Freshwater Biodiversity in Crisis

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Source: Adapted from *Pilot Analysis of Global Ecosystems: Freshwater Systems* and *World Resources 1998–99*

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Summary:

Freshwater ecosystems—the diverse communities found in lakes, rivers, and wetlands—are the most endangered of all major ecosystem types, and face increasing threats from dams, water withdrawals, pollution, and overfishing.

In a world in which it seems that nearly every natural ecosystem is under stress, freshwater ecosystems—the diverse communities of species found in lakes, rivers, and wetlands—may be the most endangered of all. Freshwater ecosystems have lost a greater proportion of their species and habitat than ecosystems on land or in the oceans, and they face increasing threats from dams, overextraction, pollution, and overfishing.

How Crucial Are Freshwater Ecosystems?

Freshwater systems occupy only 0.8 percent of Earth's surface (McAllister et al. 1997:5), but they are rich in species and vital as habitat. An estimated 12 percent of all animal species live in fresh water (Abramovitz 1996:7). Many others, including humans, depend on fresh water for their survival. In Europe, for example, 25 percent of birds and 11 percent of mammals use freshwater wetlands as their main breeding and feeding areas (Kristensen and Hansen 1994:90).

Due to their limited area, freshwater ecosystems only contain about 2.4 percent of all Earth's plant and animal species (Reaka-Kudla 1997:90). On a hectare-for-hectare basis, however, they are richer in species than the more extensive terrestrial and marine ecosystems. (See Figure 1.) To date, scientists have discovered some 44,000 aquatic species in freshwater ecosystems, but this probably only represents a portion of all freshwater species (Reaka-Kudla 1997:90). In the last 18 years, scientists have described about 309 new freshwater species each year (Nelson 1976, 1984, 1994).

Teeming with Life

Figure 1: Species Richness by Ecosystem, 1997

ECOSYSTEM	PERCENT OF EARTH'S TOTAL HABITAT	PERCENT OF KNOWN SPECIES * Each Ecosystem Contains	RELATIVE SPECIES RICHNESS **
Freshwater	0.008	0.024	3.0
Terrestrial	0.284	0.775	2.7
Marine	0.708	0.147	0.2

* Sum does not add to 100 percent because 5.3 percent of known symbiotic species are excluded.
** Calculated as the ratio between the percent of known species and the percent of area occupied by the ecosystem.

Source: Vitousek et al. 1997: 4-6.

In addition to being biologically rich, freshwater ecosystems play a vital role in the lives of many people, providing a source of drinking and irrigation water, food, recreation, and employment. Indeed, the majority of the world's population lives near and depends on freshwater environments, with most inland cities located next to a waterway (Moyle and Leidy 1992:130). The world's fishers harvested some 8.2 million metric tons of fish from lakes, rivers, and wetlands in 1999—about 9 percent of the world's total fish catch (not including aquaculture) (FAO 2000:6). Rivers and lakes are also crucial as transportation and shipping routes, as power sources, and, unfortunately, as waste sinks. All of these human uses take their toll on freshwater ecosystems.

Why is Freshwater Biodiversity Endangered?

Threats to species in freshwater ecosystems are widespread. Habitat degradation, physical alteration from dams and canals, water withdrawals, overharvesting of fish and shellfish, pollution, and the introduction of nonnative species have all increased in scale and impact in the last century. (See Figure 2: Alteration of Freshwater Systems Worldwide.) As a consequence, the capacity of freshwater ecosystems to support biodiversity—the natural variety, abundance, and distribution of species across the aquatic environment—is highly degraded at a global level.

Endangering Freshwater Biodiversity

Figure 2: Alteration of Freshwater Systems Worldwide

ALTERATION	PRE-1900	1900	1950-60	1985	1996-98
Waterways	3,125 km	8,750 km	–	>500,000 km	–
Altered for Navigation	8,750 km	21,250 km	–	63,125 km	–
Canals	41	581	1,105	2,768	2,836
Large Reservoirs* Number Volume (km3)	14	533	1,686	5,879	6,385
Large Dams (>15m high)	–	–	5,749	–	41,413
Installed Hydro Capacity (MW)	–	–	<290,000	542,000	~660,000
Hydro Capacity Under Construction (MW)	–	–	–	–	~126,000
Water Withdrawals	–	578 km^3/year	1,984 km^3/year	~3,200 km^3/year	~3,800 km^3/year
Wetlands Drainage**	–	–	–	–	–

* Large reservoirs are those with a total volume of 0.1 km3 or more. This is only a subset of the world's reservoirs.

** Includes available information for the drainage of natural bogs and low-lying grasslands as well as disposal of excess water from irrigated fields. There is no comprehensive data for wetland loss for the world.

Sources: Based on Naiman et al. 1995, as adapted from L'vovich and White 1990. Data on dams are from ICOLD 1998. Reservoir data are from Avakyan and Iakovleva 1998. Hydro capacity data are from IJHD 1998 and L'vovich and White 1990. Water withdrawal data are from Shiklomakov 1997.

In a recent study of freshwater fish, Harrison and Stiassny (1999) found that while many factors can simultaneously contribute to extinctions, habitat alteration and the introduction of nonnative species were the major causes driving the extinction of fish species. Building dams and water diversions, channelizing riverbeds, and draining wetlands are typical habitat alterations. The study reported that habitat alteration contributed to 71 percent of extinctions; nonnative species (which can compete with or feed on native species) contributed to 54 percent; overfishing contributed to 29 percent; and pollution to 26 percent of extinctions (Harrison and Stiassny 1999:298-299). Of the many ways in which humans alter freshwater ecosystems, dams are probably the most widespread and significant in their impact. Today, the world's rivers are dotted with more than 45,000 large dams—dams higher than 15 meters or impounding more than three million cubic meters of water (WCD 2000:8,11). Most of these dams were built in the last 50 years (ICOLD 1998:13).

Dam building has slowed in many countries, particularly in the developed world. In the United States, for example, since 1998, more dams have been decommissioned than built (WCD 2000:10). However, dam construction is still robust in other countries. As of 1998, there were 349 dams over 60 meters high under construction around the world, mostly in developing countries (IJHD 1998:12-14).

Dams provide unquestionable benefits—from water supply to power generation—but they disrupt the hydrological cycle profoundly, suppressing natural flood cycles, disconnecting rivers from their wetlands and floodplains, disrupting fish migrations, and altering the deposition of sediments downstream. For example, the World Commission on Dams found that more than 60 percent of the large dams it surveyed report significant problems with disrupted fish migrations (WCD 2000:82).

Rivers with multiple dams can become little more than chains of connected reservoirs, with consequent changes not only in the temperature and chemistry of river water, but in the living functions of the riverine ecosystem. Waterfalls, rapids, riparian vegetation, and wetlands are some of the habitats that disappear when dams impound rivers

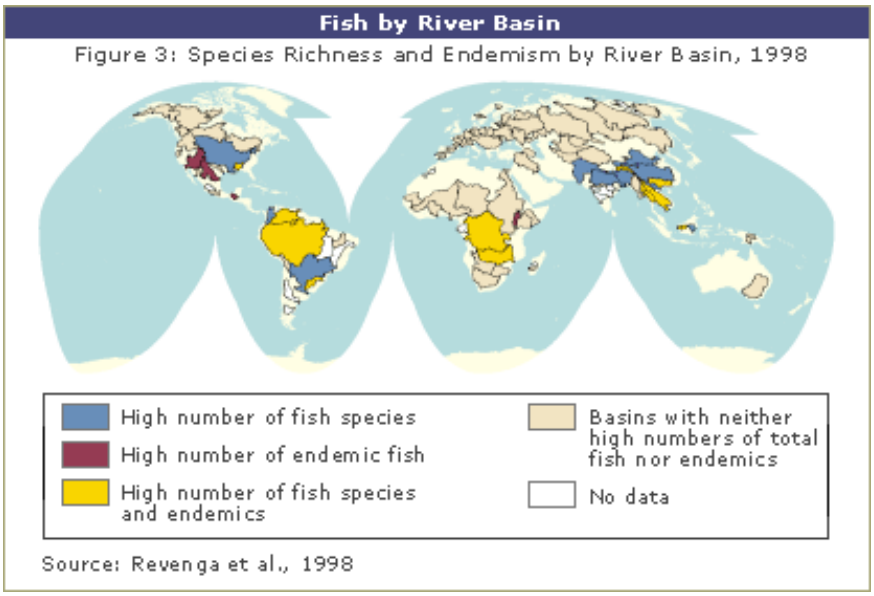
(Dynesius and Nilsson 1994:759). These habitats are essential feeding and breeding areas for many aquatic and terrestrial species, and also help to remove pollutants and maintain water quality.

How Threatened Are Freshwater Species?

One measure of the actual condition of freshwater biodiversity is the extent to which species are threatened with extinction. Globally, scientists estimate that more than 20 percent of the world's 10,000 recorded freshwater fish species have become extinct, threatened, or endangered in recent decades (Moyle and Leidy 1992:140). This number, however, may well be an underestimate (Bräutigam 1999:4).

According to the 1996 IUCN Red List of Threatened Animals, 734 species of fish are classified as threatened, of which 84 percent are freshwater species (IUCN 1996:intro p. 37; McAllister et al. 1997:38). For some countries and regions more detailed information is available. In South Africa, 63 percent of freshwater fish are threatened or endangered; in Europe, 42 percent; and in Iran, 22 percent (Moyle and Leidy 1992:138).

Unfortunately, global data on the status of the range of different freshwater species—plant and animal—is sparse, making it very difficult to quantify the overall condition of the world's freshwater biodiversity. Where we do have data, however, trends look bleak. In the United States, which has comparatively detailed data on freshwater species, 37 percent of freshwater fish species, 67 percent of mussels, 51 percent of crayfish, and 40 percent of amphibians are threatened or have become extinct (Master et al.1998:6). Indeed, studies indicate that freshwater species are being lost at an "ever-accelerating rate" (Moyle and Leidy 1992:163). Based on recent extinction rates, an estimated 3.7 percent of freshwater animal species will be lost in North America each decade, a rate nearly five times that of terrestrial animals (Ricciardi and Rasmussen 1999:1221).



Responses to Freshwater Threats

Concern for freshwater systems and their biodiversity is growing in many parts of the world, particularly among scientists. There is also recognition of the need to maintain functioning ecosystems that continue to provide the goods and services humans depend on and value, like clean water, fish, and recreation. In some cases, this has resulted in a change in practices for the better. For example, when Argentina recently sought World Bank funding to address flooding along the Parana River near one of its richest agricultural regions, it agreed to adopt a "living river" approach to the US$400 million flood control project. This means the river's floodplain and wetlands will be left intact as much as possible to preserve their functions. Consequently, traditional flood control structures like levees and concrete channels will be minimized—a significant departure from past practices (Castro 2001).

More positive still is a nascent trend toward restoring some damaged freshwater ecosystems. In the United States, Congress has approved a $7.8 billion project in southern Florida to help restore some of the natural water flow in the Everglades, an immense system of freshwater wetlands disrupted in the 1950s with an extensive system of canals and levees for flood control.

There have also been some positive changes in dam operations to try to minimize ecological damage. For example, at least 29 countries have adopted policies aimed at insuring that dams release enough water to maintain a minimum flow that supports the aquatic organisms downstream. During the dry season or in drought times, these "environmental flow releases" can mean the difference between survival and death for the large range of species that depend on the river's riparian zone (WCD 2000:81).

Unfortunately, these signs of greater awareness of freshwater ecosystems are still the exception rather than the rule (Duda 2001). With rising demand for water and food, as well as the increasing number of water development projects worldwide, experts stress that the need to manage freshwater ecosystems as the critical resource they are—not an afterthought or a luxury—is urgent.