

# **SHRIMP FARMING IN ESTUARINE ENVIRONMENT : POINTS TO PONDER**

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## **INTRODUCTION**

The capture fishery resources of India has almost reached a sustainable level and the production can only be supplemented with aquaculture. This is particularly true in case of marine shrimps. Aquaculture, besides increasing the fish production can also generate various types of job opportunities to the rural and unemployed populace including women and improve their economic and living standards. Therefore, many developing and underdeveloped coastal countries have taken up aquaculture on a war footing. Also, it has the potential to generate foreign exchange by exporting the highvalued marine products. India's annual foreign exchange earning from marine products export is around Rs.4000 crores.

The aquatic systems and the dependent organisms are very tolerant to large variations in abiotic and biotic factors and stresses brought in from external sources. However, the uncontrolled population explosion, indiscriminate use of land and water resources and

fast pace of industrialisation have been exerting more and more pressure on the aquatic environment which in the long run may adversely affect the population and diversity of the organisms and the productivity processes and potential.

The tropical estuaries are very productive systems and are being used for various types of developmental activities, most of them bring in some changes to the environment. Shrimp aquaculture has developed as the largest coastal aquaculture practice in India. In less than a decade about 85,000 ha of water spread area (WSA) have been developed for this purpose. Most of the development has been taking place around the estuarine area. It is in this context that the possible impacts of brackishwater shrimp farming on the estuarine ecosystem are briefly discussed here.

## **ESTUARINE ECOSYSTEM**

An estuary is defined as "a semi-enclosed coastal body of water which has a free connection with the open sea and with in which the sea water is

measurably diluted with freshwater derived from the land drainage" (Pritchard, 1967). They are the most dynamic and highly productive ecosystem in the world and play an important role in the life history and development of many coastal and marine species.

The physical conditions in the tropical estuaries are more variable than those in freshwater or coastal environment. The variation is primarily felt in salinity which generally maintains a well mixed homogenous condition. But it may show wide variations horizontally (upper to lower reaches) and vertically (surface to deeper layers). Tides, river flow and rain may also exert changes in salinity structure of the estuary. Variations in temperature is less conspicuous although it will be relatively colder during the winter and warmer during the summer. Turbidity is generally more due to siltation which reduces the euphotic zone considerably. This is felt more during the monsoon season.

Physiological (salinity) and physical (current velocity) events primarily define the habitat within the estuary. Most of the animals that inhabit the estuaries are euryhaline marine forms and therefore endemic species are less common. Many of them also tolerate variations in dissolved oxygen content. As a group they have evolved wide

ranges of physiological adaptations that permit them to utilise the fluctuations of the estuarine environment to their benefit.

The estuaries sustain a complex productivity process. The organic matter produced by phytoplankton through photosynthesis (primary production) is transferred to the secondary trophic level by the primary consumers (herbivorous zooplankton). Phytoplankton blooms are triggered when nutrients are in excess in the environment leading to eutrophication. Blooming of the blue-green alga *Trichodesmium erythraeum* known as the 'red tide' is a common phenomenon occurring in the coastal and estuarine waters of India.

Zooplankton in the estuaries are mostly derived from the coastal waters and as such endemic species are very rare. Their composition and diversity are essentially a function of salinity. During the monsoon season only the low saline species survive and most of the other species migrate to the relatively high saline coastal waters. Repopulation starts with improvement in salinity.

Micro-zooplankton play an important role in the food chain of the estuary. They convert bacterial biomass into animal matter on which the primary consumers feed (microbial loop), thereby short cutting the conventional food

chain.

Benthic organisms are important links in the tertiary trophic level. Many complex factors are responsible for short and long-term variations in population. Domestic wastes, industrial effluents and toxins may alter and affect the benthic community structure.

Bacteria as transformers and producers play a dual role in the food web. They break down complex organic molecules into simpler inorganic nutrients that are used by the autotrophs for photosynthesis. Their cell-bound and cell-free enzymes are responsible for carrying out several functions in the estuarine environment. The bacterial production at times exceeds the total phytoplankton production. They form important food source for flagellates and protozoans (microbial loop) in the lower trophic level and filter feeders in the higher trophic level. Some of the bacterial groups are known to be pathogens of marine organisms.

The fish fauna in the estuary is mostly constituted by migratory marine species. The tropical estuaries support a rich fishery and the catch is formed mainly by young ones of fin and shell fishes. While most of the marine shrimps use the estuary as a nursery ground the giant freshwater prawns breed here.

The tropical estuaries have the

luxuriant growth of unique mangrove vegetation either in the form of dense forest (as in Sunderbans) as fringed mangroves (as in many Indian estuaries). These estuaries support rich flora, fauna and fishery. They are very productive and also provide nutritional inputs to coastal waters.

### **SHRIMP FARMING**

Brackishwater shrimp farming has become a successful, lucrative and capital intensive venture in India, particularly along the east coast. About 85,000 ha of WSA are put in to semi-intensive/extensive shrimp farming and about 50,000 ha of WSA are in traditional sector. The annual production from aquaculture is around 100,000 tonnes. Although shrimp farming can increase the yield many fold due to the introduction of scientific farming techniques, the basic farming concept has not changed much. In the semi-intensive/modified extensive practices, use of pumps, aerators, chemicals, artificial feeds, probiotics, immunostimulants, etc. have become inevitable. However, the choice of farming sites has never changed. Most of the farms are located in the close vicinity of estuaries and tidal creeks which facilitates water exchange and waste disposal. Since this delicate ecosystem is indiscriminately being used for many other developmental activities, excess use of land for shrimp farming

may add stress to the system to which it has already been subjected to. Therefore, brackishwater shrimp farming may also affect the estuarine ecosystem if proper monitoring and management practices are not strictly adhered to. Some of the adverse effects that may possibly result as a sequel to unscientific farming practices and sub-standard management strategies are listed here.

### IMPACTS ON ECOSYSTEM

Although scientific data have not been collected systematically and sequentially to implicate that brackishwater shrimp farming has caused any major environmental hazard in India, it might have been responsible for some local problems, particularly along the east coast of India. Some of the major concerns on which to ponder are listed below:

#### ◆ Excess land use

- Shrimp farming has the greatest potential for area expansion. Since land requirement is extensive and farm development is taking place along the estuarine area, there is a possibility of converting salt pans, tidal and intertidal mud flats and mangrove areas. In less than 10 years, about 85,000 has of land have been developed for this purpose in India.

- Estuaries are very productive ecosystem and harbour a variety of flora and fauna and support rich fishery resources. This ecosystem is also frequented by several migratory species of marine fin and shellfishes including shrimps as breeding or nursery ground. Indiscriminate and excess conversion may therefore affect the resident and migratory forms and may also adversely affect the capture fishery potential of the estuarine and offshore waters.

- Mangrove areas are the first casualty. Large scale conversion of mangrove areas for shrimp farm development in many south-east Asian countries and in Ecuador had drastically reduced the capture fishery potential, particularly shrimps.

- In fact, mangrove areas have typical acid sulphate soil and are not suitable for shrimp farming. At the time of pond bottom drying, oxidation of pyrite ( $\text{FeS}_2$ ) takes place which results in the release of sulphuric acid into the pond and adjacent environment.

#### ◆ Physical disturbances

- Construction of shrimp farms may alter the shoreline configuration of the estuaries and mangrove areas. This may also

affect the coastal erosion process, production and supply of organic matter to the coastal ecosystem, nutrient recycling, etc. there by creating ecological imbalance and upsetting productivity processes.

- Construction of farms and other structures may obstruct water movement, reduce water currents and alter flow pattern leading to increased deposition of organic wastes, siltation and water quality deterioration. Creation of anoxic condition may lead to production of hydrogen sulphide and methane which are harmful to the estuarine life.
- Construction of supply and drainage canals and constant pumping and holding of brackishwater may result in hydrological changes, siltation and salt water intrusion.
- Water carrying capacity of an estuary may at times be less than the actual requirement of water for exchange in the ponds. If the requirement exceeds the flow rate of the tidal creek/supply canal, it may result in re-circulation of waste water and increase chances for establishment of bacterial pathogens and disease outbreaks.

◆ **Nutrient and organic matter enrichment:**

- Constant and excess use of ferti-

lizers and artificial feeds and generation of metabolic waste products may affect the water and sediment quality of ponds and adjacent water bodies. Direct discharge of organic wastes into the estuarine environment with out prior treatment may result in excess nutrient levels in the water column and loading of organic matter in the bottom sediment. When soluble inorganic nutrient concentrations increase beyond normal levels, algal blooms may occur (eutrophication) and toxic algal blooms may interfere with the flora and fauna. The unutilised primary resources will settle to the bottom, increasing the detrital biomass and thus providing substrata for bacterial proliferation.

- Organic enrichment of bottom sediment may directly affect the benthic life. The oxygen demand may suddenly go up, leading to anoxic condition in the sediment. This may bring about changes in biological and chemical processes in the sediment, impoverishment of benthic fauna and production of  $H_2S$ ,  $CO_2$  and methane.
- Increased levels of dissolved and particulate organic carbon may influence qualitative and quantitative changes in microbial population of water column and sedi-

ment of ponds and adjacent water bodies. Possibility of certain groups dominating the population and even appearance of pathogens can not be ruled out.

◆ **Chemical residues**

- Some antibiotics are used for treatment and prevention of diseases in the ponds. Overdose of antibiotics may produce antibiotic resistant strains of pathogens.
- Residues of some chemicals used as disinfectants, therapeutants and biocides may contain in the discharge water. Sometimes anaesthetic and hormones may also be seen in small quantities. Some of the chemicals may pollute the environment and affect the life of the organisms if present in large quantities. Since most of the chemicals are applied occasionally and in very small quantities, the discharge water may contain only permissible levels of residues.
- Excess use of chemicals lowers the quality of the cultivated shrimp and make it unacceptable for human consumption.
- Adverse effects of chemical residues to non-target organisms and possibility of establishment of drug resistant bacterial pathogenic strains are not known.

◆ **Biological concerns**

- Introduction of pathogens/diseases into the environment through accidental escape or intentional flushing of infected farm stock is a serious concern. This may facilitate spreading of pathogens/diseases to nearby ponds and adjacent areas, resulting in disease outbreaks.
- Another source of disease introduction into the ecosystem is by stocking infected postlarvae produced in the hatcheries. In recent days, almost all the brood-stock of tiger prawns have been found to be infected with white spot virus. Larvae produced from the infected mother prawns may invariably be infected, but will manifest only after stocking in the ponds. This has affected the shrimp production considerably.
- Disease may also be caused as a result of stress due to deteriorating water quality. Over-intensification, necessitating excess feeding, generation of excess metabolic waste products and other organic wastes may affect the water and sediment quality. This will create a conducive environment for pathogenic bacterial strains to enhance their virulence which are generally dormant in a healthy environment. A



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stressed animal is an easy target for pathogenic attack.

- Introduction of unknown bacterial strains in to the ecosystem is a possibility through application of imported probiotics. It is important that the bacterial strains in these products are identified and the short-and long-term effects on the ecosystem are studied.

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