Preservation

Because of their isolation and relatively recent discovery, the Galápagos have escaped the destruction so often wreaked on oceanic islands. Currently, the biggest threats to the archipelago include introduced species, loss of native biodiversity, and human visitors. For this reason, the Ecuadorean government has declared all the islands, except areas already colonized, to be a national park, managed in conjunction with the not-for-profit Charles Darwin Foundation and Research Station.

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Further Reading

Fitter, Julian, Daniel Fitter, and David Hosking. *Wildlife of the Galápagos.* Princeton, NJ: Princeton University Press, 2000.

Jackson, Michael H. *Galápagos: A Natural History.* Calgary, Canada: University of Calgary Press, 1993.

Kricher, John. *Galápagos: A Natural History.* Princeton, NJ: Princeton University Press, 2006.

McMullen, Conley K. *Flowering Plants of the Galápagos.* Ithaca, NY: Comstock Publishing Associates, 1999.

Gambia River

Category: Inland Aquatic Biomes.
Geographic Location: West Africa.
Summary: The last remaining undammed river in West Africa is an important reserve of biological diversity and support for human well-being, but is threatened by human activities.

The Gambia River winds over 700 miles (1,130 kilometers) from the Fouta Djallon highlands of northern Guinea through southeastern Senegal and The Gambia into the Atlantic Ocean. It is one of the largest rivers in West Africa and is composed of two distinct habitat types: estuary at the mouth and freshwater further upstream. Each of these supports a collection of flooded areas, swamps, mudflats, and riverine forests.

As part of the broader Senegambia Catchment area, the Gambia River is an important ecosystem for biological diversity, though it has few endemic species (those found nowhere else on Earth) in its own waters. The river supports a range of economic activities from agriculture to fishing, hunting, and transportation. It also shows promise for potential hydroelectric power. Like many of the world's aquatic and coastal systems, it is under direct threat from these anthropogenic factors.

Mangroves, Salt Marsh, Wetlands

The estuarine and freshwater zones, which are largely a function of the reach of the tide and salt water from the sea, create different communities of flora and fauna. At its mouth, the Gambia is an 8-mile-wide (14-kilometer-wide) permanently flooded ria, or funnel-shaped, estuary formed from the submergence of the lower portion of the river valley. This estuary is a matrix of mangrove swamps and creeks with riverside mudflats on elevated ground formed from silt deposition.

The river narrows as it travels further inland, though it remains about half a mile (one kilometer) wide, even 124 miles (200 kilometers) from the mouth. As the influence of the tide wanes, so does the level of flooding. The middle section of the river is only seasonally flooded, and the early stages of the river in the Fouta Djallon and southeastern Senegal—before the Gambia meets with any of its important tributaries—do not experience any flooding.

The basin of the Gambia River contains about 1,500 species of plants, 80 species of mammals, 330 species of birds, 26 species of reptiles, and 150 species of freshwater fish. This diversity results from the broad range of habitats including mangroves, freshwater swamps, salt mudflats, and Sudanian-Guinean riverine forest. Though the Gambia is important for biodiversity, it is not unique from other river ecosystems in the area. It possesses only a few endemic species. Most species are held in common with the Senegal, Bafing, and Faleme rivers and are known together as the Senegal-Gambia Catchment, or the Senegambia Catchment. Thus the Gambia River ecosystem is part of the broader Sudan-Guinean

Savanna biome, and shares several species from the Guinea-Congo Forest biome and the Sahelian biome as well.

The mangroves and wetlands of the Gambia River reach 62 miles (100 kilometers) inland from the Atlantic and comprise one of the 200 most biologically valuable ecoregions of the Earth, as listed by the World Wildlife Fund. The river supports nearly 111,000 acres (45,000 hectares) of mangrove swamp dominated by trees such as *Avicennia africana*, *Sesuvium portulacastrum*, and *Rhizophora* spp. Much of this area is covered with salt marsh herbs and halophytic (salt-loving) grasses. The mangroves support a diverse community of avifauna, both as breeding and wintering grounds.

More than 560 bird species are found here, including many migratory species arriving from Europe each winter who find refuge among the mangroves. The yellow-billed Stork (*Mycteria ibis*) and African sacred ibis (*Threskomis aethiopicus*) can be spotted along the Gambia's banks, along with the long crested eagle (*Lophaetus occipitalis*), pelicans, and others birds that find food and shelter in the area. Owls such as the African scops owl (*Otus senegalensis*) may also be found in this area.

Small-bodied mammals, such as the spotted-necked otter and greater cane rat, and larger bodied mammals such as duikers, crocodiles, hippopotamuses, and the vulnerable African manatee call this area home.

As the influence of the Atlantic tide and saltwater wanes, the *Rhizophora* mangroves thin and transition into a collection of freshwater swamps, salt flats, and seasonally flooded grasses, trees, and agriculture. The freshwater swamps are dominated by *Phragmites karka* grasses and are habitat for many species of wintering birds. The swamps create a breeding ground for mosquitoes and tsetse flies, which are vectors for malaria and sleeping sickness, respectively. The most efficient malarial vector in sub-Saharan Africa and host to the most deadly malarial parasite is *Anopheles gambiae*, named for the region in which it is common. Native fish diversity and abundance is an important control on mosquito populations and provides a key ecosystem service by regulating the malaria vector.

Human Interaction

The importance of the Gambia River to human communities is apparent from the names of the five administrative divisions of The Gambia: Western, North Bank, Lower River, Central River, and Upper River. Many Gambians outside of the capital depend directly on agriculture and fishing for their wellbeing. Wood is the most common fuel source and comes from the riverbanks and floodplain. These economic activities both depend on and severely impact the health of the river.

Nearly one-third of The Gambia has been converted to arable land dedicated to the production of rice, maize, groundnuts, millet, and sorghum. Similar land transformations have occurred in southeastern Senegal and are beginning in the mountainous Fouta Djallon of northern Guinea. These transformations began centuries ago. Flood rice cultivation has been the dominant land use on the banks of the Gambia River for recorded history. The system of flood rice cultivation used in the American south was a direct application of the system used along the banks of the Gambia; evidence suggests that American slave owners and traders targeted slaves of particular ethnic groups because of their experience in rice cultivation along the Gambia's banks.

In addition to its role in cultivation, the river and its tributaries are fished from source to mouth. Prawn is caught in the estuary, while fish are consumed over the river's entire course. Fish populations in the river remain relatively healthy. Hunting for wildfowl and mammals of all sizes is common in the riverine wetlands. Crocodiles, African manatee, and hippopotamuses have been hunted nearly to the point of local extinction in The Gambia, though hippopotamuses can be found in southeastern Senegal, where human populations are less dense.

Though the Gambia River remains the last major undammed river in West Africa, there have been recent efforts to build a hydroelectric dam on the border between Senegal and Guinea, in the region of Kedougou, Senegal. So far the governments of The Gambia, Guinea, Senegal, and Guinea Bissau have raised $700 million through the African Development Bank for construction. The dam has potential to produce 400 gigawatt

hours and would connect to power networks in all four countries, though most of the power would go to Guinea and Senegal.

On the negative side, the dam is expected to impact the sedimentary balance in the river and estuary as well as modify the salt front. It will also influence water quality, deplete mangroves, and generally lead to habitat loss and changes in the populations of some species. These concerns have led several conservation groups to begin planning for monitoring ecosystem impacts of dam construction. As a potential source of electricity as well as an important contributor of biodiversity and other ecosystem services, the Gambia River is a frontier for the management of ecosystems for both environmental and human well-being.

One effect of adding this dam to the Gambia River—the modification of the salt front—will likely be exacerbated by global warming. With higher average temperatures and projected lower annual rainfall will come faster average evaporation rates along the river, which in turn will drive greater rates of salt deposition. Global warming effects will also lead to more acute demand for irrigation water, another factor that will lead to drawing water out of the mainstem of the river and its tributaries. The spread of drier and saltier areas will cause a shift in habitat toward more halophytic plants, and thereby alter the range patterns of animals that rely on vegetation that is less salt-tolerant.

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Further Reading

Jones, Michael. *Flowering Plants of The Gambia*. Boca Raton, FL: CRC Press, 1994.

Louca, Vasilis, Steve W. Lindsay, Silas Majambere, and Martyn C. Lucas. "Fish Community Characteristics of the Lower Gambia River Floodplains: A Study in the Last Major Undisturbed West African River." *Freshwater Biology* 54, no. 2 (2009).

Verkerk, M. P. and C. P. M. van Rens. *Saline Intrusion in Gambia River After Dam Construction.* Enschede, Netherlands: University of Twente, 2005.

Webb, James L.A. Jr. "Ecological and Economic Change Along the Middle Reaches of the Gambia River: 1945–1985." *African Affairs* 91, no. 365 (1992).

Ganges River

Category: Inland Aquatic Biomes.
Geographic Location: Asia.
Summary: The lifeline of India, the Ganges River supports massive and diverse habitats but is threatened by climate change and pollution.

The national river of India, the Ganges, originates at Gaumukh as a stream called Bhagirathi, in the Gangotri glacier in the Himalayan Mountains at an altitude of 13,451 feet (4,100 meters) above mean sea level. The first town in the course of the Ganges, Gangotri, is 14 miles (23 kilometers) from its source of origin. The main stream of the river flows through the Himalayas until another two streams—the Mandakini and the Alaknanda—join it at Devprayag, the point of confluence. The river is also known as Ganga Ma, Mother Ganges, and may be called Ganges or Ganga.

The river takes its course through the Himalayan valleys until it reaches the plain at the town of Haridwar. From there, the Ganges flows southeast through the Indian states of Uttar Pradesh, Bihar, Jharkhand, and West Bengal. At Allahabad, the Yamuna River joins the Ganges. The main tributaries of the Ganges are the Yamuna, Ram Ganga, Gomati, Ghaghara, Son, Damodar, and Sapt Kosi rivers. The largest tributary, the Ghaghara, meets the Ganges in Bihar near Patna. Another important Himalayan tributary is Gandak, which flows from Nepal. The Upper Ganges supplies water to extensive irrigation works.

The Ganges flows through some of the most populous cities in India, such as Kanpur, Allahabad, Varanasi, Patna, and Kolkata. At Bhagalpur, it meanders past the Rajmahal Hills and changes its course southward. At Pakaur, the Ganges has its first distributary, the Bhagirathi River, followed by the river Hoogly. In central Bangladesh, the Brahmaputra and Meghna rivers join the Ganges. These three rivers combined are called the Padma River, which forms a delta 220 miles (354 kilometers) wide when it empties into the Bay of Bengal. The delta is also called Sundarbans; its plains are among the most fertile and densely populated regions of the world.