06 WATER QUALITY STANDARDS WITH REFERENCE TO THE INDIAN CONTEXT

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Introduction

India's fisheries and aquaculture sectors play an essential role in ensuring food security, generating employment, and contributing to the economy. As the 3rd largest producers of fish and 2nd largest aquaculture nation globally, the country relies heavily on its fishery resources. However, the sustainability and productivity of fisheries and aquaculture depend significantly on water quality, Poor water quality can not only affect the growth and survival of aquatic species but also lead to environmental degradation and public health concerns. In the Indian context, managing water quality is a multifaceted challenge due to the diverse climatic zones, widespread aquaculture practices, and increasing anthropogenic pressures. This chapter delves into the standards for water quality in fisheries and aquaculture, highlighting the critical parameters, guidelines, challenges in maintaining and the steps taken to address the issues.

Key Water Quality Parameters for Marine Fisheries and Mariculture

Water quality is a fundamental factor in sustaining the health, productivity, and biodiversity of marine fisheries. It directly influences the survival, growth, and reproduction of marine organisms, which are vital for ecological balance and economic prosperity. In marine fisheries, optimal water quality ensures the sustainability of fish stocks, supports the livelihoods of coastal communities, and upholds the integrity of marine ecosystems. It also plays a pivotal role in mariculture. It directly influences the physiological health, growth rate, and reproduction of farmed aquatic species. Suboptimal water conditions can result in stress, diseases, and reduced yields, undermining the economic viability of mariculture ventures. Key water quality parameters include:

I. Physical Parameters:

- **Temperature:** Fishes cannot control its body temperature with changes in the environment. Any fluctuations beyond its optimum temperature will affect the general wellbeing of the fish, The optimum water temperature needed for most tropical species is 27–31°C and for most temperate species are 20–28°C.
- **Turbidity:** Turbid water leads to deposition of unwanted wastes and increase organic loads in cage culture site. The turbidity in the water may be due to colloidal clay particles, dissolved organic matter and abundance of plankton. The optimum transparency required for mariculture site should be < 5 m (secchi disc reading). Suspended solids in a suitable site for culture should not exceed 10 mg/L.
- **pH:** Estuarine areas where seawater is mixed by freshwater influx are prone for huge variation in pH. The optimum range of pH for most marine species is from 7.0 to 8.5, any fluctuations will also affect the fish directly or indirectly.

II. Chemical Parameters:

- **Dissolved Oxygen (DO):** Dissolved oxygen requirements vary with species, its size and other environmental factors like temperature and salinity. In general, dissolved oxygen should preferably be around 5 ppm or more. Demersal species requires less oxygen (>3 ppm) when compared to pelagic species (>4 ppm). Low DO levels can cause fish kills and reduced feed conversion efficiency.

- **Salinity:** Inland saline waters may have salinity fluctuations due to tidal influences. Thus, the site selected for mariculture should have salinity range between 15–30 ppt for altering the species cultured according to market demands. The optimum salinity for better growth of different fish species are given in Table 1.
- **Ammonia, Nitrite, and Nitrate:** Normally in the coastal areas, sewage discharge and industrial pollution are the main sources of higher level of ammonia in seawater. Apart from this decomposition of uneaten food and debris at the bottom can affect the fish. The level of ammonia-nitrogen in the water should be less than 0.1 mg/L. The excessive amount of nitrite in water leads to the oxidation of iron in fish haemoglobin, which causes hypoxia in fish. Nitrate serves as fertilizer for phytoplankton, so the increase in its level leads to phytoplankton bloom. Nitrate (NO_3-N) and nitrite (NO_2-N) also contribute to the level of inorganic nitrogen in seawater. The total inorganic nitrogen for marine fish culture is < 0.1 mg/L. Total inorganic phosphorous plays an important role in growth of algae and other aquatic plants and it should always be < 0.015 mg/L.

Table 1: - Optimum salinity requirement for different fish species

Species	Salinity (ppt)	
	Range	Optimum
Seabass (*Lates calcarifer*)	0–33	15
Pompano (*Trachinotus* sp)	5-35	15
Grouper (*Epinephelus* sp.)	10–33	20
Cobia (*Rachycentron* sp)	15-35	25
Rabbit fish (*Siganus* sp.)	15–33	25
Snapper (*Lutjanus* sp.)	15–33	25

- **BOD / COD:** Dead phytoplankton, sewage discharge, industrial effluents, uneaten food and fish waste in the cage, becomes the source for organic load in water. Domestic sewage contains pollutants, detergents, toxic substances including several organic matters which affect well being of fish. The organic load in water can be measured by BOD / COD. The acceptable level of Biological Oxygen Demand (BOD) should not exceed 5 mg/l at 5 days period. Chemical Oxygen Demand (COD) which should be less than 1 ppm for a suitable site.

- **Heavy Metals:** Industrial effluents and other anthropogenic activities are the main source for most heavy metals which are found in seawater. So the site selected should be free and away from industrial activities and sewage discharge site. Heavy metals of importance to human and cage culture and their acceptable / safe limits are given in Table 2.

Table 2: - Acceptable limits of heavy metals in seawater

Heavy metals	Acceptable limits (ppm)
Manganese (Mn)	< 1.0
Iron (Fe)	< 1.0
Chromium (Cr)	< 1.0
Tin (Sn)	< 1.0
Lead (Pb)	< 0.1
Nickel (Ni)	< 0.1
Zinc (Zn)	< 0.1
Aluminium (Al)	< 0.1
Copper (Cu)	< 0.01
Cadmium (Cd)	< 0.03
Mercury (Hg)	< 0.004

III. Biological Parameters:

- Pathogens: Harmful bacteria, viruses, and parasites can thrive in poor-quality water, increasing disease risks.
- Plankton Population: A balanced population of phytoplankton and zooplankton is necessary for ecological stability and as a food source for certain species. Whereas algal blooms create problems to fish, directly by clogging its gills, and indirectly by depleting dissolved oxygen at night. A site which is prone for sudden bloom may be avoided while selecting for cage farming.

Water Quality standards in the Indian Context

Discharge of untreated industrial and domestic effluents into rivers and coastal waters are the main causes of marine pollution. Marine environment has the capacity to assimilate these pollutants upto certain levels depending on several factors. But when it reaches beyond the assimilative capacity of the oceans, leads to the degradation of ocean health and accumulations in the marine life. In India various research organizations and pollution control bodies have established water quality standards and guidelines tailored to the specific needs of several purposes including marine fisheries and aquaculture. These standards aim to ensure the health of aquatic species, environmental sustainability, and economic viability.

Central Pollution Control Board (CPCB) standards

The Central Pollution Control Board (CPCB), a Govt of India body enforces the Environment Protection Act (1986) to control marine pollution. It sets permissible limits for industrial discharges into marine waters. The State Pollution Control Boards (SPCBs) duty is to monitor local water quality and ensure compliance with central standards or guidelines. The CPCB issued water quality standards for coastal waters and marine outfalls under different classes depending on its end use. Of which the class SW- I, SW- II and SW- IV are related to fisheries and aquaculture.

Class	Designated best use
SW-I	Salt pans, Shell fishing, Mariculture and Ecologically Sensitive Zone
SW-II	Bathing, Contact Water Sports and Commercial fishing.
SW-III	Industrial cooling, Recreation (non-contact) and Aesthetics.
SW-IV	Harbour
SW- V	Navigation and Controlled Waste Disposal

https://cpcb.nic.in/wqm/coasteal_water_standards.pdf

Coastal Aquaculture Authority (CAA) standards

The Coastal Aquaculture Authority (CAA) a body under govt of india regulates aquaculture practices in coastal regions to prevent ecological degradation and environmental harm. It also implements guidelines for effluent discharge from aquaculture farms. A Standard for treatment of wastewater discharged from the aquaculture farms, hatcheries, feed mills and processing units has been derived by CAA. It has also standardized the Maximum Permissible Residual Levels of antibiotics and other environmental contaminants for Fish and Fishery Products.

https://www.caa.gov.in/standards_of_caa.html

Innovations in Water Quality Management

Advancements in technology have provided tools to address water quality challenges:

- Biofloc Technology (BFT)

Reduces nutrient load and improves water quality by promoting microbial activity in aquaculture ponds.

- Recirculating Aquaculture Systems (RAS)

Minimizes water use by continuously filtering and reusing water, ensuring stable water quality.

- Automated Monitoring Systems

Devices for real-time monitoring of parameters like DO, pH, and temperature enable better management decisions.

- Integrated Multi-Trophic Aquaculture (IMTA)

Combines species with complementary ecological roles to maintain water quality naturally, such as integrating fish with seaweed or shellfish.

Conclusion

Water quality management is a cornerstone of sustainable fisheries and aquaculture in India. By adhering to established standards and leveraging technological innovations, India can enhance productivity while preserving its aquatic ecosystems. Strengthening regulations, promoting farmer awareness, and investing in research will further support the growth of this vital sector. Addressing water quality challenges effectively will ensure that aquaculture continues to thrive, contributing to the nation's food security and economic development.

SUGGESTED READINGS

Boyd, C.E., & Tucker, C.S. (1998). *Pond Aquaculture Water Quality Management*. Kluwer Academic Publishers.

Central Pollution Control Board (CPCB). (2020). *Marine Pollution and Effluent Standards in India*.

Coastal Aquaculture Authority of India. (2020). Regulations and Guidelines for Coastal Aquaculture. Retrieved from www.caa.gov.in

Ministry of Fisheries, Animal Husbandry & Dairying, Government of India. (2020). Blue Revolution Initiatives. Retrieved from www.fisheries.gov.in

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