MARINE BIODIVERSITY CONSERVATION AND MANAGEMENT

Edited by

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XIII. MARINE POLLUTION IN THE COASTAL WATERS OF INDIA

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INTRODUCTION

The nearshore waters of India along the 7000 km coastline support a lucrative fishery and contributes about 90% of the total marine fish landings of the country. In addition, the EEZ (Exclusive Economic Zone, 2.105 X $10^6 km^2$) supports a substantial resource of marine organisms. Similarly, the brackishwater regions contribute to the capture fisheries of considerable magnitude and also support traditional culture fisheries in certain maritime states. It has been estimated that 9 million ha. are available in the inshore area in less than 18 m depth and 1.7 million ha. of brackishwaters in the adjoining coastal zone. In the context of the present stagnant catch trend in the inshore fisheries and considering the urgent necessity to augment fish production, increasing interest has been evinced in the optimum utilization of these water resources.

Water quality is a vital aspect for the survival and well-being of the living resources, especially in the coastal and estuarine areas. Some of these areas are now under the direct threat from the increasing load of various types of pollution. Any attempt to increase the productivity of the natural resources or by additional inputs like aquaculture is linked with the environment problem. The environmental pressure due to pollution inputs and also due to human interference on the ecosystem are on the increase. Information on marine environmental damage from various sources of pollution and human interference becomes an obvious necessity to evaluate the present level of pollution as well as to understand the impact on living resources.

Although there were isolated instances of fish kills due to water pollution reported from the estuarine and inshore waters of metropolitan cities like Bombay, Madras, Calcutta and Cochin in the 60's, no serious efforts were made till 70's to study marine pollution in these waters. An impetus was given to pollution research in India especially after the Stockholm Conference on Human Environment held in 1972.

Much of the current concern over pollution problems centres on the possible toxic effects of chemical pollutants both on human health and on organisms important to the stability and life supporting capacity of the biosphere. However, certain types of environmental damage such as the destruction of the ozone layer, the green house effect, the acid rain etc., has no national or political boundaries. That is the main reason that the world bodies such as FAO, the U.N. etc. are trying to bring together both developed and developing countries or the third world countries together to discuss and decide on remedial and control measures to reduce the environmental damage.

POLLUTION OF THE AQUATIC ENVIRONMENT AND ITS EFFECTS

Pollution of the aquatic environment and its effects on the living resources, especially the fishery resources, has assumed considerable interest as well as importance in the recent times. Reports available indicate that most of the rivers which discharge large quantities of water into the coastal marine environment are polluted and these pollutants obviously end up in the inshore coastal waters. The vast marine environment has long been used as a site for the disposal of wastes. In some cases the polluted material is discharged directly into the sea and in other cases the pollutant reaches the rivers and estuaries and finally ends up in the sea.

The marine environment is a very dynamic and complex ecosystem containing a delicately balanced fluid medium-salt water. Hence, when chemical pollutants are discharged into the sea they are not only diluted and dispersed by winds, tides, currents etc., but becomes intimately involved in the complexities of the biological food web of the sea. These toxic pollutants are not merely diluted, but may be reconcentrated by the marine biomass. When persistent toxic and carcinogenic pollutants enter the food web the pollution problem may become serious and lethal to plants, animals and man. Most of these toxic agents affect all living things and nutritional, communicative, reproductive, respiratory, genetic and a variety of other metabolic activities of the organisms may be seriously altered or destroyed. This may result in the annihilation of some population of organisms and increase in noxious groups. This results in an imbalance of the normal population pattern which can lead to serious problems in the ecosystem.

IMPORTANT GROUPS OF POLLUTANTS

The materials polluting the sea can be classified into categories such as (1) domestic sewage flushed into the sea directly or through the rivers, (2) pesticides and insecticides from agricultural fields carried by streams, rivers and estuaries (3) the industrial effluents of diverse types discharged directly or along with domestic sewage; (4) oil substances from submarine seeps, land drainage, oil tankers and refinery wastes, (5) radio active wastes discharged from nuclear power stations, (6) wastes discharged from thermal power stations, (7) solid wastes (8) military wastes and (9) debris from ocean bed explorations for oil and minerals (Goldberg, 1976).

Pollution from metals is considered important in the estuaries and inshore regions. Whether released to air, water or soil, significant amounts of metals are eventually carried into estuarine and coastal water systems. Many of these metals are found in organisms in concentrations that are high in comparison to the surrounding medium. Hence, the biota concentrate many metals relative to their environment. Some of these elements have no apparent biological functions and it appears that organisms have little capability for selective uptake or excretion. Such metals may not be toxic to the host organisms, such as zinc or copper in oysters, but they may be passed up the food chain to higher organisms and ultimately to man.

Table 1. Trace Metals in the Indian Ocean Average Conc (ug/1)

Copper	(Cu)	0.2
Zinc	(Zn)	0.6
Cadmium	(Cd)	0.02
Mercury	(Hg)	0.01
Nickel	(Ni)	0.30
Iron	(Fe)	0.46
Lead	(Pb)	0.03

(Source : C.S.P. Iyer, 1994)

Table 2. Trace Metals in Coastal Waters of India

Coastal Region	Location	Conc. (ug/1)
Gujarat	Dwaraka	Pb - 210
	Mithapur	Cd - 170
Kerala	Cannanore	Zn - 40
	Calicut	Hg - 0.4
	Cochin	Cu - 10
		Pb - 8
		Cd - 0.8
	Veli	Hg - 0.5
Tamil Nadu	Cuddalore	Cu - 15

(Source : C.S.P. Iyer, 1994)

Table 3. Comparative account of mercury levels in the Indian Coastal and Estuarine waters (Hg/ug/1)

Area	*Level of Mercury*	*Source*
1. Indian coastal waters	0.20	Sanzgiri *et. al.*, 1988
2. Arabian Sea	0.078	Qasim *et. al.*, 1988
	0.013 - 0.018	Singbal *et. al.*, 1978
	0.09	Sanzgiri *et. al.*, 1979
3. Bay of Bengal	0.045	Qasim *et. al.*, 1988
4. Binge Bay, Karwar	0.146 - 26.68	Kureishy *et. al.*, 1986
	0.91 - 2.62	Krishnakumar & Pillai, 1990
5. Thane Creek, Bombay	0.247	Zingde & Desai, 1981
6. Cochin Backwaters (Moov. River)	1.2 - 50.0	Balchand & Nambisan, 1986
7. Cochin inshore waters	1.02	Alavandi *et. al.*, 1988

(Source : V.K. Pillai [Ph.D. Thesis] 1991)

Table 4. Sediment quality of Coastal India with respect to Heay Metals (ug/g)

	Gujarat	*Maha-rashtra*	*Kerala*	*Tamil Nadu*	*Andhra*	*Orissa*
Cu	18-190		28.3-158			
Zn	28-387		8.7-150			
Cd	5-89	1-6.7	0.5-49	1.0-3	0-2.2	
Ni	18-172					
Cr	33-500					
Pb	0-47	0-90.9	4.7-57.4	18-40	23-40	
Hg	0-0.75	0.04-0.52	0.1-2.9			

(Source : C.S.P. Iyer, 1994)

Information on the seasonality of pollutants, especially metals, is important in designing, monitoring programmes using bioaccumulator species to understand the variations in toxicant levels in the area. Extensive studies conducted on the bivalve *Sunetta scripta* in the inshore waters of Cochin revealed that the metal load in the bivalve showed an increase during the monsoon season indicating the apparent influence of river run off and reduction in salinity in the seasonality of metal uptake. In the case of copper, the smaller individuals recorded relatively higher load than that of larger ones.

Repeated sampling and analysis carried out over several years in a number of animals to understand the levels of heavy metals in the body tissues from the Cochin inshore waters showed that the bivalves followed by crabs were having higher levels of metals compared to finfishes, but the levels were within the levels recommended for marine seafoods.

Among the marine biota, the suspension feeding bivalve molluscs accumulate and concentrate most of the pollutants within their tissues to concentrations significantly above ambient levels in the environment and facilitates accurate chemical analysis and assessment. The use of bivalve molluscs and in particular, mussels, as sentinel organisms for indicating levels of pollutants in coastal marine waters has been established in various mussel watch programmes. However, measuring physiological effects and cellular responses of metal pollutants using mussels to evaluate 'biological effects' of pollution is a comparatively new approach in marine pollution monitoring studies.

The physiological and cellular response of *Perna viridis* after one and two weeks chronic exposure to copper and mercury were evaluated in response to filteration rate; O:N ratio and scope of growth and growth efficiency and it was observed that all these functions in metal exposed mussels decreased significantly in comparison to controls. Digestive cells and tissues of metal exposed mussels have severe pathological changes such as increased lipofuscin accumulation, digestive tubule dilation, tubule breakdown and cilia loss in the digestive diverticula. Compared to mercury, copper accumulated more in the tissues of exposed mussels. It was also observed that the physiological and cellular responses of mussels to copper and mercury were generally in the same direction, although mercury exposed mussels were comparatively less affected (Krishnakumar *et.al.*, 1990)

PRESENT STATUS OF POLLUTION IN THE INDIAN COASTAL WATERS

The quality of the Indian Ocean is comparable to that of any other part of the globe. Recent studies carried out under the COMAAPS Programme, during the period 1988-93, has revealed that coastal water quality is generally good except in some isolated pockets. However, it is of concern that the number of such pockets or 'hot spots' are on the increase. The Annual Report of the Department of Ocean Development (1991) indicates that some areas have been affected seriously though in some cases the contents of dangerous pollutants are within the limits or are washed by tidal flushing.

The report indicated certain amount of oil pollution in the Neendakara area near Quilon in the coastal waters. The high oil content was observed near the Quilon harbour due to the discharge of large quantities of oil and related waste into the coastal waters.

National Institute of Oceanography (Goa) conducted a programme in 1976-Marine Pollution (Petroleum) Monitoring Pilot Project (MAPMOPP) and their studies revealed large scale occurrence of tar balls from petroleum spills from Kutch to Kanyakumari. Due to the shoreward direction of surface currents during the monsoon months, it enhances the process. It has been reported that about 1000 tonnes of tar balls were deposited along the coast during 1976. It is also reported that upto a depth of 20 meters, the Arabian sea-waters contain 32.5 parts per billion of dissolved and dispersed petroleum residues derived from oil spills, refinery effluent and atmospheric fall out. For the bay of Bengal, the average content was 24.1 ppb.

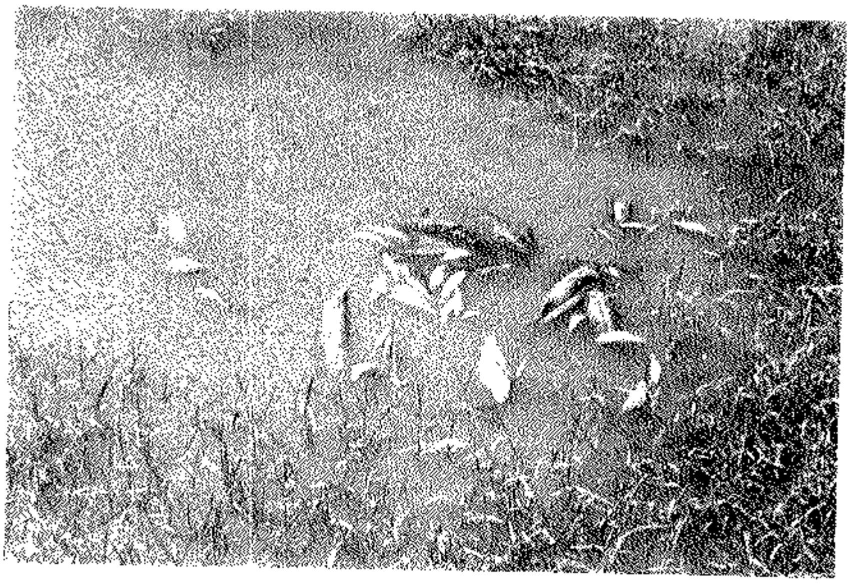
The DOD study also showed that large quantities of ammonia is entering the marine environment off Porbander, which is originating from soda ash industry. Although the observed levels of ammonia may not result in visible impact such as fish mortality, long-term ecological damage to marine life cannot be ruled out due to high toxicity of free ammonia. The coastal waters in some areas continue to show high level of pollution during the ebb tide period especially off Thane and Mahim creeks near Bombay. The pollution of the Bombay waters is caused by the huge quantities of domestic and industrial waste waters discharged into the sea.

Similarly the study showed a disturbing picture about the Andhra coast which is affected by high contents of heavy metals and other pollutants. Although diluted considerably by tidal mixing, concentrations of ammonia off Visakhapatnam due to sewage and industrial waste is likely to affect the coastal waters, the report pointed out. The levels of pollutants due to heavy metals in most of the locations along the Bengal and Orissa coasts were below the standard limits. Although the presence of mercury was noticed off Haldia and Ganjam the concentrations were found to be very low.

Environmental pollution caused by residues of run offs from agricultural areas and other inorganic pollutants has received great importance in developed countries. But in this region research on these aspects has only recently begun and practically very little information on the impact of chemical residues on living aquatic resources of the sea and brackishwater is available. Despite limited information on the types of and levels of pollutants, the increasing pollution of the littoral waters of Indian coast by agricultural and industrial effluents and by petrochemical discharge has prompted widespread demands for better controls and more adequate resource management.

It is a fact that in recent years, large doses of pesticides have been used to augment agricultural production. It is reported that India uses about 1,00,000 tonnes of pesticides annually and it is assumed that about 25% of these find their way to the sea. Most of the marine fishes are extremely susceptible to chlorinated hydro-carbons, while crustaceans tend to accumulate the same in high concentrations. Informations regarding the extent of pollution of the various water bodies in India is fragmentary. DDT residues as high as 2.2 ppm and BHC from 0.06 to 1.1 ppm have been reported from various fish species. The results of the National Pollution Monitoring Programme conducted by

Fish mortalities due to industrial pollution at 2 different areas
in Cochin estuarine system



DOD showed that the clams collected off Madras and Pondicherry coasts showed higher levels of DDT and reflected the current usage of DDT for vector control in urban localities. Similarly, the level of HCH residues were slightly higher in clams collected off Porto Novo, Pondicherry and Nagapatinam coasts, which shows predominant usage of HCH for agricultural purposes.

CONTROL AND MONITORING MEASURES

The legal aspects of pollution control in the management of coastal waters need special mention. Most of the maritime states have introduced pollution control measures through statutory boards constituted for the purpose and the Central Pollution Control Board functions as an advisory body in problems of policy matters.

In the developed countries laws are enforced more stringently and definite guide lines are given through conventions, especially the two conventions held in London and Oslo (1972) against dumping of hazardous wastes in the sea. The Stockholm conference held in 1972 also emphasised the need for protection of the marine environment and an Action Plan was developed which recommended that "Government use the best practical means available to minimise the release to the environment of toxic or dangerous substances, especially if they are persistent substances such as heavy metals and organo-chlorine compounds, until it has been demonstrated that their release will not give rise to unacceptable risks or unless their use is essential to human health or food production, in which case appropriate control measures should be applied.

The Stockholm action plan contains a special chapter related to marine pollution. These recommendations are directed to a great extent towards further research and monitoring in the marine environment. Hence, at the present context, the best environmental policy would be to prevent the creation of pollution problems at their source rather than trying to counter act their effects. Since the parameters to be measured are too numerous it is necessary to identify certain critical areas and critical parameters and monitor a series of small changes as a guide to survilance for developing criteria and standards and fashioning of appropriate controls and monitoring mechanisms.