the last hundred years. Rivers have been dammed and diverted to meet the demands of human settlement and development of this arid region. In the process, scores of unique freshwater ecosystems have been altered or destroyed and many organisms dependent upon these habitats have declined in both numbers and area of historic occurrence. The near disappearance of fishes native to these waters is a case in point, and their decline has occurred unintentionally and almost unknowingly by most Americans.

After Congress passed the Endangered Species Act of 1973, the United States Fish and Wildlife Service within the Department of the Interior, was charged with the responsibility of identifying and protecting threatened and endangered species of fish and wildlife. During this process, a search for a facility to work with imperiled fishes of the American Southwest, including northern Mexico, was initiated. Of the approximately 88 fish species listed as threatened or endangered in the United States, sixteen (ca 18%) are currently being held and cultured at Dexter National Fish Hatchery and Technology Center, Dexter, New Mexico, the facility eventually selected to carry out this important work.

The Dexter hatchery was constructed in 1931 and 1932, and for over 40 years produced warmwater game fish for stocking federal and state waters throughout the Southwestern United States. With other Fish and Wildlife Service hatcheries in the states of Texas and Oklahoma fulfilling the federal commitments for game fish formerly produced at Dexter, and the added responsibility for endangered fishes, the mission of the Dexter facility changed completely in 1978. No other place in the world, to our knowledge, has such a concentration of rare and endangered fishes at a single locality, nor the responsibility for maintenance of genetic diversity, assemblage and documentation of biological data, and development of complete culture techniques for such an array of unique native fish species. Although only sixteen species are presently being maintained at Dexter, a total of 29 species have been held for one or more purposes since the beginning of the program.

The Dexter facility has been designated a Technology Center, one of only four in the United States Fish and Wildlife Service. This was done partly in recognition of the unique fishery development work that has been carried out by Dexter personnel, past and present, and the continuing responsibility to further the recovery of threatened and endangered fishery resources as assigned.

Dexter NFH & TC is located in the Pecos River Valley of southeastern New Mexico (Figure 1), 200 miles southeast of Santa Fe, the State Capitol. The elevation is 3,600 ft MSL (1108 m), annual precipitation averages 12 in (30 cm), and the native vegetation is semidesert scrub and grasses common to the northern fringes of the Chihuahuan Desert. Surrounded by agriculture, the center derives it's water supply from four shallow ground water wells 150 ft (46 m) in depth capable of pumping approximately 2,000 gpm (ca 8,400 lpm). Water temperature at the well heads is a constant 64 degrees F (17 degrees C) and the pH averages about 8.4 - 8.5.

There are 48 earthen ponds varying in size from 0.15 to 1.8 acres (.07 to 0.8 HA) and depths from 3 to 6 feet (.93 to 1.85 M). All water supply lines and drain lines for each pond are maintained separately to ensure that no mixing of fish can occur. This is essential since many of the species being maintained are congeneric and could hybridize if they coexisted in the same pond. To ensure that no fish from one pond are accidentally introduced to another pond, different

equipment is used from pond to pond or the previous set sterilized prior to reuse. This practice also prevents any possible transfer of fish diseases or parasites from one population of fish to another.

FACILITY OBJECTIVES

Dexter NFH & TC has three primary objectives: 1) Refuge, 2) Research and Development, and 3) Reintroduction.

1) REFUGE - The facility serves as a refugium for imperiled species which are threatened with extinction in the wild. Populations of refuge species are maintained in captivity in case a man-caused or natural disaster should eliminate the wild population. Under these conditions, captive fish can be used to reintroduce the species back into it's historic range once habitat conditions are sufficiently restored for survival in the wild. Species fitting this category sometimes are limited to only one or two natural localities, sometimes only a single spring and its outflow for a short distance.

2) RESEARCH AND DEVELOPMENT - Often, little biological or life history information is known about the imperiled species brought to Dexter. Therefore, within time and manpower constraints, all the data that can be collected while these fish are maintained in captivity must be aggressively pursued.

3) REINTRODUCTION - Plans for many of the species call for reintroduction efforts so techniques to successfully spawn, hatch, and culture the fish must be developed. For those species requiring such, production of large numbers of individuals of various sizes must be accomplished. These fish are utilized in reintroduction efforts into historic habitats of the respective species where natural populations have been diminished or extirpated.

REASONS FOR DECLINE

Although there are numerous reasons for decline of species, nearly all can be attributed to interference by technological man. These man-caused perturbations of aquatic ecosystems nearly always involve habitat degradation of one form or another, are numerous, and can be either direct or indirect.

A major problem in America is the construction of dams which have multiple impacts on the aquatic environment including 1) blocking spawning migrations and other intra-river movement of fishes, 2) change from a riverine to lacustrine environment above dams and in flow and temperature regimes below dams, 3) water diversions which often result in complete desiccation of river stretches below dams, and 4) hydropower operations which can kill fish which enter the penstocks and impeller chambers as well as causing large and unnatural daily fluctuations in downstream flows due to "peak demands" for power generation.

A second major impact on native American fishes has been the introduction of exotic (= non-native, regardless of origin) species. Exotics often out-compete native fishes for both food and space resources as well as preying directly on their various life stages. Once established, particularly in large, diverse aquatic systems, they are impossible to remove. Only in small, isolated spring/spring-run desert systems or in high mountain streams above natural or man-made barriers that prevent reinvasion by exotics, have American fish conservationists found long-term success in removing them. Minckley and Douglas (1991) summarized the magnitude and significance of the exotics problem this way: "The presence of non-native fishes may prove a far greater problem to native fish survival than all our other environmental abuses combined."

A third major impact on aquatic ecosystems in the arid regions of western North America (USA and Mexico) is ground water pumping. This has led to a reduction in flow or the complete drying up of many springs and the consequential reduction or demise of many populations of native desert fishes.

Other impacts on aquatic ecosystems include but are not limited to 1) poor livestock grazing and timber harvesting practices which can lead to soil erosion and arroyo cutting, which in turn can lead to dewatering of bosques, 2) dumping

of industrial and municipal wastes and pollutants, 3) temperature increases due to fossil fuel power generation which requires water to turn steam turbines, and 4) in the case of rivers, channelization, i.e., turning rivers into man-made channels by dredging of bottom substrates and armoring of banks with riprap.

Another factor which can lead to serious decline in species is over exploitation/harvest. This is particularly true with commercially important species and unregulated sport fishing where fishing pressure is heavy. Advances in technology have greatly enhanced man's ability to harvest fish and many freshwater, brackish, water and marine species are now declining under intense commercial fishing pressure.

FISH ACQUISITION, QUARANTINE AND GENERAL MAINTENANCE

Wild fish are brought to Dexter in truck mounted distribution tanks specifically designed for fish maintenance over long time periods and distances. Once at the facility, fish are quarantined, inspected for diseases and parasites, treated, and eventually taken to designated holding ponds. Depending on feeding rates, spawning requirements, growth of aquatic vegetation, and distribution for reintroduction, fish held in individual ponds are moved to new, clean holding ponds at least twice annually and often three times.

Table No. 1 shows the species of fish presently being held and cultured at Dexter NFH & TC and where they occur in the wild. With only the exception of four species, i.e., Pahranagat roundtail chub, Warner sucker, shortnose sucker and Lost River sucker, all species are from New Mexico or a state contiguous to New Mexico borders (Arizona, Utah, Colorado, Texas, Chihuahua and Sonora).

Table No. 2 lists the species of fish being maintained at Dexter by family, common name, scientific name, and Federal listing status.

SPAWNING AND CULTURE

Spawning techniques developed for fishes presently held at Dexter rely primarily on hormone induced ovulation (hypophysation) of ova and hand stripping of both ova and milt. On occasion, males also receive hormone injections to increase or encourage milt flow. Thus far, two categories of hormones have proven highly satisfactory in meeting all spawning requirements: CP = carp pituitary, and HCG = human chorionic gonadotropin. In the United States, both products can be purchased from several commercial sources with appropriate approval of the Food and Drug Administration (FDA). Presently acetone dried CP costs approximately $100 U.S. dollars per gram (1,000 mg) and HCG about $40 U.S. dollars per 10 milliliters (= 10,000 I.U.'s). To date, the FDA has not approved the use of Ovaprim at our facility.

Carp pituitary is the hormone of choice when spawning female cyprinids. Individual fish receive an intraperitoneal (IP) injection of CP at a rate of 2 mg/lb (4 mg/kg) of body weight. Well maturated females will ovulate 20 to 24 hours post injection. Accurate assessment of spawning condition (state of maturation) is essential since under-developed fish will often take up fluids and sometimes die if injected prematurely. Learning to "read" the state of maturation through secondary sexual characteristics is valuable in this process. If male cyprinids require hormone injections due to low or no milt flow, a single dose of HCG injected intramuscularly (IM) at a rate of 300 I.U.'s/lb (600 I.U.'s/kg) is normally sufficient to achieve desired results.

Human chorionic gonadotropin is the hormone of choice when spawning female catostomids. Individual fish receive three intramuscular (IM) injections of HCG, each, 24 hours apart, at a rate of 150 I.U.'s/lb (300 I.U.'s/kg) of body weight. Well maturated females will ovulate 20 to 24 hours following the third and final injection. Experience has shown HCG to be a more "gentle" hormone and take less of a physical toll on fish if they are not fully maturated. When injected as prescribed herein, we have observed no direct mortalities from HCG use, even in under-maturated fish. Therefore, accurate assessment of spawning condition is not as critical with HCG as it is with CP relative to fish well being, but it is critical to overall spawning success. If required, male catostomids receive the same dosage of HCG as male cyprinids, also via IM injection.

Ova are stripped into pans containing a saline sperm diluent to which milt from two or more males is also added. The mixture of diluent and gametes is stirred with a feather to ensure adequate mixing and to keep ova from sticking to the pan. Water is added, followed by a bentonite clay slurry that helps break down the sticky surface of the egg. The slurried clay is then washed from the eggs and they are placed in floating, mesh lined baskets while water hardening occurs. Fertilized ova are allowed to water harden for a minimum of 30 minutes prior to enumeration and placement in incubators.

Fertilized, water hardened eggs are enumerated gravimetrically and placed in either Heath tray or McDonald jar incubators. We incubate eggs at 70 degrees F. Eggs begin hatching in about 96 hours and complete hatching in about 120 hours. Newly hatched sac fry are placed in inside holding tanks to permit additional development to the "swim up" stage which usually takes about four days. Fry are then enumerated gravimetrically and stocked into fertilized earthen ponds at a rate ranging from 100,000 to 125,000 per surface acre. Ponds are watered up one week prior to planned fry stocking and are fertilized with alfalfa pellets (organic N source) at 100 lbs/SA and inorganic super phosphate at 50 lbs/SA weekly until zooplankton populations finally climax after several weeks. Our soils are highly alkaline and require no additional potassium supplementation. Fry feed initially on zooplankton populations in the ponds and are later converted to commercially prepared feeds applied to the pond surface. We feed commercially prepared, closed formula diets common to American fish culture operations.

Production fish are maintained in ponds from 4 to 30 months, depending on the size requirement of the reintroduction program. Growth rates for various species are different and each must be managed based on experience gained in individual culture efforts. Prior to shipment, fish are inventoried and allowed to clean themselves out for at least 48 hours to help with maintenance of water quality during transport.

Smaller refugia species such as pupfish, gambusia and topminnow are not fed commercial diets but maintain large populations (up to 20,000 in a .15 acre pond) on naturally occurring food organisms in their aquatic environment. All fish six inches (15 cm) or more in length are fed prepared diets based on their particular

status. Predatory species are fed forage fish in addition to prepared diets to ensure good health, spawning condition, and maintain their wild feeding instincts as much as possible.

GENETIC DIVERSITY

Either before or at the time wild fish are brought into captivity for refuge, propagation and possible reintroduction, "genetic fingerprints" for each species, and for different populations or stocks of the same species if apropos, should be established so that baseline data exists to guide and monitor all future activities. Although "gene banking" can be considered for conservation purposes, generally speaking it should be an action of last resort. Efforts should be concentrated on habitat and species maintenance to properly conserve rare or declining fishery resources.

Many of the larger fishes maintained at Dexter are extremely long lived so that the same brood fish are maintained and spawned year after year. Razorback sucker and bonytail chub are known to exceed 40 years of age and Colorado squawfish are suspected of reaching 80 or more years of age in the wild. One of the stocks of F1 Colorado squawfish brood produced from wild fish have been maintained in captivity for 18 years and are still highly productive. Therefore it is important that such fish being held in captivity are initially derived from a broad genetic base to ensure maximum genetic diversity can be carried forward through proper spawning schematics to succeeding F2 generations. For other, shorter lived species, it is important to periodically add new fish from the wild to the captive population in order to maintain genetic diversity since multiple generations are produced in captivity in just a few years. This can lead to loss of genetic diversity through inbreeding and result in genetic bottlenecking if permitted to continue unchecked.

All induced spawning is carefully planned from a genetic diversity standpoint so that reintroduced fish are genetically fit. Therefore, all species must be monitored on a routine basis to ensure that genetic diversity is maximized at every opportunity. When feasible, between 150 and 500 adult fish are maintained as a genetically diverse broodstock for production species.

Individual brood fish are marked with PIT (Passive Integrated Transponder) tags, a biologically inert, glass encapsulated microchip with a coil antenna (Dimensions: 12mm X 2.1mm). Pit tags are read with a scanner which "activates" the microchip and each individual tag transmits a separate 10 point alpha-numerical identification. With this ability to monitor and track individual fish, maximum genetic diversity can be planned into all spawning programs. Additionally, each brood fish can be tracked chronologically over time because an individual performance record can be maintained in a data base for the species.

CONCLUDING REMARKS

To all those responsible, I applaud and congratulate you for planning and organizing this seminar. I anticipate that it is but the first of many and am honored to be in your presence and participate with you in this important inaugural event. As scientists and conservationists, we share a unique concern for the varied natural resources which enhance our quality of life.

The number of species maintained at Dexter changes periodically depending upon need, and despite many successes, Dexter is not meant as a final solution to saving endangered fishes. The American "Endangered Species Act of 1973" also calls for the protection of the habitat on which listed species depend for their continued natural existence. The "Clean Water Act" has also played a significant role in maintenance of water quality in the U.S. The goal of the U.S. Fish and Wildlife Service is to coordinate development with the needs of all fish and wildlife, particularly imperiled species. Hindsight, it is said, is the best teacher. We can see the mistakes we have made in the past and, hopefully, learn from them and take corrective action in the future. So, although efforts at Dexter are highly important to the conservation of imperiled fish species in western America, we must continue to concentrate on even larger and more important issues that are the ultimate key to success in conserving our natural resources. These of course involve habitat protection through legislative mandates and conservation easements or direct purchase.

Will these sometimes seemingly feeble efforts, such as the Dexter NFH & TC operations, really make a difference, or can we measure the effectiveness of captive propagation and reintroduction as a means of maintaining or preserving biodiversity? Perhaps only time will reveal the final answer to this question, but those who follow us will rightfully ask, I am sure, what we as present day eco-stewards did to stem the loss of splendid biological diversity which we inherited. Therefore, those of us concerned with or responsible for these resources, either by choice, decree or both, must push forward steadfastly or we will undoubtedly continue to lose ground in this "battle against extinction" (Minckley and Deacon, eds. 1991). To pause is to fail and to do nothing should strike at the very foundation of our ecological conscience's. As we press forward in this effort, we must call upon, and develop where necessary, the best scientific knowledge available to achieve our objectives. With careful and intelligent planning, loss of our natural resources, including the elimination of species, need not be the price of modern progress.

I leave you with a couple of final thoughts common to American conversation on species conservation: 1) Extinction is forever! 2) Endangered means there's still time! I wish you success in your "battle against extinction", while you still have time.

TABLE 1 - SPECIES MAINTAINED AT DEXTER NFH & TC AND THEIR AREA OF OCCURRENCE

SPECIES	STATES OF OCCURRENCE									
	NM	AZ	UT	CO	TX	CA	NV	OR	CH	SO
Family Catostomidae										
Razorback sucker	?	X	X	X		X	X			
Lost River sucker						X		X		
Shortnose sucker						X		X		
Warner sucker						X		X		
Family Cyprinidae										
Colorado squawfish	X	*	X	X						
Bonytail chub		X	X	X						
Chihuahua chub	X								X	
Virgin River roundtail chub		X	X				X			
Pahranagat roundtail chub							X			
Woundfin		X	X				X			
Beautiful shiner	+								X	
Family Ictaluridae										
Yaqui catfish		X							X	X
Family Cyprinodontidae										
Desert pupfish		X				X				X
Leon Springs pupfish					X					
Family Poeciliidae										
Gila topminnow	*	X								
Big Bend gambusia					X					

USA States: NM = New Mexico, AZ = Arizona, UT = Utah, CO = Colorado, TX = Texas, CA = California, NV = Nevada, OR = Oregon

Mexican States: CH = Chihuahua, SO = Sonora

X = natural populations presently occur in these states
? = unknown, but probable occurrence
* = historic population(s) extinct; present population(s) reintroduced from Dexter stock
+ = historic population(s) extinct; reintroductions from Dexter stocks will occur in the next two or three years

TABLE 2 - LIST AND FEDERAL STATUS OF SPECIES MAINTAINED AT DEXTER NFH & TC

SPECIES	SCIENTIFIC NAME	FEDERAL STATUS *
FAMILY Catostomidae:		
Razorback sucker	Xyrachen texanus	E
Lost River sucker	Deltistes luxatus	E
Shortnose sucker	Chasmistes brevirostris	E
Warner sucker	Catostomus warnerensis	E
FAMILY Cyprinidae:		
Colorado squawfish	Ptychocheilus lucius	E
Bonytail chub	Gila elegans	E
Chihuahua chub	Gila nigrescens	T
Pahranagat roundtail chub	Gila robusta jordani	E
Virgin River roundtail chub	Gila robusta seminuda	E
Woundfin	Plagopterus argentissimus	E
Guzman beautiful shiner	Cyprinella f. formosa	T
FAMILY Ictaluridae:		
Yaqui catfish	Ictalurus pricei	T
FAMILY Cyprinodontidae:		
Leon Springs pupfish	Cyprinodon bovinus	E
Desert Pupfish	Cyprinodon macularius	E
FAMILY Poeciliidae:		
Gila topminnow	Poeciliopsis o. occidentalis	E
Big Bend gambusia	Gambusia gaigei	E

*E = Endangered
T = Threatened

ACKNOWLEDGEMENTS

Information presented herein represents the work of many individuals associated with Dexter NFH & TC during the past 14 years. Their many efforts are recognized as the basis for being able to present this paper and truly represents a team effort of dedicated individuals. Particular thanks go to Roger L. Hamman and Theophilus Inslee who played the major role in developing the spawning techniques described within this document. Their individual publications documenting this work in detail, which were unavailable to me during preparation of this manuscript while in India, are available from the Dexter facility upon request. Additionally I thank Troy Winham, Donald Hales, Sharon Coats, James Brooks, Caryl Williams, Phillipe Sosa, Joe Owens and James Lay for their positive attitudes, consistent help and friendship over the years which has made working at Dexter an extra special experience.

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APPENDIX II

NATIONAL SEMINAR ON ENDANGERED FISHES OF INDIA

25-26 APRIL 1992

ALLAHABAD, UTTAR PRADESH, INDIA

Sponsored by

NATIONAL BUREAU OF FISH GENETIC RESOURCES, ALLAHABAD
&
NATURE CONSERVATORS, MUZAFFARNAGAR

KEYNOTE SPEECH GIVEN AT INAUGURAL SESSION OF THE SEMINAR

by

BUDDY L. JENSEN, DIRECTOR
DEXTER NATIONAL FISH HATCHERY AND TECHNOLOGY CENTER
P.O. BOX 219
DEXTER, NEW MEXICO 88230 USA

25 APRIL 1992

The Honorable Sri Lenka, Professor Chopra, Dr. Dhadrai, Dr. Das, Professor Verma, fellow colleagues and scientists, ladies and gentlemen. In this setting I am reminded of a similar event that took place in Death Valley, California almost 25 years ago. The primary difference was that the Death Valley meeting consisted only of scientists and conservationists concerned about a dwindling desert resource of the American West - native desert fishes.

Government, in and of itself, was not involved in the beginning. It took this group of scientists, and the organization they eventually evolved into, The Desert Fishes Council, years of effort to finally prompt government involvement and recognition of the serious abuse of desert aquatic ecosystems of the American West. Today, in Allahabad, your government, the Indian Council of Agricultural Research, and some of it's top scientists and key personnel, grace this Inaugural Session with not only their presence, but with a clear vision of and commitment to the plight and needs of the endangered fishery resources of India.

Therefore, on this historic occasion, for all those responsible, I congratulate and applaud you for your efforts in organizing this seminar. It is an honor for me to be in your presence. As scientists and conservation biologists, we share a unique concern for the natural resources which enhance the quality of life for all our citizens. In America, it took 10 years, from 1968 until 1978, to start the program at Dexter NFH & TC. May I be so bold as to challenge you, not to let 10 years slip by. Let this seminar not only be the starting point, but also the catalyst that keeps your program moving forward - do not let bureaucracy grind your efforts to a halt.

I borrow directly or paraphrase in my following comments a few scattered remarks

by one of my American colleagues in his preface to the "Battle Against Extinction", a recently published book regarding the history and struggle of first a few, and finally many individuals, to save the unique desert fishes of western North America. For you now, organizing in an effort to find ways to protect your endangered fishery resources, I recommend it highly and consider it to be REQUIRED READING for anyone truly involved in fish conservation efforts anywhere in the world.

In dealing with endangered animals, it is unfortunate that we must deal at the level of individual species. This forces us to focus attention on single parts of ecosystems, while ecosystems themselves should be the subjects of our efforts. Endangered species are, none-the-less, the messengers of change, and we must heed their messages! To neglect them means we neglect the symptoms of an even greater environmental problem, because the subjects of this seminar are only but a part of the total natural system which supports the human species. As more and more parts fail, greater pressure is placed on the remaining portions of the ecosystem caught up in this massive and rapid change.

Americans, and Indians as well, are exploiters of the environment. This reminds me of the following statement of David Ehrenfeld (see my paper in proceedings of the seminar for literature reference):

> "Not all the winds and storms and earthquakes and seas and seasons of the world have done so much to revolutionize the earth as man has done since the day he came forth upon it and took dominion over it."

So, as the human species, we place great demands upon our environment. In

America, more than ever before, the public is demanding the conservation of natural resources. In response to these demands, Federal and States laws have been passed to achieve these goals. These are steps in the right direction, but the demand for both consumptive and non-consumptive use of the natural resources of the nation continues to increase. Therefore it is paramount and essential to success, that administrators and legislators and politicians, as well as scientists and conservationists, carry this battle forward, for we fight a "Battle Against Extinction." I close with two thoughts from the American conservation movement that you can ponder: Extinction is forever! Endangered means there's still time! I wish you success in your battle against extinction, while you still have time.

 APPENDIX

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DEXTER, NEW MEXICO

Fish and Wildlife Service

Endangered and Threatened Species Listing and Recovery Priority Guidelines

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice.

SUMMARY: The U.S. Fish and Wildlife Service has developed guidelines governing the assignment of priorities to species for listing as Endangered and Threatened under the Endangered Species Act of 1973, as amended (Act) and development and implementation of recovery plans for species that are listed under the Act. The guidelines aid in determining how to make the most appropriate use of resources available to implement the Act.

EFFECTIVE DATE: The guidelines are adopted as of September 21, 1983.

FOR FURTHER INFORMATION CONTACT: Mr. John L. Spinks, Jr., Chief, Office of Endangered Species, U.S. Fish and Wildlife Service, Washington, D.C. 20240, (703/235-2771).

SUPPLEMENTARY INFORMATION:

General

The Service recognizes that it is necessary to assign priorities to listing, delisting, reclassification, and recovery actions in order to make the most appropriate use of the limited resources available to implement the Act. The following priority systems are based on an analysis of such factors as degree and immediacy of threat faced by a species, needs for further information, and species' recovery potentials. Inasmuch as such assessments are subjective to some degree, and individual species may not be comparable in terms of all considerations, the priority systems presented must be viewed as guides and should not be looked upon as inflexible frameworks for determining resource allocations. Draft guidelines were published on April 19, 1983 (49 FR 16756). These final guidelines are based on that draft.

Summary of Comments and Recommendations

Comments were received from the following organizations: the Center for Environmental Education (also representing Defenders of Wildlife, Humane Society of the United States, and Natural Resources Defense Council); Chevron U.S.A., Inc.; The Ecological Society of America; Environmental Defense Fund; the law firm of McCarty, Noone and Williams (representing the Colorado River Water Conservation District); Pacific Legal Foundation; Western Timber Association; and Wildlife Legislative Fund of America. Three of the comments expressed general support for the guidelines as proposed, without offering any recommendations for change. Substantive recommendations are addressed below:

Comments on Listing, Delisting, and Reclassification Priorities

Because of the detailed and specific nature of comments on the listing portion of the guidelines, they are addressed individually. The Center for Environmental Education *et al.* (CEE) recommended that the Service emphasize listing of qualified species over delisting of species no longer in need of protection, and also stated that delisting should be undertaken only for species with no present need for protection and unlikely to need such protection in the future. The Service agrees in principal with this comment. It should be recognized, however, that the retention of recovered or extinct species on the lists undermines the overall credibility of the lists, and the Service believes that it is justifiable to devote resources to the removal of such species when they are identified.

CEE also expressed concern that consideration of degree and immediacy of threat be tempered by a consideration of benefit from listing and availability of information. They favored subsuming immediacy within degree of threat and adding the other two considerations as "pragmatic" criteria in the system. The Service continues to believe that separate consideration of immediacy is warranted in order to help ensure that the system is most effective in

53

forestalling imminent extinctions. Although, as noted by CEE, this may result in listing resources being devoted to species whose recovery would be difficult and costly, such considerations are addressed in the recovery priority system, where recovery potential is expressly considered. Inasmuch as listing is an identification process, it appears to be most appropriate to proceed on a "worst-first" basis and list those species in greatest immediate danger of extinction first. Inclusion of a "benefit from listing" criterion would not, in the opinion of the Service, improve the priority system. The Service believes that all listed species derive some benefit from their identification as Endangered or Threatened. The magnitude of such benefits, however, are often largely unpredictable at the time of listing and would be difficult to quantify within the framework of a simple, workable priority system. The Service also rejects the inclusion of an "availability of information" criterion in the priority system because this seems unnecessary. Availability of information adequate to determine a species' status is necessary before any assessment of the appropriateness of listing can be addressed. To this extent, availability of information is implicit in any priority system that might be adopted, and its statement as an explicit criterion adds little, if anything, to the effectiveness of the system. CEE also expresses concern that, if information were to become available on a group of species in a particular area indicating that some were eligible for listing as Endangered and others as Threatened, the proposed system might preclude listing of all the eligible species in the area. The Service believes that it retains sufficient flexibility under the proposed system to proceed with listings of all the appropriate species in such a situation when this would increase the overall efficiency of the listing process by avoiding duplicative regulations. It should be recognized that the setting of listing priorities is an intermittent, rather than continuous, activity, and that information developed on a species believed to have a high priority may indicate that a lower priority is justified, but that this situation would not necessarily preclude its being listed while the status information was available and current. CEE further takes issue with the proposed system's "taxonomy" criterion, stating:

It may be true that certain monotypic genera of plants such as the three redwoods that dominate particular ecosystems make an important and irreplaceable contribution to maintenance of the diversity of those ecosystems, but it doesn't follow that subspecies of coyote bush are any more interchangeable or less important in chaparral ecosystems. An ecological preference for preserving monotypic genera of animals makes even less sense. It appears that the California condor, a monotypic genus, may have less ecosystem impact that any of several butterfly subspecies.

The Service believes that the CEE comment confounds two different concepts. Taxonomy is included in the proposed system as a crude reflection of genetic distinctness in an attempt to provide for the preservation of maximum genetic diversity in ecosystems. Genetic distinctness of a taxon, however, may have little bearing on the importance of the taxon's impact on the functioning of the ecosystem to which it belongs. Judging a taxon's functional contribution to its ecosystem is generally much more difficult and does not lend itself to the framework of a simple priority system. The Service recognizes that there are aspects of species' biology, such as this one, that are not appropriately incorporated within the listing priority system, and it is for this reason that the system is not designed to be used in a rigid fashion. The Service has attempted to use the system flexibly so that important biological considerations that fall outside the scope of consideration of the system can figure into particular decisions on an *ad hoc* basis.

The CEE comment further disputes the appropriateness of giving consideration to monotypic genera in setting listing priorities, citing the large number of monotypic genera of hummingbirds and the apparent lack of accompanying genetic diversity in the group. The Service recognizes that the consideration given monotypic genera is only an approximate measure of genetic distinctness and that taxonomic concepts and standards vary among different groups of organisms. Nevertheless, if used with proper understanding of this lack of taxonomic uniformity, the criterion appears to be useful and is retained in the priority system. In practical terms, the Service expects to only rarely have need for the priority categories reflecting monotypic genera, because there are relatively few such taxa among the candidate species now recognized, but believes that such taxa generally reflect a level of genetic distinctiveness worth noting in the system. It should also be recognized that the system only sets *relative* priorities and that this is the lowest order of priority-setting, so that a species would at most move up one level in priority by virtue of its representing a monotypic genus, and species not representing monotypic genera would only rank below monotypic genera facing equally serious and immediate threats.

Finally, the CEE comment cites the 1982 Senate Committee Report on amendments to the Endangered Species Act and its stated preference only for listing species before subspecies and subspecies before populations as justification for deleting consideration for monotypic genera. CEE notes that the importance attached to monotypic genera in the proposed system appears to imply a value of species not provided for in Section 2 of the Act, which refers to "esthetic, ecological, educational, historical, recreational, and scientific" values of species. The Service believes that the Act's provision that species are of educational and scientific value more than adequately justifies the modest consideration proposed to be given monotypic genera, which may represent highly distinct gene-pools deserving of continuing scientific and educational attention.

The Ecological Society of America (ESA) expressed general support for the proposed system, but made several recommendations for changes. ESA recommended that greater emphasis be placed on listing candidate species than on delisting species no longer in need of protection, noting that the possibility of removing a species from the list is always open, whereas extinction may foreclose the option of listing some species. The Service agrees in principal with this comment, as explained below in response to a similar comment from the Environmental Defense Fund.

ESA also observed that the average number of species per genus is generally lower among higher organisms, e.g., mammals and birds, than among various invertebrate groups and plants, because of differing taxonomic concepts and standards. They expressed concern that the consideration afforded monotypic genera in the proposed system could thus work to favor vertebrate species, as in the former system that was expressly rejected by Congress. The Service believes that the benefit of affording consideration to taxonomic distinctness, if the consideration is applied flexibly and with due appreciation of differing taxonomic standards, outweighs any bias that might be introduced into the priority-setting process.

In a related observation, ESA pointed out that there are highly distinct organisms that are nevertheless not placed in monotypic genera, and that the taxonomic criteria contained in the system are inflexible. The Service, as has been pointed out previously, does not view any facet of the system as inflexible, and will reserve the

-54

discretion to assign appropriate priorities to highly distinct and genetically isolated organisms whether or not they constitute monotypic genera.

Finally, ESA requested a clarification of the applicability of the proposed system to unnamed populations. The Act includes populations of vertebrate animals in its definition of "species." Because this portion of the definition applies only to vertebrates, it appears inadvisable to incorporate it formally into the priority system. The Service intends to generally afford vertebrate populations the same consideration as subspecies, but when a candidate subspecies and a candidate population have the same numerical priority, the candidate subspecies will generally have priority.

The Environmental Defense Fund (EDF) expressed concern that too much time might be devoted to setting of species priorities, and that this might detract from actual implementing of listing tasks. The Service agrees that no more time than is necessary should be devoted to the assigning of priorities. Because of this consideration, the Service has deliberately attempted to formulate a system that is simple and that assigns species priorities in a straightforward manner without the need for complex analysis. EDF also expressed concern over the interrelationship of the three systems contained in Tables 1., 2., and 3. As explained below in the summary of comments on the recovery priority system, Tables 1. and 2. are largely independent of Table 3. Further, it is not possible, in the opinion of the Service, to formulate a direct relationship between the systems in Tables 1. and 2. As is explained in the narrative portion of the guidelines, it is anticipated that the need to delist species or reclassify them from Endangered to Threatened will be identified largely through mandated 5-year reviews or through petitions. Once such actions have been identified and assigned priorities, they will be considered for possible action within the Service's annual planning process.

Establishing specific criteria for ranking the priorities of listing proposals versus delisting proposals would take away the flexibility needed by the Service to efficiently apportion its resources. Although the same statutory criteria apply to make the listing and delisting determinations, the factual considerations for setting listing and delisting priorities are quite different. General rules cannot govern this complex mesh of priorities. However, it would generally be found that candidate species facing immediate, critical threats should have priority for listing over competing delisting proposals under consideration at the time. Likewise, a delisting proposal for a recovered species that would eliminate unwarranted restrictions on significant, identifiable activities may, in appropriate instances, take precedence over listing proposals for species not facing severe, imminent threats. In deciding on which proposals will receive priority, the Service must examine the overall "mix" of potential listings and delisting and assess the relative priorities of the various proposals in light of that "mix." Of course, this assessment process will constantly change as new candidate species are brought to the Service's attention and as listed species attain recovery or become extinct.

EDF also recommended that terms used in the proposed system be more precisely defined and, in particular, recommended that the "degree of threat" criterion be quantified in a way that parallels the standards for finding "jeopardy" under Section 7 of the Act. The Service believes that the circumstances applying to most species are individualistic enough as to be incapable of precise definition or quantification beyond the level proposed. In particular, with regard to determinations of degree of threat, the parallel with considerations under Section 7 of the Act seems faulty. Consultations under Section 7 address known and carefully identified actions that may affect the survival of a species. Degree-of-threat considerations for listing a species may address highly speculative future actions, or more frequently, documented decline of a species for poorly-known or unknown reasons. Such considerations often cannot be quantified, and an attempt to do so might only serve to make priority-setting, rather than listing, the main activity of the program, as feared by EDF (see above). The Service believes that it has access to sufficient biological expertise to permit the admittedly loose definitions of terms to be interpreted appropriately.

EDF also recommended that "degree" be replaced by "magnitude" under "threat." The Service agrees that the latter term is somewhat more precise, and has altered the final guidelines accordingly.

EDF expressed concern that the "immediacy" criterion for threat not be applied so rigidly that Endangered species would always be listed in preference to Threatened species, which might be more recoverable. In general, the Service intends that species judged Endangered should be listed before those judged Threatened. Once again, it is worth noting that listing is an identification process and, other considerations being equal, should proceed on a "worst-first" basis. Nevertheless, the Service intends that species originally judged to be faced with immediate threats, but which prove not to face such immediate threats when sufficiently complete status information is developed, may be listed nevertheless in order that current status information need not be gathered again later on.

EDF supported the concept of immediacy of threat as a useful addition to the priority system but observed that:

> Specifically, we are concerned that the immediacy of threat criterion may ultimately rely on and be distinguished by the availability of scientific information about such threats. Because such threats are not well-known, however, a dearth of information may preclude necessary and expeditious action by the Service. We therefore suggest that the immediacy of threat criterion should be defined and delimited by what are necessarily somewhat subjective best judgments about the expected temporal sequence and realization of a threat; not just the known or unknown occurrence of such threats. We believe the Service recognizes this in its attempt to distinguish two categories ("actual identifiable" versus "potential, intrinsically vulnerable") but falls short in that effort by distinguishing "latent" from "potential" by the presence or absence of information available about such threats (e.g., "known occurrence or lack of * * *."). Hence, to the maximum extent possible, judgments about the immediacy of threat should be guided by how quickly the threat posed by any one of the five statutory factors may affect those populations of a candidate species at risk.

The Service believes that such a recommendation, if adopted, would render the system unworkable. It could make priorities responsive to highly speculative but rapidly-realized threats such as earthquake or volcanic eruption. The Service prefers in setting priorities to rely on known or reasonably predictable threats to a species' survival and known vulnerability to reasonably probable future conditions.

Because they believe that all threats are by definition potential, EDF recommends that "potential" be replaced by "non-imminent" in the system. Insomuch as a threat in this context is one of extinction, and is only realized when a species is extinct, this is a point well taken by the Service. The final system is altered accordingly.

EDF also recommended that an "ecosystem" criterion be incorporated into the system, similar to the "conflict" criterion in Table 3. This would be intended to identify species of ecologic

55

importance and to accommodate the provision of the Senate Environmental and Public Works Committee's report on the 1982 amendments to the Act:

> Biologically it makes sense to treat all taxonomic groups equally or even to place some special emphasis on protecting plants and invertebrates since they form the bases of ecosystems and food chains upon which all other life depends.

S. Rep. No. 419, 97th Cong., 2d Sess. 14 (1982).

The Service fully appreciates the importance of species that are ecologically significant, and intends to give this importance due consideration in determining listing goals, but does not consider this an appropriate element in the listing priority system. This kind of information is seldom available at the time a species is considered for listing and, if included, would only raise it in priority above species that were equal in all other respects under the system. In addition, the Service believes that all species are of some importance to ecosystems, so that a simple "yes-or-no" decision would rarely be possible. Thus, it appears most reasonable to consider "ecosystem importance" on an *ad hoc* basis outside the formal priority system, when such importance is identifiable. EDF also requests clarification of the consideration to be given vertebrate populations under the priority system. As explained above in reply to a similar enquiry from ESA, the Service intends that vertebrate populations generally be accorded the same consideration as that given subspecies.

Finally, EDF suggests that species may be identified for delisting or reclassification from Endangered to Threatened by virtue of their having met objectives for such action in recovery plans. The Service certainly intends to consider identified recovery goals in planning delistings or reclassifications, but will assign priority for such actions according to the criteria in Table 2.

The Pacific Legal Foundation (PLF) supported development of priority guidelines, expressing the opinion that the Endangered Species Act " * * * has been misused by some as a vehicle by which major construction projects and reasonable development of our natural resources have been delayed or stopped." The Service agrees that guidelines are desirable as a method of helping to ensure appropriate use of resources. The Service has always attempted to proceed on the basis of the best scientific knowledge available in implementing the Act, whether through the listing or recovery of Endangered and Threatened species. PLF also recommends that all listing, delisting, or reclassification actions be undertaken in strict compliance with the guidelines and that, for every species that is listed, reclassified, or delisted, a discussion of each of the criteria in the relevant priority system table should be supplied. The Service, as has been mentioned above, does not view the priority systems as dictating actions so much as providing flexible guides in making rational decisions. In this light, it is counterproductive to explain how each action fits the priority system so long as species subject to the actions qualify under the conditions of the Act.

PLF also expressed the opinion that is redundant to consider both "degree" and "immediacy" of threat. As has been explained above, the Service continues to believe that the distinction is a useful one.

Finally, PLF requested a clarification to indicate that, " * * * no protection is afforded individual gene pools below the taxonomical level of subspecies." The Service notes that, in the case of vertebrate animals the Act specifically provides for the listing of populations. The recommendation of PLF in this instance would thus contradict the Act. As explained above, the Service intends to generally assign vertebrate populations the same priority of consideration as that afforded subspecies.

Comments on recovery priorities. Several of the comments on the recovery priority system are conveniently categorized and addressed topically below:

1. *Taxonomy.* Some concern (two comments) was expressed concerning the use of taxonomic uniqueness as a criterion for determining recovery priority. This issue has been addressed in the above section for listing priority.

In one comment, it was recommended that a better measure than taxonomy would be the species' ecological significance. For this purpose, a species with "high" ecological significance would be one for which recovery measures would likely benefit the conservation of the listed or candidate species as well. It was recommended that Ecological Significance should substitute for Taxonomy in Table 3.

To the extent possible, the Service has adhered to this philosophy of considering ecosystems in its recovery plans. This is evident by the following recovery plans (includes both draft and approved plans) which utilize an ecosystem or multi-species approach: Antioch Dunes (three species), Eureka Valley Dunes (two species), Hawaiian Forest Birds (four species), Hawaiian Sea Birds (four species), Hawaiian Water Birds (three species), Kauai Forest Birds (six species), San Bruno Mountain (two species), San Clemente Island (seven species), NW Hawaiian Islands Passerine Birds (three species), and the San Marcos River Endangered and Threatened species (four species), (technical review draft stage).

Because ecosystems are already considered and it is difficult to quantify "Ecosystem Significance," the Service elects not to substitute Ecosystem Significance for Taxonomy in Table 3.

2. *Recovery potential and associated costs of recovery.* Two comments expressed concerns about the recovery potential of a species and an efficient investment of resources. The Service is in agreement with the concerns expressed and will expand the narrative of the guidelines to accommodate this concern. Priority will be given to those species and projects that offer the greatest potential for success. The recovery potential of a species will be determined by consideration of the following criteria:

	High recovery potential	Low recovery potential
Biological and ecological limiting factors.	Well understood	Poorly understood.
Threats to species survival.	Well understood easily alleviated	Poorly understood or pervasive and difficult to alleviate.
Management needed [1]	Intensive management not needed, or techniques well documented with high probability of success.	Intensive management with uncertain probability of success, or techniques unknown or still experimental.

[1] When possible and biologically feasible, data pertinent to the recovery of a particular taxon will be extrapolated from known ecological requirements or management techniques for closely related taxa.

Regardless of this recovery potential, the Service will strive to undertake for every high threat species those minimum survival efforts which will at least stabilize its status and prevent its extinction. Once such "emergency" measures have been taken, further recovery work designed to eventually lead to delisting of the species will be evaluated according to the recovery potential described above.

Several specific comments are addressed below:

Chevron expressed a desire to have greater public involvement in the preparation of recovery plans. This has been done to a limited degree in the past for those plans where a conflict, or

56

potential conflict, has been known to exist, e.g., Northern Rocky Mountain wolf, San Bruno Mountain, San Marcos River Endangered and Threatened species, and the small whorled pogonia. The Service will continue to invite public participation for those species where conflicts or controversies are known to exist.

PLF stated that it is unclear (in Table 3) if there is any differing treatment between Endangered and Threatened species. The distinction between Endangered and Threatened species occurs in the Degree of Threat criterion. It is generally understood that the Degree of Threat is greater for Endangered species than for Threatened species.

PLF also suggested that an additional column be added to Table 3 that would give greater priority in the preparation of recovery plans to those species which are Endangered throughout all their range over those species that are Endangered throughout a portion of their range. Although it is not specifically stated, this concern is reflected in the first criterion (Degree of Threat) of Table 3. A species which is Endangered throughout its range would be listed higher on the degree of threat scale than would be a species Endangered throughout a portion of its range. In reality, most species which are listed are Endangered throughout their ranges. Even though it is legally acceptable to list populations of vertebrates, this practice represents the exception rather than the rule.

ESA recommended that for listing and recovery efforts, populations and named subspecies should have the same priority, since the possession of a name is often based more on tradition than on any meaningful measure of distinctiveness. This issue is addressed in the above Listing Section. In addition, the above reply to a comment from PLF indicates that priority be given to species which are Endangered throughout all their range rather than just to a population. Populations will be addressed when there is sufficient justification, but this is the exception rather than the rule.

EDF expressed the hope that the Service will devote most of its resources to implementing listing and recovery planning efforts and not to prioritizing such tasks. The listing portion of this concern is addressed in the earlier section of this article. The Service is mandated by the Endangered Species Act, as amended, to the preparation of recovery plans giving priority to those species most likely to benefit from such plans. In doing so, the Service will also focus on those species that are, or may be, in conflict with construction or other development projects or other forms of economic activity. The proposed guidelines are intended to provide a means to identify, and rank, those species most likely to benefit from such plans. It is also necessary that the limited resources for the implementing of recovery actions be allocated in the most judicious fashion possible. This can only be possible by having a sound system for ranking proposed recovery actions.

EDF commented that it remains unclear specifically how the three priority models (Tables 1, 2, and 3) relate to one another. Table 3, Recovery Priority, is independent of Tables 1 and 2. It is to be expected that many species would have a similar ranking when evaluated by Tables 1 and 3. However, differences between species, or recovery potential could reduce these similarities of ranking. This concern is also addressed under listing comments, above.

EDF also found the tasks priority—recovery priority system somewhat confusing. They agreed that the Service's limited resources should be distributed equitably to all listed species, but were not sure specifically how this will be accomplished. They requested clarification of this situation. They commented that, "presumably recovery plans for species facing the highest degree of threat will designate more priority 1 tasks than those plans for species jeopardized by a lower degree of threat."

Generally, plans for species facing the highest degree of threat will designate more Priority 1 tasks than those plans for species jeopardized by a lower degree of threat. However, exceptions may occur. For example, a highly-Threatened isolated desert fish may be in imminent danger from siltation associated with adjacent cattle grazing. Possibly only one task, i.e., fencing, would warrant a Priority 1 designation.

Furthermore, as indicated in the earlier summary of comments on recovery potential and associated costs regardless of the recovery potential, the Service will strive to undertake for every high-threat species those minimum survival efforts which will at least stabilize its status and prevent its extinction. Once such "emergency" measures have been taken, further recovery work designed to eventually lead to delisting of species will be evaluated according to the recovery potential described above. To ensure consistency in the utilization of the recovery priority system, all draft recovery plans will be reviewed by the same office at the Washington level. Additionally, all funding proposals for implementation of recovery actions will also be reviewed by the same office at the Washington level.

Priority Guidelines

Listing, Delisting, and Reclassification Priorities. In the past, the Service has informally assigned priorities for listing species as Endangered or Threatened on the basis of several different systems. In 1979, a report to Congress (General Accounting Office, 1979) recommended that the Service officially adopt a listing priority system based primarily on consideration of the degree of threat faced by a species. Following this report, the 1979 Amendments to the Endangered Species Act (Pub. L. 96-159, 93 Stat. 1241) required that guidelines be established and published in the Federal Register, including "* * * a ranking system to assist in the identification of species that should receive priority review for listing * * *." Such a system was adopted (U.S. Fish and Wildlife Service, 1980), but not published in the Federal Register. This system was subsequently revised (U.S. Fish and Wildlife Service, 1981) so that priority for listing would be assigned within a given category of Degree of threat so as to generally favor vertebrate animals ("higher life forms") in the following order: mammals, birds, fishes, reptiles, amphibians, vascular plants, invertebrates.

The 1982 Amendments to the Endangered Species Act (Pub. L. 97-304) retained the requirement that guidelines be published. However, the amendments and the accompanying Conference Report necessitated revision of the 1981 system. Specifically, the amended Act requires that the priority system address delisting as well as listing of species and the Conference Report stated opposition to the adoption of any system that would give consideration to whether species were "higher or lower life forms." The present system is intended to satisfy the requirements of the amended Act.

1. *Listing and reclassification from Threatened to Endangered.* In considering species to be listed or reclassified from Threatened to Endangered, three criteria would be applied to establish 12 priority categories as follows (Table 1):

TABLE 1.—PRIORITIES FOR LISTING OR RECLASSIFICATION FROM THREATENED TO ENDANGERED

Threat		Taxonomy	Priority
Magnitude	Immediacy		
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies	6
Moderate to low.	Imminent	Monotypic genus	7
		Species	8
		Subspecies	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies	12

Explanation. In keeping with the recommendation of the General Accounting Office (GAO) and the Service's previous policy, the first criterion would be magnitude of threat. Species facing the greatest threats to their continued existence would receive highest listing priority.

The second criterion, immediacy of threat, is intended to assure that species facing actual, identifiable, threats are given priority over those for which threats are only potential or that are intrinsically vulnerable to certain types of threat but not known to be presently facing such threats. In assigning a species to a priority category under immediacy of threat, the Service would consider the known occurance or lack of documented detrimental trade or harvest, habitat modification, significantly detrimental disease or predation, and other present or potential threats.

The third criterion is intended to devote resources on a priority basis to those species representing highly distinctive or isolated gene pools, as reflected by the taxonomic level at which they are recognized. The more isolated or distinctive a gene pool, the greater contribution its conservation is likely to make to the maintenance of ecosystem diversity. This final criterion implements the Act's stated concern for ecosystem conservation by recognizing the distinctness denoted by assignment of a species to a monotypic genus, as well as the relative distinctness denoted by the recognition of a taxon at the level of species or subspecies.

2. *Delisting and Reclassification from Endangered to Threatened*—The Service currently reviews listed species every 5 years in accordance with Section 4(c)(2) of the Act to identify any that might qualify for removal from the lists, or reclassification. When species are identified in the curse of these periodic reviews as warranting deletion from the lists or reclassification from Endangered to Threatened, priority for preparation of regulations would be assigned according to the system below (Table 2), employing two criteria to yield six categories. It should be pointed out that the priority numbers in Table 1 and 2 are not comparable.

TABLE 2.—PRIORITIES FOR DELISTING AND RECLASSIFICATION FROM ENDANGERED TO THREATENED

Management impact	Petition status	Priority
High	Petitioned action	1
	Unpetitioned action	2
Moderate	Petitioned action	3
	Unpetitioned action	4
Low	Petitioned action	5
	Unpetitioned action	6

Explanation. In considering species for possible delisting or reclassification from Endangered to Threatened, this system is intended to focus on species whose original classification has become inappropriate due to changed circumstances or new information. Priority considerations would concern whether or not maximum protection under the Act is necessary any longer and whether the listing causes an unwarranted management burden or unnecessarily restricts human activities.

The first consideration of the system accounts for the management burden entailed by the species' being listed, which, if the current listing is no longer accurate, could divert resources from species more deserving of conservation efforts.

Because the Act mandates timely response to petitions, the system secondly considers whether the Service has been petitioned to remove a species from either of the lists or to reclassify it from Endangered to Threatened. This consideration is also intended to assign highest priority to those species whose delisting is likely to remove the greatest impacts on human activities inasmuch as such species would also be likely to be subjects of petitions.

It is not intended that existence of a petition or identified management impact with regard to a given species would automatically direct or mandate any particular decision regarding its removal from the lists or its reclassification. The priority system is intended only to set priorities for the development of rules for species that no longer satisfy the listing criteria for their particular designation under the Act. The decision regarding whether a species will be retained on the lists or in the Endangered category must still be based on the considerations contained in Section 4(a)(1) of the Act and 50 CFR 424.11.

Recovery Plan Preparation and Implementation Priorities. The importance of recovery plans as guiding documents for recovering species has been recognized since 1972, when the Service developed its first draft recovery plan. Although the Service strongly encouraged their development, and some plans were developed, preparing a recovery plan for a species was elective until the 1978 Amendments to the Act required the development of a recovery plan for every listed Endangered and Threatened species, except when the Secretary determines that "* * * such a plan will not promote the conservation of the species."

Through fiscal year 1977, recovery plan development was not based on any established priority system. During fiscal year 1977, the Service developed a draft recovery priority system to be used as a guide for recovery planning and resource allocation. The system included three criteria—degree of threat, recovery potential, and taxonomic status, arranged in a matrix of 12 categories. The 1979 GAO report recommended that this draft recovery priority system be approved and implemented.

The present system expands the taxonomy criterion to include "monotypic genus." This would expand the matrix to yield 18 species recovery numbers (see Table 3). As described in the preceding section on listing, this addition is intended to devote resources on a priority basis to these species representing highly distinctive or isolated gene pools.

The previous system (as referenced in the 1979 GAO report) was adopted in 1980 (U.S. Fish and Wildlife Service, 1980). This system was subsequently revised to give priority within the existing matrix to taxonomic groups (higher life forms) as in the 1981 listing priority system. The system presently adopted deletes this preference for higher life forms and adds a new criterion on conflict required by the 1982 Amendments.

In particular, the 1982 Amendments specify that recovery plans shall, to the maximum extent practicable, give priority to those Endangered species or Threatened species most likely to benefit from such plans, particularly those species that are, or may be, in conflict with construction or other development projects or other forms of economic activity. The present system is intended to satisfy the requirements of the amended Act. It utilizes a modification of the three-factor system originally adopted by the FWS in 1980 but includes a fourth factor, conflict,

which, if applicable, elevates the species in priority for development of a recovery plan and is to be an additional element in determining what actions are to be implemented for the recovery of a species. This fourth factor gives priority within each category in the preparation of recovery plans to those species that are, or may be, in conflict with construction or other development projects or other forms of economic activity. Thus, the species will retain its numerical rank and will acquire the letter designation of "C" indicating conflict, e.g., priority 7 would become 7C. The categories would be assigned as follows:

TABLE 3.—RECOVERY PRIORITY

Degree of threat and recovery potential	Taxonomy	Priority	Conflict
High.			
High	Monotypic genus	1	1C, 1.
High	Species	2	2C, 2
High	Subspecies	3	3C, 3
Low	Monotypic genus	4	4C, 4
Low	Species	5	5C, 5
Low	Subspecies	6	6C, 6.
Moderate			
High	Monotypic genus	7	7C, 7.
High	Species	8	8C, 8
High	Subspecies	9	9C, 9.
Low	Monotypic genus	10	10C, 10.
Low	Species	11	11C, 11.
Low	Subspecies	12	12C, 12.
Low			
High	Monotypic genus	13	13C, 13
High	Species	14	14C, 14.
High	Subspecies	15	15C, 15.
Low	Monotypic genus	16	16C, 16
Low	Species	17	17C, 17.
Low	Subspecies	18	18C, 18

Explanation. The first step for the conservation of any species is to prevent its extinction. Thus the species with the highest degree of threat have the highest priority for preparing and implementing recovery plans. A species can be put in either a high, moderate, or low category, which represents the degree of threat. The high category means extinction is almost certain in the immediate future because of a rapid population decline or habitat destruction. Moderate means the species will not face extinction if recovery is temporarily held off, although there is continual population decline or threat to its habitat. A species in the low category is rare, or is facing a population decline which may be a short-term, self-correcting fluctuation, or the impacts of threats of the species' habitat are not fully known.

Within the above categories, resources should be used in the most cost-effective manner. Priority for preparing and implementing recovery plans would go to species with the greatest potential for success. Recovery potential is based on how well biological and ecological limiting factors and threats to the species' existence are understood, and how much management is needed.

Priority will be given to those species and projects that offer the greatest potential for success. The recovery potential of a species will be determined by consideration of the following criteria:

	High recovery potential	Low recovery potential
Biological and ecological limiting factors.	Well understood	Poorly understood.
Threats to species' existence.	Well understood easily alleviated	Poorly understood or pervasive and difficult to alleviate.
Management needed [1].	Intensive management not needed, or techniques well documented with high probability of success.	Intensive management with uncertain probability of success, or techniques unknown or still experimental.

[1] When positive and biologically feasible data pertinent to the recovery of a particular taxon will be extrapolated from known ecological requirements or management techniques for closely related taxa.

Taxa that are most genetically distinct should receive priority within any given category of degree of threat. Monotypic genera will be given priority over species, subspecies, or populations. This last criterion is in recognition that the loss of the most genetically distinct taxa is of greater significance than the loss of less genetically distinct taxa. That is, for example, the loss of a full genus is of greater significance than the loss of a single species or population of that species.

The second requirement concerning recovery plans mandated by the 1982 Amendments is that priority be given to those species "that are, or may be, in conflict with construction or other development projects or other forms of economic activity." This requirement will be satisfied by having any listed species or subspecies, lacking a recovery plan, and identified as being, or having a recognizable potential for being, in conflict with a construction or development project, automatically qualify for the conflict column of the matrix. This species would then be considered high priority for having a recovery plan developed.

Conflict with construction or other development projects would be identified in large part by consultations conducted with Federal agencies under Section 7 of the Act. Any species identified through Section 7 consultations as having generated a negative biological opinion which concluded that a given proposed project would violate Section 7(a)(2) of the Endangered Species Act or resulted in the recommendation of reasonable and prudent alternatives to avoid a negative biological opinion, would be assigned to the conflict category and would be given priority over all other candidates for recovery plan preparation and implementation in the same numerical category not involving a conflict. The Service would also contact other Federal agencies for their identification of listed species that are, or may be, in conflict with construction or other development projects or other forms of economic activity. Any species identified by this process would be assigned to the conflict category and would also be given priority over other candidates for recovery plan preparation and implementation within the same numerical category (see Table 3) not involving a conflict.

A task priority (1–3) is used in conjunction with species recovery numbers (1–18 or 1C–18C) in ranking those tasks that need to be accomplished for the recovery of a species. This combination results in a two-tiered priority system (species recovery number-task priority number) which serves to distribute the resources of the program equitably for all listed species. Recovery tasks will be assigned priorities based on the following:

1. *Priority 1.* An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

2. *Priority 2.* An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

3. *Priority 3.* All other actions necessary to provide for full recovery of the species. (Recognizing that the ultimate success of the Program is species recovery, priority 3 action likely to lead to full recovery and delisting of a species in the foreseeable future will tend to rank higher than other priority 3 actions.)

The highest priority activity (research proposal, permit proposal, etc.) is a 1C–1 priority (species recovery number 1C; task priority number 1).

This is an action necessary to prevent extinction for a monotypic genus, with a high recovery potential, under a high degree of threat and in conflict with a construction or other development project. If resources were channeled into activities based solely on the recovery priority of a species, these resources would be utilized primarily for species with a recovery priority of 1C to 6. However, when the species' priority is viewed in conjunction with the task priority, we are able to identify the most critical activities for all species. This system would insure that resources are

59

distributed to the most critically Endangered species and would recognize those species approaching recovered status.

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Authors

This notice was prepared by Dr. John J. Fay and Mr. W. L. Thomas of the Office of Endangered Species, U.S. Fish and Wildlife Service, Washington, D.C. 20240.

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J. Craig Potter

Acting Assistant Secretary for Fish and Wildlife and Park/Data.

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60

NARRATIVE

The woundfin should be considered reasonably safe from extinction (i.e., downlist to threatened) if the existing and marginal habitats in the Virgin River are upgraded and stabilized, present populations are maintained, and one other population established in a different drainage within the probable historic range. To delist the woundfin, a third self-sustaining population must be established in a separate drainage within the historic range. For these transplanted populations to be considered self-sustaining, the populations should number over 100,000 adults and exist in the habitat for at least 10 years. For introduction sites stocked under the essential experimental population designation, successful reproduction and recruitment dependant upon the carrying capacity of each site will determine the presence of a self-sustaining population. The number 100,000 was chosen to provide a specific goal. It indicates the stocked fish have greatly expanded their numbers in new habitat and have found a suitable niche. This number compares favorably to the minimum estimate of woundfin in the Virgin River. In addition, both the Virgin River habitat and the habitat of the transplanted population will have to be free from threats associated with physical, chemical, or biological modification that might make the habitat unsuitable for woundfin.

In order to accomplish the primary objective, the following recovery effort is being proposed.

1.0 Maintain and enhance existing woundfin populations and their habitats in the Virgin River.

Presently the only viable woundfin population is in the Virgin River. The Recovery Team recommends that the first order of business in the recovery effort should be to protect and maintain this existing population and its habitats. It appears that the Virgin River population is in no immediate jeopardy providing the remaining habitats are not further degraded. The population, however, could be enhanced by rehabilitation of portions of the Virgin River that provide marginal habitat.

1.1 Monitor existing populations.

Population monitoring provides a means of assessing the well-being of a species and obtaining information on the success of management techniques. Little is known about historic woundfin population fluctuations in the Virgin River, and a data base is essential to further management attempts. Monitoring is now ongoing.

1.11 Establish monitoring procedures and schedules.

The monitoring procedure is contained in the Appendix along with a list of sampling station locations presently being monitored.

1.12 Recommend monitoring personnel.

An agreement has been reached between the U.S. Fish and Wildlife Service and the States involved to contract monitoring activities to an outside firm. Presently, Dr. James Deacon is under contract to the U.S. Fish and Wildlife Service for this activity, and is being assisted by the Recovery Team. Annual reports of these activities are available.

1.2 Monitor woundfin habitats.

Because certain habitat conditions in the Virgin River are essential to the well-being of woundfin, changes which may occur in the habitat may affect woundfin populations. To evaluate changes in habitat and correlate these changes with woundfin numbers, trend data for habitat must be gathered. This information will be important in maintaining and enhancing existing woundfin populations.

1.21 Establish monitoring procedures and schedules.

Because of the inherent difficulty in monitoring habitat change we are not presently able to initiate this program. Studies are needed to develop monitoring procedures and recommend monitoring schedules. Information collection under segments 1.32 and 1.41 will aid in this effort.

1.22 Recommend monitoring personnel.

Monitoring personnel recommendations will be made when monitoring procedures and schedules are developed.

1.23 Implement monitoring.

Monitoring personnel will monitor according to procedures and schedules established in 1.21.

1.3 Identify existing self-sustaining population requirements.

Important data have been collected as a result of ongoing population monitoring work; however, additional studies are required to obtain information essential to woundfin population management and enhancement.

-62'

1.31 Synthesize existing data on woundfin.

A substantial amount of information relating to woundfin has been collected. Presently, this information is contained in numerous published and unpublished reports and data files. Summarizing these data into a single report would aid biologists in understanding what information is available, help in planning future directions, and possibly precipitate additional analysis and interpretation of existing data.

1.32 Identify and describe preferred woundfin habitat.

We presently have some information on preferred spawning and rearing habitats but lack data on habitat use during winter. Specific studies should be designed to identify winter habitat requirements of woundfin. Additional data should be collected and evaluated during other periods of the year, especially during summer low flow and spring high flow periods. These studies must adequately quantify preferred woundfin habitat for all life stages. Obtaining appropriate data would require a minimum of a two-year study with at least monthly sampling of depth, velocity, temperature, and water quality. The results of such studies can be used to protect existing populations and to evaluate potential enhancement and transplant opportunities.

1.33 Determine interaction between native and exotic fishes, and factors presently excluding exotic fishes from the Virgin River.

Much concern has been expressed about the negative impact that exotic fishes have on native fish populations, particularly the woundfin. Little specific data are available to identify the interactions that occur or the magnitude of the problem. Presently, few exotic fishes are found in the Virgin River where woundfin are most abundant. The reasons they are not present are unclear, but appear related to the harsh habitat conditions found in the Virgin River. Studies need to be performed to identify characteristics of the river which must be preserved to exclude exotic fishes. Studies of seasonal and spawning habitat preference (same as 1.32) of exotic fishes should be made and compared with available habitat in the Virgin River. These studies should be integrated with studies proposed under 1.32. Information should also be collected to describe the potential impact of predation on woundfin

63

and competition between woundfin and exotic fishes, particularly the red shiner. With these data in hand, positive management programs can be proposed to avoid these problems.

1.34 Document and record movements of woundfin.

Essentially nothing is known of woundfin movement in the Virgin River, although some investigators suspect their movements may be significant. Effort should be made to document major movement by woundfin. Of particular interest will be movements between habitats and into and out of tributary streams. Mobility exhibited by woundfin will be an important consideration in management and reintroduction efforts. A suitable marking technique must be developed prior to initiating a movement study.

1.35 Perform additional studies to clarify woundfin life history requirements.

These are studies that will add to our existing knowledge of woundfin biology, and should increase our capacity to understand and be responsive to the needs of the woundfin. These studies would be of smaller scope and could possibly be incorporated into larger study objectives. Among studies included under this category would be: (1) determining use of irrigation canals by woundfin; (2) assessing woundfin reproduction and mortality below Mesquite Diversion; (3) determining use of LaVerkin Creek and other tributaries by woundfin; (4) conducting laboratory studies to record chemical (salinity, chlorine, etc.) preferences and limits for woundfin; (5) etc.

1.4 Identify factors maintaining present Virgin River habitat.

Habitats in the Virgin River from LaVerkin Springs to the Mesquite Diversion currently support self-sustaining woundfin populations. To maintain woundfin in that area it will be necessary to prevent further deterioration of habitat conditions that now exist.

1.41 Determine flows necessary to maintain optimum habitat conditions for woundfin.

Studies should be initiated to correlate available flows to habitat maintenance. Additional gauging stations are required to provide more precise flow information in the

Virgin River. Once the relationship between flow and habitat is established, recommendations based upon results of items 1.32 and 1.33 can be made to provide a flow regime which will maintain the desired woundfin habitat in the river.

1.42 Document water movement in the Virgin River basin.

Considerable information is available reporting water movement in the Virgin River basin. These data and any additional data necessary should be collected and summarized to document when, where, and how much water is being removed or received in the basin. It is essential that the water budget of the Virgin River basin be adequately defined so the feasibility of various water management proposals can be determined.

1.5 Protect woundfin habitat in the Virgin River.

If the self-sustaining woundfin population in the Virgin River is to be maintained and the species delisted, it is vital that the habitat be secured.

1.51 Review and comment on all projects which might impinge on woundfin and their habitats.

To achieve objective 1.0 it will be necessary to stay abreast of proposed projects in the watershed that may impact woundfin and their habitat. Primary responsibility for review and comment on these projects will rest with the individual States or agencies under whose jurisdiction they fall.

1.52 Obtain management authority over woundfin habitats.

An effort should be made to obtain management authority for woundfin habitats. River access is needed by management agencies to perform habitat maintenance and enhancement programs. The State agencies should be the parties obtaining such authorities.

1.53 Prepare management plans to protect habitat.

A Virgin River habitat management plan should be prepared to identify woundfin habitat to be protected through specific management practices.

65

1.54 Develop feasibility studies on vegetation management.

Vegetation adjacent to the Virgin River and within the watershed influence habitat conditions for woundfin. Feasibility studies should be initiated to determine the best means of vegetation management.

1.6 Enhance marginal habitat in present range.

To increase the size of the present woundfin population in the Virgin River, it is recommended that marginal habitat reaches be examined for possible enhancement potential. This work will be based largely on information obtained by habitat preference and hydrology studies. (Tasks 1.32 and 1.4)

1.61 Identify marginal habitat.

Marginal reaches of the Virgin River that are recommended for possible upgrading include the reaches from the Mesquite diversion to Lake Mead and from the Washington-St. George Canal Company diversion downstream to Little Round Valley.

1.62 Identify needed habitat enhancement features.

From studies accomplished under items 1.3 and 1.4, enhancement features can be recommended and marginal habitat can be manipulated for woundfin populations. Enhancement features could range from placement of instream structures, to channelization, to control of water rights.

1.621 Identify experimental sections of the Virgin River that can be used to test habitat manipulation.

To evaluate the overall value of enhancement features, experimental sections of the river should be selected for field testing. The Team recommends segments of the marginal habitat identified in 1.61 be considered as possible test sites. Prior to field testing of enhancement alternatives, a one-year baseline study should be performed to establish pre-study conditions.

1.622 Test and evaluate methods of enhancing the Virgin River as woundfin habitat within the test sites.

Determine enhancement alternatives for test sites and evaluate their effectiveness in creating and

maintaining viable woundfin habitat. If necessary, additional stocks of woundfin will be introduced into test sites. Enhancement features and results should be continuously monitored for a minimum of 3 years before final evaluation.

1.63 Develop and implement management plans to enhance marginal habitat.

Once it is determined which enhancement features have the greatest potential benefit, propose site specific enhancement procedures for each of the marginal habitats in the Virgin River. Management plans should be phased so sections of marginal habitat can be enhanced as money becomes available. Budgeting and personnel to carry out the enhancement project should be identified.

1.64 Monitor the enhanced habitat and woundfin populations.

Once marginal habitats are enhanced, woundfin population monitoring within these areas will provide a means for determining the long term effectiveness of the habitat management techniques.

1.641 Establish monitoring procedures and schedules.

Habitat monitoring procedures will need to be developed for the enhanced sections. Woundfin population monitoring procedures should follow closely techniques described under 1.11.

1.642 Recommend monitoring personnel.

Recommendations of monitoring personnel will be made when monitoring procedures and schedules are developed.

1.643 Implement monitoring.

Monitoring will be done according to procedures contained within the appendix (Population Monitoring Procedures). New sites will be identified.

2.0 Restore and manage populations of woundfin in suitable areas of former range.

Two additional populations of woundfin should be established and maintained in suitable habitat within their probable historic range.

2.1 Enhance habitat in introduction sites.

Using criteria developed from monitoring studies and field observations on the Virgin River woundfin population, recommend enhancement features at introduction sites with probable historic range.

2.11 Identify and enhance habitat in introduction sites.

Potential sites will be prioritized with needed enhancement features recommended. Potential sites will include, but not be limited to, that portion of the Verde River between Perkinsville and Sycamore Creek, the Gila River mainstream above Safford, and the San Francisco River above its confluence with the Gila. In addition, Tonto Creek and the Hassayampa River will be evaluated for their suitability. A final report prepared by the Arizona Game and Fish Department will be presented to the U.S. Fish and Wildlife Service.

2.12 Consider obtaining experimental, nonessential population designation for woundfin introductions.

Once the U.S. Fish and Wildlife Service receives a recommendation for woundfin introduction sites the designation of these introduced populations as experimental, nonessential, under the Endangered Species Act, as amended, may be necessary. It will be the responsibility of the U.S. Fish and Wildlife Service to gain experimental population status for the proposed introductions in accordance to Section 10(j) of Endangered Species Act Amendments of 1982, Pub. L. 97-304.

2.13 Conduct environmental assessments for introduction sites.

To comply with the NEPA process, it will be necessary to prepare an environmental assessment for all sites found suitable for woundfin introductions on public lands. The environmental assessment will identify any conflicts with current management practices by land management agencies, make recommendations for elimination of such conflicts, and identify agency roles in management of the introduction(s). Preparation of the environmental assessments will begin after the initial selection of introduction sites is accomplished.

2.2 Obtain sufficient woundfin to introduce into suitable sites in former range.

Once suitable habitat has been selected and state permission to stock obtained, woundfin will be introduced. State agencies

and the U.S. Fish and Wildlife Service will conduct the actual stockings by providing equipment and personnel. Fish for stocking will be provided by the U.S. Fish and Wildlife Service from woundfin propagation at Dexter National Fish Hatchery and/or from collection in the wild.

2.21 Develop hatchery propagation techniques for woundfin.

Woundfin broodstock have been collected from the Virgin River and transported to Dexter for propagation. Techniques will be developed to produce 10,000 fish per year for introduction purposes until two experimental populations have been established.

2.22 Collect woundfin from the wild for use in introductions.

Woundfin for introductions should be collected from the wild during the period March-April prior to initiation of spawning. This time period is also before irrigation diversion when fish congregate below diversion structures for the Washington-St. George Canal Company (Utah) and the Mesquite irrigation diversion (Nevada).

2.23 Determine Stocking Rates

At least 1,000 woundfin (numbers dependent upon availability) will be introduced into each approved site. Stocking will be conducted annually until two experimental populations are established.

2.24 Introduce woundfin into suitable habitats.

Using fish from either Dexter NFH, or fish collected from the Virgin River, stock suitable habitat with at least 1,000 woundfin into each site.

2.3 Monitor introduced fish and habitat.

Introduction sites will be monitored twice annually to determine success of the introductions. Monitoring will and include observations on woundfin presence and abundance, water flow and quality, and other fish species present. Monitoring of

61

ongoing and proposed management practices which may affect the success of the introduction(s) will also be conducted. Introductions into selected sites should continue for 10 years or until natural reproduction occurs. Stocking should then cease but monitoring should continue annually. If, at the end of 10 years, natural reproduction has not occurred, stocking should be discontinued. Data obtained from such sites should be evaluated for refinement of criteria used in selecting introduction sites.

2.31 Establish monitoring procedures and schedules.

Methodologies established under 1.11 and 1.21 will be used to develop monitoring procedures and schedules.

2.32 Recommend monitoring personnel.

Recommendations of monitoring personnel will be made when monitoring procedures and schedules are established.

2.33 Implement monitoring.

Monitoring personnel will monitor according to procedures and schedules established in 2.31.

2.4 Manage all restored woundfin habitat to assure self-sustaining populations.

Using information collected under 1.3 and 1.4 implement a habitat management program to assure a self-sustaining woundfin population.

2.41 Obtain management authority over restored habitats.

Refer to discussion under 1.53.

2.42 Review and comment on all projects which may affect woundfin and their habitat.

Refer to discussion under 1.52.

3.0 Establish an information and education program.

To inform the public of the recovery effort and to give them information about the woundfin, funds should be expended on information and education material.

10

3.1 Produce an information pamphlet on the Virgin River fishes.

An information pamphlet should be prepared describing the woundfin and explaining some of its biology. The pamphlet should also describe the Virgin River and its importance to the woundfin and other fish and wildlife. A section giving reasons for preserving species in nature should also be included.

3.2 Produce an audio-visual program on the Virgin river ecosystem with emphasis on the native fish.

Along with the pamphlet, a short film (15-20 minutes) should be prepared on the Virgin River ecosystem. This film should present a view of the ecosystem as a whole, in which the woundfin is an integral part and not a special animal separate from the rest.

4.0 Enforce all State and Federal laws protecting woundfin populations and habitat.

Woundfin are protected by the Department of the Interior and the States of Arizona, Nevada, and Utah. Agencies or groups having or proposing projects should be informed of the status of the woundfin and woundfin habitat and their responsibility to conserve listed species and their habitat so that no unintentional infractions of laws or destruction of fish or habitat occurs. Section 7 consultation requirements must be pointed out to all Federal agencies considering projects which may impact the species or its habitat.

4.1 Inform the necessary agencies of the status of the woundfin and recovery effort.

The Recovery Plan and annual monitoring reports will be distributed to all concerned agencies by the FWS.

4.2 Assist State and Federal agencies in carrying out their regulatory responsibilities.

The U.S. Fish and Wildlife Service will, by updating and refining the Recovery Plan and by providing informed comment on related issues, assist state and other Federal agencies in carrying out their regulatory responsibility to protect the woundfin and its habitat.

71