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INFLUENCE OF SOME BOTTOM WATER OCEANOGRAPHIC FEATURES ON DEMERSAL FISH CATCHES IN THE ARABIAN SEA OFF MANJESWAR*

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ABSTRACT

In order to understand the possible reasons for the monthwise fluctuations of demersal fish catches obtained by experimental bottom trawling at 20 m depth in the Arabian Sea off Manjeswar, certain oceanographic features from bottom waters such as temperature, salinity, dissolved oxygen and water currents have been correlated with the fluctuation of the demersal fish catches in the area.

Throughout the period of investigation, the trawl catch obtained when the trawling was performed against the bottom water current was more than the trawl catch obtained when the trawl net was operated along with or across the current. This was attributed to the increased trawling efficiency based on the knowledge of the bottom water current. A significant, direct, positive correlation occurred between bottom water temperature and trawl catch during the study period. The highest trawl catch of 65 kg during March coincided with the highest bottom water temperature of 29.2°C and the lowest catch of 7.5 kg during September coincided with the lowest temperature of 25.9°C. There was a direct correlation between trawl catch and bottom water salinity for all the months except during April and May. Remarkably lower catches were obtained during May and September which coincided with the lowest oxygen values of 3.78 and 3.45 ml/l during these months respectively.

INTRODUCTION

MARINE environment is dynamic. Due to numerous forms of interaction between sea and air, between sea surface and bottom and between sea and coast, monthly, seasonal and regional variations occur in the oceanographic conditions. Fluctuations in physical, chemical and biological conditions of the ocean cause variations in the intensities of fisheries. The knowledge of both the behaviour of fish and the gear performance in relation to current speed and direction is required to obtain optimum performance from towed fishing gear (Saila and Flowers, 1969). For operating the nets and improving the fish catches, it is essential for fishermen to be aware of the direction of movement of water at fishing depths. In the present investigation, an attempt has been made to find out the effect of water currents and some other oceanographic features at the bottom on demersal fish catches in the fishing grounds off Manjeswar in the Arabian Sea. Such studies have not been carried out earlier in the States of Kerala and Karnataka.

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MATERIAL AND METHODS

Investigations on bottom water oceanographic factors and experimental bottom trawling were conducted in the Arabian Sea of Manjeswar at monthly intervals from January to May and from September to December 1984 using the fishing vessel M. F. V.

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Dolphin. Observations could not be made from June to August due to Monsoon rough weather conditions. The area of study included two sections, perpendicular to the coast, one off Manjeswar and the other off Someswar. Four stations were selected along each section, first station at 20 m depth (S M 1, MJ 1), second station at 30 m depth (SM 2, MJ2), third station at 40 m depth (SM 3, MJ 3) and fourth station at 50 m depth (SM 4, MJ 4) respectively (Fig. 1). All the observations were made when the boat was anchored. The direction and speed of the bottom water currents (0.5 m above the bottom) were measured at all the stations with a 'Lynx' direct reading and direction finding current meter. Bottom water temperature and salinity at each station were recorded using a Salinity-Temperature-Depth recorder. The bottom water samples for dissolved oxygen were collected using a Nansen reversing water bottle. The samples were later analysed for the dissolved oxygen content in the laboratory (Strickland and Parsons, 1972). Simultaneously with the oceanographic observations experimental bottom trawling was carried out twice at 20 m depth for demersal fish catch. The duration of each trawling was 30 minutes. First trawling was done from Someswar to Manjeswar and the second was done from Manjeswar to Someswar. The total weight of the trawl catch of each haul was immediately recorded. Details of fishing vessel and fishing gear used for the investigations are given in Table 1.

TABLE 1 a. *Particulars of the fishing vessel*

Name of the vessel	..	M.F.V. DOLPHIN
L.O.A.	..	13.26 m (43'5")
Tonnage	..	18.5
H.P.	..	88-102
Trawling speed (knots)	..	1.5-2.0
Crew	..	5

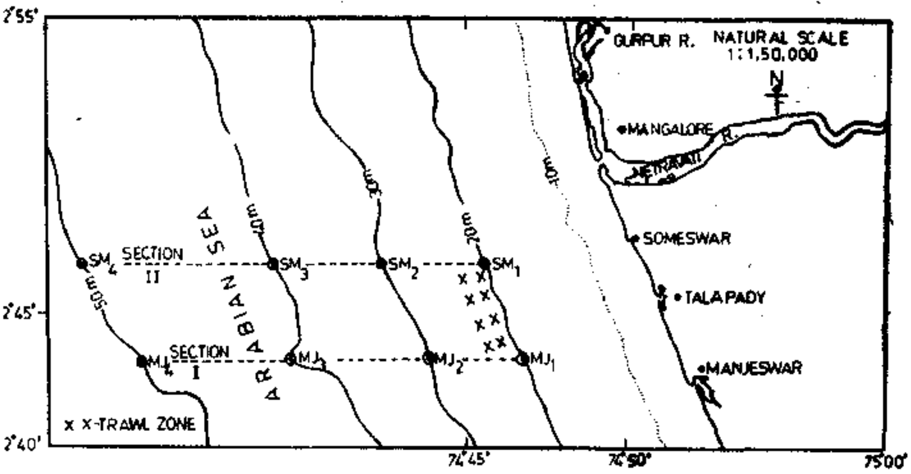

Fig. 1. Locations of sampling stations.

TABLE 1 b. *Specifications of the fishing gear (Trawl net)*

Name of the gear	..	39.2 Four seam bottom trawl
Type	..	Otter trawl
Foot rope length (m)	..	39.2
Cod and mesh size (mm)	..	30

RESULTS AND DISCUSSION

Bottom water currents

In the area of investigation, the bottom water current during January was generally directed between north-north-west and north

north-east and east (Table 2). The bottom current was directed between west-northwest and earth-north east in the month of February and between south-west and west during March. In April, bottom water currents were flowing between south-southwest and southwest. In general, the bottom current flow during May and September was between southeast and south-southwest. The bottom water currents in October recorded a flow between west-southwest and south, while in the month of November the bottom water currents were directed between north-west and east-north-east. The general flow of bottom currents in December was between west-northwest and northeast. Gouveia and Varadachari (1979) found that the bottom currents were flowing approximately parallel to the coast of Mangalore, upto a depth of 12 m in the sea. Bottom currents were generally high during January and showed a decrease in February and March, bottom water current intensities were comparatively higher in April and May. The strength of current was high in September and moderate during October. In November, the current continued to be moderate in their intensities decrease in their speeds.

Temperature

The bottom water temperature monthly values in the sea off Manjeswar exhibited generally a bimodal oscillation (Table 3). This type of temperature variation with two maxima and two minima was also noticed for bottom waters by Suresh *et al.* (1978) along the Mangalore Coast. However, the time of occurrence of maxima for bottom water was different from that of surface water observed by other workers along the west coast. Generally, for bottom water off Manjeswar the primary maximum was during November-December for 30, 40 and 50 m depth stations. For 20 m depth stations, the primary and secondary maxima were in

TABLE 2. *Bottom water currents at different stations located along Sections I and II off Manjeswar and Someswar in the Arabian Sea during 1984*

Section	Station	Jan.		Feb.		Mar.		Apr.		May		Sep.		Oct.		Nov.		Dec.	
		Di	Sp	Di	Sp	Di	Sp	Di	Sp	Di	Sp	Di	Sp	Di	Sp	Di	Sp	Di	Sp
I	MJ 1	332	0.20	320	0.10	238	0.05	212	0.25	178	0.10	194	0.20	183	0.10	310	0.20	315	0.10
	MJ 2	358	0.25	38	0.075	242	0.05	218	0.30	180	0.20	142	0.20	194	0.15	60	0.19	324	0.10
	MJ 3	350	0.30	64	0.10	244	0.10	220	0.20	172	0.05	168	0.20	200	0.20	65	0.20	352	0.10
	MJ 4	357	0.25	32	0.10	268	0.10	218	0.10	168	0.25	154	0.35	202	0.20	65	0.25	306	0.10
II	SM 1	18	0.15	294	0.10	235	0.10	206	0.20	162	0.25	143	0.40	251	0.30	330	0.15	330	0.10
	SM 2	352	0.175	32	0.10	245	0.025	213	0.20	196	0.30	162	0.35	173	0.25	82	0.20	310	0.30
	SM 3	12	0.15	22	0.10	254	0.020	210	0.30	166	0.30	133	0.25	180	0.25	320	0.25	298	0.20
	SM 4	8	0.10	306	0.10	241	0.05	204	0.20	191	0.30	154	0.20	235	0.20	75	0.20	42	0.10

TABLE 3. *Monthly variation of sea bottom water temperature (°C) at different stations along sections I and II in the fishing grounds off Manjeswar during* 1984

Section	Station	Jan.	Feb.	Mar.	Apr.	May	Sep.	Oct.	Nov.	Dec.
I	MJ 1	28.4	28.6	29.3	28.7	27.3	26.0	26.3	28.4	28.3
	MJ 2	28.6	28.8	28.0	28.6	26.7	25.2	26.1	29.2	28.6
	MJ 3	28.7	28.7	28.1	28.0	26.5	24.0	25.8	28.7	28.7
	MJ 4	23.5	28.6	27.8	27.0	25.9	23.2	24.9	28.8	28.8
II	SM 1	28.1	28.5	29.1	28.8	27.5	25.8	26.4	28.6	28.2
	SM 2	28.2	28.3	28.6	28.3	27.1	25.3	25.5	28.5	28.7
	SM 3	28.0	28.4	28.4	28.0	26.6	24.1	25.0	28.4	29.0
	SM 4	28.4	28.3	28.0	27.1	26.0	23.8	25.1	28.7	29.0

March and November respectively. The secondary maximum temperature for deep water stations (*i.e.* 30, 40 and 50 m depth stations) was in February-March. The primary minimum was in September while the secondary minimum was in December-January.

As stated by Sverdrup *et al.* (1942), at subsurface depths the variation of temperature depends upon the variation of the amount of heat that is directly absorbed at different depths, the effect of heat conduction, variation in currents related to lateral displacement of water masses and the effect of vertical motion. The lowest bottom water temperature recorded during September could be attributed to the cooling effect of the southwest monsoon and also to the effect of upwelling along this part of the coast. The maximum annual variation of bottom temperature was 5.6°C at the 50 m depth station and the minimum range was 3.3°C at the 20 m depth station in the sea off Manjeswar.

Salinity

A double oscillation for bottom water salinity was observed for all the stations during the one year period (Table 4). The primary and secondary maxima of salinity were during April-May and October-November respectively. Sankaranarayanan and Qasim (1969) and Suresh *et al.* (1978) also observed a double

TABLE 4. *Monthly distribution of bottom water salinity (‰) of different stations located along sections I and II in the fishing grounds off Manjeswar during* 1984

Section	Station	Jan.	Feb.	Mar.	Apr.	May	Sep.	Oct.	Nov.	Dec.
I	MJ 1	32.8	33.7	35.3	35.8	35.8	34.1	34.5	34.8	33.4
	MJ 2	33.3	34.0	35.5	36.2	36.0	34.0	34.8	34.8	33.6
	MJ 3	33.6	34.2	35.7	36.3	36.0	34.7	35.0	35.1	34.1
	MJ 4	33.9	34.2	35.8	36.5	36.2	34.9	35.2	35.2	34.2
II	SM 1	32.9	33.8	35.2	35.7	35.7	33.6	34.4	34.7	33.4
	SM 2	33.2	33.8	35.6	35.9	36.1	33.7	34.7	34.8	33.6
	SM 3	33.4	34.3	35.7	36.0	36.1	34.1	34.9	35.0	34.0
	SM 4	33.5	34.3	35.8	36.1	36.3	34.6	35.1	35.1	34.1

oscillation for bottom water salinity for Cochin and Mangalore coastal waters respectively. The maximum annual fluctuation for salinity was 3.0‰ at the 20 m depth station and minimum annual variation was 2.8‰ at the 50 m depth station in the sea of Manjeswar.

TABLE 5. *Monthly distribution of bottom water dissolved oxygen (ml/l) at different stations located along the sections I and II in the fishing grounds off Manjeswar during 1984*

Section	Station	Jan.	Feb.	Mar.	Apr.	May	Sep.	Oct.	Nov.	Dec.
I	MJ 1	4.82	4.68	4.25	4.28	3.83	3.56	4.34	4.48	4.83
	MJ 2	4.85	4.57	4.15	4.17	3.47	3.19	4.08	4.44	4.65
	MJ 3	4.45	4.59	4.15	4.02	3.35	3.05	4.13	4.45	4.62
	MJ 4	4.49	4.39	4.15	3.46	3.12	2.96	4.18	4.45	4.57
II	SM 1	4.63	4.43	4.24	4.15	3.74	3.35	4.23	4.44	4.75
	SM 2	4.58	4.43	4.38	4.17	3.55	3.09	4.22	4.46	4.74
	SM 3	4.49	4.25	4.15	3.96	3.28	3.22	4.19	4.67	4.85
	SM 4	4.69	4.15	3.92	3.69	3.06	2.22	4.03	4.55	4.75

Dissolved oxygen

The maximum dissolved oxygen content for bottom water was found during December-January for all the stations in the sea off Manjeswar (Table 5). Comparatively low values of dissolved oxygen were observed during May. September recorded the lowest value dissolved oxygen throughout the area of study. One of the probable causes for reduction in oxygen during this month was perhaps the upwelling process prevailing at this time along with part of the southwest coast. In the present investigation, a unimodal oscillation for dissolved oxygen was recorded.

As Broudel and Page (1955) opened low values of dissolved oxygen for the bottom waters could possibly be due to slow diffusion and rapid oxidation by the bottom sediments, the highest annual variation of dissolved oxygen observed during the present study was 2.53 ml/l at the 50 m depth station and the lowest annual fluctuation was 1.27 ml/l at the 20 m depth station.

Currents and demersal fish catches

To find out the possible influence of bottom water currents on demersal fish catches in the present study, the average of the two bottom water current readings (direction only) at 20 m depth pertaining to Manjeswar and Someswar sections was taken as the direction at the fishing depth. Fig. 2 shows the direction of trawl and current direction with trawl catch at 20 m depth for all the months of investigation. Even during March, when the current direction was west-southwest, the catch obtained when the net was towed against the current was higher than when it was towed across the current.

Incidentally, the catch obtained in this month was the highest during the period of investigation. Even though the trawl catch obtained was more when the net was towed against the current than when it was towed with the current. The increase in trawl catch when the trawling was performed against the bottom water current could be due to the possible increase in the opening of the bottom trawl thus increasing the catching efficiency of the trawl net. This observation provides a useful information to the fishermen and helps to avoid indiscriminate operation of the trawl net, thus saving the fishing time and effort.

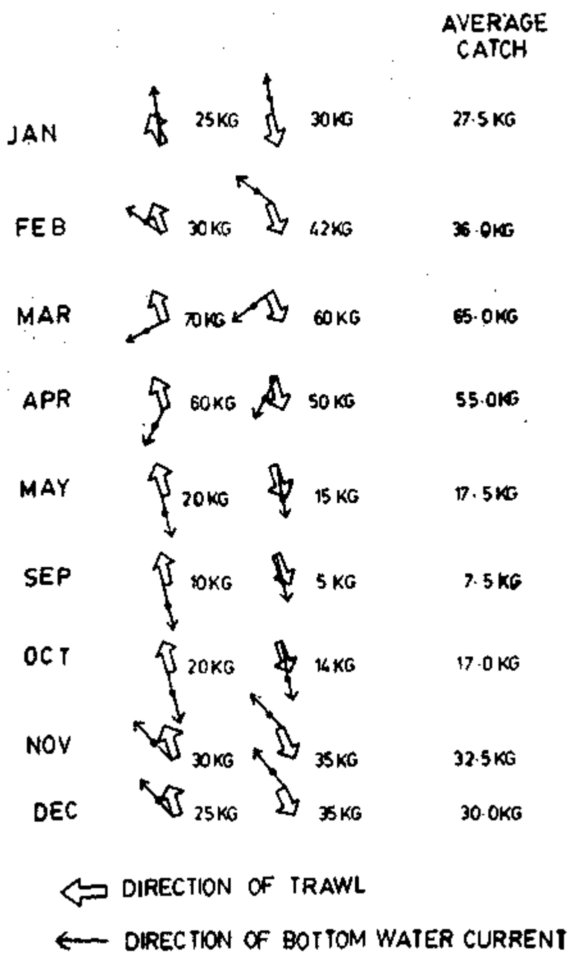

Fig. 2. Direction of trawling and bottom currents with trawl catches.

The study also showed the necessity of having a clear knowledge of the currents for successful trawling operations in the sea.

Other oceanographic features and demersal fish catches

To investigate the possibility of relationship if any, between oceanographic factors like sea water temperature, salinity and dissolved oxygen and demersal fish catches, the temperature, salinity and dissolved oxygen values from bottom water of eight stations observed in the area of study during each month were averaged and plotted against the total fish catch obtained at the 20 m depth zone (Fig. 3). Bottom temperature appeared to have played a significant role in the distribution of fishes both directly and indirectly. From January till March, the fish catch increased significantly. This situation very well coincided with the increase in bottom water temperature declined during the months of April and May and accordingly the fish catch also decreased in April and May. As per the observations, the lowest bottom water temperature recorded was 25.9° C during September and accordingly the lowest trawl catch of 7.5 kg (average) was observed in the same month. After registering the lowest catch in September, the trawl catch gradually increased till November and then a drop in fish catch was found in December. Following similar pattern, the bottom water temperature also increased from September till November and then a drop was noticed in December. Hence the present study revealed the existence of a positive correlation between bottom water temperature and trawl catch.

A positive correlation between trawl catch and bottom water temperature was reported earlier by Benakappa *et al.* (1979) and Maddikery (1981) along the different regions of the South Kanara Coast. However, such a type of correlation could be expected to hold good only till the optimum temperature favourable for fish stock is reached. Fish catch may decrease once the temperature value exceeds the optimum value since every fish stock has its own preferential temperature optimum. Huntsman (1958) observed lowest catches of herring in the coldest months and highest catches during summer months. In general Cod fishery was associated with warm waters as indicated by Graham (1951). Similarly even in the present investigation, higher catches of 65 kg and 55 kg were associated with warm temperature during March (29.2°C) and April (28.75°C). Likewise lowest catch was obtained during September when the bottom water temperature was lowest.

In the present study, there was a direct correlation between trawl catch and bottom water salinity for all the months except during April and May, which showed an inverse relationship. Jayaraj (1982) reported an inverse relationship between salinity and trawl catch during May and December. The fluctuations in salinity might result in the impairment of osmotic regulations of fish. In addition to the salt concentration, the correlations observed might be brought about indirectly by the advective effects of various factors such as dissolved oxygen, density of water and ionic composition of water (Holliday, 1971). Salinity appeared to have a decisive bearing on the demersal fishes, especially during their early life stages.

As far as the distribution of fish is concerned in general, under normal conditions in the sea, the dissolved oxygen content does not act as a limiting factor. However, the low oxygen content of water was found to restrict the distribution of fish. The striking feature of the Arabian Sea in general, and the west coast of India in particular, is the presence of sub-surface oxygen minimum layer which starts to rise along the continental shelf due to the seasonal start of upwelling during the southwest monsoon period. It is a well known fact that this phenomenon has a direct influence on the distribution of fish. In the present study also, remarkably lower catches were obtained during May and September. Lowest oxygen of 3.78 and 3.45 ml/l were obtained for these months respectively, which could be due to upwelling along this area. The prevalence of upwelling along South Kanara Coast from May to August was indicated by Suresh *et al.* (1979). Sankaranarayanan and Qasim (1969) noticed lowest fish and prawn catches off Cochin coinciding with minimum values of temperature and oxygen near the bottom. Jayaraj (1982) observed significantly lower trawl catch during September when the bottom waters recorded a minimum oxygen of 7.65 ml/l. In the present investigation also, strikingly low trawl catch was obtained during September when there was a steep fall in bottom water dissolved oxygen content.

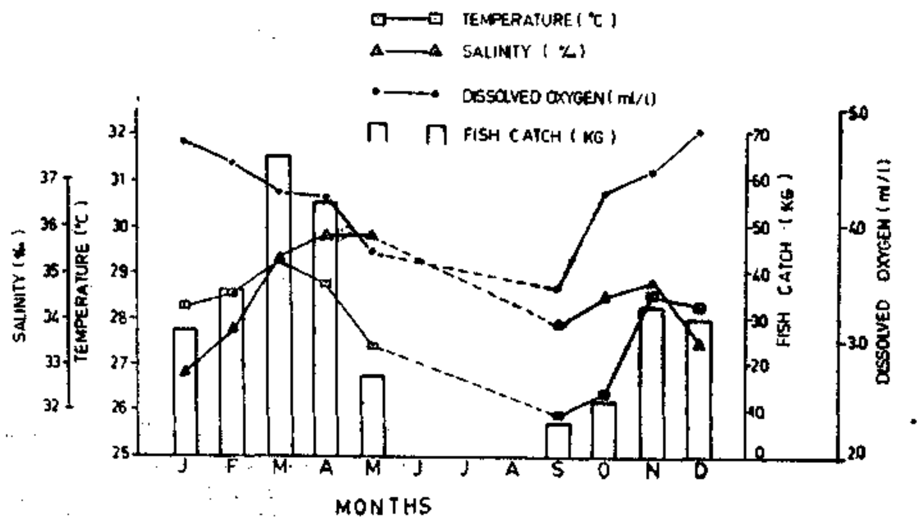

Fig. 3. Correlation between hydrographical parameters and trawl catches.

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