

Review Article

Effects Of Ghost Fishing On Ecosystems and Biodiversity

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Abstract

Ghost fishing is when fishing equipment is lost or abandoned and keeps on catching organisms in an uncontrolled manner in the water body, which creates an environmental impact on aquatic ecosystems and biodiversity. Due to the fact that most fishing equipment is made of durable artificial materials, it tends to stay active in the environment for a considerable amount of time, causing unaccounted mortality to both target and non-target species. Ghost fishing may impose more pressure on endangered species and, in the end, cause restructuring of populations, species extinction, predator-prey relationships, and food web interactions. Ghost fishing affects other organisms in a way different from causing their mortality. Ghost fishing equipment that settles to the bottom of the water or moves along the bottom has the potential to cause physical harm to the benthic ecosystem and may even cause invasion by certain organisms into new areas. Moreover, fishing gear made of synthetic polymers like polyamide, polyethylene, and polypropylene has the potential to break down slowly in the water and cause microplastic pollution by adding plastic to aquatic food webs. Because deaths caused by ghost fishing are not recorded in official catches, it may also contribute to an underestimation of total fishing mortality and fish stock assessment, which could cause faulty fishery management policies. Hence, stopping ghost fishing and the removal of lost or discarded fishing gear are necessary for biodiversity conservation, habitat protection, pollution prevention, and sustainable fisheries management.

Keywords: Ghost fishing, biodiversity, ecosystem, fish stock, fishing gear.

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1. Introduction

Ghost fishing is normally described as the total direct and indirect consequences of abandoned, lost, and other disposed fishing gear (ALDFG) that remain functional after escaping the control of fishers, and thus affect the life of aquatic organisms and habitats. This happens because the current fishing gears are made of robust synthetic polymers, such as PA, PE, and PP, and thus can remain intact in water for long periods and, under certain conditions, continue capturing aquatic organisms. Passive fishing gears, including gillnets, trammel nets, traps, and fyke nets, continue catching targeted and untargeted organisms after being lost, and thus constitute the main sources of ghost fishing.

The effects of ghost fishing gear are not only about the death of the trapped animals, but include other ecological impacts as well, such as habitat destruction, loss of biodiversity, disruption of food chain dynamics, the presence of artificial substances in aquatic habitats, and the spread of non-native species. Recent systematic reviews have found biodiversity loss and habitat destruction as among the major ecological impacts of ghost fishing [1], [2], [3],[4].

Among other effects caused by ghost fishing, there is also the effect of continued and unrestricted fishing of commercial fish and shellfish species. As it has been noted above, the fishing efficiency of passive fishing gear that has been lost and is no longer controlled by fishers can last for some time, which means that the mortality of these organisms caused by the gear is an extra mortality factor that does not show up in official fishing statistics. Organisms caught in such gear may die because of starvation, injuries, diseases, predation, cannibalism, or

unfavorable environmental conditions. Besides, the preservation or decay of dead organisms in the fishing gear may attract more organisms, leading to a continuous cycle of catching and death in some cases [1], [3].

2. Impacts Of Ghost Fishing on Aquatic Ecosystems

However, this decrease in fishing efficiency is often associated with the gradual degradation of the physical integrity of the equipment, its net height, sedimentation, and biofouling. Nonetheless, the decrease in the effectiveness of the gear does not mean that the ecological effects of this fishing equipment will be diminished in a short time. The kind of fishing equipment and its materials, water depth, currents, sea bottom characteristics, as well as the amount of biofouling, may have an important impact on the period and intensity of ghost fishing. In inland water bodies, the lack of sufficient surface area, changes in water levels, high levels of exploitation of the coast, and complicated bottom structures may cause the accumulation of lost fishing gear in certain regions. In addition, small-scale fishing without records, the lack of standardized reporting on losses of fishing gear, and the lack of professional retrieval capabilities prevent the assessment of the real amount of lost fishing gear [5].

Fishing gear may be lost because of various environmental, operational, and socioeconomic factors. Major causes include severe weather conditions, currents, waves, and fluctuations in water levels; entanglement with rocky or obstructed bottom structures; interactions and conflicts with commercial vessels or other fishing activities; failure of buoys or connecting components; inadequate maintenance; operator error; deliberate disposal to eliminate evidence of illegal fishing activities; the absence of appropriate waste-reception facilities at ports; and the costs associated with the disposal of fishing nets that have reached the end of their operational life [6], [7].

Ayaz et al. [8] investigated the ghost-fishing characteristics of monofilament and multifilament gillnets in İzmir Bay and reported that monofilament nets continued fishing for 106 days, whereas multifilament nets remained active for 112 days. The study demonstrated that weekly catch rates decreased exponentially over time; nevertheless, lost nets continued to capture aquatic organisms for several months. Moreover, the overall fish catch rates of monofilament nets were reported to be significantly higher than those of multifilament nets.

A pilot study conducted in Lake Ohrid demonstrated that old and lost fishing nets can accumulate on the lake bottom and can be successfully recovered through targeted retrieval operations [9]. Systematic investigations of lost angling gear have also highlighted the environmental pollution associated with recreational fishing, particularly through the accumulation of fishing lines, hooks, and metal sinkers in aquatic environments [10].

Dartay [11] estimated that approximately 7.2 km of gillnets, 4.4 km of trammel nets, and 500 traps/fyke nets are lost annually in Keban Dam Lake and demonstrated that these passive fishing gears, once lost from fishers' control, may constitute a significant ghost-fishing threat to freshwater species. One of the most important management implications of this uncontrolled mortality is the potential underestimation of actual total fishing mortality. Since individuals that die in ghost fishing gear are not included in commercial landing statistics, such mortality may represent an additional source of uncertainty in stock assessments, particularly in fisheries where fishing gear losses are substantial. Therefore, monitoring mortality associated with abandoned, lost, or otherwise discarded fishing gear (ALDFG) is important for sustainable fish-stock management.

The ecological impacts of ghost fishing gear are not restricted to target species. When fishing gear is operated under the control of fishers, factors such as target species, fishing period, fishing grounds, and gear soak time can be managed to a certain extent. Once fishing gear is lost, however, these control mechanisms are eliminated. Consequently, ghost fishing gear may capture not only fish, crustaceans, cephalopods, and other invertebrates, but also non-target organisms such as seabirds, marine mammals, and sea turtles.

One of the most significant conservation concerns associated with ghost fishing gear is its non-selective interaction with threatened and protected species. Global assessments conducted by FAO and UNEP have identified sea turtles, seabirds, and marine mammals among the major vulnerable groups affected by ALDFG. Synthetic fishing nets that retain their physical integrity for prolonged periods may act as a persistent source of low-level mortality, potentially resulting in substantial consequences for small or vulnerable populations [3].

In the case of the research carried out by Ayaz et al. [8] in İzmir Bay, 29 species of organisms were found in the ghost fishing nets, namely 22 species of fish, five species of crustaceans, one species of cephalopod, and one species of gastropod. The uncontrolled catch of fish in the ghost fishing nets is not limited to the deaths of organisms caught there. The injuries that those who manage to escape suffer can affect their swimming and feeding activities, cause infections, and make them more vulnerable to predators. Hence, while evaluating the environmental effects of ghost fishing, not only the number of organisms died in fishing nets but also their possible sublethal impacts should be considered. Such sublethal impacts include reduced growth, alteration of swimming and feeding behavior, poor reproductive success, oxidative stress, changes in enzyme activities, immune suppression, and tissue injury.

It was noted in the same study that 17 animals of an endangered species, *Pinna nobilis*, had died. This proves that ghost fishing gear is not a threat only to mobile species but could also cause harm to sensitive and sessile species through currents and movements of the fishing gear. Thus, the impact of ghost fishing gear in protected areas, spawning sites, nurseries, seagrasses, reefs, and habitats of highly threatened species is much higher ecologically than an equal quantity of lost fishing gear in areas that are not as sensitive. In other words, the evaluation of ghost fishing gear should not be made solely on the amount of lost fishing gear but also on the sensitivity of the habitat and species interacting with the gear.

Floating nets, buoys, and ropes create artificial substrates upon which bacteria, microalgae, invertebrates, and other organisms can attach and grow. Drifting in currents, the items may transfer the attached organisms out of their natural dispersion ranges and aid biological rafting processes and possibly introduce non-indigenous and invasive organisms. The extent of this risk depends on how long the item remains in the water body, its buoyancy, transport mechanisms, and the vulnerability of the receiving habitat to biological invasions [12].

The role of fishing gear materials in global plastics pollution differs between environmental compartments and geographic regions. The significant share of nets, ropes, and other fishing gear waste detected in offshore oceanic garbage patches indicates that fishing materials can survive in the marine environment and travel long distances [13].

Lost fishing equipment is capable of physically harming benthic habitats as it will move on the bottom of the sea or lakebed, depending on the waves and water currents, as well as entangling in benthic structures. The consequences of such physical interactions might be the abrasion of benthic life forms, their detachment, entanglement in nets, changes in the substrate composition, and movement of the benthic structures to other places. Coral species, hydrocorals, and other benthic life forms that have structures that grow over the substrate are especially susceptible to entanglement with fishing equipment. Contact between ghost gear and coral structures leads to injuries, destruction, death, and modification of benthic structures that offer protection and food to organisms living there. Research has shown that lost fishing gear and lines increase mortality of *Millepora alcicornis* colonies and decrease feeding of herbivorous fish in these colonies. Therefore, the impact of physical harm to benthic habitats is not only limited to those organisms that will directly interact with the gear. Any form of harm to the habitat-forming organisms can also have indirect impacts on other species that rely on such habitats for protection, nutrition, or reproduction purposes. Hence, the ecological impact of ghost fishing gear could go beyond the individual organism level to encompass habitat-level impacts as well [1], [3].

Artificial fishing nets, ropes, and fishing lines may be subject to deterioration and gradually disintegrate into smaller pieces due to ultraviolet (UV) radiation, changes in temperature, wave action, mechanical friction, and biodegradation. Consequently, through this process of degradation, ALDFG can move from entangling marine wildlife through macroplastics to being a possible producer of microplastics. Fragmentation is determined by certain variables, such as type of polymer, chemical additives, time spent in the environment, and hydrodynamic energy. Released into the environment, these pieces can travel through the entire water column, settling in sediments or being ingested by plankton, benthic organisms, and fish, thus entering the aquatic food web [14].

3. Impacts on Biodiversity and Food Webs

The ongoing mortality of both target and non-target species through ghost fishing might have effects on species abundance, composition, and biodiversity. More specifically, the elimination of certain species that serve important roles in nature, including commercially exploited species, predators, herbivores, and habitat builders, might cause changes in species interactions and influence aquatic ecosystem functioning [2], [3].

In addition, fish and invertebrate species captured and killed due to ghost fishing will attract other species of organisms that will come to consume these dead fish and other invertebrates. Subsequent entrapment and capture of these scavenger species by the same ghost fishing gear will start a new cycle of secondary capture events after the first one. Therefore, even after fishing activities stop, the ghost fishing gear will continue to act as a source of artificial mortality for quite a while.

Any destruction of benthic habitats might further increase the impact of ghost fishing indirectly on biodiversity. The destruction of coral reefs, seagrass beds, and other structurally complex habitats may result in a decrease in habitats for juveniles, invertebrates, and feeding grounds for many fish species. Indeed, systematic and bibliometric analysis conducted recently has revealed that biodiversity loss and habitat destruction are the main ecological impacts of ghost fishing [2], [4].

Furthermore, the long-term and ecosystem-scale impacts of ghost fishing gear on food webs may ultimately be reflected in the degradation of ecosystem services, including food provision, habitat support, recreational opportunities, aesthetic values, and safe navigation [4].

9. Conclusion

In summary, the negative effects of ghost fishing on aquatic ecosystems need to be considered an environmental issue that goes far beyond the continued catching of fish by lost fishing equipment. Unreported deaths of target fish species, the catching and death of non-target and protected species, habitat damage, indirect impact on biodiversity and trophic interactions, plastic and microplastic pollution, and transportation of invasive species are the different facets of the same environmental issue. Consequently, ghost fishing management needs to be approached using an ecosystem-based perspective, which includes the prevention of fishing equipment loss, quick detection and retrieval of the lost fishing equipment, and focusing on the retrieval of lost equipment in sensitive ecosystems, among other measures.

Some of the key knowledge gaps include the poor representation of inland water and artisanal fisheries in the current body of literature, lack of standard approaches to measure rates of fishing gear losses, uncertainty about the connection between ghost fishing period and overall mortality, insufficient studies on the impact of ghost fishing on sub-lethal and population levels, inability to identify microplastics as a product of fishing gear, and a lack of evaluation of the efficiency of management and retrieval actions in the long run.

Future research should categorize the reasons for lost fishing gears based on the types of gear and regions, include suitable control areas in their research design, document the temporal changes in the physical status and fishing efficiency of lost gears, and at the same time measure the mortality rates of the target, non-target, and protected species. Moreover, stock assessment models should take into account the number of lost gears, the period in which the gears are still fishing, and uncertainties related to their catching efficiency. The application of such models will contribute to the accurate estimation of the total fishing mortality rate and help develop mitigation strategies to address ghost fishing.

Author Contributions

Conceptualization, Writing, Submission.

Conflict of Interest

The author(s) declare no conflicts of interest.

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