Box 1.9 Trade-Offs: Lake Victoria's Ecosystem Balance Sheet

Trade-offs among various ecosystem goods and services are common in the management of ecosystems, although rarely factored into decision making. For example, farmers can increase food production by applying fertilizer or expanding the land they have under cultivation, but these strategies harm other goods and services from the land they farm, like water quality and biodiversity.

In very few cases do resource managers or policy makers fully weigh the various trade-offs among ecosystem goods and services. Why? In some cases, lack of information is the obstacle. Typically, not much is known about the likely impact of a particular decision on nonmarketed ecosystem services such as water purification or storm protection. Or, if such information does exist, it may not include estimates of the economic costs and benefits of the trade-offs. In other cases the obstacle is institutional. A government's Ministry of Agriculture naturally focuses primarily on its mission of food production and lacks the expertise or mandate to consider impacts of its actions on water quality, carbon sequestration, or coastal fisheries, for instance.

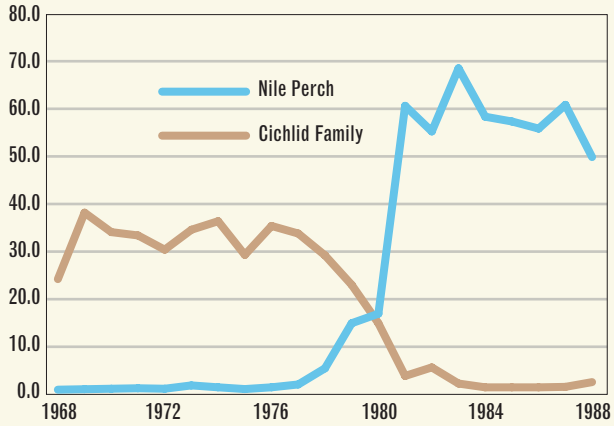
The example of Africa's Lake Victoria illustrates how profound and unpredictable trade-offs can be when management decisions are made without regard to how the ecosystem will react. Lake Victoria, bounded by Uganda, Tanzania, and Kenya, is the world's largest tropical lake and its fish are an important source of food and employment for the region's 30 million people. Before the 1970s, Lake Victoria contained more than 350 species of fish from the cichlid family, of which 90 percent were endemic, giving it one of the most diverse and unique assemblages of fish in the world (Kaufman 1992:846–847, 851). Today, more than half of these species are either extinct or found only in very small populations (Witte et al. 1992:1, 17).

The collapse in the lake's biodiversity was caused primarily by the introduction of two exotic fish species, the Nile perch and Nile tilapia, which fed on and outcompeted the cichlids for food. But other pressures factored in the collapse as well. Overfishing depleted native fish stocks and provided the original impulse for introducing the Nile perch and tilapia in the early 1950s. Land-use changes in the watershed dumped pollution and silt into the lake, increasing its nutrient load and causing algal blooms and low oxygen levels in deeper waters—a process called eutrophication. The result of all these pressures was a major reorganization of the lake's fish-life. Cichlids once accounted for more than 80 percent of Lake Victoria's biomass and provided much of the fish catch (Kaufman 1992:849). By 1983, Nile perch made up almost 70 percent of the catch, with Nile tilapia and a native species of sardine making up most of the balance (Achieng 1990:20).

Although the introduced fishes devastated the lake's biodiversity, they did not not destroy the commercial fishery. In fact, total fish production and its economic value rose considerably.

Trading Biodiversity for Export Earnings

Percentage Contribution to Lake Victoria Fish Catch (Kenya Only), 1968–1988



Source: Achieng 1990:20, citing Fisheries Department of Kenya, *Statistical Bulletin.*

Today, the Nile perch fishery produces some 300,000 metric tons of fish (FAO 1999), earning $280–$400 million in the export market—a market that did not exist before the perch was introduced (Kaufman 2000). Unfortunately, local communities that had depended on the native fish for decades did not benefit from the success of the Nile perch fishery, primarily because Nile perch and tilapia are caught with gear that local fishermen could not afford. And, because most of the Nile perch and tilapia are shipped out of the region, the local availability of fish for consumption has declined. In fact, while tons of perch find their way to diners as far away as Israel and Europe, there is evidence of protein malnutrition among the people of the lake basin (Kaufman 2000).

The sustainability of the Nile perch fishery is also a concern. Overfishing and eutrophication are major threats to the fishery, and the stability of the entire aquatic ecosystem—so radically altered over a 20-year span—is in doubt. The ramifications of the species introductions can even be seen in the watershed surrounding Lake Victoria. Drying the perch's oily flesh to preserve it requires firewood, unlike the cichlids, which could be air-dried. This has increased pressure on the area's limited forests, increasing siltation and eutrophication, which, in turn, has further unbalanced the precarious lake ecosystem (Kaufman 1992:849–851; Kaufman 2000).

In sum, introducing Nile perch and tilapia to Lake Victoria traded the lake's biodiversity and an important local food source for a significant—although perhaps unsustainable—source of export earnings. When fisheries managers introduced these species, they unknowingly altered the balance of goods and services the lake produced and redistributed the economic benefits flowing from them. Knowing the full dimensions of these trade-offs, would they make the same decision today?