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WETLANDS

Wetlands are found on every continent except Antarctica, and at every latitude from the tropics to the tundra. About 6 percent of the land surface of the Earth is wetlands, and in the boreal regions this is 11 percent. Wetland ecosystems on global scales cover more than 1,280 million hectares, an area 33 percent larger than the United States.

Individual wetlands are often relatively transient features of a landscape. They may have differing water levels depending on seasonal changes and climate. They may fill with debris. Water-loving plants invade the margins of a lake; as detritus collects, marsh-loving plants replace them; afterward the bog fills and shrubs and trees can enter. Meanwhile wetlands will be generated elsewhere on the landscape.

Wetlands

Though sometimes transient, wetlands considered as a biological phenomenon are often long-lived and constantly present throughout Earth's evolutionary past, and there is no cause for wetlands not to persist indefinitely in the future. Like the forest and the sea, mountains and rivers, lakes and islands, wetlands are a form of landscape that Earth has regularly been producing over the epochs of natural history.

Wetlands vary in size from small soggy areas and pools to vast tracts covering many thousands of hectares, both freshwater and brackish. Wetlands are dominated by water, but there is a wide water gradient from drier uplands to deep water, and this often differs depending on rainfall from season to season and year to year. As a result, what is recognized as wetlands varies, depending somewhat on whether the focus is plants adapted to flooding and saturated soil or wildlife so adapted, or the water table relative to ground surface, or the wet/dry season of the year.

Wetlands may be the most threatened of all landscape types. The world has lost half its wetlands since 1900. The United States has lost over half its wetlands. Most wetlands in Europe have been drained or filled for development. Africa, South America, and Asia are continually developing vast wetland areas for food and fiber. The Millennium Ecosystem Assessment, sponsored by the United Nations, has an assessment: *Ecosystems and Human Well-Being: Wetlands and Water*. The authors express concern: "The degradation and loss of wetlands is more rapid than that of other ecosystems. Similarly, the status of both freshwater and coastal wetland species is deteriorating faster than those of other ecosystems" (Millennium Ecosystem Assessment 2000, p. ii).

Since 1989, the U.S. Environmental Protection Agency has had a policy of "no net loss" of wetlands, resulting in a quagmire of controversies about what counts as wetlands (a golf course lake with swampy shoreline?), wetland remediation, loss (of acres or function?) and gain (when does "wet land" become "wetland"?). With wetland legislation, this has resulted in legal quarrels about what is a jurisdictional wetland, what permits may be required to dredge or fill them, or when a mitigation is successful—often destroying a wetland in one place and creating a substitute one elsewhere. A frequent judgment is that recreated wetlands are no match for the originals (Kaiser 2001). A National Research Council report was quite blunt: "The goal of no net loss of wetlands is not being met for wetland functions by the mitigation process, despite progress in the last 20 years" (National Research Council 2001, p. 2).

On international scales, the Convention on Wetlands of International Importance (commonly called the Ramsar Convention, from its first adoption at Ramsar,

Iran, in 1971) has become increasingly important, with, since 1987, a permanent secretariat headquartered at the International Union for the Conservation of Nature and Natural Resources in Switzerland. By the turn of the twenty-first century, 117 nations had joined the convention and there were over a thousand wetland sites (Frazier 1999).

The wide varieties of wetlands and the varieties of peoples experiencing them over many centuries have generated a rich terminology: bogs; marshes; mires; muskegs; aapa peatlands, palsa bogs; fens; swamps; wetland moors; wetland prairies; tidal salt marshes; mangrove wetlands; river floodplains, deltas; wetland alluvial fans. Scientists have attempted more precision in classifying schemes (Cowardin et al. 1979; Gore 1983; National Research Council 1995; Mitsch and Gosselink 2000). The National Research Council report cautioned that certain types of wetlands (fens and bogs) are much more difficult to restore than others; some may be impossible to restore.

Human encounters with wetlands have distinctive dimensions (Vileisis 1997). Wetlands have been much misunderstood environments, perhaps the most misunderstood (Miller 1989). The contemporary term *wetlands* has been chosen partly to avoid classical terms such as *swamp*, *bog*, *mire*, which have negative connotations. A "pleasant mire" is almost a contradiction in terms. Swamps are damp, marshy, overgrown, rank, dismal, gloomy. They are uninviting places where one has to contend with insects while trying to keep from falling into the treacherous mud. Wetlands are often believed to be wastelands, best to be filled, drained, and converted into a useful resource.

Traditionally, there was an element of truth in such dislike. *Miasma*, from a Greek word for pollution, was poisonous air rising from the rotting bogs. *Malaria* means "bad air," and the disease was more often caught by those who lived near wetlands, breathing this bad air. That the disease was carried by a protist in mosquitoes, breeding in stagnant or slow moving waters, was unknown until the 1890s.

Wetlands have economic uses and provide ecological services (Maltby 1986; Gore 1983; Richardson 1994; Mitsch and Gosselink 2000, Chapter 16). They provide habitats for fishing and for hunting waterfowl; they may contain timber that can be harvested. Rice, a staple grain for over half the world, is grown on managed agricultural wetlands. Peatlands provide fuel and energy. Coastal marshes are critical to the marine fishing, shellfish, and shrimp industries. Eighty percent of the commercial catch off the southeast U.S. coast is linked to salt marshes. There may be important biogeochemical transformations involving phosphates, nitrogen



Wetland Habitat in Wisconsin. The term "wetland" refers to various transient features of a landscape, but essentially includes any area dominated by water. Wetlands may be one of the most threatened ecosystems, and because of their important economic and biological uses, recent efforts have been made in an attempt to preserve these landscapes. However, as in the United States, legal measures to retain a net amount of wetlands produces additional problems and controversy. PHOTO BY RYAN HAGERTY/U.S. FISH AND WILDLIFE SERVICE.

compounds, sulfur compounds, and carbon. Wetlands serve for water storage and as filters for wastewater treatment. Wetlands provide flood control. In one notable example, damage in New Orleans from hurricane Katrina (2005) was much worse than it might have been, as a result of wetland losses. The four decades of wetlands loss before the turn of the twenty-first century increased storm surges about three feet (Stokstad 2005). The Millennium Ecosystem Assessment analysis also laments: "Many water resource developments undertaken to increase access to water have not given adequate consideration to harmful trade-offs with other services provided by wetlands" (Millennium Ecosystem Assessment 2000, p. ii).

Scientific understanding of wetlands has led to their better appreciation. The first misperception to be set aside is that wetlands are wastelands biologically. Wetlands can be high in biodiversity and biomass productivity, especially if open to hydrologic and nutrient fluxes. "Wetlands ... are among the most fertile and productive ecosystems in the

world" (Maltby 1986, p. 9). There is often less diversity in northern wetlands than in those in warmer regimes, but the fewer species there may be present in enormous numbers. In wetlands, obtaining nutrients and oxygen can be problematic, sometimes resulting in ingenious solutions to these stresses.

Wetlands offer unusual experiences of natural history (Rolston 2000). The slowed processes of decay underwater keep the evidences of former life close to the surface. The black ooze is a mixture of silt and partly decayed plants and animals that have gradually piled up on the bottom. The waterlogged remains are oxygen-starved, compared to terrestrial sites, and decay slowly: waterlogged logs, a soggy thatch of dead plants, or peat. The retreat of the glaciers left a Finnish landscape of lakes, scoured hollows, kettles, bogs, and mires. Many Finnish mires are thought to have existed continuously for 8,000 years (Ruuhijärvi 1983, p. 48). Studies of the pollen preserved therein record life in these wetlands, ongoing with vigor for eight millennia.

Wetland plants can tolerate extremes of moisture, nutrients, and oxygen in the soil. Insectivorous plants have adapted to the nitrogen-deficient soils of bogs by reversing the usual trophic pyramids, in which insects typically eat plants. Here plants eat insects, as with the sundews, pitcher plants, Venus flytraps, or bladderworts. Marshes and mires are remarkable places for adapted fit, complex networks connected in biotic community, as we learn when we try to recreate them.

Bird life in wetlands can be abundant, with distinctive adaptations to life in the wetlands. The ducks include mallards, pintails, shovelers, buffleheads, teal. There are also the blackbirds, coots, grebes, cormorants, pelicans, mergansers, gallinules, jacanas, herons, marsh hawks, cranes (Hurt 2007). Perhaps the most celebrated of the northland water/birds are the loons, ancient, deep-diving birds with their striking call.

In sum, wetlands are "biological supermarkets" for the diversity of life (Mitsch and Gosselink 2000, p. 4). Wetlands are especially demanding environments to understand and to conserve. Wetlands are challenging scientifically, economically, politically, socially, philosophically, ethically. Conserving them, we respect life; and, as the Millennium Ecosystem Report insists, the integrity of wetlands is closely linked to human well-being.

SEE ALSO *Biodiversity; Hurricane Katrina; Millennium Ecosystem Assessment; Rivers; U.S. Environmental Protection Agency; Water.*

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