

Management of Aquatic Fauna

The notion of [sustainable development](#) is sometimes regarded as an unattainable, even illogical notion because development inevitably depletes and degrades the environment.

[Ray Hilborn](#), of the [University of Washington](#), distinguishes three ways of defining a sustainable fishery.

- *Long term constant yield* is the idea that undisturbed nature establishes a steady state that changes little over time. Properly done, fishing at up to [maximum sustainable yield](#) allows nature to adjust to a new steady state, without compromising future harvests. However, this view is naive, because constancy is not an attribute of marine ecosystems, which dooms this approach. Stock abundance fluctuates naturally, changing the potential yield over short and long term periods.
- *Preserving intergenerational equity* acknowledges natural fluctuations and regards as unsustainable only practices which damage the [genetic](#) structure [destroy habitat](#), or deplete [stock levels](#) to the point where rebuilding requires more than a single generation. Providing rebuilding takes only one generation, [overfishing](#) may be economically foolish, but it is not unsustainable. This definition is widely accepted.
- *Maintaining a biological, social and economic system* considers the health of the human ecosystem as well as the marine ecosystem. A fishery which rotates among multiple species can deplete individual stocks and still be sustainable so long as the ecosystem retains its intrinsic integrity. Such a definition might consider as sustainable fishing practices that lead to the reduction and possible extinction of some species.

Social sustainability

Fisheries and aquaculture are, directly or indirectly, a source of livelihood for over 500 million people, mostly in developing countries. While biodiversity is important, people need [food security](#).

Social sustainability can conflict with biodiversity. A fishery is socially sustainable if the fishery ecosystem maintains the ability to deliver products the society can use. Major species shifts within the ecosystem could be acceptable as long as the flow of such products continues.

Humans have been operating such regimes for thousands of years, transforming many ecosystems, depleting or driving to extinction many species.

According to Hilborn, the "loss of some species, and indeed transformation of the ecosystem is not incompatible with sustainable harvests. For example, in recent years, [barndoor skates](#) have been caught as [bycatch](#) in the western Atlantic. Their numbers have severely declined and they will probably go extinct if these catch rates continue. Even if the barndoor skate goes extinct, changing the ecosystem, there could still be sustainable fishing of other commercial species.

At the Fourth World Fisheries Congress in 2004, [Daniel Pauly](#) asked, "How can fisheries science and conservation biology achieve a reconciliation?", then answered his own question, "By accepting each other's essentials: that fishing should remain a viable occupation; and that aquatic ecosystems and their biodiversity are allowed to persist."

Overfishing

Overfishing can be sustainable. According to Hilborn, overfishing can be "a misallocation of societies' resources", but it does not necessarily threaten conservation or sustainability".

[Overfishing](#) is traditionally defined as harvesting so many fish that the yield is less than it would be if fishing were reduced.^[1] For example, [Pacific salmon](#) are usually managed by trying to determine how many spawning salmon, called the "[escapement](#)", are needed each generation to produce the maximum harvestable surplus. The optimum escapement is that needed to reach that surplus. If the escapement is half the optimum, then normal fishing looks like overfishing. But this is still sustainable fishing, which could continue indefinitely at its reduced stock numbers

and yield. There is a wide range of escapement sizes that present no threat that the stock might collapse or that the stock structure might erode.[1]

On the other hand, overfishing can precede severe stock depletion and fishery collapse.[12]

Hilborn points out that continuing to exert fishing pressure while production decreases, stock collapses and the fishery fails, is largely "the product of institutional failure."

Today over 70% of fish species are either fully exploited, overexploited, depleted, or recovering from depletion. If overfishing does not decrease, it is predicted that stocks of all species currently commercially fished for will collapse by 2048.

A Hubbert linearization ([Hubbert curve](#)) has been applied to the [whaling](#) industry, as well as charting the price of [caviar](#), which depends on [sturgeon](#) stocks. Another example is [North Sea cod](#). Comparing fisheries and mineral extraction tells us that human pressure on the environment is causing a wide range of resources to go through a Hubbert depletion cycle.

The global continental shelf, highlighted in cyan

See also: [Environmental effects of fishing](#) and [Destructive fishing practices](#)

Nearly all the world's [continental shelves](#), and large areas of [continental slopes](#), underwater ridges, and [seamounts](#), have had heavy [bottom trawls](#) and [dredges](#) repeatedly dragged over their surfaces. For fifty years, governments and organizations, such as the [Asian Development Bank](#), have encouraged the fishing industry to develop trawler fleets. Repeated bottom trawling and dredging literally flattens diversity in the [benthic](#) habitat, radically changing the associated communities.[17]

Fishing with a lift net in [Bangladesh](#). Coastal fishing communities in Bangladesh are vulnerable to flooding from sea-level rises.[18]

Main article: [Fisheries and climate change](#)

Rising ocean temperatures[19] and [ocean acidification](#)[20] are radically altering [aquatic ecosystems](#). [Climate change](#) is modifying fish distribution[21] and the productivity of marine and freshwater species. This reduces sustainable catch levels across many habitats, puts pressure on resources needed for [aquaculture](#), on the communities that depend on fisheries, and on the oceans' ability to capture and store carbon ([biological pump](#)). [Sea level rise](#) puts coastal [fishing communities](#) at risk, while changing rainfall patterns and water use impact on inland (freshwater) fisheries and aquaculture.

Island with [fringing reef](#) in the [Maldives](#). [Coral reefs](#) are dying around the world.[22]

Main article: [Marine pollution](#)

A recent survey of global ocean health concluded that all parts of the ocean have been impacted by human development and that 41 percent has been fouled with human polluted runoff, [overfishing](#), and other abuses.[23] [Pollution](#) is not easy to fix, because pollution sources are so dispersed, and are built into the economic systems we depend on.

The [United Nations Environment Programme](#) (UNEP) mapped the impacts of stressors such as climate change, pollution, [exotic species](#), and [over-exploitation](#) of resources on the oceans. The report shows at least 75 percent of the world's key fishing grounds may be affected.[24][25][26]

Diseases and toxins

See also: [Fish diseases and parasites](#), [Harmful algal blooms](#), and [Mercury in fish](#)

Large predator fish contain significant amounts of mercury, a neurotoxin which can affect [fetal development](#), memory, mental focus, and produce tremors.

Separately, the release of wastewater polluted with [microbes](#), [hormones](#), human and animal medicines and other contaminants can kill fish, reducing sustainable harvests.

Fisheries management

[Fisheries management](#) draws on [fisheries science](#) to enable sustainable exploitation. Modern fisheries management is often defined as mandatory rules based on concrete objectives and a mix

of management techniques, enforced by a [monitoring control and surveillance](#) system.

- Ideas and rules: Economist [Paul Romer](#) believes sustainable growth is possible providing the right ideas (technology) are combined with the right rules, rather than simply hectoring fishers. There has been no lack of innovative ideas about how to harvest fish. He characterizes failures as primarily failures to apply appropriate rules.

- Fishing subsidies: Government subsidies influence many of the world fisheries. Operating cost subsidies allow European and Asian [fishing fleets](#) to fish in distant waters, such as West Africa. Many experts reject fishing subsidies and advocate restructuring incentives globally to help struggling fisheries recover.

- Economics: Another focus of conservationists is on curtailing detrimental human activities by improving fisheries' market structure with techniques such as salable [fishing quotas](#), like those set up by the [Northwest Atlantic Fisheries Organization](#), or laws such as those listed below.

- Sustainable fisheries certification: A promising direction is the independent certification programs for sustainable fisheries conducted by organizations such as the [Marine Stewardship Council](#) and [Friend of the Sea](#). These programs work at raising consumer awareness and insight into the nature of their seafood purchases.