Aquatic Biosecurity in India: Regulatory Gaps, Surveillance Integration and Policy Priorities

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Summary

This article addresses the need for developing an aquatic biosecurity policy involving prevention, detection, and disease surveillance in freshwater and marine ecosystems. By examining two evidence cases of the Ulhas River and shrimp aquaculture, the article proposes several policy recommendations to establish a coordinated mechanism for aquatic biosecurity in India.

Introduction

India has recently increased its focus on biotechnology, biosafety, and biosecurity. The BioE3 Policy, launched in August 2024, encourages efficient biomanufacturing and emerging sectors like marine biotechnology. However, aquatic biosecurity spans multiple regulatory regimes, including aquatic animal health, invasive species management, shipping and transport, environmental monitoring, and biotechnology.[1]

Aquatic biosecurity involves preventing, detecting, assessing, and managing biological hazards in freshwater and marine ecosystems. Rivers, estuaries, and coastal waters support fisheries, aquaculture, maritime trade, and marine biotechnology, but their connectivity also enables organisms and pathogens to spread between farms, natural habitats, and regions.

The National Surveillance Programme for Aquatic Animal Diseases (NSPAAD), managed by the ICAR-National Bureau of Fish Genetic Resources (NBFGR), has laid the foundation for surveillance of aquatic animal diseases in India. Phase II of this programme was initiated in February 2023.[2] However, disease surveillance alone does not address all risks associated with deliberate introductions, invasive species, maritime transport, or environmental applications of biotechnology.

This paper examines how India can improve aquatic biosecurity by connecting existing surveillance systems, clarifying regulatory responsibilities and adopting risk-based procedures for biological introductions and environmental releases.

Contrasting Cases: Environmental Intervention and Aquatic Disease Risk

Case 1: Ulhas River: An intended environmental benefit

In April 2021, Saguna Rural Foundation, the Ulhas Nadi Bachav Kruti Samiti and residents facilitated the release of approximately 20,000 grass carp and silver carp into the Ulhas River. The fish were brought from Kolkata to control aquatic vegetation, particularly water hyacinth and water lettuce. The organisers also expected the fish to support local fishing livelihoods.[3]

The example highlighted how a community-based environmental intervention could aim at both ecological and economic objectives. It is worth noting that introducing live organisms into open-water environments also raises issues regarding species identification, health checks, and ecological impact. Despite the lack of negative impacts observed in the Ulhas River case, there is no information on whether any screening or ecological impact assessment was conducted.

These uncertainties do not mean the intervention was necessarily harmful, but they highlight why the intended benefit of a biological introduction should be considered alongside its potential risks. ICAR-NBFGR's guidance on aquatic exotics and quarantine emphasises the importance of assessing the likelihood of establishment and its potential consequences. Such an assessment helps clarify the risks of organisms imported from abroad and species transferred within India.[4]

A suitable assessment of the Ulhas River intervention would have had to consider whether the fish were correctly identified, whether their source stock was healthy, whether they could establish or disperse, and how their interactions with native organisms would be monitored. To address such wildlife movement in the future, India should develop a risk-based procedure for intentional aquatic introductions that identifies the competent authority, specifies the evidence required before release, and assigns responsibility for monitoring afterwards.

Case 2. Shrimp aquaculture: Viral disease as a biosecurity risk

Another example, which contrasts with the one above, is shrimp farming, where biological threats can cause huge economic losses. The chapter by Vijayan and Sanil from 2010 entitled 'Biosecurity in Indian Fisheries and Aquaculture' in *Vistas in Marine Biotechnology* by the Central Marine Fisheries Research Institute, considers the influence of viral diseases, movement of infected shrimp populations, as well as quarantine and exclusion from pathogens. In their chapter, the authors point out the danger of WSSV associated with the transportation of shrimp populations.[5,6]

WSSV can cause severe mortality in farmed shrimp. Other relevant viruses include Infectious Hypodermal and Haematopoietic Necrosis Virus (IHHNV), Yellow Head Virus (YHV) and Taura Syndrome Virus (TSV).[7] Their significance varies by host species, geographic distribution, and disease status. In freshwater shrimp aquaculture, Macrobrachium rosenbergii Nodavirus (MrNV), associated with white tail disease, is another relevant concern.[8,9] However, these viruses recognised as shrimp pathogens are not prevalent in Indian aquaculture. The aforementioned study discussed above detected WSSV and IHHNV but reported negative results for YHV and TSV in the sampled shrimp.

However, other pathogens may threaten shrimp culture, including those identified in a study on Pacific white shrimp (Litopenaeus vannamei), which found that 80% of the sampled shrimp were infected with WSSV, IHHNV, or both. Approximately 60% were infected with both pathogens, and infected shrimp were harvested at an early stage of 50 to 72 days after culturing. The results show that pathogens already present in the receiving area may threaten the immunity provided by specific-pathogen-free stocks.[10]

This consideration matters for policy-making, as surveillance should be based on actual detection levels, host susceptibility, and introduction potential rather than treating all known pathogens as equally likely. Screening imported or moved stocks reduces the risk of pathogen introduction, but it does not prevent infections through neighbouring farms, infected equipment, water, or even living vectors. Proper control therefore relies on a mix of stock certification, quarantine when necessary, farm hygiene, traceability, and disease surveillance.

The Ulhas River and shrimp cases illustrate two sides of aquatic biosecurity. In aquatic biosecurity, the movement of ships, cargo, aquatic animals, and even discarded materials can disrupt an already vulnerable ecosystem. Even intentional biological introductions may be intended to address an environmental problem, while poorly controlled biological movements can create disease and economic risks. Neither case supports a blanket prohibition on moving aquatic organisms. Both support risk assessment, appropriate authorisation, and monitoring proportionate to the activity. Biosecurity should not be limited to land-based pathogens and species; it should consider all aspects of maritime and aquatic movement as part of its broader security approach.

Why This Matters for India: Lessons from Australia and New Zealand

The presence of carp and shrimp in small water bodies and the pathogen risks or even rewards that come with them is a clear microcosm of the biological security risks India faces. Coastlines, ports, estuaries, and aquaculture areas create multiple routes through which disease organisms and foreign species can spread from one place to another. This issue has been managed successfully in both Australia and New Zealand.

Australia

AQUAPLAN 2022-2027 is Australia's strategic plan to ensure aquatic animal health. It includes border biosecurity, enterprise and regional biosecurity, surveillance, diagnostic capability, emergency preparedness, veterinary medicines, and research and innovation.[11] For India, the key lesson is to build on NSPAAD by linking disease surveillance with biological traceability, diagnostic networks, and coordinated outbreak responses.

Australia also operates a national marine pest surveillance strategy that monitors priority ports, marinas, beaches, and marine protected areas. Selected ports use molecular surveillance to support marine pest monitoring and domestic ballast water management.[12] This matters for India because detecting a pathogen in a shrimp farm and detecting a non-native marine organism near a port require different methods and scales of investigative surveillance. Still, both findings may need coordinated investigation across different oversight organisations.

New Zealand

New Zealand provides a more targeted example. Its marine surveillance

programme checks about 6,000 sites across its 12 busiest ports and marinas twice a year, using trapping, underwater searches, and shore searches. The programme sends unidentified organisms to laboratories for testing.[13] The programme addresses organisms that may arrive through ballast water, vessel hulls and marine infrastructure.[14]

India can adopt and modify these practices through phased surveillance pilots at selected ports, estuaries, and aquaculture sites. Priority areas for such pilot studies can be selected based on shipping traffic, ecosystem vulnerability, aquaculture density, and known vector systems. The goal should be to detect anomalies and have a clear methodology for verification and response. These comparisons do not mean India needs to simply replicate Australian or New Zealand institutions. They show how existing disease surveillance can be linked with environmental monitoring and how surveillance can be directed towards locations where biological introductions are more likely. For India, the immediate priority is to assess how these functions can be coordinated within the existing mandates of fisheries, maritime and environmental authorities.

Principal Aquatic Biosecurity Risks

1. Aquatic pathogens and biological movement

Transfer of broodstock, eggs, larvae, and other live organisms through water may introduce pathogens from one farm to another, or from farms to the wild. Ornamental fish trade and aquaculture carry their own risks and pathways for transmitting pathogens. NSPAAD provides the basis for identifying and notifying aquatic animal diseases; however, its findings are best supported by information on biological movements.[15]

When a rare organism or mortality occurs, it may be necessary to assess whether the threat extends beyond the premises. In such cases, conduct environmental testing where appropriate, without assuming that all on-farm events indicate a broader ecosystem-wide issue.

2. Ballast water and biofouling

Ships can move aquatic organisms around using ballast water and organisms that have adhered to their hulls and underwater parts. There is an International Maritime Organization's Ballast Water Management Convention, which deals with biological invasions through ballast water, and the revision of the organization's biofouling guidelines in 2023 dealing with yet another way of introduction. Efforts to create an international legal instrument on biofouling were started in 2025.[16]

India's Merchant Shipping Act, 2025 and the Merchant Shipping (Control and Management of Vessels' Ballast Water and Sediments) Rules, 2026 comprise the domestic framework being developed for ballast water management. It is imperative to understand the difference between the notification and commencement of the legislation. It is therefore essential to check the commencement provision of the Rules, 2026, and India's current status under the Ballast Water Management Convention against the Gazette notification and the Directorate General of Shipping's records to establish which Rules are in force.[17]

The two measures, vessel compliance information and environmental monitoring, have distinct roles. Environmental monitoring may reveal abnormal organisms

in the vicinity of ports, but the presence of an organism does not necessarily mean a particular ship introduced it. India must improve coordination among relevant authorities without neglecting investigation methods.

3. Aquaculture traceability

Aquaculture depends on the movement of live animals and biological materials. Inadequate records can make it difficult to trace disease outbreaks to their sources. High-risk transfers should therefore be supported by records identifying the species, source facility, destination, health status and applicable authorisations. Additional testing or quarantine should depend on the species, pathogen, source and destination risks.[18]

The objective is to track biological movements more accurately and make disease investigations more effective.

4. Marine biotechnology and AI-enabled research

The BioE3 Policy identifies marine biotechnology and biomanufacturing as research and development areas. Such activities may include seaweed cultivation, marine-derived products, aquatic animal health products and biological production systems.[19]

Laboratory research, contained production, and environmental release create different exposure pathways. Assessments for environmental release should consider organism identity, genetic modification where applicable, survival, reproductive capacity, dispersal, pathogenicity, and interactions with native organisms.

AI can support organism identification, genomic analysis, and disease prediction, but its use alone does not establish a biosecurity threat. Oversight should reflect the biological capability being developed and whether the activity could lead to environmental exposure.

Institutional and Policy Gaps

India's challenge is to coordinate institutions with different statutory responsibilities. Existing programmes address aquatic animal health, biotechnology, maritime transport, and biodiversity, but the extent to which their reporting, risk-assessment, and incident-response procedures connect requires further examination.[20]

Four areas require particular attention. The first concerns coordination between institutions responsible for aquatic animal health, maritime transport, environmental protection, public health and biotechnology. The second concerns the availability of information on biological movements, disease findings and introduction pathways, which is necessary to investigate the source and spread of aquatic biological hazards. The third concerns assigning approval and monitoring responsibilities for aquatic introductions and environmental releases, including assessing ecological compatibility. The fourth concerns integrating aquatic disease surveillance with environmental monitoring, particularly when unusual biological findings occur outside aquaculture facilities.

These gaps, however, do not mean existing authorities lack the legal power to act; rather, they show us how existing mandates, information systems, approval processes, and surveillance programs interact and can be improved upon. The policy priorities listed in Table 1 thus focus on defining these issues before developing more regulation.

Table 1: Indian Policies Concerning Aquatic Biosafety and Biosecurity

Gap no.	Gap identified	Existing institutional basis	Policy priority
1.	Fragmented institutional responsibilities and unclear incident referrals	Department of Fisheries; ICAR-NBFGR;[21] Directorate General of Shipping; relevant environmental and public health authorities.[22]	Coordinate and create referral protocols for cases that span several regulatory areas.
2.	Limited links between biological movements, disease findings and risk information	Department of Fisheries; ICAR-NBFGR; NSPAAD; relevant maritime and environmental authorities.[23]	Create a national aquatic biological risk registry and enhance tracking of high-risk biological transfers.
3.	Uncertainty over approval, ecological assessment and monitoring of introductions and releases	National Biodiversity Authority; State Biodiversity Boards; relevant central and state environmental authorities; DBT and applicable biosafety institutions.[24]	Review and determine roles in the current approval processes and the associated risk assessments and monitoring after release.
4.	Limited integration of disease surveillance and environmental monitoring	NSPAAD; fisheries and aquatic animal health institutions; port and environmental monitoring authorities; relevant public health institutions.[25]	Develop incident-reporting procedures and surveillance pilots that link aquatic diseases to environmental monitoring.

Source: Multiple sources as studied by the author

Policy Recommendations

India should integrate aquatic biosecurity into its One Health program, to the extent that the risks threaten animal, human, and environmental health. The Joint Plan of Action on One Health Approach adopted by the World Health Organization (WHO), the Food and Agriculture Organization (FAO), the United Nations Environment Programme (UNEP) and the World Organisation for Animal Health (WOAH) serves as an international template for coordination. The International Maritime Organization (IMO) offers a separate mechanism to address biological movements involving maritime transport, including ballast water and biofouling. India should consider creating an independent National Aquatic Biosecurity Coordination Authority under the Department of Biotechnology (DBT), or an internal coordination body within an existing agency. Here are four recommendations for a National Aquatic Biosecurity Coordination Authority, or for the organisations currently overseeing this area, mapped to address the aforementioned gaps.

Establish a central coordination mechanism for aquatic biosecurity.

The Union Government can study the feasibility of setting up a National Aquatic Biosecurity Coordination Authority under DBT to coordinate and delineate roles among ongoing programs in aquatic animal health, maritime transport, environmental regulation, public health, and marine biotechnology. Such an authority could formulate referral protocols that identify agencies responsible for investigating disease outbreaks and biological events near ports, and for any application of biotechnology to the environment. It will enable joint investigations in cases of overlapping regulatory jurisdictions and coordination with the National One Health Mission and other international organisations.

Develop a national aquatic biological risk register and traceability system.

India needs to establish a national aquatic biological risk register that considers priority pathogens, alien species, introduction routes, and organisms planned for release in the environment. Under the proposed body's coordination, it should compile details on identification, distribution, pathogen links, existing risk assessment reports, permissions, and uncertainties, distinguishing between actual presence and hypothetical dangers. Where possible, the register should integrate transfer records of high-risk movements of live aquatic animals, including species, source and destination, health status, and relevant permissions.

Introduce risk-based procedures for aquatic introductions and environmental release.

Relevant national and state government agencies should review the current process for determining when an aquatic organism introduction requires approval, who approves it, what information must be provided, and what monitoring must occur after release. These decisions should be based on the organism's type, health status, pathogen risks, and ability to establish itself ecologically, disperse, and interact with native species. The Ulhas River example shows that health certification may not determine ecological suitability, and marine biotechnological activity needs clearer definition as research moves into field trials.

Integrate aquatic disease surveillance with environmental monitoring and incident reporting.

NSPAAD needs to continue playing an important role in aquatic animal disease surveillance and build connections with environmental surveillance in certain ports, estuaries, river systems, and aquaculture areas. NSPAAD needs to collaborate on reporting unusual mortality, the emergence of unknown disease pathogens, the introduction of non-native species, and the illegal release of organisms through referral processes to joint investigations by the appropriate organisations involved in fisheries, shipping, environment, and public health. Environmental DNA (eDNA) and other surveillance methods can help detect unusual biological events; however, these must be supported by diagnostic tests and appropriate sampling when needed. Pilot projects need to be evaluated for detection ability, false positives, cost, and whether they trigger an investigation.

Conclusion

India's aquatic biosecurity requirements extend beyond aquatic animal health to invasive species, maritime transport, environmental surveillance and emerging biotechnology. Existing programmes such as NSPAAD, the BioE3 Policy and the evolving

ballast water management framework address important parts of this landscape. Still, their effectiveness depends on coordination between fisheries, maritime, environmental, public health, and biotechnology institutions. The release of Ulhas River fish species highlights the need to evaluate the ecological and disease risks posed by deliberate introductions of biological organisms. Meanwhile, shrimp viral infections like WSSV and IHHNV underscore the importance of traceability and farm biosecurity. Australia's national aquatic animal health strategy and New Zealand's marine pest monitoring program provide additional examples.

India should prioritise four measures: establish a central aquatic biosecurity coordination mechanism; develop a national biological risk register linked to traceability; introduce risk-based procedures for aquatic introductions and environmental releases; and integrate disease surveillance with environmental monitoring and incident reporting. A dedicated coordination authority under DBT, or an equivalent unit within an existing institution, could link these activities to the One Health framework and facilitate domestic coordination with relevant international frameworks from the IMO, WHO, FAO, UNEP, and WOAH. Such an arrangement should build on existing institutional capacities, clarify responsibilities and support joint investigations without duplicating statutory functions. The objective should be to develop a coordinated, risk-based approach that enables India to identify and manage aquatic biological hazards while supporting responsible aquaculture, maritime activity and marine biotechnology.

Views expressed are of the author and do not necessarily reflect the views of the Manohar Parrikar IDSA or of the Government of India.

Endnotes:

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