# Endangered Species and Loss of Marine Biodiversity

*Ecosystems worldwide are experiencing rapid degradation and a severe loss of biodiversity as a result of diverse human activities. Seafood production is one major contributor to biodiversity loss across coastal and oceanic habitats. Declining species abundance and ranges weaken the resilience and threaten the functionality of ecosystems, particularly in the face of climate change, which undermine their long-term production capacity. The future viability of the seafood industry rests on reversing the current trajectories of biodiversity loss. Reducing negative human pressures on threatened and endangered species and habitats will be essential.*

## Overview

Global loss of biodiversity across land and ocean is happening at an unprecedented rate in human history.[1] Human activities have impacted all known marine habitat types on the planet, from coastal waters and the open ocean through to the deep-sea.[2,3] This represents a threat to human wellbeing and prosperity, as it erodes the health of the ecosystems that society and industry depend on for food and job security as well as human health and wellbeing. It also undermines the future potential of global capture fisheries, which are projected to decline in the 21st century due to loss of biodiversity, if not properly managed.[4]

The growing number of endangered and threatened species around the world is perhaps one of the most symptomatic illustrations of how human activities impact ecosystems. Up to 1 million species are threatened with extinction. The current rate of species extinction is tens to hundreds of times higher compared to the average rates over the last 10 million years, and almost 33% of reef-forming corals and more than a third of all marine mammals are threatened.[1]

Difficulties in reaching consensus on the standards for what constitutes an "endangered" species, is exacerbated by data limitations and rapidly changing environmental and climatic conditions. While these challenges are significant for marine species, broad trends are evident and alarming, and are in many instances directly linked to seafood production (capture fisheries and marine aquaculture). Despite a number of international conventions and regulatory bodies with obligations for conservation and sustainable use of natural resources, many have failed to stop or slow biodiversity loss.

## What are endangered species?

Endangered species are plants and animals that are one step away from going extinct (Table 1).

Table 1. Four categories of extinction.

| | Description | Example |
|---|---|---|
| ***Commercial extinction*** | The depletion of a species to the point that it is no longer found in sufficient abundance to maintain profitable commercial harvest. | Newfoundland Atlantic Cod (*Gadus morhua*) |
| ***Local extinction*** | The condition of a species that ceases to exist in a given geographic area, though it still exists elsewhere. | Bull kelp (*Durvillaea* spp.) in New Zealand |
| ***Ecological extinction*** | The reduction of a species to such low abundance that, although it is still present in the community, it no longer interacts with other species and cannot fulfil its ecological role. | Vaquita (*Phocoena sinus*)[15] |
| ***Extinction (or extinct in the wild)*** | The termination of a species. Generally considered to be the death of the last individual of the species. A species is extinct in the wild when it only survives in cultivation or captivity. | Caribbean monk seal (*Monachus tropicalis*) |

The International Union for Conservation of Nature (IUCN) describes endangered species as having *'a very high risk of extinction as a result of rapid population declines of 50 to more than 70 percent over the previous 10 years (or three generations), a current population size of fewer than 250 individuals, or other factors'*. The IUCN Red List, the world's most comprehensive inventory and database on the ecological status of species, identifies "threatened" species as those that are either *Vulnerable*, *Endangered*, or *Critically Endangered* (Figure 1A). The threat category assigned for a species is often comprised of multiple population scores, and may mask the health of particular populations (i.e., a group of organisms of the same species that occupy a particular area). The leatherback sea turtle (*Dermochelys coriacea*), for instance, has an overall classification of *Vulnerable*, but four of the seven assessed populations are *Critically Endangered* (Figure 1B).

## Marine biodiversity loss

Fishing involves the removal of biomass from the ocean and has substantial impacts on the targeted fish populations as well as non-target species and habitats. The proportion of overfished stocks has increased from 10% in 1974 to 34% today.[5] This overexploitation has negative consequences for ecosystems and commercial profitability, resulting in billions of dollars in lost revenues due to continued overfishing of depleted

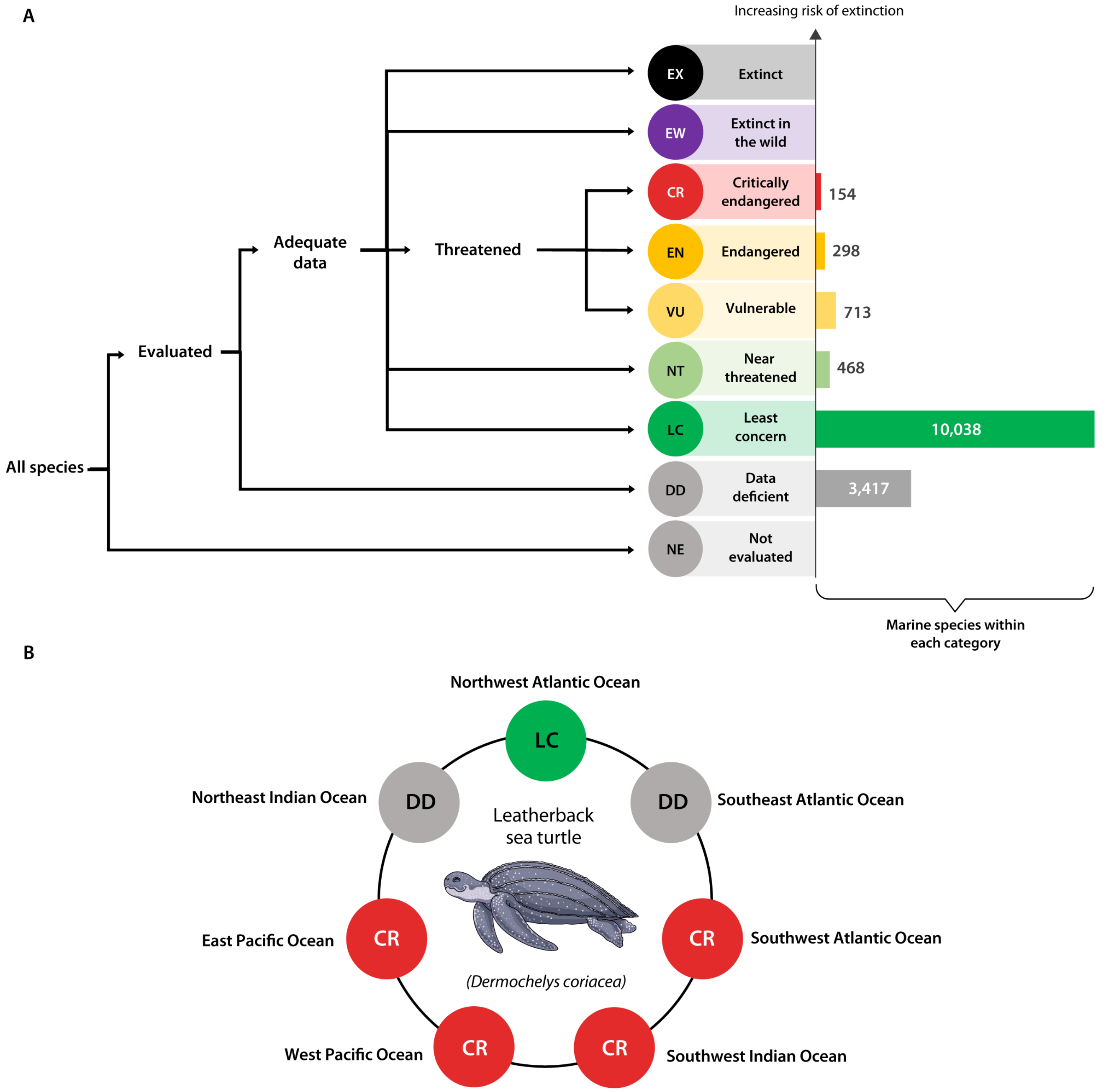
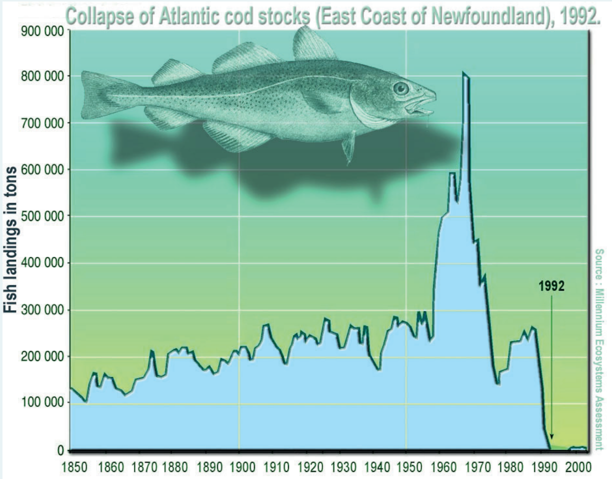



**Figure 1. (A)** IUCN Red List classification framework and number of marine species within each of the categories as of March 2021 (https://www.iucnredlist.org/search/stats). While it includes approximately 15,000 marine species, these are mainly vertebrates, and comprise less than 1% of the roughly two million species that are estimated to inhabit the ocean. **(B)** Of the seven populations of leatherback sea turtles, one is *least concern* (LC), two are *data deficient* (DD) and four are *critically endangered* (CR).

## Box 1. The Newfoundland cod stock collapse

In 1883, the world-renowned biologist Thomas Henry Huxley infamously stated: "*I believe, then, that the cod fishery… and probably all the great sea fisheries, are inexhaustible: that is to say that nothing we do seriously affects the number of fish. And any attempt to regulate these fisheries seems… to be useless*". Less than a century later, one the largest fisheries in history, Newfoundland Atlantic Cod (*Gadus morhua*), had collapsed (99% reduction in spawning stock biomass) and 35,000 jobs had been lost. Despite a drastic 40-year fishing moratorium, the ecosystem has become dominated by crustaceans, the stock still has not recovered, and the species is now considered to be commercially and ecologically extinct.[33]




(**A**) Fishers hauling their cod trap, Change Islands Fisheries, Newfoundland, 1921. Photo available at the Newfoundland's Grand Banks (**B**) Collapse of Atlantic cod stocks off the East Coast of Newfoundland in 1992, adapted from the Millennium Ecosystem Assessment (2005).

populations (Box 1).[6,7] Depletion from excessive fishing may also result in reductions of species body size and their range.[8-11]

Marine capture fisheries represent the single largest cause of increased extinction risk among marine species (Figure 2). Some species, such as seabirds, sharks and rays, are particularly vulnerable to being caught as bycatch in fisheries. Of the 40 albatross and large petrel species, 21 are classified as *vulnerable*, *endangered* or *critically endangered*, while 16 of the 31 oceanic sharks are now *endangered* or *critically endangered*.[9]

In some cases, threatened species are still actively targeted by fishing operations, with at least 91 threatened species (comprising 1.6% of the total catch volume and 2.5% of the value based on ex-vessel price data) found in global catch and import records, including some tuna, billfish and shark populations.[12] Regardless of whether threatened species are being targeted or are unintended

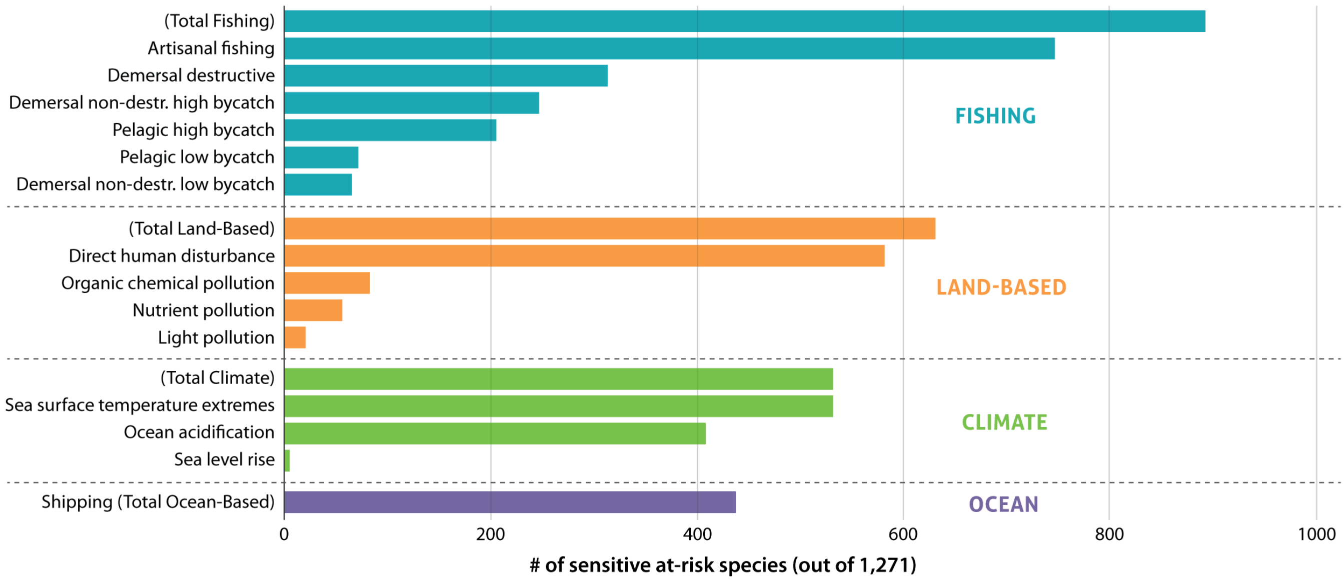



**Figure 2**. Stressors affecting at-risk marine species (i.e., defined as *threatened* or *near-threatened* in the IUCN Red List) based on threat information from IUCN Red List assessments. Categories "Total" count species that are sensitive to one or more stressors in the category. Overall, 70% of at-risk species are sensitive to one or more fishing stressors. Adapted from O'Hara et al.[19]

bycatch, these species are being further depleted due to the degradation of important habitats, climate change and reductions in prey availability.[13,14]

## Habitat degradation

Marine species are all part of broader biological communities, which together with their surrounding environment (i.e. their habitat) form ecosystems. While it is uncommon to refer to habitats as being 'endangered', their degradation, fragmentation and loss can jeopardize the fate of species of ecological and economic importance and entire ecosystems. In addition, while a species of commercial interest may be sustainably harvested, changes in its environment, the depletion of their prey, or illegal, unreported and unregulated (IUU) fishing may lead to a higher risk of commercial, ecological or local extinction.

In addition to forming the foundation of multiple ecosystem types, certain habitats play important roles as spawning and nursery grounds.[20] While some species spawn over large extents of the open ocean, where their larvae are transported by ocean currents, a large proportion of species of cultural, nutritional and economic importance rely on coastal habitats for reproduction and protection in their early life; these include mangrove forests, seagrass meadows or coral reefs (Figure 3).

Both wild-capture and aquaculture operations can result in habitat degradation. Over the past 20 years, climate-induced sea level rise and deforestation for uses such as aquaculture production have led to a 35% loss in global mangrove forest coverage, which currently experiences decline rates between 1-2% per year.[21] Similarly, seagrass meadows, which provide critical habitat for species of fisheries interest, are declining at 7% per year primarily due to coastal development and climate change.[22]

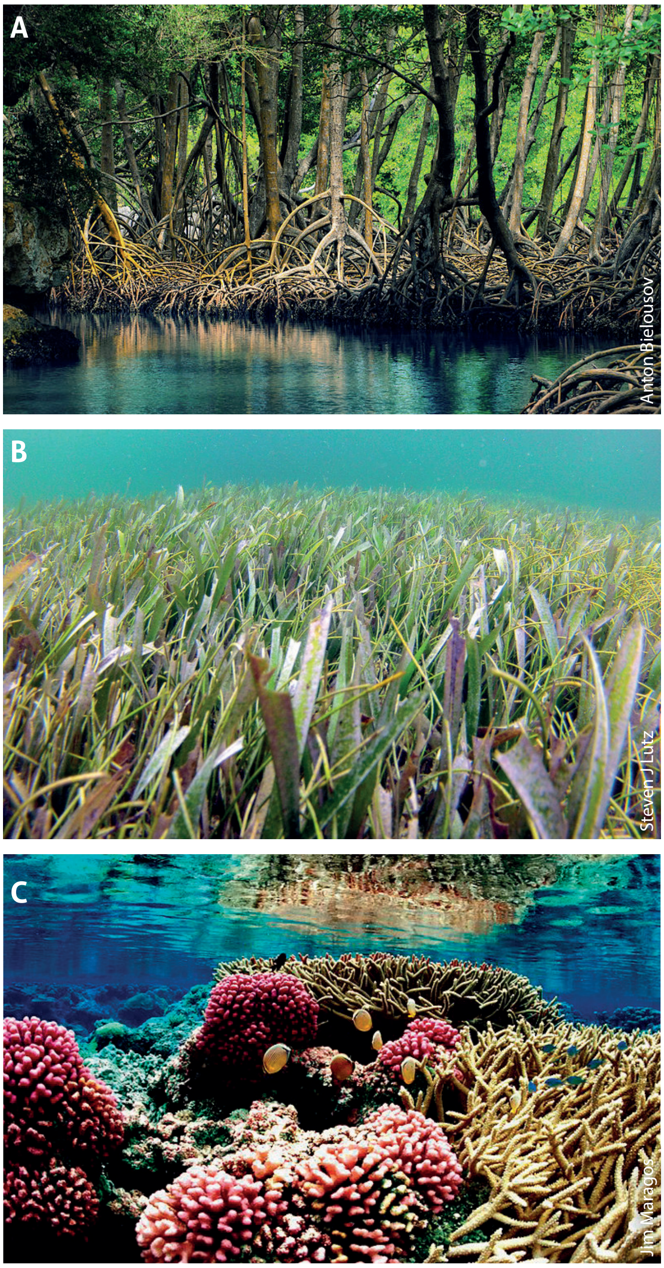



**Figure 3**. Three key marine habitats for biodiversity: (**A**) Mangrove forests (**B**) Seagrass meadows (**C**) Coral reefs.

Table 2. Examples of relevant international conventions and frameworks used to ensure the conservation of marine biodiversity and habitats. Some of these provides guidelines and best practice, while others like CITES are legally binding for ratifying states.

| Framework | Scope | Link |
|---|---|---|
| *Convention on Biological Diversity (CBD)* | A convention for the conservation of biological diversity and the fair and equitable sharing of benefits arising from genetic resources. | www.cbd.int |
| *Convention on International Trade in Endangered Species (CITES)* | Multilateral treaty for the conservation of endangered fauna and flora. | www.cites.org |
| *Convention on Migratory Species (CMS)* | Global platform for the conservation and sustainable use of migratory animals and their habitats. | www.cms.int |
| *Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR)* | International treaty for the conservation of wetlands. | www.ramsar.org |
| *Agreement on the Conservation of Albatrosses and Petrels (ACAP)* | The Agreement which strives to conserve albatrosses and petrels by coordinating international activities to mitigate threats to their populations. | www.acap.aq |

**Box 2: Regional fisheries management organizations**

Since 1949, 14 RFMOs have been established with the mandate to conserve and manage transboundary species targeted or impacted by fisheries. These international bodies are tasked with collecting fisheries statistics, assessing resources, making management decisions and monitoring activities. Significant gaps of relevance for endangered species remain, including the absence of RFMOs for large parts of the ocean (e.g. Southwest Atlantic, Eastern Indian Ocean), and an uneven focus on endangered species among existing RFMOs. While some RFMOs have initiated non-retention policies and designated Vulnerable Marine Ecosystems and associated closures, RFMO have insufficient bycatch and mortality limits for non-target species groups. Independent oversight ranges across RFMOs, where some mandate 100% observer coverage, whereas others only have observers on a small fraction of all operations.[26]

While the prospects for mangrove forest or seagrass meadow restoration initiatives are realistic, the impacts of bottom trawling on benthic ecosystems can affect these habitats and their species for decades to centuries.[23] Many bottom dwelling species have evolved to grow and reproduce at far slower rates than those in shallower coastal waters due to extreme conditions of pressure, temperature and lack of light. UN General Assembly Resolutions 61/105 (2006) and 64/72 (2009) limit deep-sea fisheries in international waters due to their long-lasting detrimental effects on the habitats and biological communities, particularly those of seamounts and ridge systems. This resulted in the establishment of a process to identify and avoid Vulnerable Marine Ecosystems (VMEs).[24]

## A patchy legal framework

There are multiple international conventions, treaties and management bodies that govern human interactions with marine biodiversity (Table 2). Some have a mandate to manage individual species, while others cover entire regions or individual sectors. Adopting measures to reduce the extinction risk of marine biodiversity requires a holistic approach to what can be complex legal and jurisdictional landscapes.

Aquaculture production and the majority of fishing occurs within Exclusive Economic Zones (EEZs), making effective domestic policy crucial to achieving sustainable management of marine resources and coastal habitats. Yet there are some 25,000 transboundary species with distribution that extends across two or more EEZs, which depend on multilateral collaboration around management and conservation measures. Regional fisheries management organizations (RFMOs) (Box 2) are a key mechanism for such efforts, although few have operationalized obligations to reduce adverse impacts on non-target species.[25]

## What can the seafood industry do?

Stewardship of natural resources is anchored in a growing realization that transforming ocean use is a necessity for a prosperous and equitable society. Mitigating impacts on at-risk biodiversity is critical to supporting healthy, thriving and resilient marine ecosystems. The seafood industry has an important role to play, not least by ensuring that existing regulations are followed. Regulations may include input control measures like gear, effort or area restrictions, and output controls such as lists of species to avoid, or annual catch limits. Although implementation of such measures has proven insufficient to effectively reduce threats to many species groups, there is a large range of bycatch mitigation technologies that have proven to be effective (Figure 4). Not only do they reduce excess mortalities of non-target species, they often also reduce bait loss, cumbersome work with entangled animals, and ultimately, closures of fisheries governed with "bycatch quotas". Further use of existing technologies and industry innovation, can substantially reduce the threats to endangered species.

There is growing evidence of progressive industry leaders who move beyond compliance and take voluntary measures to reduce their impacts on non-target biodiversity or critical habitats. Examples include measures taken e.g., by SeaBOS members such as the use of non-entangling fish aggregating devices (FADs) in purse seine fishing, the guarantee of a shark-free supply chains, the voluntary closure of areas that are important for breeding colonies of Antarctic penguins, as well as transparency and traceability efforts to increase on-board observer coverage.

Some of these actions are part of broader fisheries improvement projects (FIPs), which over the past decade have emerged as one of the most promising avenues for advancing sustainable practices in marine fisheries,[27] while others may be associated with a rapidly growing landscape of external incentives like sustainability-linked loans.[28] Additional highly impactful, low-cost measures include the more systematic collection of biological data, such as genomic samples for fisheries-independent abundance assessments,[29,30] which are emerging thanks to science-industry engagement.

Ultimately, the seafood sector is only one of many land-based and ocean-based industries contributing to the overall decline in ocean health.[2] The impacts of climate change, plastic pollution, shipping, dredging, drilling and other activities, represent additional stressors to the

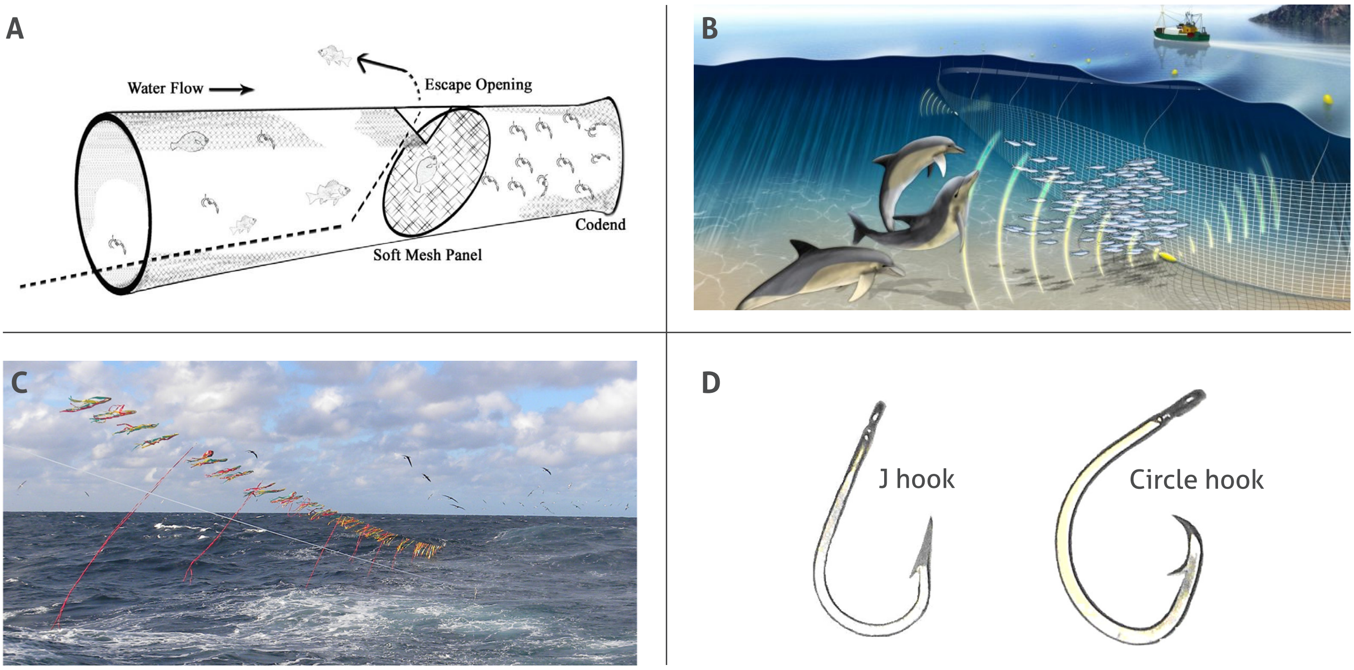



**Figure 4.** Examples of innovations to reduce bycatch and impacts on endangered and threatened species. (**A**) Bycatch reduction devices, used for instance in shrimp trawl fisheries, with an opening to allow escapement of non-target species such as dolphins, seals, and turtles. Illustration Brian Owens in Frimodig.[34] (**B**) Acoustic deterrent devices, also known as pingers, are intended to keep species such as cetaceans and seals away from gillnets. Illustration designed by Andy McLaughlin (www.tcistudio.co.uk) for the Cornwall Wildlife Trust. (**C**) Tori line used to reduce seabird bycatch in pelagic longline fishing by scaring birds away from the area where the baited hooks sink. Photo from Domingo et al.[31]. (**D**) Circle hooks (right) are designed be more effective than J hooks (left) at reducing captures of turtles because of their rounded shape with the point oriented perpendicular to the shank. Adapted from Gilman et al.[32].

marine environment, which may threaten the viability of capture fisheries and aquaculture operations. Yet the seafood industry is vitally dependent on a functioning biosphere, healthy fish populations and resilient ecosystems – along with a reputation that this industry is making its best efforts to maintain the existence of the ecosystems they operate in. Voluntary commitments by seafood companies to address biodiversity loss and endangered and threatened species illustrate this recognition and effort, and can create new norms of best practice for ocean industries. Such actions can also be a catalyst for effective public policies and improved legislation across all sectors to reverse trends of biodiversity loss and reduce the number of endangered, threatened and extinct species.

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