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Fishing, aquaculture and the environment

Fishing exploits a wild natural resource and until the 1970s and the 1980s, the abundance of catches favoured its industrialization, leading to the depletion of some stocks (herring, cod, etc.). Meanwhile, the development of aquaculture contributed to meeting the growing demand, though without reducing the pressure on marine stocks. This brief describes the main negative externalities of fishing and aquaculture on the environment, and presents some solutions to address them.

According to the Food and Agriculture Organization of the United Nations (FAO), aquatic products constituted 17% of animal protein intake of the world's population in 2017.[1] Global demand increased by 3% per year over the period 1961-2017, that is more than the population growth, and is expected to continue at a rate of +1.2% per year in the coming years. This growing demand is met mainly through the development of aquaculture, as marine fish catches have been relatively stable since the 1980s.

However, fishing and aquaculture activities have impacts on the environment, the first of which being the pressure on wild stocks. For example, some aquaculture industries, such as the farming of high-value omnivorous or carnivorous species (e.g. salmon, which is the second most consumed species in the European Union (EU) and is almost entirely farmed[2]), use wild marine species in their feed, and thus encourage the exploitation of these stocks to meet the high demand.

Numerous political, legal and technical measures have already been proposed or applied to improve practices. Stakeholders (researchers, start-ups, foundations, NGOs, etc.) have also taken up the issue, explored new avenues that are beneficial to the environment and to biodiversity, and tangible progress has been made.

Firstly, this note briefly describes the fisheries and aquaculture state in the world. Secondly, it presents some of their effects on the environment. Thirdly, it raises some possible solutions.

1 - Issues related to the exploitation of fishery resources

The FAO is the main provider of global data on fisheries and aquaculture. Some stakeholders consider that these data sometimes underestimate actual catches, in particular concerning artisanal, subsistence and recreational fishing, and because of illegal fishing and of the difficulty of quantifying discards of unwanted catches at sea.[3]

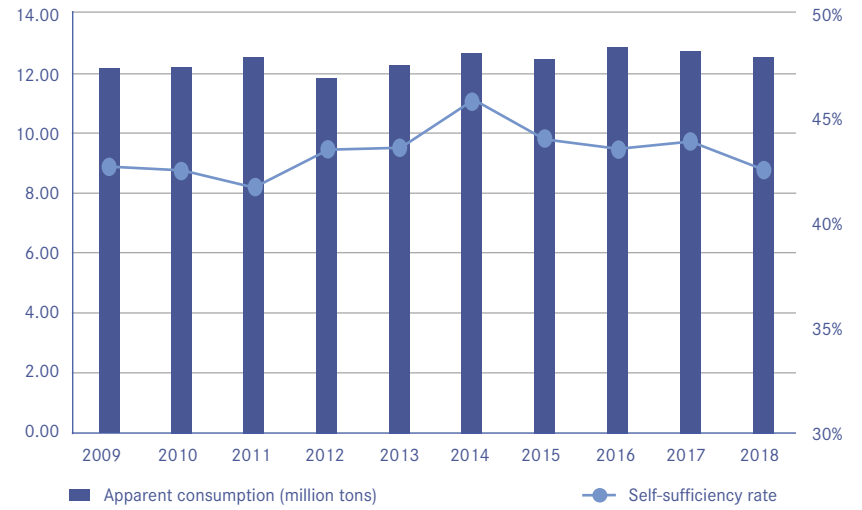
In 2018, global fish production reached a record high of 179 million tons (169 million in 2015).[1] 46% of this amount came from aquaculture. China is the world's largest producer and exporter of capture and aquaculture fishes, with 35% of the production.

The production of fish for direct human consumption continues to grow: it represented 88% of the world's production in 2018 (67% in 1960). 82% of the remaining fishes are used to produce meal and oil for farmed fish feed.

In 2018, the self-sufficiency rate for fishery and aquaculture products in the EU was around 43%;[2] this figure has remained almost stable since 2008. Europeans therefore consume twice as much as they fish and farm (Figure 1), and import mainly from Norway (26% of import volumes), China (8%) and Iceland (5%). These imports are mainly salmon, cod, tuna, Alaska pollock, fishmeal and shrimp. In 2018, 87% of shrimps consumed in the EU were imported. However, the craze for this product encourages its farming and therefore the deforestation of mangroves,[4] which are a critical habitat for the renewal of stocks.

1. FAO, 2020, *The state of the world fisheries and aquaculture.*
2. EUMOFA, 2020, *Le marché européen du poisson*, Commission européenne.
3. Pauly D, Zeller D, 2016, "Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining", *Nature communications 7*, 102444.
4. Agarwal N et al., 2019, *Getting the shrimp's share. Mangrove deforestation and shrimp consumption, assessment and alternatives*, IDDRI.

Figure 1 - **Trends in European apparent consumption and self-sufficiency rate for fishery and aquaculture products**



Note: Apparent consumption is defined as the sum of the quantities caught for food use, produced by aquaculture, and imports, minus the total export quantities.

Source : EUFOMA 2020[2]

Media, advocacy groups and social networks are increasingly taking up these issues. They contribute to public debates and raise consumers' awareness about the negative externalities of fishing and aquaculture.

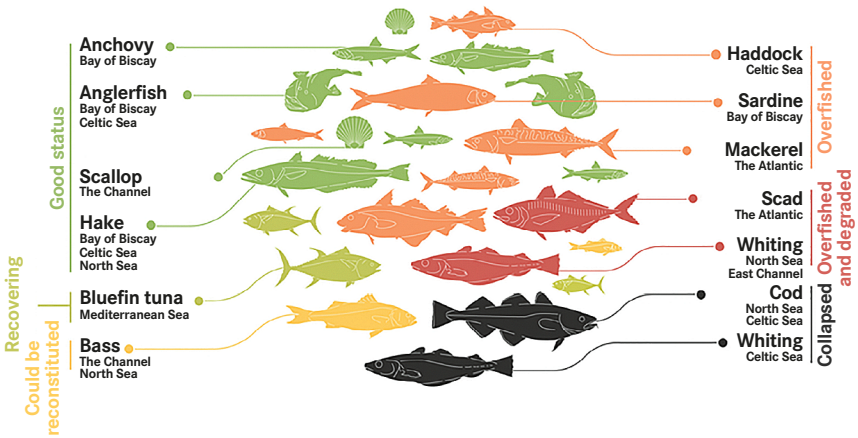
2-Impacts on stocks and the environment

Fishing and aquaculture directly affect wild fish stocks, but they also have effects on the environment and ecosystems.

The issue of stock renewal

Fishing impacts fish stocks, as overexploitation threats over one-third of them in 2017 (10% in 1974). This is especially the case in the Southwest Atlantic Ocean (of which stocks 53% are exploited in an unsustainable way in 2017), in the Southeast Pacific Ocean (55%), in the Black Sea (63%) and in the Mediterranean Sea (63%, according to the FAO[1]). In the EU, the state of the stocks has improved significantly since the implementation of the "maximum sustainable yield"[5] in 2009. However, 63% of them are still overexploited in 2019 and those of lesser importance, i.e. accounting for less than 10% of the total catches in cumulated terms, do not benefit from scientific monitoring. For example, cod and whiting stocks in the Celtic Sea collapsed,[6] while anchovy and hake stocks in the Bay of Biscay are being sustainably exploited[7, 8] (Figure 2).

Figure 2 - **Ecological status of some stocks connected to European waters**



Source : Ifremer[8]

Some unselective fishing practices lead to the catch of unwanted animals, be they fish species (unmarketable, out-of-quota or too small) or not. The former are generally discarded at sea, but their survival is uncertain after being caught in the nets and taken out of the water. 8% of catches are alleged to be unwanted like so,[9] with important variations depending on what gear is used: by-catches are very limited with small-mesh nets, but sometimes significant with trawling.[10]

Some observers also consider that fleets are now disproportionate to the available resources. According to a study, despite the doubling of the number of fishing vessels in the world between 1950 and 2015, the quantities fished each day decreased by 80%.[11]

Finally, it must be reminded that 30% of catches are alleged not be monitored.[3] This is obviously the case for illegal fishing. For example, more than one third of the vessels fishing in the international waters of the Southern Ocean sail without any identification system.[12] In addition, the fish caught in recreational fishing is poorly taken into account in statistics and fishing management policies. However, it is not negligible: WWF estimated in 2018 that 10% of the fish caught in the Mediterranean Sea is harvested by amateurs.[13] So is 30% of the sea bass caught in the Atlantic

5. Amount of fish that can be harvested over the long term without degrading the reproductive process of the species.
6. Insufficient renewal for continued harvesting.
7. Stock whose abundance is greater than or equal to the level of the maximum sustainable yield.
8. Ifremer, 31/01/2020, *Bilan 2019 de l'état écologique des poissons pêchés en France métropolitaine. Près de la moitié des volumes de poissons pêchés provient de populations exploitées durablement*, Communiqué de presse
9. Eayrs S, 2009, *Guide pour la réduction des prises accessoires dans la pêche au chalut des crevettes tropicales*, FAO.
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13. WWF, 2018, Evaluating Europe's course to sustainable fisheries by 2020.
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15. FAO, 2017, *GLOBEFISH Highlights. A quarterly update on world seafood markets.*

Ocean, in the Channel and in the North Sea, according to a 2009-2011 survey by Ifremer.[14] The FAO, for its part, observes that recreational fishing is expanding worldwide, particularly in developing countries.[15] For all these reasons, the state of fish stocks is potentially overestimated.

Impacts on some ecosystems

Overfishing can also destabilize trophic chains and therefore ecosystems. For example, it can lead to the proliferation of jellyfish, as they have fewer competitors for their food (zooplankton, consumed for example by anchovies) and fewer predators (tuna and turtles).[16] As they become more numerous, jellyfish capture more larvae of crustaceans and small juveniles.

Aquaculture also has an impact on ecosystems. Some farming methods create organic (food scraps, excrement, etc.), chemical (antibiotics, pesticides, etc.) and bacteriological (viruses, parasites, etc.) pollutions. In addition, farmed fish sometimes escape from their cages and reproduce with wild populations, reducing the genetic variability of the species.

3 - Some avenues for action

Making fishing and aquaculture more sustainable is a major objective to ensure food security for a growing world population. This issue is now a recurring theme in international discussions. To meet this challenge, three types of actions are predominantly referred to: controlling the pressure on stocks; extending the protection and the monitoring of stocks; fighting environment degradation and pollution.

Controlling the pressure on stocks

Awareness of the fragility of wild stocks already allowed implementing measures to regulate access to the resource, such as the limitation of the number and power of vessels. To this end, the EU sets maxima for each Member State, in kilowatts and in gross tonnage: a vessel may only enter into service if it replaces another of equal or greater power and capacity.[17] In addition, the duration of the fishing season is flexible. For example, in the Bay of Bengal (Bangladesh), fishing has been banned for two months in summer 2019, as opposed to the usual three weeks.[18] Although effective, this ban threatened the survival of artisanal fisheries and is alleged to have resulted in over-investment to increase fishing capacity and catches during the permitted periods.

To limit this investment race, quotas can be set. For example, bluefin tuna in the Mediterranean Sea was threatened with extinction in 2000. In 2007, the introduction of quotas led to a rapid recovery of the stocks.[19]

Such quotas could be further improved by making their allocation conditional on compliance with environmental criteria (use of selective fishing gear, etc.).[19] Furthermore, the effectiveness of quotas depends on our capacity to measure faithfully the state of stocks, through measurement protocols, diagnoses or technologies such as the one used to assess the Nephrops stocks in the EU: they are monitored by video to count the number of burrows and, then, to extrapolate the number of animals. Quotas are nevertheless a complex policy tool to govern: the catch rates set by the EU under its Common Fisheries Policy (CFP) exceeded scientific advice 41% of the time in 2019.[19]

The above measures, though proven efficient, are not implemented worldwide nor for all stocks. Although, distinguishing products from controlled fisheries is an issue for some consumers. Certification systems address this demand by facilitating the identification of more sustainable products. However, the effectiveness of these labels is sometimes questioned: for example, the biomass of half of the overfished tuna stocks certified with the MSC label in 2011 has not increased since certification.[20] To guarantee the legibility and credibility of the information provided, a solution could be to create a European public label, affixed to both local and imported products, indicating the status of the stock concerned[19].

Some experts question the caught of wild fishes when they are used as feed for farmed fish and shrimp, instead of being used for human consumption. To remedy this situation, it is necessary to find alternative feed that would maintain a similar level of animal production. For example, fish by-products that are not suitable for human consumption are already used in aquaculture feed.[21] Researchers are also working on replacing fishmeal and fish oil with vegetable proteins. However, this replacement raises difficulties for carnivorous farmed species because it reduces the palatability of the feed.[22] Basing the selection of these species on their ability to digest plant products would improve the performance of feed substitution. Another avenue is the use of insect meals and oils, as authorized by the EU in aquaculture since July 2018. Several companies have already entered this market. In addition, carnivorous fish and farmed shrimp must consume fish oil to be of nutritional interest, especially in terms of omega-3. Replacing this oil requires to develop substitutes, such as micro-algae. However, the cost of production of these algae hinders their use.[23]

Extending the protection and the monitoring of stocks

Restoring stocks also requires establishing marine protected areas. By restricting or even prohibiting fishing in these areas, a greater number of animals reproduce there, and the new generations then repopulate neighbouring areas. The World Parks Congress called for the protection of 30% of the world's waters. To achieve this, a study in Brazil shows that even small marine protected areas are crucial for the renewal of stocks and have a positive effect on captures in quantity and size.[24] The use of digital tools (geolocation, etc.) would improve the targeting of areas to protect, giving priority to the ones of greater importance for the species of interest.[25]

16. Bussi-Copin C, Goy J, 2019, « L'invasion des méduses », *Pour la science - Hors-série*, n° 104, pages 82-89.
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18. Sciences et Avenir, 09/06/2019, *Bangladesh : des manifestants bloquent une autoroute contre une interdiction de pêcher*.
19. Commission des affaires européennes, 2019, *Rapport d'information sur une pêche durable pour l'Union européenne*, Assemblée nationale.
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24. Rolim F. A *et al.*, 2019, "Network of small no-take marine reserves reveals greater abundance and body size of fisheries target species", *Plos One*.
25. White T D *et al*, 2019, "Predicted hotspots of overlap between highly migratory fishes and industrial fishing fleets in the northeast Pacific", *Science Advances*.

The fight against the overexploitation of stocks also relies on a better control of by-catches (non-targeted animals), discards, and illegal and recreational fishing. To this end, research studies improving the selectivity of fishing gears. For shrimp fishing, excluder devices reduce turtle catches by 97%. They are now mandatory in Australia, French Guiana and many areas in the United States[9]. Similarly, the accidental capture of dolphins by French pelagic trawlers led professionals to join forces with Ifremer to develop solutions. An encouraging approach is that of an acoustic repellent, and its first tests show a decrease in accidental catches by 65%.[26]

To reduce discards of unmarketable or low-value fish, the EU introduced a landing obligation for quota species in the CFP in 2013. However, its implementation seems difficult.[19] For their part, some private stakeholders are raising consumers' awareness on neglected species. Since 2019, chefs have made June 8 the day of "little-known fishes" to encourage their consumption by cooking them to today's taste.

Illegal fishing and aquaculture create an uncontrolled pressure on the resource. In the EU, the "Collecte de Localisation Satellites" group (satellite tracking system) offers the detection of these practices through the processing of satellite images and data. The EU also adopted a commercial rule to fight against illegal fish imports: its domestic market is closed to third countries whose fishing and aquaculture sectors do not respect particular criteria. For example, Sri Lanka was concerned and quickly changed its practices.

Fighting degradation and pollution

Due to its impact on fish mortality, especially on juveniles, commercial electric fishing will be prohibited in June 2021 in the EU. In addition, as trawling scrapes seabed and thus deteriorates habitats, progressively bringing subsidies to this fishing gear to an end could accelerate its replacement by other techniques.[19]

Several options are available to reduce plastic waste resulting from the loss of fishing gears. In Italy, fishermen can sell plastics recovered at sea, for recycling.[19] In addition to the positive impact on the environment, this measure allows them to diversify their income. Other commercial solutions are emerging to collect plastics polluting the oceans *via* drifting collectors.[27] Another launched project aims at developing a biodegradable fishing net.[28]

Finally, the chemical and organic pollutions generated by aquaculture could be reduced by selecting species that are more resistant to certain pathologies, by vaccinating farmed fish or by adopting more extensive farming practices (e.g. Label Rouge sea bass from Corsica). For marine species, placing the cages in the open sea[29] is an option: the renewal of water is increased, which limits the use of antibiotics and favors the elimination of waste. However, maintenance costs are high. As it has been done for a long time in freshwater, the rearing of species of different trophic levels (e.g. fish and bivalves, fish and plants,[30] etc.) is another solution that guarantees both good productivity and sustainability of aquaculture: the waste of one species is exploited by another. Research aims at optimizing these systems and developing them in an open marine environment, which is although subject to the dilution of waste and thus its loss for the associated species that use it.

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Consumers are increasingly sensitive to the issue of protecting fish stocks and the marine environment. Technical solutions and policy measures have been proven to be effective in protecting ecosystems and improving the environmental performance of fishing and aquaculture sectors. Research and private stakeholders continue to develop new ones. The emergence of new issues, such as animal welfare, calls for pursuing innovations.

As fish stocks are dispersed in open sea or in different territorial waters, international concertation is fundamental to promote solutions that favor sustainability. Regional Fisheries Management Organizations (RFMOs), which gather countries with fishing interests in a specific geographical area, are thus essential and complementary to national initiatives. They implement management measures such as limiting harvesting volumes or using certain fishing gears, as well as control and sanction measures.

Finally, the effects of climate change will be added to the environmental impacts of fishing and aquaculture. Rising temperatures could lead to a decrease in the availability of nutrients, which would harm food chains and induce an overall decrease in fish stocks.

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