Journal of the Indian Fisheries Association,
12 & 13, 1982-83, 35-43

BIOLOGICAL PRODUCTIVITY AND FISHERY POTENTIAL IN THE COASTAL WATERS OFF BOMBAY

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ABSTRACT

Fishery potential of the nearshore waters of Bombay is estimated from the observed values of biological productivity at different trophic levels. The rate of primary and secondary production is relatively higher in the polluted coastal waters of Versova, Mahim and Thana. On the contrary the observed mean benthic standing stock in the polluted creek waters is far less than the relatively unpolluted coastal regions off Bombay. A poor benthic standing stock and decreasing trend in the observed fish landings clearly substantiate the effect of pollution especially on the tertiary productivity of the nearshore coastal marine environments of Bombay. Thus, the present results suggest that the higher productivity at the lower trophic levels due to pollution, may not end up with high tertiary production. Therefore, such polluted regions are to be classified as special ecosystems where the transfer coefficient may be far less than the assumed 10% conversion factor.

INTRODUCTION

The productivity of a marine ecosystem varies in space and time depending on a variety of environmental factors (Ryther, 1963). In a marine environment phytoplankton production at primary level, zooplankton as secondary producers and benthos contributing to secondary/tertiary level play a significant role in the energy transfer from one to the next trophic level. An estimate of primary, secondary and benthic standing stock provides an index to the fertility of the given marine environment. To a great extent the fishery depends on the availability of organisms at lower levels of production. A rich fishery occurs in the areas of high plankton production which in turn are the areas of enrichment (Prasad, 1969). Qasim (1977) and Qasim *et al*. (1978) correlated the fish production with the primary and secondary production rate. Nair (1982) made an evaluation on the contribution of zooplankton to the fishery potential of selected environments. The importance of benthic communities in the marine food chain is well recognized (Sanders, 1956; Mulicki, 1957; and Desai, 1973).

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There are many reports supporting the direct correlation of demarsal fishery to the benthic production (Belegvad, 1930; Sparck,1935; Slavich, 1972; Damodaran, 1973; and Harkantra *et al,* 1980.) Hence, the availability of benthos at a region can be correlated to the demarsal fishery potential of the concerned area. Considering the above an attempt has been made in the present study to correlate the productivity at different trophic levels to assess the fishery potential of the polluted coastal marine environments off Bombay.

MATERIALS AND METHODS

During 1979-80 regular observations were made from stations off Versova creek (st. 1), Versova off (st. 2), Mahim off (st. 3) and Thana creek (st. 4).

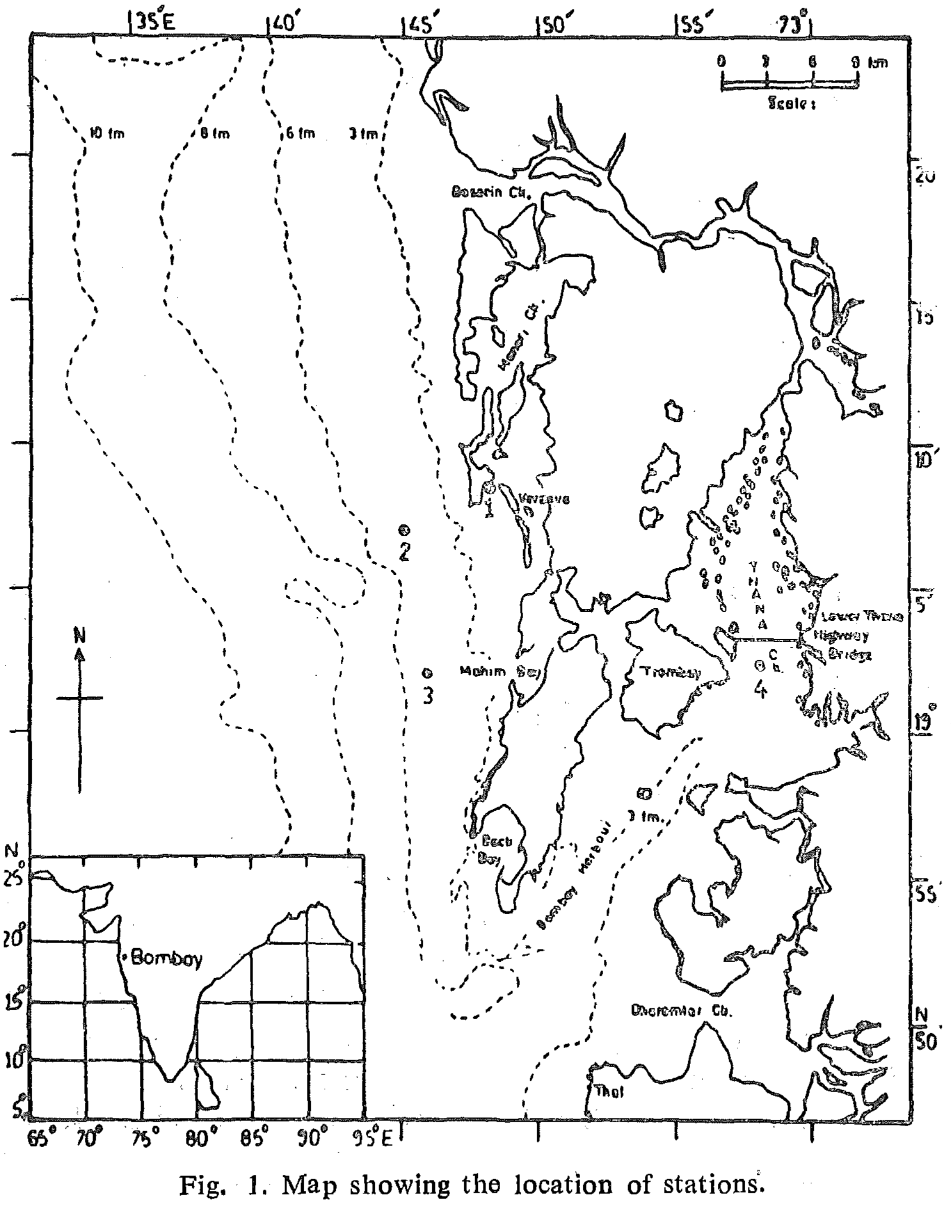

Fig. 1. Map showing the location of stations.

Data on primary productivity, zooplankton standing stock and benthic biomass were collected at regular intervals from this area (Fig.1). Fisheries data around Bombay have been obtained from the Department of Fisheries, Maharashtra State, Bombay.

The method of conversion of biological productivity from primary to secondary-level is based on Qasim *et al;* 1978. Zooplankton biomass and organic content in zooplankton are used in the evaluation of tertiary production (Nair, 1977 and Selvakumar *et al.,* 1980). Benthic production is evaluated in terms of carbon content from the wet weight of benthos. (Parulekar *et al.,* 1980 and Nair, 1980). The carbon values are multiplied by the factor two to get the annual benthic production (Sanders, 1956).

Estimate of fishery potential is on the assumption that ecological efficiency from one tropic level to the other is about 10%. To estimate tertiary production (fish) approximately 1% of primary and 10% of secondary productions are considered. A factor of 7.47 is used to raise the carbon value to obtain wet weight of fish (Cushing, 1973).

RESULTS AND DISCUSSION

Productivity and trophic levels :

Detailed accounts on the abundance and diversity of phytoplankton, zooplankton and benthos of the near shore waters of Bombay have already been reported (Gajbhiye, 1982, Varshney, 1982 and Jiyalal Ram, 1985). In this evaluation the average productivity for each trophic level alone has been considered as a measure to evaluate the tertiary productivity.

In the present investigation, the observed phytoplankton productivity was relatively higher and almost comparable between sts. 1 and 4 (Table, 1). At the same time the rate of primary productivity between sts. 2 and 3 was moderate and comparable.

The observed values of zooplankton standing stock (Table, 1) of sts. 1 and 3 were relatively lower but comparable. At st. 2, the zooplankton biomass was higher than that recorded at sts. 1 and 3. The maximum zooplankton biomass was encountered at st. 4.

The observed benthic productivity (Table 2) was relatively much lower at the creek sts. 1 and 4 than that recorded at coastal sts. 2 and 3. Station 4, sustained the lowest benthic productivity whereas the moderate productivity between sts. 2 and 3 was comparable. The nearshore and creek regions of Bombay does not sustain a rich subtidal macrofauna.

Table 1: The observed and estimated biological productivity at different stations

Station	Observed Primary Productivity (tonnes C $km^{-2}y^{-1}$)	Estimated Secondary Productivity (tonnes C $km^{-2}y^{-1}$)	Observed Secondary Productivity (tonnes C $km^{-2}y^{-1}$)	Transfer Coefficient (%)	Estimated Fishery Potential (tonnes $km^{-2}y^{-1}$)		
					Based on Primary Productivity (1)	Based on Secondary Productivity (2)	Average of 1 and 2.
1	172.57	17.26	7.92	4.6	12.89	5.90	9.41
2	138.92	13.89	10.65	7.6	10.37	7.99	9.18
3	120.92	12.09	7.16	5.9	9.04	5.38	7.21
4	194.31	19.43	17.23	8.9	14.49	12.85	13.67

Table 2: Observed benthic productivity at different stations.

Station	Biomass		Carbon content	
	Wet. Wt. (gm^{-1})	Dry Wt. (gm^{-1})	g Cm^{-1}	g $Cm^{-1}y^{-1}$
1	6.249	1.375	0.474	0.948
2	9.139	2.011	0.694	1.388
3	7.844	1.726	0.595	1.190
4	2.481	0.546	0.188	0.376

Table 3: Fish landings of Bombay (1974-1980)*

Year	Landings (tonnes)	Percentage of rise (+) & fall (–)	Prevalence percentage of rise & fall
	Greater-Bombay		
1974-76	1,22,188	–	
1975-76	1,68,522	(+)37.92	
1976-77	1,39,394	(–)17.28	
1977-78	1,33,465	(–) 4.25	(–)60
1978-79	1,42,876	(+) 7.05	
1979-80	1,11,605	(–)21.89	
	Versova		
1974-75	79,777	–	
1975-76	75,493	(–) 5.37	
1976-77	60,414	(–)19.97	
1977-78	41,037	(–)32.07	(–)80
1978-79	65.896	(+)60.58	
1979-80	47.838	(–)27.40	
	Thana		
1974-75	1,85,467	–	
1975-76	1,50,712	(–)18.74	
1976-77	1,69,054	(+)12.17	(–)60
1977-78	98,432	(–)41.77	
1978-79	1,49,592	(+)51.97	
1979-80	1,36,390	(–) 8.83	

* Data obtained from the Department of Fisheries, Maharashtra State, Bombay.

If zooplankton productivity is estimated on the basis of primary production the higher and moderate values will be at the creek sts. (1 & 4) and the coastal sts. (2 & 3) respectively. In general, the observed zooplankton productivity in all the four stations was always lower than the corresponding estimated values. The transfer coefficient (Table 1) was relatively higher (8.9%) at st. 4 than the rest. The lowest transfer coefficient factor of 4.6% was obtained at st. 1. On the other hand, the transfer coefficient values of sts. 2 (7.6%) and 3 (5.9%) were moderate. This clearly suggests that the normal transfer coefficient factor of 10% may not fit in well for the above cases. It is also noticed that the lower conversion efficiency between trophic levels was more associated with the areas polluted by organic wastes than the industrial wastes. The estimated fishery potential based on the mean phyto-zooplankton productivity clearly indicate higher values at creek sts. 1 and 4 than the coastal sts. 2 and 3 (Table 1). The estimated values between sts. 2 and 3 are almost comparable. This clearly suggests the higher tertiary and fishery potential for the creek regions as compared to coastal regions off Bombay.

Fish landing data (Table 3) of Greater Bombay, Versova and Thana reveal a highly fluctuating trend in total catch. Percentage of prevalence clearly indicates a fall in fish catch in all these three localities. Polluted regions of Bombay and Thana districts show a decline in production while the unpolluted districts of Kulaba and Ratnagiri reveal an increase of 31% and 24% respectively. This trend in fish landing data suggests the effect of deteriorating environmental conditions in the Bombay and Thana districts. A downward trend in fish production in polluted waters of Bombay has already been reported by Dwivedi and Desai (1972). According to them the fish production off Bombay upto 20 meter depth is poor and good catches are obtained only in fishing grounds located further away. On the contrary high rate of fish production is estimated from the results of primary or secondary production in the polluted regions (sts: 1 and 4).

The contribution of pelagic and demersal fishery form approximately 54% and 46% of the total marine fish landing respectively (CMFRI, 1980). The shoaling fishes and plankton feeders like sardines, mackeral etc; constitute a major part of pelagic fishery (Nair, 1982). The important demersal groups are catfishes, mullets, soles, pomfrets; shrimps etc. The variability in primary, secondary and benthic production is bound to occur in a marine environment. However, basic differences in the abundance and diversity of phytoplankton, zooplankton and benthos can also exert profound influence on the fishery potential apart from extraneous interferences.

The foregoing study very well substantiates the prevailing environmental stress on various tropic levels of the marine food chain especially in the nearshore waters of Bombay. Higher productivity at primary and secondary levels associated with greater intensity of pollution result in an estimate of higher pelagic fishery resources especially at the creek regions. At the same time the zoo and phytoplankton standing stock reveal differential efficiency in their conversion factor between severe organic polluted environment (Versova, Mahim) and the region moderately polluted by Industrial wastes (Thana creek). A poor benthic productivity at the creek stations of Versova and Thana clearly suggests, the relatively less potential for demarsal fisheries of these regions as compared to the coastal sts. 2 and 3. Since, the earlier studies on phytoplankton (Jiyalal Ram, 1985), zooplankton (Gajbhiye, 1982) and benthos (Varshney, 1982) have well indicated the less group/species diversity at creek sts. 1 and 4 as compared to the coastal stations, the observed higher primary and secondary productivity of these creek stations due to the dominace of certain more tolerant faunal groups need not necessarily end up with higher tertiary production. In Thana Creek very often the high biomass of zooplankton was due to the aggregations of gelatinous organisms like chaetognaths and medusae which contribute little to ecological efficiency. In other words, the high rate of primary and secondary productions in these polluted creeks may not be fully utilized at tertiary level to obtain the expected fish productivity. Since, most of the tertiary producers are relatively faster and free swimming organisms and also more sensitive to environmental deterioration, they can avoid the greater environmental stress by moving away from such unfavourable conditions and therefore the possibility of under utilization of primary and secondary producers in the polluted creek regions cannot be fully ruled out. Hence, the high rate of productivity of an area cannot always be an indication of the health of the ecosystem (Ketchum, 1973).

Low numerical abundance associated with low diversity of fish larvae at Mahim and Thana Creek as compared to Versova offshore regions has been reported earlier (Gajbhiye *et al.*,1982). Thus, the greater degree of assimilation and dispersion potential for pollutants (Josanto and Sarma, 1985), the relatively better water quality (Zingde *et al.*, 1979) and a moderate biological productivity (Gajbhiye, 1982; Varshney, 1982 Jiyalal Ram, 1985) of the coastal waters off Bombay suggest relatively a good fishery potential as compared to the creek and near shore regions.

Therefore it is highly probable to consider these polluted and semipolluted environments as "special ecosystem" where the normal trophic conversion factor of 10% may not be quite convincingly applicable. While evaluating the biological productivity of such ecosystem the composition and diversity of organisms need to be taken into consideration along with the production estimate at various trophic level.

ACKNOWLEDGEMENT

The authors thank the Director, National Institute of oceanography, Goa, for the facilities provided.

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