

Conservation status of the North American fish fauna in fresh water

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The status of the North American fish fauna includes 292 species of fishes in the categories of endangered, vulnerable, rare, indeterminate, and extinct. This constitutes 28% of the known fauna. The status of fishes and their habitats continues to decline, especially in the arid regions of western U.S.A. and northern Mexico. The Endangered Species Act is the most powerful tool currently available to protect rare fishes. While many fishes probably have been saved from extinction by this Act, surprisingly few have improved enough to be removed from under its protection.

Key words: endangered species; freshwater fishes; extinction; conservation; North America.

I. INTRODUCTION

The North American fish fauna exhibits some pronounced contrasts from north to south and east to west. While Alaska and Canada constitute over one-half of the continental land mass, they contain only 19% of the fish fauna (Briggs, 1986). The large, geologically stable Mississippi River basin of the eastern U.S.A. contains the bulk of the diverse minnow (Cyprinidae), sucker (Catostomidae), catfish (Ictaluridae), and sunfish (Centrarchidae) families. The western portion of North America, while contributing only about one-quarter of the species diversity as does the east, contains a great many species of restricted geographic distribution (Smith, 1981). Fishes of the western U.S.A. and northern Mexico have persisted despite geologic events such as volcanism and mountain building as well as increasing aridity (Miller & Smith, 1986).

Government water policies in the west have favoured construction of dams and water delivery systems at the expense of free-flowing rivers and natural fish communities (Hunt, 1988). The introduction and establishment of non-native species have resulted in severe declines of native fishes in Florida, western U.S.A. and Mexico (Courtenay & Robins, 1975; Moyle, 1976; Williams *et al.*, 1985). Overall, the number of fish species and subspecies in North America requiring special management because of threats to their continued existence has increased 45% during the past 10 years (Williams *et al.*, 1989). In some river systems, such as the Colorado and Rio Grande, habitats have been so extensively altered by dams and water diversions that the entire ecosystems are regarded as endangered (Hunt, 1988; Williams *et al.*, 1985).

II. MATERIALS AND METHODS

The geographic limits of fishes treated herein are restricted to North America. Our treatment includes all of Canada, the United States including Alaska (but excluding

Hawaii), and Mexico as far south as the limit of the family Cyprinidae, which on the Atlantic slope extends to the Rio Misantla in Veracruz, and on the Pacific slope to the Rio Verde in Oaxaca (see Miller & Smith, 1986).

Only full species, both described and undescribed, known from fresh water are included in Table I and subsequent analyses. Coverage includes anadromous and catadromous species, plus those marine and estuarine species that occur in the fresh waters of North America.

Species status was determined by the recent analyses of Williams *et al.* (1989) and Miller *et al.* (1989), except for differences resulting from those authors inclusion of subspecies and slightly broader geographic coverage (they included Hawaii and all of Mexico). The following International Union for Conservation of Nature and Natural Resources (IUCN, 1988) categories are utilized to indicate species' status: Endangered, species in danger of extinction and whose survival is unlikely if the causal factors continue operating; Vulnerable, species believed likely to move into the endangered category in the near future if the causal factors continue operating; Rare, species with small world populations that are not at present endangered or vulnerable, but are at risk; Indeterminate, species that are suspected of belonging to one of the above three categories but for which insufficient information is currently available; and Extinct, species for which all individuals have been extirpated. The endangered and threatened categories of Williams *et al.* (1989) are equivalent to Endangered and Vulnerable, respectively, as used here.

III. PRESENT STATUS OF THE FAUNA

Native North American fishes known from fresh waters total 1033 species in 51 families (Table I). Of this total, 292 (28%) are included in the IUCN categories as follows: 74 (7%) Endangered, 85 (8%) Vulnerable, 101 (10%) Rare, 5 (<1%) Indeterminate and 27 (3%) are Extinct. Endangered and Extinct fish species are listed in the Appendix.

The first documented fish extinctions in North America caused by humans were the whiteline topminnow, *Fundulus albolineatus* Gilbert, and Parras characodon, *Characodon garmani* Jordan and Evermann, which were extirpated about 1900 (Miller *et al.*, 1989). The rate of human-caused fish extinctions in North America has increased dramatically since 1950 (Fig. 1).

Detailed status information of individual taxa can be found in Williams *et al.* (1989) and Miller *et al.* (1989). Additional information on the biology and distribution of vanishing fishes of the United States can be found in Lee *et al.* (1980) and for Canada in McAllister *et al.* (1985).

IV. EXISTING CONSERVATION PROGRAMMES

Within North America, the United States Government has promulgated the Endangered Species Act of 1973, the most powerful tool for species conservation. The Act provides for the listing of plant and animal species, subspecies, and genetically distinct populations of vertebrate species as endangered or threatened. The endangered and threatened categories of the Act approximate the Endangered and Vulnerable categories, respectively, of IUCN. These listed species receive broad protection from actions of government agencies and are protected from 'taking' (i.e. significant habitat modification, capture, kill) by government agencies and private individuals. The official *List of Endangered and Threatened Wildlife* and *List of Endangered and Threatened Plants* are updated annually and are available from the Publications Unit, U.S. Fish and Wildlife Service, Washington, D.C. 20240, U.S.A.

TABLE I. Status of North American fishes. The table includes freshwater, anadromous, and catadromous species as well as estuarine and marine species known from fresh waters. The first column shows the number of species in each family. The last column shows the number of species listed in the preceding five categories also expressed parenthetically as percentages of the number of species in each family

Family	No. of species	Endangered	Vulnerable	Rare	Indeterminate	Extinct	No. listed and (%)
Petromyzontidae	24	0	0	2	1	1	4 (17)
Acipenseridae	8	2	2	0	1	0	5 (63)
Polyodontidae	1	0	0	1	0	0	1 (100)
Lepisosteidae	5	0	0	0	0	0	0
Amiidae	1	0	0	0	0	0	0
Hiodontidae	2	0	0	0	0	0	0
Elopidae	3	0	0	0	0	0	0
Anguillidae	1	0	0	0	0	0	0
Clupeidae	14	0	0	0	0	0	0
Engraulidae	2	0	0	0	0	0	0
Salmonidae	47	4	4	5	0	4	17 (36)
Osmeridae	7	0	1	1	0	0	2 (29)
Umbridae	4	0	0	1	0	0	1 (25)
Esocidae	4	0	0	0	0	0	0
Characidae	2	0	0	1	0	0	1 (50)
Cyprinidae	272	17	20	27	0	11	75 (28)
Catostomidae	68	8	3	11	0	2	24 (35)
Ictaluridae	47	4	8	7	0	0	19 (40)
Ariidae	4	0	0	0	0	0	0
Percopsidae	2	0	0	0	0	0	0
Aphredoderidae	1	0	0	0	0	0	0
Amblyopsidae	6	1	2	0	0	0	3 (50)
Gadidae	2	0	0	0	0	0	0
Gobiesocidae	1	0	0	0	0	0	0
Hemiramphidae	2	0	0	0	0	0	0
Belonidae	1	0	0	0	0	0	0
Rivulidae	1	0	0	1	0	0	1 (100)
Cyprinodontidae	65	13	9	7	0	4	33 (51)
Goodeidae	38	5	2	2	0	2	11 (29)
Poeciliidae	63	6	4	8	0	2	20 (32)
Atherinidae	31	0	5	1	0	0	6 (19)
Gasterosteidae	8	0	0	0	3	0	3 (38)
Syngnathidae	2	0	0	0	0	0	0
Cottidae	29	1	1	3	0	1	6 (21)
Centropomidae	9	0	0	0	0	0	0
Percichthyidae	4	0	0	0	0	0	0
Centrarchidae	35	0	1	5	0	0	6 (17)
Percidae	146	9	23	17	0	0	49 (30)
Carangidae	3	0	0	0	0	0	0
Gerreidae	8	0	0	0	0	0	0
Haemulidae	5	0	0	0	0	0	0
Sciaenidae	3	0	0	0	0	0	0
Cichlidae	11	4	0	0	0	0	4 (36)
Embiotocidae	2	0	0	0	0	0	0
Mugilidae	4	0	0	0	0	0	0
Dactyloscopidae	1	0	0	0	0	0	0
Eleotridae	7	0	0	0	0	0	0
Gobiidae	20	0	0	1	0	0	1 (5)
Bothidae	3	0	0	0	0	0	0
Pleuronectidae	1	0	0	0	0	0	0
Soleidae	3	0	0	0	0	0	0

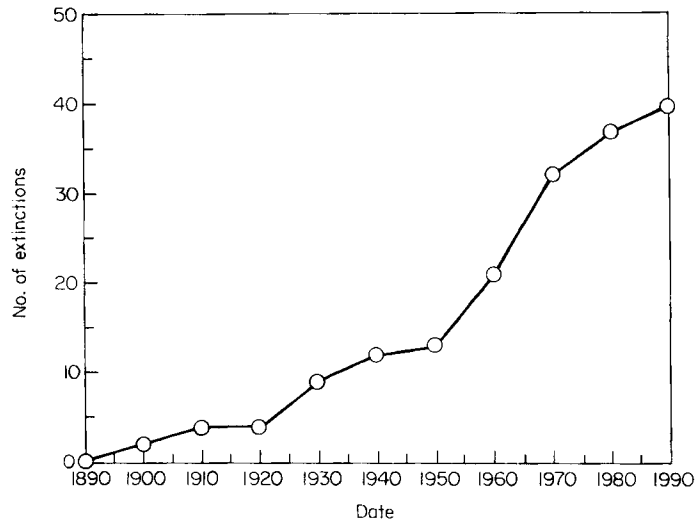


FIG. 1. Cumulative number of fish extinctions by decade in North America during the past century. Graph based on 27 species extinctions from Table I plus 13 subspecies extinctions as described by Miller *et al.* (1989).

The list of endangered and threatened species protected by the Endangered Species Act is extensive, but does not include all vanishing species that warrant protection. Of the 102 U.S.A. species classified as Endangered or Vulnerable in Table I, only 54 (53%) are listed pursuant to the Endangered Species Act.

The Act also contains international provisions. For the U.S.A., the Act implements the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Under CITES, the U.S. Secretary of the Interior must determine that the import into the U.S.A. or export from that country of species or their products will not harm the species in question.

Canada and Mexico lack such powerful species conservation legislation. Canada maintains an official list of extinct, endangered, threatened, and rare wildlife through the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The Subcommittee on Fish and Marine Mammals of COSEWIC periodically publishes a list of species of interest as well as status reports on individual species in special issues of *The Canadian Field-Naturalist* (Campbell, 1987). For Mexico, the most complete list of rare fishes is published by the American Fisheries Society (Williams *et al.*, 1989) although a larger monograph is in preparation (Ceballos, in prep.).

V. NEEDED CONSERVATION STRATEGIES

1. In all countries, natural history surveys should be increased to monitor native fish populations, to identify areas under increasing threat, and to identify habitats containing large numbers of vanishing fishes. Canada and Mexico lack baseline surveys of much of their aquatic habitats.

2. In all countries, programmes of genetic and ecological studies are needed to manage endangered fishes. All too often, conservation actions fail because they are

not based on sound biology. Vrijenhoek *et al.* (1985), for example, demonstrated that the failure of numerous introductions of the Sonoran topminnow, *Poeciliopsis occidentalis* (Baird and Girard), was caused by the selection of a genetically invariant form as the source population. Topminnows from another population that display substantial genetic variability, which facilitates greater success in establishing new populations, are now used to restock historic habitats.

3. In the U.S.A., increase funds and staff adequately to carry out provisions of the Endangered Species Act. Insufficient funds and staff are particularly apparent in the listing programme, where a large backlog of species await listing, and in the recovery programme, where widespread failure to implement recovery plans has resulted in few species exhibiting any increase in abundance. In the past 10 years, only seven fishes previously categorized as endangered or threatened have significantly improved in status in the U.S.A. (Williams *et al.*, 1989).

4. In Canada and Mexico, develop and implement legislation designed to protect endangered species and their habitats.

5. In all countries, a conservation strategy should be developed to protect remaining natural communities that support a relatively intact native fish fauna. Nearly all endangered aquatic ecosystems in North American desert regions still contain one or more streams or springs with an intact complement of native fishes. For example, despite the overall loss of habitat in the Gila River system of the southwestern U.S.A. and northwestern Mexico, one small tributary, Aravaipa Creek, contains seven native fishes including two listed as threatened pursuant to the Endangered Species Act (Williams *et al.*, 1985). An additional example is the La Media Luna spring and lagoon complex in the Rio Verde system of central Mexico, which harbours six rare fishes and three endemic crustaceans (Williams *et al.*, 1985).

6. In all North American countries, we should develop policies to stabilize human population growth and reduce resource consumption, particularly in the U.S.A.

Historically, much of the world has looked to the United States for leadership in developing strategies to solve our conservation problems. The Endangered Species Act of 1973 is an excellent model for other countries to follow, yet this is not the final solution. The list of species under protection of the Act seems to grow endlessly, with few species ever recovering from endangered status. Despite its power, the Act provides no more than a temporary respite for species threatened with extinction. More permanent protection will come when the demands of the human population decrease and our lifestyle becomes fully sustainable and more harmonious with nature.

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APPENDIX I. Endangered and Extinct (Ex) fish species of North America

Petromyzontidae: *Lampetra minima* Bond & Kan, 1973 (Ex).

Acipenseridae: *Scaphirhynchus albus* (Forbes & Richardson, 1905); *Scaphirhynchus* sp. (Alabama).

Salmonidae: *Coregonus alpenae* (Koelz, 1924) (Ex); *C. huntsmani* Scott, 1987; *C. johannae* (Wagner, 1910) (Ex); *C. nigripinnis* (Gill, 1872) (Ex); *C. reighardi* (Koelz, 1924); *C. zenithicus* (Jordon & Evermann, 1909); *Coregonus* sp. (Opeongo); *Salvelinus agassizi* (Garman, 1885) (Ex).

Cyprinidae: *Cyprinella panarcys* (Hubbs & Miller, 1978); *C. xanthicara* Minckley & Lytle, 1969; *Dionda mandibularis* Contreras-Balderas & Verduzco-Martinez, 1977; *Dionda* sp. (Mezquital); *Evarra bustamantei* Navarro, 1955 (Ex); *E. eigenmanni* Woolman, 1895 (Ex); *E. tlahuacensis* Meek, 1902 (Ex); *Gila crassicauda* (Baird & Girard, 1854) (Ex); *G. cypha* Miller, 1946; *G. elegans* Baird & Girard, 1853; *Gila* sp. (Parras slender); *Gila* sp. (Parras wide); *Iotichthys plegethontis* (Cope, 1874); *Lepidomeda albivallis* Miller & Hubbs, 1960; *L. altivelis* Miller & Hubbs, 1960 (Ex); *Moapa coriacea* Hubbs & Miller, 1948; *Notropis amecae* Chernoff & Miller, 1986 (Ex); *N. aulidion* Chernoff & Miller, 1986 (Ex); *N. cahabae* Mayden & Kuhajda, 1989; *N. mekistocholas* Snelson, 1971; *N. orca* Woolman, 1894 (Ex); *N. simus* (Cope, 1875); *Phoxinus cumberlandensis* Starnes & Starnes, 1978; *Plagopterus argentissimus* Cope, 1874; *Pogonichthys cisoides* Hopkirk, 1973 (Ex); *Ptychocheilus lucius* Girard, 1857; *Rhinichthys deaconi* Miller, 1984 (Ex); *Stypodon signifer* Garman, 1881 (Ex).

Catostomidae: *Catostomus microps* Rutter, 1908; *C. warnerensis* Snyder, 1908; *Catostomus* sp. (Salish); *Chasmistes brevirostris* Cope, 1879; *C. cujus* Cope, 1883; *C. liorus* Jordan, 1878; *C. muriei* Miller & Smith, 1981 (Ex); *Deltistes luxatus* (Cope, 1879); *Lagochila lacera* Jordan & Brayton, 1877 (Ex); *Xyrauchen texanus* (Abbott, 1861).

Ictaluridae: *Noturus baileyi* Taylor, 1969; *N. stanauli* Etnier & Jenkins, 1980; *N. trautmani* Taylor, 1969; *Prietella phreatophila* Carranza, 1954.

Amblyopsidae: *Speoplatyrhinus poulsoni* Cooper & Kuehne, 1974.

Cyprinodontidae: *Cualac tessellatus* Miller, 1956; *Cyprinodon alvarezi* Miller, 1976; *C. bovinus* Baird & Girard, 1853; *C. elegans* Baird & Girard, 1853; *C. latifasciatus* Garman, 1881 (Ex); *C. macularius* Baird & Girard, 1853; *C. meeki* Miller, 1976; *C. pachycephalus* Minckley & Minckley, 1986; *C. radiosus* Miller, 1948; *Cyprinodon* sp. (Monkey Spring) (Ex); *Cyprinodon* sp. (Palomas); *Cyprinodon* sp. (Santa Rosa); *Empetrichthys latos* Miller, 1948; *E. merriami* Gilbert, 1893 (Ex); *Fundulus albolineatus* Gilbert, 1891 (Ex); *Lucania interioris* Hubbs & Miller, 1965; *Megupsilon aporus* Miller & Walters, 1972.

Goodeidae: *Allotoca maculata* Smith & Miller, 1980 (Ex); *Amea splendens* Miller & Fitzsimons, 1971; *Ataeniobius toweri* (Meek, 1904); *Characodon garmani* Jordon & Evermann, 1898 (Ex); *C. lateralis* Günther, 1866; *Girardinichthys viviparus* (Bustamante, 1837); *Hubbsinia turneri* de Buen, 1941.

Poeciliidae: *Gambusia alvarezi* Hubbs & Springer, 1957; *G. amistadensis* Peden, 1973 (Ex); *G. gaigei* Hubbs, 1929; *G. georgei* Hubbs & Peden, 1969 (Ex); *Priapella bonita* (Meek, 1904); *Xiphophorus couchianus* (Girard, 1859); *X. gordonii* Miller & Minckley, 1963; *X. meyeri* Schartl & Schroeder, 1988.

Cottidae: *Cottus echinatus* Bailey & Bond, 1963 (Ex); *C. pygmaeus* Williams, 1968.

Percidae: *Etheostoma australe* Jordan, 1889; *E. fonticola* (Jordan & Gilbert, 1886); *E. nuchale* Howell & Caldwell, 1965; *E. sellare* (Radcliffe & Welsh, 1913); *Etheostoma* sp. (Cuatro Ciénegas); *Etheostoma* sp. (Cherokee); *Percina antesella* Williams & Etnier, 1977; *P. jenkinsi* Thompson, 1985; *P. rex* (Jordan & Evermann, 1889).

Cichlidae: *Cichlasoma bartoni* (Bean, 1892); *C. labridens* (Pellegrin, 1903); *C. minckleyi* Kornfield & Taylor, 1983; *Cichlasoma* sp. (Media Luna).
