

Greenpeace 'Red-Grade' Criteria for Unsustainable Fisheries

This set of criteria has been designed to identify relatively quickly the most unsustainable fisheries that Greenpeace considers should be avoided (graded red).

Uses of the criteria

1. The criteria are used in the development of various national and the international Greenpeace red lists of species that have a high risk of being sourced from unsustainable fisheries or farms (refer to the Red Criteria for Unsustainable Aquaculture).
2. The criteria can be used to advise fish buyers within the retail and catering industries to identify all fisheries that should be avoided as part of a sustainable seafood procurement policy that aims to:
 - Avoid the worst
 - Support the best
 - Change the rest.

How does it work?

The procedure is based on answering a relatively simple set of 'worst practice' questions in various aspects of fishing for which an answer of 'yes' immediately grades a fishery as red. The questions are not presented in order of importance, rather they are ordered in a manner that allows the assessor to ask as few questions as possible, with the minimum detailed research required, to determine whether a fishery should be graded red.

Fisheries are defined according to the species targeted (using the scientific name), the stock, and the fishing method used. Each criterion includes one or two key questions to ask of a fishery along with supporting information and key references:

1. Fishing in deep-water habitats
2. Using destructive fishing methods
3. Overfishing
4. Targeting highly vulnerable species
5. Using indiscriminate fishing methods
6. Impacting on threatened or protected species
7. Illegal, Unregulated and Unreported (IUU) Fishing

The final criterion is broken into two parts: the first follows the same format as the other criteria while the second allows the user to assess down to the level of the owner/operator/vessel within a fishery. A glossary of fishery and aquaculture terms is included at the end (terms included in the glossary are in bold text).

Use of data

The assessment is only as good as the information used. Please use the most recent stock data published. For other criteria, please use data published within the last five years, or provide good evidence that older data is relevant to the current situation.

What if data is not available?

We do not grade fisheries as red for having a lack of data, with one exception – fisheries that target highly vulnerable species are graded red where there is no evidence to show that the stock is not being overfished (see criteria 3 and 4).

Many small-scale local fisheries are data-poor – there is no scientific data available on stock status, fishing rates, or the wider impacts on the environment. These fisheries often have a lower impact than larger fisheries and are of particular importance to local communities. We encourage fish buyers to support small-scale local fisheries that use low-impact fishing methods to provide stock data and improve their sustainability as part of the 'Improve the Rest' section of sustainability policies.

On what basis are fisheries/species then listed on Greenpeace red lists?

The key fisheries and farms supplying each of the most commonly sold species nationally are assessed. Where the majority of these fisheries or farms are graded as red, the species are then placed on the red list. The resulting national red lists vary as they focus on the key 15–20 red list species sold in the supermarkets in their country rather than on every species sold. Species that do not appear on these red lists are not necessarily sustainable – indeed some may be sourced from fisheries or farms which are graded red, but are rarely sold in a particular country.

Why do we focus on red lists?

We focus on red lists for a number of reasons. Firstly, identifying fisheries or farms that are truly sustainable is a complicated and time consuming process – we need to consider a fishery's direct impacts on the marine environment, as well as the impacts on the wider environment (particularly with regard to climate change and pollution) and on local communities. For this reason we have developed red list of seafood from fisheries or farming practices which are clearly the most damaging and in need of immediate attention – they separate the worst from the rest.

Secondly, seafood buyers need to give consideration to other factors such as transport, processing and packaging of seafood, and therefore need some flexibility to compare and chose various 'better' options in order to reduce the environmental and social impacts of their overall consumption practices.

Greenpeace does have criteria for sustainable fisheries which can be used by retailers as a guide for finding the best alternatives. This can be downloaded from:

www.greenpeace.org/international/press/reports/criteria-sustainable-fisheries

Criterion 1: Fishing in deep-sea habitats

The deep oceans – the areas beyond and below the edge of continental shelves – are one of the last great wilderness areas. They typically support marine life that is particularly sensitive to disturbance. Many of the deep-sea species are delicate and slow-growing, such as cold water corals that can live for thousands of years. Deep-sea fish species, most of which are already highly vulnerable to overfishing (see criterion 4), aggregate on isolated topographic features such as **seamounts**, and as a consequence are easy to overexploit.

Advances in technology and research are constantly revealing new information about remote ocean habitats such as canyons, **seamounts**, **hydrothermal vents** and **cold seeps**. Rapid expansion of deep-sea fisheries, as well as demands on other resources (including oil and gas exploration and, in the near future, deep sea mining), threaten widespread and irreversible damage to such sensitive habitats, even before they have been fully documented.^{1, 2, 3, 4}

Deep-sea fisheries are all too effectively exploiting the last refuges for commercial fish species. Greenpeace believes that, rather than being seen as a replacement for declining resources in shallow waters, deep-sea species and the complex habitats they occupy should be subject to immediate and strictly enforced conservation measures.

1. Does this fishery operate in sensitive deep-sea habitats* (hydrothermal vents, cold seeps, coldwater coral reefs, seamounts, or canyons)?

Yes. RED

No. Go to criterion 2.

*Key indicators: the fishery targets deep-sea demersal or benthic species and the method used is a bottom fishing method including trawls, longlines, gillnets or pots.

Criterion 2: Using destructive fishing methods

Indiscriminate methods that impact on marine species as well as their habitats are the most unsustainable of fishing practices. The most damaging practices – fishing with explosives and poisons – are banned in many countries. However, they are still used illegally, often in coral reefs, especially in Southeast Asia, the Pacific and East Africa.⁵ The other key damaging practices – **bottom trawling** or bottom ‘dragging’ and **dredging** – are used globally.

Bottom trawls (including flatfish **beam trawls** and **demersal ‘otter’ trawls** for demersal round fish) and dredges (including suction and hydraulic dredges) disturb the **benthic** (bottom dwelling) ecosystem in a number of ways. The following general physical impacts have been well-documented in a wide range of studies and reviews (some examples are included in the reference list⁶):

- Direct removal, damage, displacement, or death of animals and plants living in or on the seabed, and short-term attraction of scavengers into the path of fishing gear.
- Disturbance of the upper layers of the seabed causing short-term re-suspension of sediments and pollutants into the water column, re-mineralization of nutrients and contaminants, and resorting of sediment particles.
- Alteration of habitat structure and complexity – e.g. flattening of wave-forms, removal of rock, and removal of organisms that influence the 3-dimensional structure of the seabed.
- Changes in community structure, and reductions in overall benthic biodiversity, biomass and production, with knock-on effects for **pelagic** (mid-water) production, biochemical processes and wider functioning of the marine ecosystem.

The magnitude of these impacts is not uniform for all bottom trawl fisheries, and depends on certain factors (e.g. the type of trawl gear used, habitat composition, life history of component species, the natural disturbance regime). However, even those areas containing the least sensitive benthic environments are often trawled so regularly that they have little chance to recover, and there are significant levels bycatch. Fish that are too small or the wrong species to sell are thrown overboard, dead or dying. Demersal otter trawls commonly throw away over 30% of their catches (by weight) while for beam and shrimp trawls this is often much higher (see criterion 5).^{7,8}

Furthermore, a recent study shows that trawling appears to have impacts on ecosystems even at depths where trawlers do not go by removing young fish from the upper continental slopes, before they move down to colonise the lower slopes as adults.⁹

Considering firstly, that management bodies have tended to put very few limits on where bottom trawls can operate (i.e. a lack of spatial planning) and, secondly, there is a serious lack of marine reserves globally that would allow for the recovery of heavily fished areas and for scientific comparison of unfished and fished areas, Greenpeace does not currently support the use of bottom trawling.

2. Does this fishery use any one of the following methods: explosives or poisons, demersal otter trawls, beam trawls, or dredges?

Yes. RED

No. Go to criterion 3.

Criterion 3: Overfishing

The **FAO** estimates that, by 2007, 80% of the world's assessed fisheries stocks were fully exploited (52%), over-exploited (19%), depleted (8%), or recovering from depletion (1%).¹⁰ Despite the perception that marine fish are highly resistant to large population reductions, for many species there is very little evidence for rapid recovery from prolonged decline.^{11, 12, 13}

Fisheries scientists generally assess the status of a fish population or **stock** by applying various mathematical models of the dynamics of the population, which estimate the overall fishing rate (**F: fishing mortality**) and the size of the adult stock (**SSB: spawning stock biomass**).

Most management methods set two key 'limit reference points' that indicate whether the stock/fishery is in an 'undesirable' state. The first is the SSB below which the stock should not be allowed to fall (B_{lim}). The second is the maximum rate of fishing that maintains the stock above B_{lim} – this is usually expressed as the proportion of the entire population caught in a year (F_{lim}). Some management methods also define 'threshold reference points', or 'precautionary limits' (F_{pa} and B_{pa}) which are set as 'triggers' to ensure that there is a low risk that the limit reference points are breached accidentally.

Unfortunately, methods used to calculate limit and precautionary reference points vary, not just from management system to management system, but even within one system depending on the data available for each stock. To quote a review of this issue: "All limit reference points are not created equal in terms of their inherent degree of cautiousness."¹⁴

One of the most common limit references used, and the one used by the FAO, is based on the concept of the '**maximum sustainable yield**' (MSY) – the largest average catch that can continuously be taken from a stock under existing environmental conditions. F_{MSY} is the fishing rate that will produce the MSY, and B_{MSY} is the stock size that can support the MSY. As defined by the FAO, stocks that are at B_{MSY} are considered 'fully fished' while stocks that have fallen below B_{MSY} are considered 'overfished.' Many fisheries managers use MSY as the target for setting exploitation levels. Some managers set precautionary targets to ensure MSY is not overshot.

However, even fisheries management based on the MSY concept has serious limitations. The key problems with this focus on the MSY are that, firstly, the stock level and the fishing rate that will produce the MSY are very difficult to determine accurately, particularly given the environmental changes we currently face due to climate change and ocean acidification. Secondly, scientists have argued for years that even at MSY, stock instability and risk of **recruitment** failure are already high. Finally, no consideration is given to predator–prey roles of the species within the ecosystem – it is single-species-focused management. There is a growing consensus within the scientific community that the F_{MSY} should be used as the upper limit of exploitation (to be avoided), and that targets should be set well below this.^{15, 16, 17, 18}

For fisheries where the MSY is unknown, or where the stock has been fished down to low levels for many years so that it is well below the B_{MSY} , management limits (B_{lim} and F_{lim}) are set based on other parameters. For fisheries managed by the European Union (EU), for example, B_{lim} is set as the SSB below which the stock is likely to have difficulty maintaining its population and F_{lim} is the rate of fishing above which the stock is likely to decline. Again, the selection of reference points varies, depending on available data. Often B_{lim} is set as the lowest stock level recorded for the fishery, in many cases these are levels that have previously resulted in stocks crashing. Management then sets 'threshold reference points', or 'precautionary limits' (F_{pa} and B_{pa}) as 'triggers' to ensure that there is a low risk that the limit reference points are breached accidentally. Historically, EU fisheries often used these 'precautionary limits' as targets, but the EU aims to increase stocks to levels where MSY-based limits can be used.

In 2002 at the World Summit on Sustainable Development, governments agreed to implement the FAO Code of Conduct for Sustainable Fishing with the goal of restoring global fish stocks by 2015.¹⁹ A key part of the code is not only to set negative limit reference points – the levels at which stock collapse is a real danger – but also to set positive target reference points. Ideally, a truly sustainable management practice would set fishing target levels well below current fishing rates to allow recovery to much larger stock levels, in order to ensure a plentiful stock that considers both human use and the

ecosystem as a whole.²⁰ For example, a fishery targeting slow-growing species that produce few young requires a much lower fishing rate to be sustainable, as would **forage fish** (such as herring, menhaden, squid, and krill) which are abundant but whose populations fluctuate widely under various environmental influences, are key prey for many larger marine species, and therefore require considerably more precautionary management.

In reality, few fisheries management practices have set these positive targets and many continue to set targets as close as possible to the limit reference points, continuing to allow fishing even when precautionary limits are triggered (if set at all), with little regard for the impacts on the overall ecosystem.

Finding a simple method to consistently identify the most unsustainable practices across the range of different management practices is very difficult. At best, we can grade red any fishery which is operates under single-species focussed management where the stock has dropped to levels below precautionary limits set by management, or where the stock is above these limits but management is allowing fishing at a rate which is causing a decline in the stock. (Key phrases to look for in stock reports are provided below.)

3a. Is the current adult stock level considered to be so low* that there is a risk that the population may struggle to maintain itself?

Yes. RED

No. Go to criterion 3b.

*Key phrases used in stock reports:

- The SSB is below, or at risk of being below full **reproductive capacity** ($<B_{pa}$)
- The stock is below, or at risk of being below B_{MSY}
- The stock is below the threshold or trigger precautionary reference points set for the fishery
- The stock is overfished, depleted, or in long term decline
- Where stock status is described as 'unknown' or precautionary reference points have not been set, consider the fishery to be at risk if recruitment is impaired (young fish are not joining the adult stock) AND/OR age, size or sex distribution is skewed relative to the natural condition (e.g. there are few adults above a certain size or age; fish are maturing much smaller than normal; many more males than females) AND the stock has been declining over the past five years

3b. Is there a risk that the most recently reported fishing rate will cause, or is causing, a decline in the stock in the short to medium term* AND has the management failed to address this according to scientific advice in the latest quotas?

Yes. RED

No. Go to criterion 3

*Key phrases used in stock reports:

- The fishing mortality/rate is above both F_{pa} and F_{lim}
- The fishing mortality/rate is above F_{MSY}
- The fishing mortality/rate is above the limit reference points set for the fishery
- The stock is being harvested unsustainably, or overfishing is occurring
- Fishing pressure should be reduced
- The management plan is not in accordance with the precautionary principle

Criterion 4: Targeting highly vulnerable species

Many fish species have life histories that render them highly vulnerable to overfishing (long life span, late age of maturity, slow growth rates, low reproductive capacity, low metabolic rate, and habitats that

are also vulnerable to fishing), with little resistance to overexploitation. Key examples include many deep-water **demersal** species, species that aggregate at seamounts, coral reef species, and many species of the cartilaginous fish group – sharks, skates, rays and chimeras.^{21, 22, 23}

Most commercial fish that are listed on the FishBase²⁴ database in the ‘very low resilience’ category and/or the ‘high vulnerability’ (or above) category to fishing are already declining in many areas, and an increasing number appear on the **IUCN Redlist** each year. Greenpeace considers this a key indicator that highly vulnerable species should not be commercially targeted by fisheries without evidence that a strong ecosystem-based management system protects the species from overfishing.

4. Does this fishery target species that are categorised on www.fishbase.org as having ‘very low resilience’ and/or ‘high vulnerability’ (or above) AND there is insufficient data to assess the stock and fishing rate (criterion 3)?

Yes. RED

No. Go to criterion 5.

Criterion 5: Using indiscriminate fishing methods

Unselective fishing practices that catch and kill large numbers of juvenile fish; low value or non-commercial fish, cephalopods and crustaceans; seabirds; turtles; and/or marine mammals, are highly unsustainable. This high ‘bycatch’ can have significant negative impacts on both commercial and non-commercial species by, for example, killing threatened species, removing key food species from ecosystems, or dramatically reducing juvenile numbers before they have a chance to mature and spawn. In addition, much of this bycatch is undocumented so that catch statistics produced for fisheries management are inaccurate.²⁵

As a key example, 63% (by number) of the 186 million fish and cephalopods (totalling 72,000 t) caught commercially in Britain – 117 million fish weighing 24,500 tons – are thrown back into the English Channel and other British seaways because they are found to be too small or the wrong species²⁶ (beam trawlers and demersal otter trawlers were together responsible for more than 90% of these discards). By weight this figure is 34%, similar to the FAO’s figure of 37.9% for the UK.²⁷

Whether this bycatch is thrown away at sea, or landed as ‘trash fish’ for fertilizers, animal feed or fish meal, high levels of bycatch are unsustainable. Management practices should aim to reduce discards to zero, and ensure that all species landed are marketable and well-managed from an ecosystem perspective.

5a. Does this fishery use an indiscriminate fishing practice that results in 20% or greater by weight of the catch of fish and cephalopods (commercial and non-commercial) being discarded?

Yes. RED

No. Go to criterion 5b.

5b. Does this fishery use an indiscriminate fishing practice that results in 20% or greater by weight of the catch that is landed being composed of juveniles or unmarketable species?

Yes. RED

No. Go to criterion 6.

NOTE: Although ideally we would consider ALL discards, including shellfish, by number rather than weight (because discards include disproportionate amounts of small, immature fish), these figures are very difficult to find because discard figures, if recorded at all, tend to focus on finfish by weight of catch.

Greenpeace recognises that fisheries management bodies globally are in various stages of implementing discard bans and/or reducing bycatch. Setting a broad cut-off figure that identifies worst practice is difficult, as the impact of bycatch on marine ecosystem varies from fishery to fishery, depending on the state of stocks and vulnerability of the ecosystems, and is not always reflected in proportional bycatch figures. For example, a very large fishery catching around 1 million tonnes of fish with a 1% bycatch can have a greater impact than a small fishery catching only 1000 tonnes and 10% bycatch. The cut-off figure of 20% bycatch (for discards/landings) by weight was selected with the understanding that fisheries management working towards ecosystem-based management will set fisheries-specific allowable interim and target levels below this value depending on the target and bycatch species caught and their relative impacts on the ecosystem impacts.

Criterion 6: Impacting on threatened or protected species

Non-commercial marine species that are classified as **threatened, endangered, critically endangered** or under moratorium by national or international conservation bodies must be given full protection from the impacts of fisheries. Fisheries that continue to have adverse impacts on these listed species, either by causing further decline of species or displacing species from the area, are considered by Greenpeace as amongst the most unsustainable. (Commercial species that are classified on these lists are addressed specifically by stock in criterion 3.)

6a. Is this fishery associated with adverse impacts on any population of any non-target species classified on reputable domestic or international conservation lists* as threatened, endangered, critically endangered or protected OR is listed as moratorium species?

Yes. RED grade

No. Go to criterion 6b

*Conservation lists: Examples include **IUCN Redlist** (new or updated assessments since 2000. Older assessments must be qualified with other recent data), **CITES** Appendices, **OSPAR** List of Threatened and/or Declining Species and Habitats, China Species Red List, US Endangered Species Act, Canada's Committee on the Status of Endangered Wildlife, New Zealand Threat Classification System List.

6b. Is this fishery associated with adverse impacts on any population of any non-target species for which there is recent reputable scientific evidence that they should be classified as threatened, endangered, critically endangered or protected?

Yes. RED grade

No. Go to criterion 7

Criterion 7: Illegal, Unregulated and Unreported Fishing

Illegal, Unregulated and Unreported fishing, also known as IUU or pirate fishing, is an issue of international concern. It has a major impact on coastal communities, the fishing industry and the marine environment.^{28, 29}

'Illegal' refers to vessels operating in violation of the laws of a fishery that are set by the country (or countries) in whose waters the fishery operates or, in the case of high seas fisheries, by regional fishery management organisations or arrangements (RFMO/As). 'Unreported' refers to fishing that is unreported or misreported to the relevant national authority or RMFO/A. 'Unregulated' describes fishing by vessels that are not registered to any particular country, or vessels flying the flag of a country that has not agreed to operate under the rules of the RMFO which governs the particular

fishing area or species. Unregulated fishing must also refer to fishing in areas or on species for which no conservation and management measures exist. Although this is not properly addressed in the definition of IUU fishing contained in the FAO *International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing*,³⁰ there is increasing recognition that this type of unregulated fishing must be addressed. This increased recognition includes UN General Assembly (UNGA) resolutions such as UNGA resolution 61/105 on high sea bottom fisheries.³¹

Greenpeace does not support the sale of any species caught by owners and/or operators that engage in IUU fishing. As part of its work to stop IUU fishing, Greenpeace maintains two blacklists of IUU vessels. The Official Blacklist is compiled from publicly available official registries of IUU vessels and companies, such as blacklists from a number of RFMO/As. Greenpeace reviews all official blacklists on an annual basis and updates the Official Blacklist accordingly.

The second list, the Greenpeace Blacklist, contains information on vessels and companies that have been recorded engaging in IUU activities, but have not yet been blacklisted by an official body. Greenpeace encourages stakeholders to report irresponsible fishing vessels and companies that fish without a license or are in breach of management and conservation measures together with supporting evidence to the administrator of the blacklist website.

7a. Does this fishery operate in areas, or target species, for which no conservation and management measures exist through the regulations of a regional fisheries management organisation or arrangement*?

Yes. RED

No. This fishery is not RED graded. Continue to 7b.

*Regional Fisheries Management Organization or Arrangement: This may include interim measures implemented by participants in negotiations to establish a RFMO, such as in the negotiations to establish South Pacific Regional Fisheries Management Organization. The effectiveness of such measures may vary.

The final part of this criterion does not grade a whole fishery red, but does allow the user to assess individual owner/operators within a particular fishery. For the broader fishery, a note of caution is made on this criterion when IUU is known to be an issue in the region of the fishery.

7b. Do any of the following statements apply to the supplier of fish from this fishery?

- **The vessel and/or operators are blacklisted***
- **Full traceability of the fish from the point of capture to the point of sale cannot be provided**
- **Transshipments occur at sea without 100% independent observer coverage OR transshipments occur when they are forbidden by law.**

Yes. RED

No. The operator is not RED graded.

*Blacklists: Examples include IUU vessel lists maintained by Regional Fisheries Management Organizations and Arrangements, the FAO, and Greenpeace: <http://blacklist.greenpeace.org>

Glossary of fisheries and aquaculture terms

Aquaculture	Cultivation or farming of any aquatic species – marine or freshwater, plant or animal.
Beam trawl	A type of bottom trawl in which the horizontal opening of the net is provided by a heavy beam mounted at each end on guides or skids which travel along the seabed. On sandy or muddy bottoms, a series of 'tickler' chains are strung between the skids ahead of the net to stir up the fish from the seabed and chase them into the net. On rocky grounds, these ticklers are replaced with chain matting. Used mainly for flatfish and shrimp fishing.
Benthic	Bottom-dwelling.
Biomass	The total weight of a group (or stock) of living organisms or of some defined fraction of it (e.g. spawners), in a given area, at a particular time.
B_{MSY}	Biomass corresponding to maximum sustainable yield (MSY). Often used as a biological reference point in fisheries management, it is the long-term average biomass expected if fishing at the rate of F_{MSY} (see Fishing mortality).
Bottom trawl	A trawl designed to work at the sea bottom. The lower edge of the net opening drags along the seabed, and is normally protected by a thick ground rope and ballasted with chains, sinkers, rubber discs, bobbins, etc. Bottom trawls include low-opening trawls for demersal species such as beam trawls and shrimp trawls, and high-opening demersal otter trawls for semi-demersal or pelagic species.
Brood stock	Eggs, juveniles or adults of a species, from which a first or subsequent generation may be produced in captivity, whether for growing in aquaculture or for release to the wild for stock enhancement.
Bycatch	The part of a catch other than the adults of the target species, which is taken incidentally. Some or all of it may be returned to the sea as discards, usually dead or dying.
Cetacean	A marine mammal of the order <i>Cetacea</i> , including whales, dolphins and porpoises.
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora.
Common Fisheries Policy	(CFP). The policy under which the EU manages all fisheries within the European EEZ .
Cold seep	An area of the seabed where hydrogen sulphide, methane and other hydrocarbon-rich fluid-seepage occurs, often in the form of a brine pool.
Critically Endangered	Facing an extremely high risk of extinction in the wild in the immediate future (IUCN definition).
Danish seine	A fishing net with a conical net bag with two relatively long wings. Two long heavy ropes, one attached to each wing, are used to encircle a large area of the seabed to herd the fish into the net and then to haul the net in. Used for benthic fish such as flatfish.

Data Deficient	Presumed to be at some risk of extinction, but there is inadequate information to make a direct, or indirect assessment of this risk based on its distribution and/or population status (IUCN definition).
Demersal	Of a fish or other organism: living near or on the seabed. Of a fishery, etc: operating within this zone. Demersal fish include species such as haddock and cod and flatfish.
Demersal otter trawl	A type of bottom trawl with rectangular 'doors' or 'otterboards' to keep the mouth of the cone-shaped net open horizontally while the net is being towed. A vertical opening is maintained by weights on the bottom and floats on the top. The net is dragged along the sea bed with the aid of bobbins, rollers and 'rockhoppers' which can roll across or dig into the bottom or bounce over obstacles.
Dredge	Gear used in fishing for shellfish, consisting of a rugged triangular steel frame and tooth-bearing bar, behind which a mat of linked steel rings is secured. A heavy netting cover joins the sides and back of this mat to form a bag in which the catch is retained. Shellfish such as scallops are raked out of sand or gravel and swept into the bag. Several dredges are towed together from a tow bar and larger vessels generally tow two bars.
Endangered	Not Critically Endangered , but facing a very high risk of extinction in the wild in the near future (IUCN definition).
EU	European Union.
Exclusive economic zone	(EEZ). The maritime zone under national jurisdiction (up to 200 nautical miles from the coast), within which a coastal state has the right to explore and exploit, and the responsibility to conserve and manage, the living and non-living natural resources.
FAO	Food and Agriculture Organisation of the United Nations.
Fishing mortality	(F). The total rate of deaths of fish directly due to fishing. Usually expressed as the proportion of the entire population caught in a year. F_{MSY} is the rate which, if applied constantly, results in the maximum sustainable yield (MSY) of fish. F_{lim} is the rate above which recruitment will decline substantially, usually set as the F_{MSY} . F_{pa} is the precautionary approach limit set to allow for uncertainty in survey data and to ensure F_{lim} is not reached accidentally.
Fishmeal	Protein-rich meal derived from processing whole fish (usually small pelagic forage fish, and bycatch) as well as by-products from fish processing plants. Used mainly as feeds for poultry, livestock, and aquaculture species.
Forage fish	Abundant, schooling species (such as sardines, herrings, Alaska pollock, menhaden, krill, and squid) that are described as 'fuel for the food web' because they are the food that sustains diverse assemblages of larger predators higher up in the ocean food chain – seabirds, marine mammals, and other fish species. ³² Although highly abundant, their populations fluctuate widely under various environmental influences. Forage fish were once a relatively small share of the global marine fisheries, but industrial fishing technologies have enabled the removal of ever-growing quantities from the oceans, with little thought as to the impacts on marine ecosystems. The Peruvian anchoveta fishery is now the largest in the world (10.7 million tonnes in 2004), and seven of the top ten fisheries (by weight) target forage fish. ³³ Most of these fish are caught

and processed directly into **fishmeal** and fish oil to be used in poultry, livestock, and aquaculture feeds.

Hydrothermal vent	A fissure in the seabed from which geothermally heated water issues.
ICES	International Council for the Exploration of the Sea. Scientists working through ICES gather information about the marine ecosystem. ICES Advisory Committee develops this information into advice which is used by the 20 member countries to help them manage resources in the North Atlantic Ocean and adjacent seas.
Industrial fisheries	Fleets of large vessels, using highly mechanised means to catch and process fish and shellfish, particularly for purposes other than human consumption (e.g. fishmeal, fertilizer).
IUCN	World Conservation Union (formerly the International Union for Conservation of Nature and Natural Resources).
IUCN Redlist	The world's most comprehensive inventory of the global conservation status of plant and animal species. It is widely considered to be the most objective and authoritative system for classifying species in terms of the risk of extinction. Classification groups are: Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, or Extinct.
IUU fishing	Illegal, unreported and unregulated fishing. Also known as pirate fishing.
Least Concern	At a lower risk of extinction in the wild and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category. (IUCN definition)
Maximum sustainable yield	(MSY). The highest theoretical yield that can be continuously taken from a stock under existing environmental conditions without significantly affecting recruitment.
Near Threatened	At a lower risk of extinction in the wild but close to qualifying for the Vulnerable category (IUCN definition).
Nursery	An area where juvenile fish live and grow.
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
Overfished	In fisheries science, a stock is considered to be in an overfished state when it has reached an explicit limit set by management, below which the population may fall to a level too low to ensure reproduction at a rate sufficient to maintain it. (Exact definitions vary between management systems).
Overfishing	In fisheries science, overfishing is occurring when the fishing mortality has reached an explicit limit set by management, above which the stock is expected to decline towards an overfished state. (Exact definitions vary between management systems).
Pair trawl	A large pelagic trawl towed between two boats. Associated with bycatch of marine mammals.
Pelagic	Of a fish or other organism: spending most of its life in the mid-water, with little contact with or dependency on the seabed. Of a fishery, etc:

	operating within this zone. Pelagic fish include species such as herring and sardine.
Pelagic trawl	A trawl designed to work in mid-water, targeting pelagic fish. The front net sections are often made of very large meshes or ropes, which herd the fish towards the back of the funnel-shaped net. Pelagic trawls may be towed by one or two (pair trawl) boats. Associated with bycatch of cetaceans and other marine mammals.
Quota	A share of the total allowable catch (TAC) for a given fishery, allocated to an operating unit such as a country, a vessel, a company or an individual fisherman (individual quota), depending on the system of allocation. Quotas may or may not be transferable, inheritable or tradable.
Recruitment	The rate at which a population is added to each year. Recruitment to an exploitable (i.e. mature) stock is generally through growth of juvenile individuals and/or migration into the stock area.
RFMO	Regional Fisheries Management Organization. RFMOs are responsible for managing fish stocks on the high seas and fish stocks which migrate through the waters of more than just a single State. RFMOs also have a duty to conserve all species associated or affected by their fisheries, including seabirds, turtles, dolphins, sharks and other non-target species.
Reproductive capacity	(RC). A measure of a stock's ability to maintain its SSB at a level below which recruitment will decline substantially. RC is determined by comparing the SSB to the biomass limit reference point (B_{lim}) and the biomass precautionary approach reference point (B_{pa}).
Spawning stock biomass	(SSB). The total weight of all fish in the population which contribute to reproduction.
Seamount	A mountain rising from the seabed that does not reach to the water's surface.
Stock	A population from which catches are taken by a fishery. A stock is usually defined in terms of a particular population more or less isolated from other populations of the same species and hence self-sustaining.
Stock status	Assessment of the situation of a stock . The FAO express this as: protected, under-exploited, intensively exploited, fully exploited, over-exploited, depleted, extinct or commercially extinct.
Suction/hydraulic dredge	Water is shot into sediments and displaced shellfish are collected the in a mesh bag (hydraulic) or sucked to the surface through a pipe (suction).
Total allowable catch	(TAC). The catch allowed to be taken from a resource in a specified period (usually a year), as defined in the management plan. The TAC may be allocated to the stakeholders in the form of quotas , as specific quantities or proportions of the TAC.
Trawl	A funnel-shaped net that is towed through the water by one or more vessels.
Tropic level	The position that an organism occupies in a food chain, i.e. what it eats, and what eats it.
Vulnerable	Not Critically Endangered or Endangered , but facing a high risk of extinction in the wild in the medium-term future (IUCN definition).

References

- ¹ Baker KD, Devine JA, Haedrich RL (2009). Deep-sea fishes in Canada's Atlantic: Population declines and predicted recovery times. *Environmental Biology of Fishes* 85(1): 79–88, 2009.
- ² Morato T, Watson R, Pitcher T, Pauly D (2006). Fishing down the deep. *Fish and Fisheries* 7: 23–33.
- ³ De Forges R, Koslow JA, Poore GCB (2000). Diversity and endemism of the benthic seamount fauna in the southwest Pacific. *Nature* 405: 944–7.
- ⁴ Roberts CM (2002). Deep impact: The rising toll of fishing in the deep sea. *Trends in Ecology & Evolution* 17: 242–5.
- ⁵ Coral Reef Alliance (2008). Resource library> Issue briefs> Exploitive fishing. *Coral Reef Alliance website*. The Coral Reef Alliance, San Francisco, CA, USA. Accessed Sept 2009 at: www.coralreefalliance.org/index.php?option=com_content&task=view&id=59&Itemid=67
- ⁶ Many more reviews and studies can be found in the reference lists of these reports:
- Allen JI, Clarke KR (2007). Effects of demersal trawling on ecosystem functioning in the North Sea. *Marine Ecology Progress Series* 336: 63–75.
- Collie JS, Escanero GA, Valentine PC (2000). Photographic evaluation of the impact of bottom fishing on benthic epifauna. *ICES Journal of Marine Science*; 57: 987–1001. Accessed Sept 2009 at: http://seagrant.gso.uri.edu/research/georges_bank/Assets/Collieetal2000.pdf
- Gray JS, Dayton P, Thrush S, Kaiser MJ (2006). On effects of trawling, benthos and sampling design. *Marine Pollution Bulletin*; 52: 840–43.
- Hiddink JG, Jennings S, Kaiser MJ, Queirós AM, Duplisea DE, Piet GJ (2006). Cumulative impacts of seabed trawl disturbance on benthic biomass, production and species richness in different habitats. *Canadian Journal of Fisheries and Aquatic Sciences*; 63: 721–36. Accessed Sept 2009 at: www.sos.bangor.ac.uk/~ossc06/pdf/Hiddink%20et%20al.%20CJFAS.pdf
- Hinz H, Hiddink JG, Forde J, Kaiser MJ (2008). Large-scale responses of nematode communities to chronic otter-trawl disturbance. *Canadian Journal of Fisheries and Aquatic Sciences* 65: 723–32.
- Kaiser MJ, Ramsay K, Richardson CA, Spence FE, Brand AR (2000). Chronic fishing disturbance has changed shelf sea benthic community structure. *Journal of Animal Ecology* 69: 494–503.
- Kaiser MJ, Collie JS, Hall SJ, Jennings S, Poiner IR (2002). Modification of marine habitats by trawling activities: Prognoses and solutions. *Fish and Fisheries* 3: 114–36.
- Kaiser MJ, Clarke KR, Hinz H, Austen MCV, Somerfield PJ, Karakassis I (2006). Global analysis of response and recovery of benthic biota to fishing. *Marine Ecology Progress Series* 311: 1–14.
- Sheppard C (2006). Trawling the seabed. *Marine Pollution Bulletin*; 52: 831–5.
- Watling L (2005). The global destruction of bottom habitats by mobile fishing gear. In: Norse EA, Crowder LB (Eds) (2005). *Marine conservation biology: The science of maintaining the sea's biodiversity*. Island Press, Washington DC, USA.
- ⁷ Kelleher K (2005). *Discards in the world's marine fisheries. An update*. FAO technical paper 470. Rome, Italy: Food and Agriculture Organization of the United Nations. Accessed Sept 2009 at: www.fao.org/docrep/008/y5936e/y5936e00.htm

-
- ⁸ Enever R, Reville A, Grant A (2007). Discarding in the English Channel, Western approaches, Celtic and Irish seas (ICES subarea VII). *Fisheries Research* 86: 143–52.
- ⁹ Bailey DM, Collins MA, Gordon JD, Zuur AF, Priede IG (2008). Long-term changes in deep-water fish populations in the northeast Atlantic: A deeper reaching effect of fisheries? *Proceedings of the Royal Society B: Biological Sciences* 27:1965–9.
- ¹⁰ FAO (2009). *The state of world fisheries and aquaculture 2008 (SOFIA)*. Biennial report. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. Accessed Sept 2009 at: www.fao.org/docrep/011/i0250e/i0250e00.HTM
- ¹¹ Hutchings JA (2000). Collapse and recovery of marine fishes. *Nature* 406: 882–5.
- ¹² Hutchings JA (2004). The cod that got away. *Nature* 428: 899–900.
- ¹³ Reynolds JD, Dulvy NK, Goodwin NB, Hutchings JA (2005). Biology of extinction risk in marine fishes. *Proceedings of the Royal Society B: Biological Sciences* 272: 2337–44. Accessed Sept 2009 at: www.sfu.ca/biology/faculty/reynolds/documents/Reynolds_2005PRS.pdf
- ¹⁴ Rosenberg AA, Restrepo VR (1996). Precautionary management reference points and management strategies. In: FAO (1996). *Precautionary approach to fisheries. Part 2: scientific papers*. Prepared for the Technical Consultation on the Precautionary Approach to Capture Fisheries (Including Species Introductions), Lysekil, Sweden, 6–13 June 1995. FAO Fisheries Technical Paper. No. 350, Part 2. Food and Agriculture Organization of the United Nations, (FAO) Rome, Italy. 210p. Accessed Sept 2009 at: www.fao.org/docrep/003/w1238E/w1238e00.HTM
- ¹⁵ Garcia SM (1996). The precautionary approach to fisheries and its implications for fishery research, technology and management: An updated review. In: FAO (1996). *Precautionary approach to fisheries. Part 2: scientific papers*. Prepared for the Technical Consultation on the Precautionary Approach to Capture Fisheries (Including Species Introductions), Lysekil, Sweden, 6–13 June 1995. *FAO Fisheries Technical Paper*. No. 350, Part 2. Food and Agriculture Organization of the United Nations, (FAO) Rome, Italy. 210p. Accessed Sept 2009 at: www.fao.org/docrep/003/w1238E/w1238e00.HTM
- ¹⁶ Helfman GS (2007). *Fish conservation: A guide to understanding and restoring global aquatic biodiversity and fishery resources*. Island Press, Washington DC, USA.
- ¹⁷ Norris W (2005). The application of reference point management in WCPO tuna fisheries: An introduction to theory and concepts. Scientific Committee Fifth Regular Session, 10–21 August 2009, Port Vila, Vanuatu. Western and Central Pacific Fisheries Commission (WCPFC), Kolonia, Pohnpei. WCPFC-SC5-2005/ME-WP-01. Accessed Sept 2009 at: www.wcpfc.int/doc/me-wp-01/wez-norris-application-reference-point-management-wcpo-tuna-fisheries-introduction-theo
- ¹⁸ Worm B, Hilborn R, Baum JK, Branch TA, Collie JS, Costello C, Fogarty MJ, Fulton EA, Hutchings JA, Jennings S, Jensen OP, Lotze HK, Mace PM, McClanahan TR, Minto C, Palumbi SR, Parma AM, Ricard D, Rosenberg AA, Watson R, Zeller D (2009). Rebuilding global fisheries. *Science* 325; 578–85.
- ¹⁹ UN (2002). *Report of the World Summit on Sustainable Development. Johannesburg, 26 Aug–4 Sept 2002*. United Nations, New York, NY, USA. Accessed Sept 2009 at: www.unctad.org/en/docs/aconf199d20&c1_en.pdf [see p23, article 31]
- ²⁰ FAO (1999). Indicators for sustainable development of marine capture fisheries. *FAO Technical Guidelines for Responsible Fisheries* 8. Food and Agriculture Organization of the United Nations, (FAO) Rome, Italy. 68p. Accessed Sept 2009 at: www.fao.org/DOCREP/004/X3307E/X3307E00.HTM

-
- ²¹ Cheung WWL, Watson R, Morato T, Pitcher TJ, Pauly D (2007). Intrinsic vulnerability in the global fish catch. *Marine Ecology Progress Series* 333: 1–12. Accessed Sept 2009 at: www.int-res.com/articles/feature/m333p001.pdf
- ²² Devine JA, Baker KD, Haedrich RL (2006). Deep-sea fishes qualify as endangered. *Nature* 439: 29.
- ²³ García VB, Lucifora LO, Myers RA (2008). The importance of habitat and life history to extinction risk in sharks, skates, rays and chimaeras. *Proceedings of the Royal Society B: Biological Sciences* 275: 83–9. Accessed Sept 2009 at: www.fmap.ca/ramweb/papers-total/Proc_R_Soc_B_in_press.pdf
- ²⁴ Froese R, Pauly D (Eds) (2008). FishBase. Online version (01/2008). Accessed Sept 2009 at: www.fishbase.com/search.php
- ²⁵ Kelleher K (2005). *Discards in the world's marine fisheries. An update*. FAO technical paper 470. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. Accessed Sept 2009 at: www.fao.org/docrep/008/y5936e/y5936e00.htm
- ²⁶ Enever R, Revill A, Grant A (2007). Discarding in the English Channel, Western approaches, Celtic and Irish seas (ICES subarea VII). *Fisheries Research*; 86: 143–52.
- ²⁷ Kelleher K (2005). *Discards in the world's marine fisheries. An update*. FAO technical paper 470. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. Accessed Sept 2009 at: www.fao.org/docrep/008/y5936e/y5936e00.htm
- ²⁸ FAO (2002). *Stopping Illegal, Unreported and Unregulated (IUU) fishing*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. Accessed Sept 2009 at: www.fao.org/DOCREP/005/Y3554E/y3554e01.htm
- ²⁹ For more information and documents on IUU fishing, go to the illegal fishing information website maintained by Chatham House, London, at: www.illegal-fishing.info
- ³⁰ FAO (2001). *International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. Accessed Sept 2009 at: www.fao.org/DOCREP/003/y1224e/y1224e00.HTM
- ³¹ UNGA (2006). *A/RES/61/105 – Sustainable fisheries, including through the 1995 Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, and related instruments*. United Nations General Assembly (UNGA), New York, NY, USA. Accessed Sept 2009 at: <http://daccessdds.un.org/doc/UNDOC/GEN/N06/500/73/PDF/N0650073.pdf?OpenElement>
- ³² Marine Fish Conservation Network (2008). Forage Fish. *www.foragefish.org website*. Marine Fish Conservation Network, Washington, DC, USA. Accessed Sept 2009 at: www.foragefish.org/index.html
- ³³ FAO (2007). *The state of world fisheries and aquaculture 2006 (SOFIA)*. Biennial report. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. Accessed Sept 2009 at: www.fao.org/docrep/009/A0699e/A0699e00.htm