

# Understanding and Enhancing Fishing Practices for A Sustainable Future

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**Abstract.** Since the 1980s, global demand for marine resources has increased. Overfishing has doubled fish stocks, which undoubtedly poses a major threat to biodiversity and ecological balance. This study delves into the environmental impacts of six main fishing methods: purse seine, trawling, dredging, gillnet, longlining, pole, and line. This study analyzes their principles, applicability, and impact on ecosystems. To address these challenges, the study explores potential improvements and adjustments, emphasizing the importance of sustainable practices. This paper concludes that overfishing, as a major problem in fisheries, poses a direct threat to the conservation of biodiversity and maintaining ecological balance. Because various organisms have different habits and habitats, resource fishing must be conducted by scientific methods to ensure maximum protection and economic benefits to the ecosystem. Overall, sustainable fisheries are essential to safeguard the long-term health and sustainability of Marine resources. By implementing selective fishing methods, utilizing technological innovations, and advocating for responsible fishing practices, people can reduce the negative environmental impacts of fisheries and conserve biodiversity. Governments, communities, and fishermen work together to promote sustainable fisheries practices and ensure the future of marine resources.

**Keywords:** Fishing methods; sustainable fisheries, fishing equipment, protection of biodiversity.

## 1. Introduction

The proportion of fish stocks that are overfished has more than doubled globally since the 1980s [1]. This means that the current high demand and high growth trend of human beings for marine resources. The importance of marine resources encompasses meeting urgent global human needs for food and economic development. As the main way to exploit marine resources, fisheries have become the backbone of livelihood and economic growth in coastal areas. Conversely, humans are also facing potentially huge impacts on the marine environment, including but not limited to overfishing and ecological damage [2]. As a major problem of fisheries, overfishing poses a direct threat to protecting biodiversity and maintaining ecological balance. Because various organisms have different habits and habitats, resource capture must be carried out through scientific methods to ensure the greatest protection of the ecosystem and the highest economic benefit.

Within this background, the current study takes an in-depth look at six different fishing methods, including purse seine, trawling, dredging, gill nets, long lining, pole and line. Also, it discusses the species of organisms to which they are applicable. At the same time, different fishing methods have also led to different types and degrees of ecological damage.

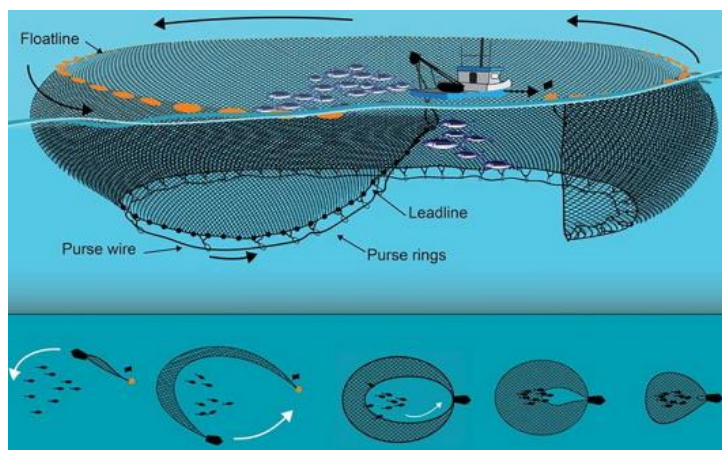
To better understand and solve this problem, this study conducted an in-depth analysis of possible improvements and adjustment methods of different fishing methods and reviewed some based-on solutions to real-world situations. This effort aims to reduce the negative impact of fisheries on the environment and ensure the health and sustainability of marine resources. First, this article explores six different fishing methods, analyzes the principles, applicability and environmental impacts of different fishing methods, as well as conducts an in-depth analysis of possible improvements and adjustments to different fishing methods. The paper then delves into technological innovation and sustainable fishing methods. Finally, recommendations are given for fisheries in today's world.

## 2. Introduction of 6 fishing methods

There are many common fishing methods, including purse seine, trawling, dredging, gill nets, long lining, pole and line. Different fishing methods are suitable for different species of organisms and will also cause different types and varying degrees of ecological damage. This article mainly introduces and discusses the applicability, applicable species and environmental impact of these fishing methods.

### 2.1. Purse Seine

Different from the traditional fishing method, the word "purse seine" is relatively obscure and difficult to understand, and it is not easy to imagine the behavior as soon as you see the word. So, it is very important to introduce how the system works beforehand. The principle of purse seine is divided into four steps, positioning, ranching, seine, and net closing. As shown in Fig. 1, the five processes of purse seine. From Fig. 2 it can be seen that the final state when the purse seine is ready. Seining is a fishing method based on large fishing nets. Extra-large fishing nets float vertically in the water with the assistance of floats and other devices. Then the fishing boat engine provides power to actively form a semi-enclosed net bag. The characteristic of the seine net is that there is a line at the bottom of the net to seal the escape route. Finally, a "purse" is formed to gather the fish and then close the net [3].



**Fig 1.** Overview of purse seine [3].

Generally, purse seine is used for fish such as tuna, herring, and mackerel [4]. These fish have one thing in common, they are all fish that can form "fish schools". "Fish school" refers to the phenomenon of a group of fish gathering closely together in the water and moving together. This collective behavior helps each fish in the school gain several advantages, including defense against predators, increased foraging efficiency, and an enhanced chance of survival. But again, fish schools are very concentrated, and when faced with huge fishing nets that are miles long, fish schools can easily be caught in one catch, which is very profitable.

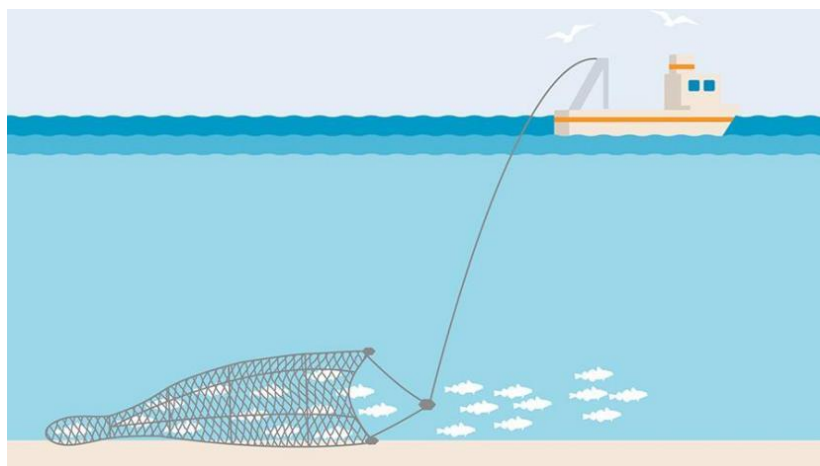


**Fig 2.** Overview of purse seine closure [5].

However, there is a potential drawback as purse seine nets, often spanning miles, can easily capture entire fish schools, leading to significant profits. Yet, this method may unintentionally catch unwanted species or under-aged fish, causing ecological damage. According to the literature, many fish caught using purse seine are discarded for reasons including but not limited to being too small or of low commercial value [4]. The incidence of discards can be reduced to a certain extent by limiting the mesh size of purse seine nets and using sonar and fish locating systems.

## 2.2. Trawling

Trawling is one of the most violent and direct methods of fishing. That is to use a ship as power to tow a fishing net with a metal frame on the seabed. Fig. 3 shows the operating principle of trawling. With the characteristics of indiscriminate fishing, any living and non-living things smaller than the hole diameter will be loaded into the conical net. Bottom trawling is also associated with large amounts of unwanted catch or by-catch because the nets used may be non-selective. This may result in the accidental capture of non-target species, juvenile or undersized fish.



**Fig 3.** Overview of trawling [6].

Generally, common bottom-dwelling organisms such as shellfish, shrimp, flounder, and cod are often caught using trawl nets.

Due to the different violent methods used for fishing like trawling and dredging and the inevitable contact between trawl fishing gear and the seabed, it is very likely to cause damage to the original local habitat. Destroying the shelter of local organisms will take time to recover, and may even cause irreversible damage.

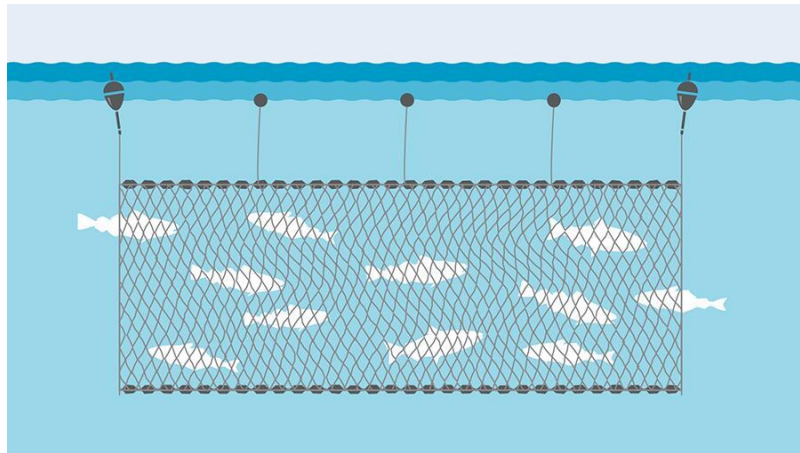
## 2.3. Dredging

Dredging is very similar to trawling, at least the principles are the same. The difference is that the boats no longer tow fishing nets but change to metal baskets. And dredging is more specialized, with general dredging focused on collecting shellfish. Compared with trawling, the environmental damage caused by dredging is more serious because both the depth of entry into the soil and the weight of the equipment itself are greater than that of trawling. Their weight and size may cause greater physical impact on benthic organisms and benthic habitats. This can lead to the destruction of coral reefs, seagrass beds and other ecosystems.

## 2.4. Gillnet

A gillnet is a wall made of fishing nets. Similar to the early stages of purse seine, buoys and the like provide buoyancy to allow it to hang vertically below the water's surface. Unlike ordinary fishing nets, the mesh of a gill net is designed to allow only the head of a fish to pass through the mesh hole. After the fish head passes through the net hole, it will struggle to escape, and the gills will naturally become entangled with the fishing net. The more the fish struggled, the tighter the net became. Fig. 4 shows the operating principle of gillnet. This passive fishing method is less damaging to the

environment and species than large-scale active fishing. Target species can be selected by limiting the mesh size length and height of the gillnet. To prevent accidental capture of non-target species or juvenile fish, causing greater damage to the environment.



**Fig 4.** Overview of gillnet [7].

Typical target species include barracuda, herring, mullet, rockfish, bass, anchovies, sturgeon, swordfish, and tuna.

However, when encountering marine mammals, they will face high risks, and the hole size of the gillnet should be designed to prevent the capture of these species as much as possible.

## 2.5. Longlining

Longlining, as its name suggests, is fishing with a very long rope. Traditional fishing is done with a rope and a hook. Longlining is very similar, using a fairly long rope with dozens or even hundreds of hooks on the rope. After placing the bait, sit back and wait. Come and harvest after some time. Compared with other active fishing methods, like purse seine, trawling and dredging, longlines are relatively less harmful to the environment, but equally, they are less efficient. Due to the characteristics of longlining, a single long line is used with multiple small fish hooks hung on it. The result is more precise targeting of target species, less capture of non-target species, and less so-called “incidental capture” or “by-products.” In contrast, purse seine uses large nets to capture entire sea areas, which may result in large-scale fishing and widespread impacts on non-target species and benthic ecosystems.

## 2.6. Pole and line

This type of fishing is one of the most interesting. After locating the target fish school, spray water from the fishing boat onto the water surface and throw a large amount of bait onto the water surface. This technique is called nesting. This behavior will give the fish the illusion that the prey is active and cause them to fall into a feeding frenzy. The entire school of fish does this behavior. At this time, the fishermen swing their rods, and the barbless hook will hook the fish to the deck, and the cycle repeats. This fishing method is sustainable, like the bonito tuna fishery in the Maldives, with low by-catch levels and sustainable fish populations, allowing fish stocks to remain healthy and MSC certified.

## 3. The trend of sustainable fisheries

The simplest way to understand sustainable fisheries is to avoid using large machinery for fishing, in other words, to prevent fishing from being too efficient. Traditional pole fishing and cast-net fishing can hardly cause damage to fish numbers and populations in a large area. However, in a modern society with such strong demand, it is unrealistic to use purely manual methods for fishing operations. Therefore, aquaculture has become a must.

Aquaculture, as a method of artificially raising and cultivating aquatic organisms, has many advantages. One of the main advantages is that aquaculture works by cultivating aquatic organisms in a controlled artificial environment, which is very stable. And the numbers of all living things are known and documented. Aquaculture can reduce fishing pressure on wild fish and other aquatic life and help maintain the balance of marine ecology. In contrast, large-scale machine fishing usually involves large-scale fishing, which can easily lead to large-scale fishing of non-target species and imbalance of the ecosystem. This could better protect wild stocks from the threat of overfishing, making fisheries more sustainable. Aquaculture creates jobs in many communities and contributes to economic development through consistent production quality.

#### 4. Conclusion

In addition to a detailed exploration of fishing methods, the research also contains technological innovation and sustainable fishing methods. By introducing more environmentally friendly technologies and strategies, it is expected to promote more sustainable fishing activities. The research includes not only improving existing fishing equipment but also developing new technologies to reduce the negative impact of fisheries on the marine environment. The importance of developing and enforcing codes of conduct by fishermen, governments, and international organizations is also highlighted throughout the study. By establishing clear industry codes and enforcing them, fisheries activities can be managed more effectively, non-compliance can be reduced, and resources can be secured sustainable use of marine resources. To provide sufficient food and economic opportunities for future generations and to achieve responsible development and management of marine resources, cooperation from all of the parties around the world is needed. While considering the above factors into consideration, the method can more comprehensively recognize the value and needs of marine resources. Through scientific fisheries management, technological innovation, and transnational cooperation, people can achieve the sustainable development of marine resources and ensure their reasonable and responsible use in the future. This not only has a direct impact on the current social economy but also has a profound impact on the health of the global ecosystem and the protection of biodiversity.

#### References

- [1] Darasi, F., & Aksissou, M. Longline, trawl, and purse seine in coastal fishing of Tangier port in North-west of Morocco. *The Egyptian Journal of Aquatic Research*, 2019, 45(4), 381–388.
- [2] Gillnets fishing gear - marine stewardship council. MSC International - English. (n.d.-a). <https://www.msc.org/what-we-are-doing/our-approach/fishing-methods-and-gear-types/gillnets>
- [3] Jacob, C., Buffard, A., Pioch, S., & Thorin, S. Marine Ecosystem Restoration and biodiversity offset. *Ecological Engineering*, 2018, 120, 585–594.
- [4] Ritchie, H., & Roser, M. (2023, December 28). Fish and overfishing. *Our World in Data*. <https://ourworldindata.org/fish-and-overfishing>
- [5] Tejerina, R., Hermida, M., Faria, G., & Delgado, J. The purse-seine fishery for small pelagic fishes off the Madeira Archipelago. *African Journal of Marine Science*, 2018, 41(4), 373–383. <https://doi.org/10.2989/1814232x.2019.1678520>
- [6] What is bottom trawling. MSC International - English. (n.d.-b). <https://www.msc.org/what-we-are-doing/our-approach/fishing-methods-and-gear-types/demersal-or-bottom-trawls>
- [7] What is purse seine fishing? prepladder.2022, December 28. <https://www.prepladder.com/upsc-study-material/purse-seine-fishing>