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Risk Factors in the Natural Habitat of Fish: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Fish can be found in abundance in most bodies of water. Despite the fact that no species has yet been detected in the deepest 25% of the ocean, they are present in almost every aquatic environment, from the abyssal and even hadal depths of the deepest oceans (where they can be found as cusk-eels and snailfish) to the high mountain streams. Habitat destruction is the leading cause of biodiversity loss. The rise in nutrient loading, particularly nitrogen, is one of the main factors contributing to habitat degradation. Trawling diminishes the environment's complexity by removing sedimentary features and biogenic structures like sponges, bryozoans, and shell aggregates. The construction of dams on tidal rivers has harmed estuarine habitat: estuary community structure, water chemistry, food webs, and loss of freshwater and estuary habitats. Since 1950, the catch of fishes associated with coral reefs has declined by 60% per unit of effort. Ever growing human populations and acidity have significantly impacted fish diversity. The literature reviewed unequivocally demonstrated how anthropogenic effects have altered ichthyofauna and reduced biodiversity in aquatic environments around the globe. Identifying current and potential habitat hazards and the conservation and improvement actions required to eliminate or minimise those concerns is crucial in determining important fish habitats.

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1. INTRODUCTION

The term "habitat" has been described as "the structural elements of the environment that attracts organisms and serves as a centre of biological activity" [1]. In the present context, it refers to a variety of sediment types, such as mud through boulders, bed patterns, such as sand waves and ripples and flat mud, as well as the co-occurring biological structures, such as coral, seagrass, sponges, shells, and burrows [2].

Geomorphology of the water body (beds, banks, shape), flow characteristics (high, low, quick, slow), and bed substrate (for example, gravel or sand) type are among the abiotic components, along with water chemistry. In inland waters, these traits are typically very dynamic and directly impact fish and other living organisms [3]. Other things that make up fish habitat include the following:

- Substrate-giving substances, such as rocks, coral, gravel, sand, and mud
- The different kinds of vegetation that are there, such as overhanging vegetation, reeds, water plants, algae, dead wood (snags), seaweed, seagrasses, mangroves, and salt marsh
- The habitat's shape and characteristics, such as the presence of reefs, pools, and riffles
- Relationships with other ecosystems and waterways, such as wetlands, streams, estuaries, floodplains, lakes, and beaches.

1.1 Causes of Habitat Loss

Habitat destruction (habitat loss and habitat reduction) is the process by which a natural habitat becomes incapable of supporting its native species. The organisms that previously inhabited the site are displaced or dead, thereby reducing biodiversity and species abundance [4]. Habitat destruction is the leading cause of biodiversity loss [5,39]. Depending on the type of habitat, exposure, and other environmental factors, specific threats to fish habitat will typically vary in type and severity by location [6,7,39,40]. Listed below are some of the most prevalent risks to habitat:

1.2 Eutrophication

The rise in nutrient loading, particularly nitrogen, is one of the main factors contributing to habitat degradation. Increased eutrophication has generally negative impacts. Increased amounts of nutrients entering a bay via sewage, agricultural fields, and lawn fertilizers encourage primary production, which in turn causes a rise in phytoplankton and macro-algae growth, a decrease in water clarity, and changes in the water's chemistry [8,40,46,47]. The dominance of species that are difficult to integrate into the existing trophic structures modifies the makeup of the algal species [9,39]. A notable illustration of the impact of habitat degradation on fish communities is the modification and disappearance of eelgrass habitats as a result of eutrophication [3]. The Pseudo-nitzschia algal bloom coincided with the abrupt mass fish mortality incident (1.25 metric tonnes) in Puducherry, India's Chunnambar backwater [41]. According to a Long Island Sound report, Connecticut's oyster aquaculture business saves $470 million yearly compared to more conventional nutrient-reduction strategies, including better wastewater treatment and agricultural best management practices [59].

1.3 Trawling

Trawling diminishes the environment’s complexity by removing sedimentary features and biogenic structures like sponges, bryozoans, and shell aggregates [17,53,54,55]. This has implications for fisheries since certain fish species' physical structure may be crucial to their survival and growth [10,53,57].

1.4 Bycatch

Bycatch discards, or non-targeted species or undersized individuals, can also significantly impact the habitat of fisheries [16]. Large amounts of dead bycatch may be disposed of, which may change the organic matter loading, lead to changes in dissolved oxygen profiles, and affect nutrient cycling in addition to the apparent direct consequences on populations and marine food chains [15,14,40]. According to an FAO analysis, the annual global marine capture fisheries discards between 2010 and 2014 were 9.1 million tonnes (95% CI: 6.7 - 16.1 million tonnes), or 10.8% (10.1% -11.5%) of the average annual catch over that period. The bottom trawls, including otter trawls, shrimp trawls, pair bottom trawls, twin otter trawls and beam trawls, were responsible for about 46% (4.2 million tonnes) of the yearly discards [58].

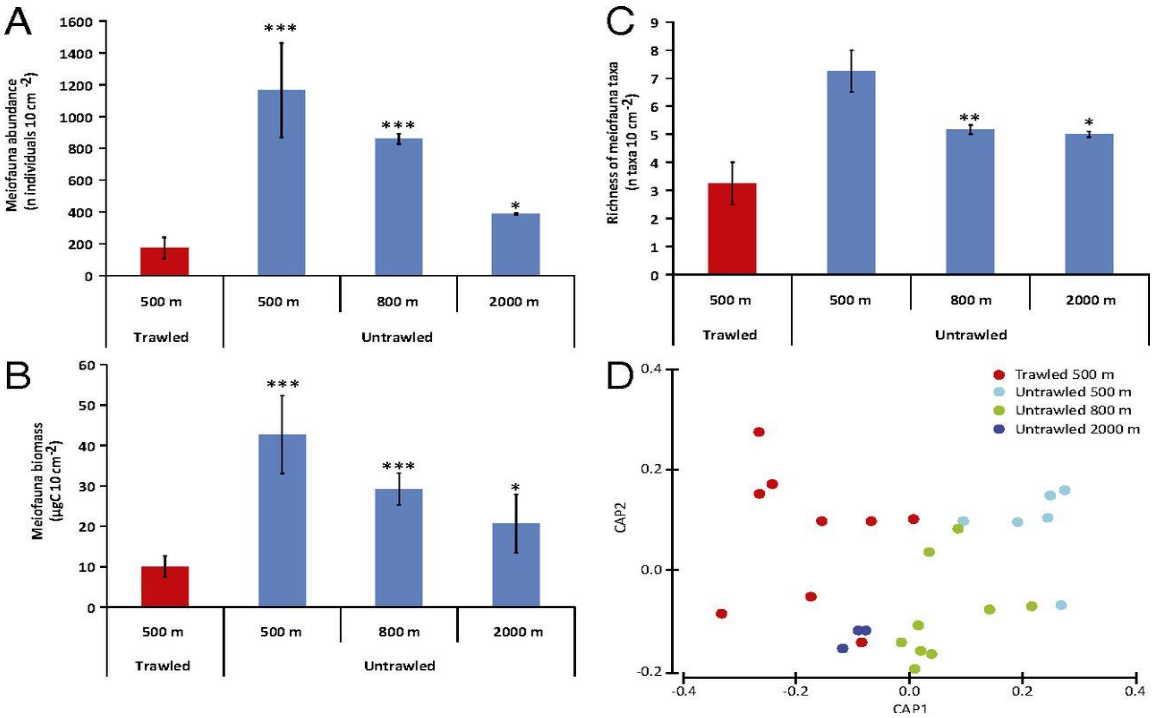

Fig. 1. Showing meiofauna in sediments from the La Fonera Canyon that were trawled and untrawled at various depths. Abundance (A), biomass (B), and biodiversity (as richness of taxa) (C) A biplot after canonical analysis of the primary coordinates shows differences in the composition of the meiofauna communities Error bars show SEs between stations at comparable depths and impact levels or SDs between replicates for data at 2,000 m deep. *P < 0.05; **P < 0.01; ***P < 0.001 vs. untrawled samples from 500, 800, and 2,000 m [56]

1.5 Dams

The construction of dams on tidal rivers has harmed estuarine habitat. Estuary community structure, water chemistry, food webs, and loss of freshwater and estuary habitats are all affected by flow, sediment delivery, salinity, and temperature variations. By removing or diverting 40% of the Skokomish River's annual runoff, Washington State has lost 6% of its total unvegetated flats, 40% of its low intertidal area, 18% of its eelgrass area, and less of its mesohaline mixing zone [18,40].

1.6 Power Plant

Numerous reviews have been conducted on the effects of power plants on power plants can have an impact on fisheries by:

- Modifying estuarine production cycles through variations in water temperature and circulation patterns fisheries [19].
- Rising water temperatures increase death, decrease growth, and disrupt spawning [20].
- Raising mortality rates through direct impingement of larvae and juveniles on input screens [21].
- Increasing fisheries species mortality due to the direct impact of their feed species.
- Increasing mortality and decreasing growth by the release of poisons such as chlorine, bromine, copper, and zinc [22,23].

It was discovered that high levels of forage fish entrainment by power plants could result in significant (>25%) losses to total population production for striped bass and bluefish [22]. Dams may be the first significant disturbance for anadromous river herring, (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*), in numerous rivers and streams in the northeastern United States [37,38].

1.7 Low DO Level

One of the most serious consequences of coastal waterway eutrophication is habitat deterioration and loss caused by a lack of dissolved oxygen (DO). Reducing the amount of oxygen in the water or sediments causes changes in the microbial community composition and even the mortality of some species (hypoxia, 2 mg/L) or all of them (anoxia) [42,43]. Although oxygen depletion occurs naturally in some systems, especially offshore basins, it has been exacerbated by increased sewage and fertiliser inputs caused by development and agriculture near estuaries [44,45,46]. According to study, excessive nitrogen imports have moderately to severely deteriorated 65 percent of the contiguous U.S.'s estuaries and coastal waters. Excessive nutrient loading results in algal blooms and waterways with low oxygen levels (hypoxic waters), which can kill fish and seagrass and diminish vital fish habitats [59].

1.8 Sea Level Rise

Global warming and rising sea levels may significantly impact estuarine fish populations and coastal fisheries [24,25,47,51,52]. Future high tides will frequently flood a larger portion of salt marsh surfaces if the sea level rises more quickly than the capacity of these surfaces to accrete peat and sediment [48,49,50,51]. If the marsh retains its stability, it will expand the estuarine fish habitat. But the marginal sea-level shift over the past 50 years is insufficient to account for the current sharp declines in fisheries.

1.9 Fishing

Fishing can interfere with the dynamics of organic matter and benthic primary production. Such effects can be observed at relatively small spatial scales in semi-closed systems, including bays, estuaries, and fjords. There may be disturbances in these processes in open coastal and outer continental shelf systems [60]. In the Mozambique Channel, effective small-scale fishing activity increased 60 times from a little over 386,000 kilo-watt days in 1950 to over 23 million kilo-watt days in 2016 [62]. From the late 1970s to roughly 2010, fishing effort and capacity expanded dramatically around the world before stabilizing [64]. Depending on the quantity of fishing effort, however, the relative rates of other processes (such as natural processes) may reduce the consequences of fishing disturbances [61]. Fish health and quantity is impacted by bottom trawling when the ratio of available prey to competitor density changes [65].

1.10 Human Impacts

Numerous factors have changed the water quality and fish habitat over the past century, impacting native fish populations. Examples include:

a. **Coastal Development**: Rising coastal development threatens coastal wetlands' function and diversity. Removing trees and vegetation from riverbanks can reduce the amount of shade and raise the water temperature. Additionally, a lack of vegetation causes more erosion and sedimentation, which changes spawning grounds. Fish can't migrate upstream to reach essential spawning habitats if there are dams or other barriers in their way.
b. **Invasive Species:** Fish endemic to the area contend with invasive species for food and habitat. Fish that have replaced local species in some areas include the round goby and the Eurasian ruffe. An invasive species may alter its habitat. Zebra mussels boost water clarity and minimise food for native species by filtering bacteria, encouraging aquatic plant growth.
c. **Pollution:** Sewage overflows, urban and agricultural runoff, and industrial pollutants are just a few of the pollution-related factors that continue to harm fish habitat and the Great Lakes water quality. For example, the native *schizothorax* fish species in Kashmir's Dal and river Jhelum of India has drastically declined due to changes in water quality parameters [34-36].

2. MANAGEMENT

1. Human activities and stressors impacting freshwater and marine fishes will likely become more widespread, intense, and damaging if prevention, effective management (such as fisheries), restoration, or adaptation programmes are not implemented.
2. Decades of study and experience in the field of freshwater management have yielded a wealth of knowledge regarding integrated catchment management [26], the restoration of aquatic habitats [27], the management and removal of dams [28], and the provision of environmental flows. [29] riparian and floodplain processes and their restoration [30,31]. Enforcing proper laws (such as catch-and-release restrictions), establishing no-take zones in places essential for reproduction and recruitment, and even managing relocation and reintroductions, fish populations can be restored [32].

3. Identification of current and potential habitat hazards, as well as the conservation and improvement actions required to eliminate or minimise those concerns, is a crucial step in the process of determining important fish habitats. A major problem is the destruction and deterioration of aquatic ecosystems, which are crucial for the sustainability of fish populations. According to Kennish (1998), [33] 60% of the world's population resides within 60 kilometres of the shore.
4. FRPA rules pertaining to fish habitats In the Forest Planning and Practises Regulation (FPPR) and the Woodlot License Planning and Practices Regulation (WLPPR), the government has set goals and practice specifications for managing water, riparian regions and fish habitats. Wherever these habitats are found on the land base, FRPA regulations safeguarding such habitats are in effect.

Preventing landslides, maintaining natural surface drainage, re-vegetation, road construction, maintenance, and deactivation are examples of general practice requirements that may also protect fish habitat. Other requirements include general wildlife measures, resource features, and wildlife habitat features. Frequent dredging is necessary to ensure proper water exchange between the sea and the backwaters. Oyster aquaculture can be promoted wherever required to absorb the excess nutrients from turbid waters. Besides, institutions must uphold right-based fishery management to strike a balance between global social, ecological, and economic needs.

3. CONCLUSION

Both biotic (living) and abiotic (non-living) elements make up a habitat. Habitat destruction is the leading cause of biodiversity loss. The rise in nutrient loading, particularly nitrogen, is one of the main factors contributing to habitat degradation. There are many reasons for habit loss, such as Eutrophication, Pollution, Invasive Species, Fishing, Sea level rise etc. Dal Lake has likely degraded due to increased sewage inflow, pollution, organic loads, and other factors. The production of *schizothorax* fish had a dramatic fall due to the significant changes recorded since the 1990s to 2023. The dissolved oxygen levels have drastically decreased due to excessive weed and macrophyte development, which directly results from lake pollution. However, some measures should be taken for the management of habitat, such as the restoration of aquatic habitats, enforcing proper laws (such as catch-and-release restrictions), establishing no-take zones in places essential for reproduction and recruitment, and even managing relocation and reintroductions, fish populations can be restored, the government has set goals and practice specifications for managing water, riparian regions and fish habitats. So, to protect nature, we must take the necessary steps to prevent habitat loss. Besides, there is much to be learned by studying past fishing practices, and they can guide essential decisions for conserving the marine as well as inland resources and the habitats on which humanity depends now and in the distant future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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