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Fresh Water and Fisheries: Methodology

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Abstract

Freshwater aquaculture production in 2011 was 44.3 million tons or 29% of world fisheries production. Roughly 95% of this production was from Asia – China was the leading country. Ponds are the common culture system, but raceways, cages, net pens, and water re-use systems are important. Seed stock for grow-out is produced in hatcheries from farm-reared brood stock. Fertilizers, feeds and mechanical aeration increase production in ponds. Competition with agriculture for land and water, wetland destruction, water pollution, and lack of fish meal and oil for use in feeds could limit aquaculture [1]. There is an effort to avoid these impacts.

Aquaculture, freshwater or marine, is dependent upon good water quality to sustain maximal fish growth. Ammonia and nitrate are toxic to fish. NH3 should be kept at levels below 0.05 mg l−1. Nitrite (NO2) should be kept below 0.5 mg l−1. Aerobic bacteria play a key role in detoxifying ammonia. Nitrosomonas bacteria convert NH3 to NO2, and Nitrobacter bacteria convert NO2 to NO3. For every milligram of ammonia converted about 5 mg of oxygen is consumed. An additional 5 mg of oxygen is required to satisfy the oxygen demand of the bacteria involved [2]. Thus, reduced concentrations of dissolved oxygen may contribute to increased concentrations of ammonia, nitrate, and phosphate in the water column. Phosphate, which is an essential element for life, can be detrimental to the biosphere in high concentrations. Since the discovery in 1988 by L. Liebermann that yeast contain granules (volutin) composed of high-polymer polyphosphates, a diverse group of microorganisms have been reported to effectively take up inorganic phosphate from the medium and convert them into biopolymers. Polyphosphates have been associated with the capsule in Neisseria gonorrhoeae, outside the plasma membrane, or as long-chain cytoplasmic reserves. In some microorganisms, these granules can account for as much as 25% of the weight of the organism and the process can be highly efficient in phosphate removal [3]. For example, in the A/O process of activated sludge treatment, involving alternate anaerobic and aerobic cycles, a bacterial population (largely composed of a typical soil bacterium – Acinetobacter lwoffi) that accumulates polyphosphate even under extremely low phosphate concentrations is enriched. Since the consortium in the A/O process denitrifies ammonium as well as removes phosphate from the environment, it provides attractive possibilities for aquaculture. A variation of this has already been incorporated into the sequencing batch reactor for recirculating aquaculture systems. Despite the disparities in size and volume of marine and freshwater realms, a strikingly similar number of species is found in each – with 15 150 Actinopterygian fishes in fresh water and 14 740 in the marine realm [4]. Their ecological and societal values are widely recognized yet many marine and freshwater fishes increasingly risk local, regional or global extinction. The prevailing threats in aquatic systems are habitat loss and degradation, invasive species, pollution, over-exploitation and climate change. Unpredictable synergies with climate change greatly complicate the impacts of other stressors that threaten many marine and freshwater fishes. Isolated and fragmented habitats typically present the most challenging environments for small, specialized freshwater and marine fishes, whereas overfishing is by far the greatest threat to larger marine

and freshwater species. Species that migrate within or between freshwater and marine realms may face high catchability in predictable migration bottlenecks, and degradation of breeding habitat, feeding habitat or the intervening migration corridors [5].

Conservation reserves are vital to protect species-rich habitats, important radiations, and threatened endemic species. Integration of processes that connect terrestrial, freshwater and marine protected areas promises more effective conservation outcomes than disconnected reserves. Diadromous species in particular require more attention in aquatic restoration and conservation planning across disparate government agencies [6].

Human activities and stressors that increasingly threaten freshwater and marine fishes must be curbed to avoid a wave of extinctions. Freshwater recovery programmes range from plans for individual species to recovery of entire basin faunas [7]. Reducing risks to threatened marine species in coastal habitats also requires conservation actions at multiple scales. Most of the world's larger economically important fisheries are relatively well-monitored and well-managed but there are urgent needs to curb fishing mortality and minimize catch of the most endangered species in both realms.

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Introduction

Aquatic systems form both a mosaic and a continuum of habitats ranging from the freshwater springs, rivers, lakes and wetlands of continents and islands to estuaries, shallow coastal habitats, reefs and the seas. Their fish inhabitants are numerous – more than 30 000 described species (Nelson et al., 2016) – and remarkably diverse in size, morphology, physiology, habitat requirements, diet and life-history strategy (Helfman et al., 2009). Despite the disparities in the size and volume of marine and freshwater realms, a strikingly similar number of species is found in each, with 15 150 Actinopterygian fishes in fresh water and 14 740 found in the marine realm (Carrete Vega and Wiens, 2012). The greatest species diversity is found along continental shelves, in reefs associated with islands and in freshwater habitats, where isolation by the rise of mountains, creation of island systems, and sea-level fluctuations has created opportunities for speciation [8].

Fish comprise a large fraction of standing biomass of aquatic ecosystems (Jennings et al., 2008). They constitute over half of all vertebrate species and contribute in numerous ways to the diversity and functioning of aquatic ecosystems, and to the health, well-being and economies of societies in every geographic realm (Craig, 2015; Hughes, 2015). Nevertheless, many marine and freshwater fishes are threatened by critical population declines and increasingly risk local or global extinction [9].

This contribution offers an appraisal of the conservation status and relative extinction risk for freshwater and marine fishes, comparing and contrasting the shared features and peculiarities of threatening processes and patterns of species imperilment in these realms. Conservation and management challenges to pre-empt extinctions and recover threatened freshwater and marine fishes form the concluding section. This fresh perspective could help to guide restoration efforts and promote population recovery of the world's threatened fishes while balancing short-term and long-term sustainable development needs of many of the poorest people and countries in the world.

Conceptual framework and methodology

The KVK established in 1977 mandated to work for Khordha District of Odisha State and hosted by ICAR-Central Institute of Freshwater Aquaculture, only research institute exclusively dealing with freshwater aquaculture in India. This KVK works with the mandates of technology assessment, refinement, and demonstration in agriculture and allied sector like the other centers. In addition to that, transfer of agriculture and allied technologies through mass contact methods are major activity of KVK. Additionally, it also works on skill development through training, exposure, on-site hand holding for the farmers and farming women of the district. The KVK has six subject matter specialists in crop production, horticulture, animal husbandry, fisheries, home science, and agricultural extension [10].

Aquaculture and the live food trade

Freshwater aquaculture, the captive propagation of freshwater organisms, is growing rapidly across the globe. Approximately 46% of all seafood (freshwater and marine) production globally came from aquaculture in 2018 (the most recent year for which statistics are available), and the largest portion (60%) of this is freshwater fish (FAO, 2020). Introduction and invasion often accompany these benefits because the aquaculture industry usually selects species that thrive in local conditions, that are tolerant of a wide range of environmental conditions, and that are fast growing. These qualities also predispose species to become invasive if they escape, and aquaculture has led to numerous invasions across the globe. Although the potential for invasions from this industry is now well known, few measures have been taken to prevent escapes. Several fish species, collectively known as tilapia species, for example, are being promoted to developing countries through international aid programs, despite the fact that many of these species have a long record of escape and harm to native species and ecosystems. In the United States, bighead (Hypophthalmichthys nobilis), silver (Hypophthalmichthys molitrix) and black (Mylopharyngodon piceus) carp have escaped from aquaculture facilities in the last three decades and have invaded the Mississippi River and tributaries. These species now threaten to invade the Laurentian Great Lakes via a canal that connects these waterways.

Conclusion

Conserving the world's fishes in the long term will require mixtures of management actions. The mix must include conservation reserves that protect species-rich habitats and vital resources, important species radiations, and the greatest number of threatened endemic species. To be most effective, freshwater protected areas should have control over the upstream drainage network, the surrounding land, the riparian zone, and downstream reaches, and maintain both connectivity pathways and habitat patchiness. Recent developments in systematic conservation planning for rivers include methods to incorporate longitudinal, lateral (river to floodplain), vertical (surface–groundwater) and temporal connectivity as well as accounting for threatening processes that may compromise biodiversity protection.including climate change. Planning and legislation for conservation reserves also has to consider the socio-economic landscape and identify opportunities for maximum protection of biodiversity within the constraints of catchment land-use, river infrastructure, human activities and climate change. For example, strategic conservation planning is urgently needed in species-rich basins threatened by numerous new hydropower dams, such as the Mekong, Congo and Amazon basins.

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Non

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