

Assessment of fishery resources in relation to some physico-chemical parameter of water in Sundarbans Mangrove Ecosystem, India

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ABSTRACT

The Sundarbans comprising of Hoogli- Matla estuarine system offers an excellent eco-zones for several finfish and shellfish species as it provides physiologically suitable environment with respect to different physicochemical parameters and abundant supply of nutrients to the aquatic subsystem in the form of detritus exported from the adjoining mangrove forest subsystem. The present study has been conducted during November, 2001 to October, 2003 in order to assess the diversity of the fishery resources and also to study the feasibility of sustainable development of culture and capture fishery along this coastal belt. . So far, 118 fin fishes ,24 shrimp species and 4 species of crabs have been recorded form different parts of Sundarbans Biosphere Reserve. Information relating to fish landings (weight / month) collected from different fish landing centres along the stretch of this environment were also recorded in the present study. Physicochemical parameters like Temperature, pH, DO, BOD, Light penetration, Turbidity, Salinity, TDS, TSS, Nitrate nitrogen, Phosphate phosphorus and Silicate have been estimated to understand the seasonal dynamics of this mangrove ecosystem and also to assess whether these parameters have any role in determining fish resources availability.

Key words: Fishery resource, Fish landing, physicochemical parameters, Sundarbans.

INTRODUCTION

Mangroves are defined as those ecosystems of the intertidal tropical and subtropical zones dominated by woody halophytes, with interconnecting water courses, swamps and backwaters as well as their associated populations of plants and animals [1]. The intertidal salt tolerant halophytic vegetation constituting the main structural component of mangrove ecosystem experience the influence of two high tides and two low tides a day. The Hoogli-Matla estuarine system representing the largest one in India, covering a major portion of the Ganga- Brahmaputra deltaic complex and circumscribes marshy area called Sundarbans known for its largest mangrove forest in the country. This region is rich in faunistic resources and forms the mainstay of the capture fisheries of India. This estuarine system, particularly its lower zone, sustains important multi-species commercial fisheries exploited by multi gears. A large number of fishermen in groups of fishing parties migrate from different areas of Midnapore District, 24-Parganas District and other parts of the adjacent areas to different mangrove-deltaic island of Sundarbans in order to during winter seasons and establish temporary fishing camps and also to remain engaged in fishing during winter months (from October to February). The temporary fishing camps are locally named as 'khuties'. The present study has been conducted to assess the diversity of the finfish and shellfish species and also to scan information on fish landings collected from the different landing centres . Different physico-chemical parameters have also been estimated to understand the seasonal dynamics of this environment and also to gain an idea about the role of ecological factors in governing the distribution of different fishery resources.

Study sites

The Indian Sundarbans are located between 21⁰32' - 22⁰40' north and between 88⁰85' - 89⁰00' east, mainly within the 24 – Parganas district of the state of West Bengal (Fig-1). It lies at the apex of Bay of Bengal and the entire area is

criss-crossed by a number of estuaries viz. Hoogli, Muriganga, Saptamukhi, Thakuran, Gossaba, Vidya, Matla and Harinbhanga etc. known as Hoogli–Matla estuarine complex along with their tributaries and creeks of varying depths and widths, forming a good number of deltaic islands. The Mangrove forest of Indian Sundarbans have been variously estimated as 418,888 hectares [2&3] and as 426,300 hectares by the forest department of West Bengal. For estimating physico-chemical parameters of water, 4 sampling sites viz. Bokkhali and Frezgeranj on Hoogli estuary, Susnirchara on Saptamukhi estuary, Canning, Bhagankhali and Jharkhali on Matla estuary –the 3 major estuaries of Sundarbans have been selected. Among these estuaries, Matla is situated in the South East part of Sundarbans while two others are located on Central and South -West parts of Sundarbans and for the estimation of fish landings, three sampling sites have been selected (viz. Frezgeranj, Canning and Diamond Harbour) as these are the main three landing centres of Sundarbans.

MATERIALS AND METHODS

The study was conducted during November, 2001 to October, 2003. Monthly samplings of water were collected from the study sites and were analysed following standard methods [4-7]. Faunal components were collected and subsequently identified with the help of standard literatures [8-9]. Fishes were collected both from the intertidal belts as well as from the open water bodies with the help of different crafts (like - Dinghi, Nouka, nonmechanised and mechanised boats etc) and gears (like bag nets, gill nets, drag nets etc.). Fishermen inhabiting in the island were supplied with plastic containers and preservatives (5% buffered formalin) for keeping token sample of fishes, shrimps and crabs from their daily catch which were subsequently collected and identified. Information pertaining to total fish catch were collected by direct observation as well as in consultation with the fishermen in every month.

RESULTS AND DISCUSSION

All total 118 finfish species belonging to 83 genera, 43 families and 8 order have been documented during the study period (Table-1). Maximum number of species belong to order perciformes followed by clupeiformes and siluriformes. 24 species of shrimps belonging to 7 genera, 4 families and 1 order have been recorded. 4 species of crabs belonging to 3 genera, 1 family and 1 order have also been recorded (Table-2). Total estimated catch from the study sites during the period of November, 2001 to October, 2003 were 3830072 kg, 2851527.6 kg and 7313224.4 in Diamond Harbour, Canning and Frezgeranj respectively(Table 3-5) which revealed that maximum landing was contributed by Frezgeranj followed by Diamond Harbour and Canning landing centre.

Out of 118 fin fish species recorded in the present study, 23 species were recognised as commercially important fin fishes besides 4 species of shrimps and 2 species of crabs. The species wise catch showed that the bulk catch comprised of *Harpadon nehereus*, *Pama pama*, *Setipinna spp.*, *Trichiurus spp.*, *Tachysurus jella*, *Coilia spp.*, *Sciaena spp.*, *Lutjanus spp.*, *Anodontostoma spp.*, *Liza parsia*, *Lates calcarifer*, *Pampus argentius*, *Ilisha magaloptera* and *Tenualosa ilisha*.

The fisheries aspect of the aforesaid aquatic resources have been studied in details by many workers [10-13]. Pantulu, 1966 [14] classified the fish fauna of Hoogli- Matla estuaries into two categories i.e. residents and migrants. In general the fish fauna can be broadly classified into following categories-i) marine species which used to migrate from upstream and spawn in less saline water region of the estuary viz. *Tenualosa ilisha*, *Polynemus paradiseus*, *Sillago sihama*, *Pama pama* and *Penaeus monodon*; ii) fresh water species which spawn in saline areas viz. *Pangasius pangasius*, *Anguilla sp.*, *Macrobrachium rosenbergii*; iii) marine forms which used to visit high saline zone of the estuary for breeding viz. *Tachysurus jella*, *Osteogeniosus militaris*, *Eleutheronema tetradactylum* etc. During winter season, a calm weather prevailing in the extreme lower stretches of the estuary very close to the sea provided favourable condition for the operation of stationary bag nets. Such favourable condition prevailed till the onset of south west wind which started about the middle of February and converted the weather very rough and non-conducive for the operation of these nets. Not only this, the availability of fish vulnerable to bag nets at these fishing zones during November to January ranged from about fifteen to thirty times more than the average availability at the upper estuary throughout the year. A wide variety of gears were used by the fishermen viz. trawl nets, seine nets (small and big) drift gill net, set gill nets, cast nets, bag nets, hooks and lines. The most priced species of this estuary is *Tenualosa ilisha* amongst the clupeids; *Liza parsia* and *Liza tade* are amongst the mullets, *Eleutheronema tetradactylum*, *Polunemus indicus* are amongst the polynemids, *Lates calcarifer* amongst the perches, *Penaeus monodon*, *P.indicus*, *Metapenaeus monoceros*, *M. brevicornis*, *Accetes indicus* etc amongst shrimps, *Scylla serrata* and *Portunus pelegicus* are amongst crabs. Besides, *Pampus argenteus* also enjoys good market value. The catch landed during winter season was mostly sun-dried excepting the commercially important species.

The diversity of the fishes mainly depends upon the biotic and abiotic factors and type of the ecosystem, age of the water body, mean depth, water level fluctuations, morph-metric features and bottom have great implications. The hydro-biological features of the collection centers also play an effective role in fisheries output to a greater extent. [15]. Different physico-chemical parameters varied from season to season and also from place to place (Table-6) which were supposed to govern the distribution and abundance of the fishery resources as different fishing zones showed different fish composition.

With the rapid overall development of the country and owing to ever- increasing demand of fish as food, the aquatic ecosystems are under constant pressure of main-induced stresses resulting in the declining of the aquatic flora and fauna [16]. Water quality is an index of health and well being of a society. Industrialisation, urbanisation and modern agriculture practices have direct impact on water resources. These factors influence the water resources quantitatively and qualitatively [17]. Though the decline of the individual fish species is very often related to more than one proximate factor, the various causes of imperilment of fishes in the aquatic ecosystems have been identified as - i) loss of physical habitat due to construction of dams, weirs across the river, ii) soil erosion due to deforestation, iii) chemical pollution due to industrial and municipal wastes iv) over-exploitation and indiscriminate fishing of juveniles and brood fishes, v) introduction of exotic fish species [18]. Maintenance of fish biodiversity along with other biotic resources can be viewed as prerequisite for the well-being of human beings [19]. So, it is essential to prevent the further decline of bio resources by devising all possible measures for their conservation and rehabilitation [20-21]. In the coastal regions close to industrial area and urban areas sediment acts as sink and is the greatest potential source of inorganic and organic contaminants in the marine environment. Anthropogenic impacts those are most destructive to benthic communities [22]. The long term sustainability of the park will inevitably depend on winning communities support. Communities that successfully combine traditional livelihood with conservation are likely to contribute significantly to the biodiversity management of the park. [23]. The conservation policy should promote the management practices that maintain integrity of aquatic ecosystems, prevent endangerment and enhance recovery of the threatened species.

Table-1: List of Ichthyofauna species collected from different study sites

Sl. No.	Scientific Name and systematic position
	Class : Chondrichthyes Subclass : Elasmobranchii Order: Lamniformes Family : Sphyrnidae
1	<i>Sphyrna lewini</i> (Griffith & Smith)
	Family : Carcharhinidae
2	<i>Carcharhinus dussumieri</i> (Valenciennes)
3	<i>Scoliodon laticaudus</i> Muller & Henle
	Family: Rhiniodontidae
4	<i>Rhinodon typus</i> Smith
	Family: Rhinobatidae
5	<i>Rhinobatus granulatus</i> (Cuvier)
	Family: Dasyatidae
6	<i>Dasyatis uarnak</i> (Forsskal)
	Class: Osteichthyes Subclass: Actinopterygii Order: Clupeiformes Family: Clupeidae
7	<i>Tenualosa ilisha</i> (Hamilton Buchanan)
8	<i>T. toli</i> (Valenciennes)
9	<i>T. kelee</i> (Cuvier)
10	<i>Gadusia chapra</i> (Hamilton-Buchanan)
11	<i>Ilisha elongata</i> (Bennet)
12	<i>I. megaloptera</i> (Swainson)
13	<i>Anodontostoma chacunda</i> (Hamilton-Buchanan)
14	<i>Pellona ditchela</i> Valenciennes
15	<i>Sardinella longiceps</i> Valenciennes
16	<i>S. melanura</i> (Cuvier)
17	<i>Raconda russeliana</i> Gray
18	<i>Escualosa thoracata</i> (Valenciennes)
19	<i>Dussumieria acuta</i>
20	<i>Nematolosa nosus</i> (Bolch)
	Family: Chanidae
21	<i>Chanos chanos</i> (Forsskal)
	Family: Engraulidae
22	<i>Coila dussumieri</i> Valenciennes
23	<i>C. ramkarati</i> (Hamilton)
24	<i>C. reynaldi</i> (Cuvier & Valenciennes)

25	<i>Stolephorus indicus</i> (van Hasselt)
26	<i>Thryssa mystax</i> (Schneider)
27	<i>Thryssa mystax</i> (Schneider)
28	<i>T. dussumieri</i> (Valenciennes)
Sl. No.	Scientific Name and systematic position
29	<i>Setipinna phasa</i> (Hamilton)
30	<i>S. taty</i> (Cuvier & Valenciennes)
	Order-Myctophiformes Family: Harpadontidae
31	<i>Harpandon nehereus</i> (Hamilton - Buchanan)
	Family: Bregmacerotidae
32	<i>Bregmaceros sp.</i>
	Family: Synodidae
33	<i>Saurida elongata</i> (Temminck & Schlegel)
	Order : Siluriformes Family: Plotosidae
34	<i>Plotosus canius</i> (Hamilton-Buchanon)
	Family: Ariidae
35	<i>Arius arius</i> (Hamilton - Buchanan)
36	<i>A. jella</i> Day
37	<i>A. sona</i> (Hamilton - Buchanan)
38	<i>A. sagor</i> (Hamilton-Buchanon)
39	<i>Osteogeneiosus militaris</i> (Linnaeus)
	Family: Bagridae
40	<i>Mystus vittatus</i> (Bloch)
41	<i>M. gulio</i> (Hamilton - Buchanan)
	Family: Pangassidae
42	<i>Pangasius pangasius</i> (Hamilton - Buchanan)
	Order: Anguilliformes Family: Anguillidae
43	<i>Anguilla bengaliensis bengaliensis</i> (Gray)
44	<i>A. bicolor bicolor</i> McClelland
	Family: Muraenesocidae
45	<i>Muraenox cinereus</i> (Forsskal)
	Order: Atheriniformes Family: Belonidae
46	<i>Xenentodon cancila</i> (Hamilton - Buchanan)
	Family: Hemiramphidae
47	<i>Hemiramphus brachynotus</i> Bleeker
48	<i>H. limbatus</i> Valenciennes
	Order: Perciformes Family: Mugilidae
49	<i>Liza parsia</i> (Hamilton - Buchanan)
50	<i>L. tade</i> (Forsskal)
51	<i>Mugil cephalus</i> Linnaeus
52	<i>Rhinomugil corsula</i> (Hamilton - Buchanan)
	Family: Polynemidae
53	<i>Eleutheronema tetradactylum</i> (Shaw)
54	<i>Polynemus indicus</i> Shaw
Sl. No.	Systematic Position and Scientific Name
55	<i>P. paradiseus</i> Linnaeus
	Family: Centropomidae
56	<i>Lates calcarifer</i> (Bolch)
	Family: Ambassidae
57	<i>Ambassis nalua</i> (Hamilton - Buchanan)
58	<i>A. commersonii</i> Cuvier
59	<i>Chanda nama</i> Hamilton-Buchanon
60	<i>Paraambasis baculis</i> (Hamilton - Buchanan)
61	<i>P. ranga</i> (Hamilton-Buchanon)
	Family: Cichlidae
62	<i>Etroplus suratensis</i> (Bloch)
	Family: Nandidae
63	<i>Bedis bedis</i> (Hemilton - Buchanan)
	Family: Teraponidae
64	<i>Terapon jarbua</i> (Forsskal)
65	<i>T. theraps</i> (Cuvier)
	Family: Sillaginidae
66	<i>Sillago sihama</i> (Forsskal)
67	<i>Sillaginopsis panijus</i> (Hamilton - Buchanan)
	Family: Carangidae
68	<i>Alectis indicus</i> (Ruppell)
69	<i>Megalaspis cordyla</i> (Linnaeus)

70	<i>Atropus atropus</i> (Schneider)
71	<i>Carangoides ferdau</i> (Forsskal)
72	<i>Elepes djedaba</i> (Forsskal)
73	<i>Caranx carangus</i> (Bloch)
	Family: Menidae
74	<i>Mene maculate</i> (Bolch & Schneider)
	Family: Lutjanidae
75	<i>Lutjanus argentimaculatus</i> (Forsskal)
76	<i>L. johnii</i> (Bloch)
	Family: Leiognathidae
77	<i>Gazza minuta</i> (Bolch)
78	<i>Leiognathus bindus</i> (Valenciennes)
79	<i>L. equulus</i> (Forsskal)
80	<i>L. dussumieri</i> (Valenciennes)
82	<i>L. blochi</i> (Valenciennes)
	Family: Gerreidae
83	<i>Gerres oyena</i> (Forsskal)
84	<i>G. filamentosus</i> Cuvier
	Family: Sciaenidae
85	<i>Johnius belangerii</i> (Cuvier)
86	<i>J. macropterus</i> (Bleeker)
87	<i>J. coitor</i> (Hamilton - Buchanan)
Sl. No.	Scientific Name and systematic position
88	<i>J. gangeticus</i> Talwar
89	<i>Macropsinosa cuja</i> (Hamilton - Buchanan)
90	<i>Panna heterolepis</i> Trewavas
91	<i>Otolithus maculatus</i> (Kuhl & van Hasselt)
92	<i>Otolithoides biauritus</i> (Cantor)
93	<i>Pseudosciaena coibor</i> (Hamilton - Buchanan)
94	<i>Pama pama</i> (Hamilton - Buchanan)
95	<i>Daysciaena albida</i> (Cuvier)
	Family: Scatophagidae
96	<i>Scatophagus argus</i> (Linnaeus)
	Family: Trichiuridae
97	<i>Lepturacanthus pantului</i> Gupta
98	<i>L. savala</i> (Cuvier)
99	<i>Trichiurus lepturus</i> Linnaeus
100	<i>T. gangeticus</i> Gupta
	Family: Scombridae
101	<i>Rastrelliger kanagurta</i> (Cuvier)
102	<i>Auxis thazard</i> (Lacepede)
103	<i>Scomberomorus commerson</i> (Lacepede)
104	<i>S. guttatus guttatus</i> (Bolch & Schneider)
	Family: Stomateidae
105	<i>Pampus argenteus</i> (Euphrasen)
106	<i>P. chinensis</i> (Euphrasen)
	Family: Gobiidae
107	<i>Awaous grammepomus</i> (Bleeker)
108	<i>A. gutatum</i> (Hamilton - Buchanan)
109	<i>Glossogobius giuris</i> (Hamilton - Buchanan)
110	<i>Pseudocryptes lanceolatus</i> (Bloch & Schneider)
111	<i>Apocryptes bato</i> (Hamilton - Buchanan)
112	<i>Boleophthalmus boddarti</i> (Pallas)
	Family: Periophthalmidae
113	<i>Periophthalmus pearsei</i> Eggret
	Family: Serranidae
114	<i>Epinephelus sp.</i>
	Family: Ephippidae
115	<i>Ephippus orbis</i> (Bolch)
	Order: Pleuronectiformes
	Family: Bothidae
116	<i>Bothus ovalis</i> (Regan)
	Family: Cynoglossidae
117	<i>Cynoglossus lingua</i> (Hamilton & Buchanan)
118	<i>C. cynoglossus</i> (Hamilton & Buchanan)

Table – 2: List of Shrimps and Crabs species recorded from different study sites

Sl. No.	Scientific Name and Systematic position
	Class: Crustacea Order : Decapoda Sub-Order: Dendrobranchiata Family: Penaeidae
1	<i>Penaeus indicus</i> H. Milne Edwards
2	<i>P. monodon</i> Fabricius
3	<i>P. semewaeatus</i> (de Man)
4	<i>P. japonicus</i> Bate
5	<i>P. penicillatus</i> Alcock
6	<i>P. merguensis</i> (de Man)
7	<i>P. longipes</i> Alcock
8	<i>Metapenaeus affinis</i> (H. Milne Edwards)
9	<i>M. brevicornis</i> (H. Milne Edwards)
10	<i>M. dobsoni</i> (Miers)
11	<i>M. lysianasa</i> (de Man)
12	<i>Metapenaeopsis stridutans</i> (Alcock)
13	<i>Parapenaeopsis stylifera</i> (H. Milne Edwards)
14	<i>P. sculptilis</i> (Heller)
15	Family: Sergestidae
16	<i>Acetes indicus</i> H. Milne Edwards
17	<i>A. erythraeus</i> Nobili
	Sub-Order: Pleocyemata Infra Order: Caridea Family: Palaemonidae
18	<i>Macrobrachium rosenbergi</i> (de Man)
19	<i>M. malacomsonii</i> (H. Milne Edwards)
20	<i>M. lamarrei</i> (H. Milne Edwards)
21	<i>M. rude</i> (Heller)
22	<i>M. mirabile</i> (Kemp)
23	<i>M. javanicum</i> (Heller)
	Family: Hippolytidae
24	<i>Hippolysmata (Exhippolysmata) ensirostris</i> Kemp
	Crabs
	Order-Decapoda Family-Portunidae
1	<i>Scylla serrata</i>
2	<i>Portunus pelagicus</i>
3	<i>Portunus sanquinolentus</i>
4	<i>Charybdis cruciata</i>

Table- 3 : Total average species-wise catch (in Kg.) composition of Diamond Harbour (November,2001-October,2003)

Species Name	Year		Total	Percentage
	Nov,2001 - Oct,2002	Nov,2002 -Oct,2003		
<i>Tenualosa ilisha</i>	290678.5	293886.7	584565.2	15.26
<i>Liza tade</i>	1948	1873.7	3821.7	0.10
<i>Liza parsia</i>	4373.2	4262.3	8635.5	0.23
<i>Lates calcarifer</i>	86232	60791.3	147023.3	3.84
<i>Sillaginopsis sp.</i>	6444.2	6352.3	12796.5	0.33
<i>Sillago sihama</i>	7681.5	7886.5	15568	0.41
<i>Polynemus sp.</i>	8477.5	8650.3	17127.8	0.45
<i>Eleutheronema tetradactylum</i>	10035	9840.9	19875.9	0.52
<i>Sciaena spp.</i>	45935	44460.3	90395.3	2.36
<i>Coilia spp.</i>	46198.3	44176.7	90375	2.36
<i>Pama pama</i>	170868.1	161096	331964.1	8.67
<i>Ilisha magaloptera</i>	26675	53395.4	80070.4	2.09
<i>Mystus Spp</i>	14695.2	14056.8	28752	0.75
<i>Setipinna spp.</i>	147488.9	143977.5	291466.4	7.61
<i>Pangasius pangasius</i>	15311.8	14797.6	30109.4	0.79
<i>Tachysurus jella</i>	75228.9	72239.1	147468	3.85
<i>Pampus chinensis</i>	22766.1	22349.9	45116	1.18
<i>Pampus argentius</i>	38808.9	36369.3	75178.2	1.96
<i>Trichuirus spp.</i>	137166.8	129290.1	266456.9	6.96
<i>Harpadon nehareus</i>	198163.6	179487.3	377650.9	9.86
<i>Lutjanus spp.</i>	38302.3	37252	75554.3	1.97
<i>Rastralliger kanagurta</i>	40977.3	36960.4	77937.7	2.03
<i>Anodontostoma spp.</i>	21841	21830.3	43671.3	1.14
Shrimps	54911.1	53854.2	108765.3	2.84
Crabs	29686.8	30206.5	59893.3	1.56
Miscellaneous	396965.3	402868.3	799833.6	20.88
Total	1937860.3	1892211.7	3830072	100.00

Table - 4 : Total average species-wise catch (in Kg.) composition of Canning (November,2001-October,2003)

Species Name	Year		Total	Percentage
	Nov,2001 - Oct,2002	Nov,2002 -Oct,2003		
<i>Tenualosa ilisha</i>	202428.5	212313.8	414742.3	14.54
<i>Liza tade</i>	5512.2	2549	8061.2	0.28
<i>Liza parsia</i>	3310.2	3200.1	6510.3	0.23
<i>Lates calcarifer</i>	55025	52677.8	107702.8	3.78
<i>Sillaginopsis sp.</i>	1806.6	1664.5	3471.1	0.12
<i>Sillago sihama</i>	8914.4	8788.4	17702.8	0.62
<i>Polynemus sp.</i>	9652.1	9075.8	18727.9	0.66
<i>Eleutheronema tetradactylum</i>	9005.3	8247.2	17252.5	0.61
<i>Sciaena spp.</i>	36490.1	35828.9	72319	2.54
<i>Coilia spp.</i>	58005.7	37573.9	95579.6	3.35
<i>Pama pama</i>	102977.6	97354.7	200332.3	7.03
<i>Ilisha magaloptera</i>	73720.2	73303.7	147023.9	5.16
<i>Mystus Spp</i>	21377.2	20719.8	42097	1.48
<i>Setipinna spp.</i>	84223.6	83989.7	168213.3	5.90
<i>Pangasius pangasius</i>	17340	17544.3	34884.3	1.22
<i>Tachysurus jella</i>	23633.4	23324.4	46957.8	1.65
<i>Pampus chinensis</i>	4784.9	4688.3	9473.2	0.33
<i>Pampus argentius</i>	18066.8	17689.8	35756.6	1.25
<i>Trichuirus spp.</i>	30780.5	28774.2	59554.7	2.09
<i>Harpadon nehareus</i>	57922.3	55365.3	113287.6	3.97
<i>Lutjanus spp.</i>	15216.7	14398.9	29615.6	1.04
<i>Rastralliger kanagurta</i>	21202.8	21726	42928.8	1.51
<i>Anodontostoma spp.</i>	12170.1	10528.5	22698.6	0.80
Shrimps	94817.8	89616.6	184434.4	6.47
Crabs	29821.2	28721.2	58542.4	2.05
Miscellaneous	449717.2	443940.4	893657.6	31.34
Total	1447922.4	1395605.2	2851527.6	100.00

Table- 5: Total average species-wise catch (in Kg.) composition of Frezarganj (November,2001-October,2003)

Species Name	Year		Total	Percentage
	Nov,2001 - Oct,2002	Nov,2002 -Oct,2003		
<i>Tenualosa ilisha</i>	639525.1	637320	1276845.1	17.46
<i>Liza tade</i>	6740	7317.2	14057.2	0.19
<i>Liza parsia</i>	21209	17103.5	38312.5	0.52
<i>Lates calcarifer</i>	205855.7	207653	413508.7	5.65
<i>Sillaginopsis sp.</i>	10039	11225.2	21264.2	0.29
<i>Sillago sihama</i>	11315.4	12335.4	23650.8	0.32
<i>Polynemus sp.</i>	22077.3	22509.5	44586.8	0.61
<i>Eleutheronema tetradactylum</i>	13313.2	18072.4	31385.6	0.43
<i>Sciaena spp.</i>	68590	72378.2	140968.2	1.93
<i>Coilia spp.</i>	114775	109581.3	224356.3	3.07
<i>Pama pama</i>	168115	168321.7	336436.7	4.60
<i>Ilisha magaloptera</i>	48170	54567.2	102737.2	1.40
<i>Mystus Spp</i>	27567.5	27911.9	55479.4	0.76
<i>Setipinna spp.</i>	231530	236001.1	467531.1	6.39
<i>Pangasius pangasius</i>	45422.6	44880	90302.6	1.23
<i>Tachysurus jella</i>	110220	117547	227767	3.11
<i>Pampus chinensis</i>	57978.4	60594.4	118572.8	1.62
<i>Pampus argentius</i>	185375.7	120412.6	305788.3	4.18
<i>Trichuirus spp.</i>	249233	252377.2	501610.2	6.86
<i>Harpadon nehareus</i>	893031.9	396770.6	1289802.5	17.64
<i>Lutjanus spp.</i>	52830	54578.2	107408.2	1.47
<i>Rastralliger kanagurta</i>	92340	95205.2	187545.2	2.56
<i>Anodontostoma spp.</i>	44620	45107.9	89727.9	1.23
Shrimps	91230	93838.7	185068.7	2.53
Crabs	66284.6	64664.2	130948.8	1.79
Miscellaneous	446084.3	441478.1	887562.4	12.14
Total	3923472.6	3389751.7	7313224.4	100.00

Table-6 : Results of water analysis (November 2001 - October 2003)

Sl. No.	Parameters		S 1		S 2		S 3		S 4		S 5	
			SW		SW		SW		SW		SW	
			HT	LT	HT	LT	HT	LT	HT	LT	HT	LT
1.	Temperature (°C)	Air	20.8 - 32.2	21.6 - 33.4	19.8 - 31.8	20.2 - 30.5	19.6- 32.7	19.8- 31.5	20.2- 32.8	20.7- 32.3	20.4-33	21-32.8
		Water	19.3 - 31.8	19.4 - 31.3	19.7 - 31	18.7 - 29.7	18.5- 31.1	18.6- 30.2	19.1- 31.2	19.4- 31.5	19.9- 31.2	20.1- 32.1
2	pH		7.3 - 7.8	7.38 - 7.9	7.24 - 8.3	7.2 - 8.1	7.5-7.8	7.2-7.8	7.5-8.2	7.3-8.1	7.3-8.1	7.3-8.2
3	Salinity (‰)		13.79 - 16.15	13.24 - 17.23	5.38- 13.97	5.2 - 13.6	6.86- 19.02	6.86- 18.84	15.43- 28.32	15.61- 28.50	17.94- 29.21	17.76- 29.38
4	Light penetration (Cm.)		48 - 68	29 - 59	31-61	22 - 48	48-64	36-51	28-46	30-42	26-61	24-58
5	Turbidity (NTU)		21 - 168	122 - 228	30 - 190	58 - 279	92-176	129-216	152-468	143-245	122-348	134-364
6	Dissolved Oxygen (mg/L)		5.43 - 7.7	5.1 - 7.28	5.27 - 10.08	5.23 - 9.92	5.67- 6.89	5.27- 6.89	5.27-7.1	4.86- 8.98	5.27- 7.86	5.27- 8.92
7	BOD ₅ (mg/L)		1.62 - 3.65	2.62 - 3.65	1.21 - 4.72	1.62 - 4.46	1.22- 3.65	1.62- 2.44	1.62- 3.45	1.62- 3.66	1.63- 4.06	1.23- 3.25
8	Silicate (ppm)		10.2 - 15.5	11.2 - 15.8	14 - 16.4	14.2 - 16.6	12.5- 15.5	12.8- 16.2	14.2- 18.5	14.6- 21.5	15-20.5	16-21.4
9	PO ₄ (ppm)		0.1 - 0.8	0.2 - 1.2	0.18- 1.12	0.16-1.2	0.6 - 1.3	0.15 - 1.25	0.28- 0.98	0.22- 1.15	0.16-0.9	0.18- 1.08
10	Nitrate nitrogen (ppm)		1.12-2.8	1.64-3.2	0.84- 2.16	0.56- 2.04	1.54-3.4	1.62-3.8	0.34- 1.98	0.42- 2.04	0.28- 1.86	0.36- 1.92
11	TDS (mg/L)		14800 - 19300	9760 - 22800	9920 - 25800	7680 - 21440	13700- 22700	10560- 18600	13000- 30600	11500- 26200	15600- 31700	13400- 28600
12	TSS (mg/L)		160 - 880	140 - 1000	460 - 1640	480 - 1680	380- 1280	400- 1360	440- 1640	460- 1680	380- 1560	480- 1760

S1=Jharkhali, S2=Canning, S3=Saptamukhi, S4=Bokkhali, S5=Freserganj, SW= Surface water, HT=High Tide, LT= Low Tide

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