



Aquaculture and the Environment

WWF: Making Aquaculture Sustainable

WWF is paving the way to help the aquaculture industry minimize its environmental and social impacts and grow in a sustainable manner. We recognize that the challenges facing aquaculture management around the world are complex. So we work with industry to identify and analyze the major impacts of aquaculture production systems and promote better management practices. Some key facts paint a picture of aquaculture on a global scale:

- Asia accounts for 87 percent of all aquaculture production.
- Aquaculture produces 63 percent of the world salmon supply and 30 percent of world shrimp supply.
- One-third of all wild-caught fish are used to make feed for aquaculture production.
- One shrimp cocktail can require anywhere from 0.25 to 200 cubic meters of water depending on production methods used.
- In 2002, carp was the most produced species at 16.7 mmt. Oysters were second at 4.3 mmt.
- It can take up to 22 kilograms of wild fish to produce 1 kilogram of tuna from aquaculture.
- By volume, seaweeds account for almost 25 percent of total aquaculture production.

Conversions from Metric to U.S. Measurements

- 1 cubic meter = 1.308 cubic yards
- mmt = million metric tons
- 1 metric ton = 1.102 tons
- 1 kilogram = 2.205 pounds

Aquaculture is an important economic activity in many countries and offers opportunities to contribute to poverty alleviation, employment, community development, reduction of exploitation of natural resources, and food security in tropical and subtropical regions. The development of aquaculture has, however, generated debate over the social and environmental costs and benefits. Viewed alternatively as a solution to overfishing or as a massive threat to marine and freshwater environments, aquaculture has come to the forefront of debates about the long-term viability of global food production systems. World Wildlife Fund is working to reconcile the opportunities that aquaculture provides with the risks it poses to society and the environment.

Not Just Fish Farming

Aquaculture—often referred to as fish farming—in fact includes the production of more than 400 species of aquatic life including marine and freshwater fish, crustaceans, and seaweeds. It is the fastest growing food production system on the planet. From 1993 to 2003, aquaculture production more than doubled, reaching an estimated 54 million metric tons (mmt).

Aquaculture accounts for more than 30 percent of commercial fish and shellfish production annually. It is estimated that by 2020, aquaculture will produce more than 68 mmt (excluding aquatic plants), accounting for approximately 40 percent of global seafood production. Most countries, from China to



Manav Sawhney

The production of kelp and other seaweeds, practiced around the world, can actually benefit the environment. The plants help filter the ocean by removing excess nutrients that result from, among other human activities, sewage and agricultural runoff.



WWF-Canon/Maren Esmark

Salmon farms, such as this one in Denmark's Faeroe Islands, can have both positive and negative impacts on local communities.

Chile to Madagascar, produce fish, shellfish, and/or sea plants by aquaculture. Like agriculture, aquaculture is practiced in both developed and developing countries.

The growth of aquaculture has been spurred by an ever-increasing demand for seafood and the limited supply of wild fish. For more than 30 years, per capita seafood consumption has increased and the world population has grown, with the boom in aquaculture a response to the increasing demand.

Harvests from wild fisheries have remained relatively flat since the early 1990s. The U.N. Food and Agriculture Organization estimates

that about three-quarters of wild stocks are fully fished, overfished, or depleted. As a result, any future increases in seafood production are expected to come from aquaculture.

Threats to Habitats and Species

Aquaculture has been heralded for its potential to meet the increases in seafood demand, and to take pressure off wild fisheries. However, aquaculture can have serious impacts on the environment. Wastes from fish farms can pollute adjacent waters and harm fish and other wildlife. Chemicals, including antibiotics, can be released into the environment from aquaculture farms. Escaped farmed species can compete with wild ones for food and habitat, transfer disease, and introduce nonnative DNA into the wild gene pool.

In addition to polluting habitat, aquaculture can have direct negative impacts on wild populations of fish, birds, and mammals such as seals and sea lions. The young of farmed species produced in marine and freshwater environments are susceptible to predation by birds and other wild animals, prompting farmers to use lethal methods to control predation. Small wild fish, like anchovies, are caught to produce fishmeal and fish oil—the primary ingredients in feed given to shrimp, salmon, and other carnivorous

Feeding the Fish

Just as with livestock, many species produced from aquaculture are given feed that usually includes some fishmeal and fish oil made from small wild fish, such as anchovies. Carnivorous species, such as tuna, salmon, and shrimp, consume more fish protein than they produce, resulting in a net loss of fisheries product. One-third of all wild-caught fish are used in this manner, but the environmental impacts of removing so many small fish from the ocean remain unknown.

The sustainability of many wild fisheries will be threatened if demand for fishmeal and fish oil continues to rise. Populations of large fish and seabirds, which consume the small fish, also will be negatively affected. The aquaculture industry has reduced the percentage of fishmeal and oil in feed significantly in recent years, and continues to research ways to decrease reliance on them. Decreasing reliance on fishmeal and fish oil is one way for producers to save money while reducing their impact on the environment.



WWF-Canon/Ezequiel Navío

The market for tuna is exploding in Japan, leading to rapid growth in the tuna ranching industry. Here, yellowfin tuna are raised in the enclosures of a marine farm in the Canary Islands, Spain.

species. Fish caught to make fish feed now represent a third of the global fish harvest. As aquaculture grows, so does the pressure on these wild fisheries.

Varied Methods, Varied Impacts

It is somewhat self-evident that the impacts of aquaculture production vary by species, based on the species' unique characteristics and how they interact with their environments. But the impacts also vary by location: in rivers or lakes, inland, along the coastline, in the oceans, on the seafloor. For example, clams, scallops, oysters, and mussels filter nutrients and particulates from the water whether they are raised suspended from ropes and rafts or grown on the ocean floor. But harvesting shellfish from the seabed frequently requires dredges that disrupt and destroy natural



WWF-Katherine Bostick

The production of aquaculture species frequently relies upon hatchery-bred and -raised young, a practice preferable to capturing young from the wild. In this hard clam hatchery in Thailand, young clams are raised in tanks before they are transferred to the sea for maturation.



WWF-Katherine Bostick

One-third of wild-caught fish are used in feed for farmed fish. At some shrimp farms, the use of feeding trays, like the one above, has reduced feed use by 25 to 50 percent. Broadly applied, such efficiencies could lower overall demand for fish-based feed and reduce the impact on wild populations.

habitat, making suspended culture the better choice from the environmental perspective.

Choice of production technique or technology also determines environmental impacts, as is the case with a range of species produced in man-made ponds, including tilapia, shrimp, trout, and catfish. If the ponds are drained at harvest, nutrients are released into the environment and large volumes of water are required to refill the ponds. But when the species are harvested using nets, water and nutrients remain in the ponds for many production cycles. With today's better, and still improving, technology, many fish can be raised in recirculating systems that require very little water exchange, reducing the amount of discharged nutrient-rich effluents.

Even within salmon aquaculture that uses open net-pen technology, the management practices of different farms can produce different environmental impacts. Variables that determine environmental impacts include where net pens are built, the strength of ocean currents at different locations, the producer's efficiency of feed use, decisions on chemical and antibiotic treatments, and maintenance of pens to prevent escapes.

WWF: Shaping a Better Future

WWF scientists work with aquaculture industries around the world to reduce their environmental impacts. Experts identify and document better practices that minimize environmental

Shrimp Farming in Mangroves

Improper siting of aquaculture operations can damage delicate aquatic ecosystems. A prime example of this is the history of shrimp farming in mangrove ecosystems. The clearing of mangroves was a common practice during the rapid expansion of the industry in the 1980s and early 1990s. Shrimp farming alone appears to be responsible for some 5 to 10 percent of the global loss of mangrove habitat. Yet in some countries it has caused as much as 20 percent of the damage to mangrove areas, and in some watersheds shrimp farming has accounted for virtually all mangrove destruction.

The practice has also proven costly for shrimp farmers as the acidic soils in mangrove areas greatly reduce the productivity of a farm. Unfortunately, damage to the ecosystems had already been done by the time researchers, farmers, and governments recognized that harming the environment was a costly mistake.

Since WWF's involvement with shrimp aquaculture began in 1994, our work, as well as that of other conservation groups and progressive companies, has produced a global trend to avoid constructing shrimp ponds in mangrove areas. WWF calls on governments, nongovernmental organizations, and producers to work to ensure that this trend continues.



WWF-Canon/Hartmut Jungius

Mussels and clams are cultured on ropes suspended from buoys in the Krabbe Peninsula in the Russian Federation. Rope culture of these filter-feeders has minimal environmental impact.

harm, improve efficiency, and lower production costs. Competition is forcing the industry to consider better practices more seriously, especially when methods that promote sustainable aquaculture benefit both the environment and the farmer. Good maintenance of nets in salmon facilities reduces the likelihood of environmentally harmful escapes and ultimately safeguards profits. Inland, properly constructed fish ponds edged by healthy vegetation reduce erosion and sedimentation, saving farmers the cost of reconstructing embankments and preventing eroded soil from entering local waterways. Ultimately, producers must rely on a clean environment if they plan to continue producing in the same area for many years.

To this end, WWF brings together producers, buyers, governments, nongovernmental organizations, investors, and other key stakeholders to identify and study the major impacts of producing different species, to promote better practices, and to develop standards for sustainable aquaculture. These standards can be used as the basis for government permits and for shaping investment or buyer decision-making. Ultimately, the standards will be used by WWF to create and implement a global aquaculture certification program, rewarding producers with financial benefits for protecting the environment.

WWF's Center for Conservation Innovation

In our commitment to save a living planet, WWF focuses on reconciling the needs of people with those of nature. Food—a basic human necessity—is produced around the globe using a wide variety of agricultural and aquacultural practices, each having its own impact on the environment. As global food needs grow and consumption patterns shift to animal protein, sustainable resource management becomes even more urgent. Managing social and environmental costs and benefits is a perpetual challenge that WWF's Center for Conservation Innovation addresses as we work to conserve biodiversity through innovative partnerships focused on people-based solutions.

For more information about the agriculture and aquaculture programs of WWF's Center for Conservation Innovation, visit www.worldwildlife.org/cci



WWF-Katherine Bostick

Aerators on a shrimp farm in Thailand are used to increase oxygen levels in the ponds, making it possible to raise larger volumes of shrimp.

WWF Mission Statement

WWF's mission is the conservation of nature. Using the best available scientific knowledge and advancing that knowledge where we can, we work to preserve the diversity and abundance of life on Earth and the health of ecological systems by

- protecting natural areas and wild populations of plants and animals, including endangered species;
- promoting sustainable approaches to the use of renewable natural resources; and
- promoting more efficient use of resources and energy and the maximum reduction of pollution.

We are committed to reversing the degradation of our planet's natural environment and to building a future in which human needs are met in harmony with nature. We recognize the critical relevance of human numbers, poverty, and consumption patterns to meeting these goals.

Support WWF's work.

Call 1-888-993-1100 or visit us at www.worldwildlife.org for ways you can help WWF conserve a living planet.



WWF for a living planet®