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Comprehensive Study: Fishing Gear Mechanisms, Impacts, and advancement of Sustainable Management Practices

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ABSTRACT

Equipment or gadgets used for fishing are called fishing gear. The structure, materials, principles of capture, and operational techniques of fishing gears vary widely. There are many different types of fishing equipment devices that are made with various technologies and are operated in different ways. These tools have been roughly categorized in accordance with the FAO classification of fishing tools. Depending on the operation area and the behavior of the target fish, fishing gear comes in a variety of shapes, sizes, and compositions. The three main kinds of fishing gear technologies active gear, passive gear, and other were covered. Fishing equipment, which is essential to the fishing process, can have a direct effect on maritime environments and communities. The act of using fishing gear over which one has entirely lost control in order to continue catching fish is known as ghost fishing. Both active and passive fishing equipment can get caught up in bottom obstacles like wrecks and reefs and become lost as a result, but passive fishing equipment can also get lost due to harsh weather, accidental damage, being carried away by active fishing equipment, or by a vessel. Monitoring efforts and technological advancements can aid in addressing environmental concerns and developing eco-friendly fishing practices. Achieving a harmonious equilibrium between efficient fishing practices and responsible resource management is crucial for ensuring the long-term sustainability and well-being of marine and freshwater environments, as well as the prosperity of fishing communities.

KEYWORDS

Fishing gear, Ghost fishing, Fishing tools, Active and passive Fishing gear

Introduction

Fishing gear, which includes spears, cast nets, entangling nets, drift nets, hooks and lines, gill nets, trawls, seine nets, lift nets, clap nets, and many more, is what is used to catch fish from any body of water (Nuhu and Yaro, 2005; Tagago and Ahmed, 2011; Davies and Kwen 2012). On the other hand, fishing method refers to the methods employed with the gear. Increasing amount of knowledge on the multiple effects on populations, community structure, based on habitat and ecosystem data, fishing is one of the biggest risks to marine biodiversity and ecosystem function. (Dayton *et al.,* 1995; Roberts, 1995; Jennings and Polunin, 1996) Fishing gear refers to the equipment and tools used in the practice of fishing. It includes a variety of items designed to catch fish, such as fishing rods, reels, lines, hooks, and lures. The type of gear used depends on the fishing method and target species. Fishing gear includes rods, reels, lines, hooks, and lures. Rods come in various types and materials. Reels store and release fishing line, with different types for different purposes. Lines vary in material and properties. Hooks, sinkers, and floats serve specific functions. Lures mimic prey to attract fish. Swivels and snaps reduce line twisting. Nets help land caught fish. Tackle boxes organize gear, and fishing clothing provides comfort and protection. Accessories like pliers and electronics, such as fish finders, enhance the fishing experience. The choice depends on the target species, location, and personal preference. Various fishing gears, from traps to nets and spears, are used based on fish behavior and habitats. The development of new gear is influenced by seasonal variations in species abundance. The scientific use of fisheries resources requires an understanding of fishing gear, particularly in riparian areas where approaches vary according to terrain and ecosystems. Traditional fishing techniques are prevalent in India, lacking detailed documentation. Fishing methods are influenced by distinct fish behaviors and habitats, utilizing nets and gears of various materials and designs. Effective management of capture fisheries requires a comprehensive understanding of fishing gear, crafts, and methods. A comprehensive study of understanding fishing gear, including its mechanisms, impacts, and sustainable management, is crucial for ensuring responsible and sustainable fishing practices. By examining the mechanisms of various fishing gear types, researchers can gain insights into how they capture fish and other aquatic organisms. This understanding helps in assessing their efficiency, selectivity, and potential impacts on target and non-target species. The study also emphasizes how fishing gear affects fish populations and ecosystems through species composition changes, habitat modification, and bycatch (Choudhury, 1992; Bankole, 2003; Koleka, 2009; Davies & Kwen, 2012). By evaluating these impacts, researchers can identify potential risks and develop mitigation measures to minimize negative effects. Sustainable management of fishing gears is a key focus of the study, aiming to develop strategies and regulations that promote responsible fishing practices. This may involve gear modifications, gear selectivity improvements, and the establishment of protected areas to protect vulnerable species and habitats. By conducting a comprehensive study on fishing gear, stakeholders can make informed decisions and implement effective measures to protect fish populations, maintain ecosystem health, and ensure the long-term sustainability of fisheries. This knowledge contributes to the conservation of marine resources and supports the livelihoods of fishing communities.

Relevant concepts related to fishing gear

Stress and injury: Fishing gear invariably results in physical harm and physiological stress for the fish that come into contact with it (Trumble *et al.,* 2000; Baker and Schindler, 2009) in fact, it is impossible to catch a fish, at least on a hook, without doing both (Cooke and Sneddon, 2007). Common physical wounds that can result in fungus infections include hooking wounds, a loss of protective mucus, a loss of scales or skin, or the absence of an appendage like a fin or operculum. As a result of the long-term immune-suppressing consequences of capture-induced stress reactions, infections and diseases may develop (Lupes *et al.,* 2006), which may impede predator evasion behaviors while diseases are being treated (or may directly result in mortality in the absence of predators).

Capture techniques: The type of gear, catch depth, duration of entanglement, duration of air exposure, and handling techniques can all affect how severe the physiological and behavioral effects are (Davis, 2002; Ross and Hokenson, 1997; Davis and Parker, 2004). A fish's gill lamellae collapse when it is taken out of the water, preventing gas exchange. As a result, the fish's body tissues accumulate anaerobic metabolites that must be eliminated after release before it can resume its full capacity for exercise, a time during which it may be vulnerable example (Arlinghaus *et al.,* 2009). In cases of extreme in-net crowding and high ventilation rates that result in a localised loss of dissolved oxygen, hypoxia can even happen to fish that are still in the water (Raby *et al.,* 2012).

Principal Mechanisms of Fish Capture

Fish can be caught primarily by: 1. Filtering, using devices like trawls, seines, and traps; 2. Tangling, using devices like gill nets and trammel nets; 3. Using hand lines, long lines, or jigging for hooking; 4. Using pots and pound nets for trapping; and 5. Using fish pumps for pumping (Boopendranath, 2019). The three main behavioral variables used in the fish trapping process are bait, light, and shelter. Repulsion or avoidance responses are also employed, such as sweeping and wires in boat seines and trawls, or herding or directing by netting panels as in fixed nets and trawls (Hameed and Boopendranath, 2000).

Fishing gear design: The design process consists of three stages: a divergence phase in which the problem is analyzed, an overview of needs, specifications, operating standards, and constraints are outlined; a transformational phase in which design concepts are created; and an alignment phase in which everything is put together. where design goals, utility, and economic viability are assessed, prototypes are developed, tested, and evaluated. A preliminary design resulting from this process is then improved upon using new knowledge in an iterative loop until a final design is chosen (Boopendranath, 2019). Gillnet, entangling nets, and traps are the next most commonly used fishing equipment, followed by purse seine and trawl net. The fishing gears are divided into the following categories based on the material used in construction:

1. Gillnets, trawl nets, purse seines, and other types of netting-based fishing gear are called "net fishing gear."
2. Tackle or fishing equipment that includes hooks and lines to catch fish individually
3. Miscellaneous gear, including electrical fishing, grappling and wounding, and traps.

Net fishing gear

Gill nets and entangling nets

They are vertically suspended long walls of webbing. Rectangular walls of netting called gill nets are suspended in the swimming layer of the intended fish and are supported vertically by sinkers and floats (Fig. 1). Gills in a gill net hold fish in place while they are being caught.

Gill nets that drift either independently or next to the boat to which they are attached are employed in the upper layers of the water. Using anchors or ballast, gill nets are positioned or fastened to the bottom or a distance above it. In the upper strata, circumferential gill nets are utilised in coastal locations. The fish are surrounded before being propelled towards the net by vibrations and noise, where they are either gilled or entangled (Boopendranath, 2019).

Entanglement nets catch fish differently from meshing nets because they are constructed of lightly strung single- or multi-walled netting that is anchored vertically in the water by floats and sinkers. Large fleets are typically created by connecting nets end to end (Boopendranath, 2019).

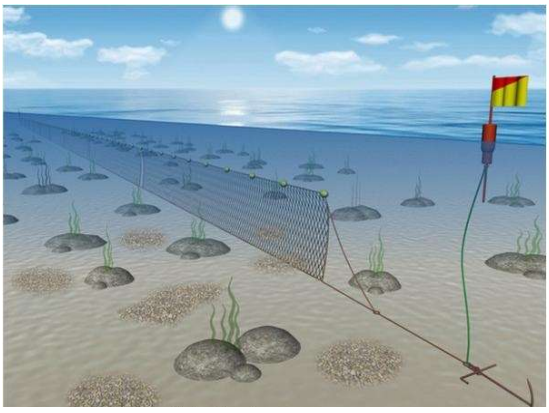

Fig 1. Set gill net (Source www.seafish.org)

Trawls

Trawl nets are conical bag nets with two wings and a cod-end that are towed by one or more boats to handle the catch (Fig 2.). Trawls are categorized as bottom, midwater, or pelagic depending on where they are used in the water column. They are divided into beam trawls based on how wide their mouths open, with a stiff wooden or steel beam keeping the mouth open in this type of trawl. otter trawls in which the trawl mouth is expanded horizontally using otter boards. There are one-boat trawls, two-boat trawls, pair trawls, bull trawls, etc. depending on the number of boats utilised (Boopendranath, 2019).

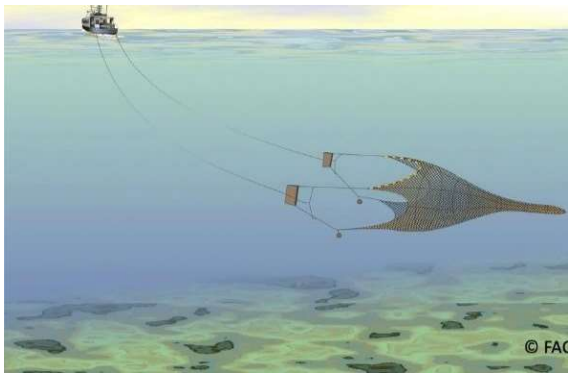

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Fig. 2. Trawl net (Source: FAO)

Purse seines

Purse seines are the most popular kind of surrounding nets; they contain a purse line that, after encircling the fish school, seals the net's bottom to prevent fish from diving to escape (Fig. 3). In accordance with the total number of vessels in service, there are two purse seines and one boat. There are different types of purse seines depending on the target species, including anchovy, sardine, mackerel, cod, and tuna. Small, medium, and big purse seines are available depending on the size of operations. Lampara net and surrounding net are small-scale industries that function without purse lines (Boopendranath, 2019).

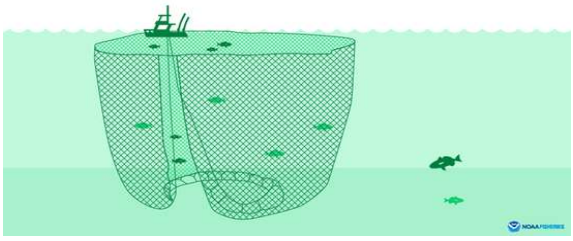

Fig.3. Purse Siene (Source: NOAA fisheries)

Tackles

Hook and Line

A hook that is concealed inside the bait or lure is used to catch fish after they have been drawn in

by edible or synthetic bait or lures that imitate the physical characteristics and motion of the natural prey. The snood or line is attached to the hook. Additionally, passing hooks or jigs that pierce the water hold the fish in place (Fig. 4). Pole and line, which can be worked manually or mechanically, jig lines, which can be worked manually or by powered jigging machines for squids drawn to light, and troll lines, which are used for predatory fish with hooks having natural or artificial baits and trail behind the moving vessel typically in the surface layers, are all significant types of hooks and lines that are actively fished with (Boopendranath, 2019).

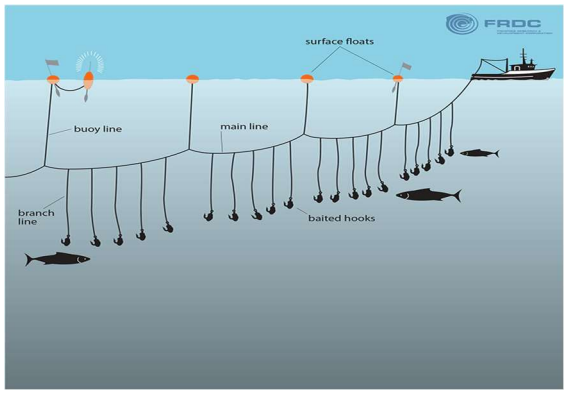

Fig. 4 Hook and Line (Source: frdc.com.au)

Miscellaneous gears

Traps: Fish are pulled or guided into traps, which are passive fishing devices with enclosures that require them to fight their way out owing to labyrinths or delaying mechanisms like funnels or constrictions (Fig. 5). Here, a variety of conventional fishing equipment is gathered.

The purpose of pots is to catch fish, crabs, or cephalopods by luring them in with baits or providing shelter for them. Wicker, wire netting, metal rods, wood, and reinforced plastic are some of the materials used to create pots, which are effectively cages or baskets. The appropriate gape size is indicated in one or more of their entries. Their locations are marked by buoys, and they are frequently positioned on the bottom in clusters or separately, joined by ropes. Large nets that are anchored to or secured to stakes are known as stationary uncovered pound nets, or set nets, in Japan. To direct schools of migratory fish towards enclosures with decelerators and closed at the bottom by netting, a leader net is maintained at an appropriate angle to the fish schools' swimming direction.

Fyke nets are formed of a cone-like bag of netting with wings to assist fish into the bag and inflexible rings that keep the cylinder form of the net body in shallow water.

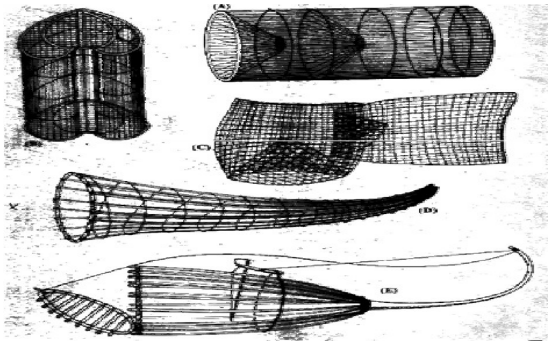

Fig. 5. Trap nets (Source: Joseph Eye)

Conical bag nets called stow nets are used in estuaries and shallow water when tidal currents are strong. The mouth of the net is held open against the stream by putting floats and ballast in place or digging stakes into the bottom. Walls, fences, weirs, and corrals made of local materials are examples of entrapment used in tidewaters.

Aerial trapping techniques are used to catch fish like mullets, which leap out of the water in reaction to disturbance, and flying fish, which are attracted to light and end up trapped in floating enclosures or rafts. Verandah nets and boat-operated aerial traps are two examples of this type of equipment.

Ghost fishing

Ghost fishing is the practise of using fishing equipment over which one has completely lost control to continue catching fish. While both active and passive fishing gears can become

entangled with bottom obstacles like wrecks and reefs and be lost as a result, passive fishing gears can also be lost as a result of bad weather, accidental damage, or being dragged away by active fishing gear or by vessels (Breen, 1990; Kaiser *et al*., 1996; Santos *et al.,* 2003). Fishermen may also discard both types of fishing gear at sea if they are broken (Arcement and Guillory 1994). Trawls are an active fishing tool that is considerably less selective for the target species but has the potential to disrupt benthic populations while in use (Jennings and Kaiser, 1998). However, when such gears are no longer within one's control, they lose their effectiveness and cease to be a significant problem as ghost fishermen (Breen, 1990; Kaiser *et al*., 1996).

Fig.6. Ghost Fishing (Source: www.hillnotes.ca)

Gillnets are an example of passive fishing equipment (Fig. 6) that can continue to catch fish for several years when the owner of the gear no longer has control of it (Chopin *et al.,* 1996; Nakashima and Matsuoka 2004). In addition, lost passive fishing gear can still be effective and catch protected species in addition to target and non-target species (Erzini *et al.,* 1997; Laist, 1997).

Gear Adaptations in order to reduce Ghost Fishing: While it is better to prevent loss in order to lessen the effects of ghost fishing and marine debris, gear adaptations can lessen the impact of ghost fishing by limiting the gear's ability to continuously fish. Ghost fishing can be decreased by using nets, pots, and traps that decompose. After a certain amount of time in the sea, corroding or biodegradable panels and rot cords can stop trapping (Arthur *et al.,* 2014; Bilkovic *et al.,* 2012; Kruse and Kimker 1993). The cotton escape cord used in the USA's Dungeness crab fishery off the coast of Washington breaks down and releases the plastic hooks on average 126 days after deployment (Antonelis *et al.,* 2011), as opposed to traps that don't employ the decomposing cord, which continue to catch crab for more than two years. Although the legislation does not define the diameter, escape cables are required in the fishery. If the laws called for a smaller diameter cord, it would probably shorten the time the phantom fish are trapped (Antonelis *et al.,* 2011). According to research conducted in Alaska, USA, corroding panels were more dependable and cost-effective, although rot cord was more practical for enforcement. Additionally, Maselko *et al.* (2013) discovered that several traps were continuing ghost fishing after the rot cord broke down because of gear blockages and marine fouling. Biodegradable adaptions for octopus traps, conger eel pots, and croaker drift nets in Korea have been created, but catch rates are negatively affected during active fishing (Maselko *et al.,* 2013; Kim *at al.,* 2014a; Kim *at al.,* 2014b). By include the users early in the design process, collaborative research with fishermen can aid in the uptake of new equipment.

Cleanup and Removals

While adjustments might lessen ghost fishing, gear removal is equally crucial. To ascertain the scope of the issue and the areas on which to concentrate cleanup and removal efforts, surveying is crucial. One simple method for doing this is visual surveying; another is to map

the bottom and locate missing gear using side-scan sonar technology. Side-scan sonar can often make it easy to locate traps and pots due to their well-known designs. Initiatives to clean up abandoned fishing gear, like the California Lost Fishing Gear Recovery Project in the United States and the Carpentaria Ghost Net Programme in Australia, are supported or managed by a number of governments, both national and local. With the help of programmes in Sweden, Poland, Norway, and the north-east Atlantic, nets, pots, and other ALDFG have been rescued (Brown and Macfadyen, 2007) (Fig. 7).

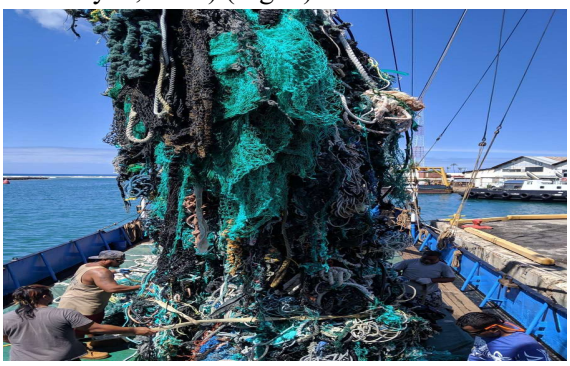

Fig. 7 Destroyed Nets collected from sea.

(Source: Ocean Voyages Institute)

Although the source of abandoned equipment can originate from anywhere in the world, removing it frequently becomes a national, state, or territorial issue (Phillips, 2017). As a result, it can readily cross political boundaries. Over 10,000 ghost nets have been collected by Ghost nets Australia in 18,000 DFG products Bilkovic *et al.,* 2012. The government of the Republic of Korea has established an incentive programme for fishermen to assist with the collection of DFG over significant fishing grounds, however this may not be a long-term solution (Cho, 2009). Programmes for cleanup and removal are expensive, cover a small region, and have limited recovery potential throughout the world (Brown and Macfadyen 2007). Derelict gear removal programmes may require a cost-benefit analysis in order to be financially justified. According to Gilardi *et al.* (2010), retrieving abandoned gill nets in Puget Sound, Washington, costs US $1358 whereas ghost fishing might cost US $19,656 in Dungeness crab throughout the net's lifetime. It is possible to restrict the scope of cleanup and recovery efforts. Nearly all of the efforts in Puget Sound to retrieve gillnets have been directed at the waterways.

Detrimental fishing gears can have significant impacts on aquatic ecosystems

Overfishing: Certain fishing gears, such as bottom trawls or large-scale nets, can lead to overfishing by capturing fish at unsustainable rates. This can disrupt the balance of the ecosystem, deplete fish populations, and disrupt the food web.

Bycatch: High amounts of bycatch, or the unintended capture of non-target species, can be caused by fishing gear that is not discriminating enough. Bycatch can include young fish, other marine organisms, and endangered or protected species. Population decreases and ecological imbalances may result from it.

Habitat Destruction: Some fishing gears, like bottom trawls or dredges, can cause physical damage to the seafloor, coral reefs, and other sensitive habitats. The dragging or scraping of these gears can destroy essential habitats, disrupt breeding grounds, and harm the overall health of the ecosystem.

Ecosystem Disruption: Detrimental fishing gears can alter the structure and functioning of aquatic ecosystems. Removing certain species through intensive fishing can disrupt predator-prey relationships, affect nutrient cycling, and lead to cascading effects throughout the ecosystem.

Biodiversity Loss: The use of harmful fishing gears can contribute to the loss of biodiversity in aquatic ecosystems. Over time, the removal of specific species or the destruction of habitats

can result in reduced species diversity and the decline of ecologically important organisms.

Genetic Changes: Detrimental fishing gears can also impact the genetic diversity of fish populations. Overfishing and selective fishing practices, such as targeting specific size or genetic traits, can lead to genetic changes within fish populations, potentially reducing their ability to adapt to changing environmental conditions.

Advancement of Sustainable Management Practices

Sustainable Fisheries Management: Understanding different fishing gears helps in assessing their impact on fish populations and the ecosystem. By studying fishing gears, scientists and policymakers can develop regulations and management strategies to ensure sustainable fishing practices and prevent overfishing.

Ecosystem Impacts: Fishing gears can have unintended impacts on non-target species and habitats. Studying fishing gears helps identify any negative effects, such as bycatch (unintentionally caught species), habitat destruction, or damage to sensitive marine environments.

Gear Selectivity: Different fishing gears have varying levels of selectivity, meaning they target specific species or size classes of fish. By studying fishing gears, researchers can assess their selectivity and develop more targeted and sustainable fishing techniques.

Innovation and Improvement: Research on fishing gears can lead to advancements in gear design and technology, making them more efficient, environmentally friendly, and selective. This can contribute to reducing the ecological footprint of fishing activities.

Conclusion

Fishing gear is an essential component of angling, consisting of rods, reels, hooks, lines, and lures. These tools are used to catch fish efficiently. However, it is important to be mindful of the environmental impact of fishing gear, particularly the issue of ghost fishing. Abandoned or lost fishing gear can continue to harm marine life, causing entanglement and death. To address this problem, responsible fishing practices, proper gear disposal, and awareness campaigns are crucial in preserving our oceans and their delicate ecosystems. The study of fishing gears is essential for understanding their mechanisms and studying their impact on fish populations and ecosystems. Fishing gears, such as nets, lines, traps, hooks, and dredges, have specific mechanisms for capturing fish. Nets entangle or enclose fish, lines with hooks lure and hook fish, traps attract and capture fish, and dredges collect shellfish from the seafloor. Studying fishing gears is crucial for sustainable fisheries management. It helps assess the impact of fishing gears on fish populations and the ecosystem, leading to the development of regulations and management strategies to prevent overfishing. The study also investigates the unintended consequences of fishing gears, such as bycatch and habitat destruction. Understanding gear selectivity is another important aspect of studying fishing gears. Different gears have varying levels of selectivity, targeting specific species or size classes of fish. Research on fishing gears enables the assessment of their selectivity, leading to the development of more targeted and sustainable fishing techniques. Moreover, studying fishing gears promotes innovation and improvement in gear design and technology. Advancements in gear design can make fishing gears more efficient, environmentally friendly, and selective, reducing the ecological impact of fishing activities. Studies on fishing gear offer important new perspectives on how they work, how they affect fish populations and ecosystems, and how they might be used to manage and conserve fisheries sustainably.

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