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BENTHIC MACROFAUNA OF COLEROON ESTUARY, SOUTHEAST COAST OF INDIA

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ABSTRACT

The ecology of benthic fauna in the lower reaches of Coleroon estuary was studied for two consecutive years (1985-87) at two stations. High faunal density was associated with moderate salinity, high primary production and high organic carbon contents of the sediment. Low density or total depletion of macrobenthos was associated mainly with heavy river run-off and shifting of bottom sediment. The faunal density showed a declining trend in the estuary and it is attributed to the activities in the newly constructed fishing harbour.

INTRODUCTION

The distribution of benthic fauna in an estuarine environment is affected by many factors, and according to Kinne (1972), no single environmental parameter can be pinpointed as an ecological master factor. Sanders (1958), Vanucci (1969), Kurian (1972), and Damodaran (1973) mentioned that the sediment characteristics might play a predominant role in the distribution of benthic fauna. Nair *et al.* (1984) pointed out that water currents, the ebb and flow of tides and various physiographic features of the estuary are believed to play a key role in the distribution and deposition of sediment in the bed of the Ashtamudi estuary. Harkantra and Parulekar (1987) found that the distribution and abundance of benthic fauna off Cochin is influenced by the dominance of sandy bottom deposits, oxygenation of bottom waters and optimal levels of organic carbon in the sediments. Moore (1972) stated that a decrease in faunal abundance with increase in depth is a common feature in the distribution of marine benthos and is ascribed to a variety of parameters revolving around hydrostatic pressure, sedimentary regime and upwelling. Humprey (1972) stated that one of the important factors regulating the distribution of benthos is the availability of food.

Benthic organisms play an important role in the aquatic ecosystem because of their importance in the marine food chain (McIntyre, 1971) and the potential of demersal fishery resources is dependent on benthos. Pazhayar in Tanjore District of Tamilnadu, India is an important fishing village having a major fishing harbour. The fishery potential of waters adjacent to this place is considered to be one among the best along the east coast of India. Information on the benthic fauna is essential in the assessment of the fishery resources of this region, but studies on the ecology of macrobenthos of Coleroon estuary, the Bay of Bengal at Pazhayar, are scanty. The purpose of the present study is to provide basic information in regard of seasonal fluctuations of benthic fauna of this estuary.

MATERIALS AND METHODS

The study was carried out at two stations in the lower reaches of Coleroon estuary (Lat. 11° 21' N; Long. 79° 50' E, Southeast coast of India) for a period of two consecutive years (October 1985-September 1987; Fig. 1). Station I is situated near the mouth of the esturay and station II is located about 2 km from station I. Station II is influenced by freshwater through inlets from the adjacent paddy fields. The mouth is always open and the tidal effect extends upstreams for a distance of about 15 km. The tidal amplitude of this estuary is about 1 m. Sediment samples were collected using a 0.08 m^2 Peterson's grab. Samples were sieved through 0.5 mm mesh size, and animals preserved in 5 % neu-

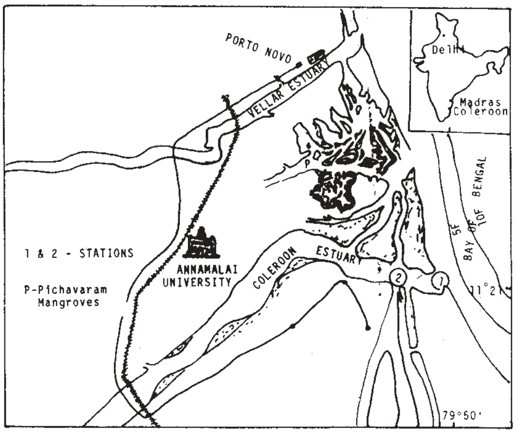

Figure 1. Map showing the two different sampling sites.

tralised formalin. A portion of the mud sample was removed from the grab, air dried, and used for sediment composition and total organic carbon analyses. The method of Krumbein and Pettijohn (1938) was used for sediment composition analysis and total organic carbon was estimated as described by el Wakeel and Riley (1956). By applying Shannon's formula (Pielou, 1975), Gleason's (1922) formula and Pielou's (1966) formula, the species diversity, species richness and evenness were calculated, respectively. Salinity, dissolved oxygen and temperature were analysed according to Strickland and Parsons (1972).

RESULTS

Species composition

The benthic fauna observed during the present study is shown in Table 1. The major groups encountered were polyhaetes, crustaceans, molluscs and 'other fauna'. The polychaetes comprised 19 genera with 23 species at station I, whereas at station II the group comprised 17 genera with 31 species. Crustaceans included 12 species of 9 genera at station I, and 7 species of 5 genera at station II. Molluscs included 13 species of 9 genera at station I and at station II, 12 species of 7 genera. The group 'other' was represented by 10 species at both stations. In total, station I had 58 species whereas station II had 50 species.

At station I, the dominant group, polychaetes constituted 53.63 % followed by molluscs (21.11 %), crustaceans 16.19 % and 'other' 4.06 %. At station II, the polychaetes ranked first in abundance (61.39 %) but was followed by crustaceans (17.83 %), molluscs (11.6 %) and 'other' (9.17 %) (Fig .2).

Species diversity, species richness and evenness

The values of species diversity, species richness and evenness for station I and II are given in Fig.3. At station I, the species diversity varied from 1.0 bits individual^{-1} (Nov. 1985) to 3.97 bits individual^{-1} (Jun. 1986). At station II, the species diversity fluctuated from 1.27 bits individual^{-1} (Mar. 1986) to 3.95 bits individual^{-1} (Sep. 1986)

The evenness at station I ranged between 0.70 (Mar. 1986) and 1.0 (Nov. 1985). At station II, evenness varied between 0.45 (Mar. 1986) and 0.97 (May 1987).

Population density

The highest population density in the present study was observed during post monsoon (March) at station I. At station II, high population density was observed during early summer (April). At both stations the highest faunal density was found during the year 1985-86. Low population density was recorded during monsoon season at station I. But at station II, low values occurred in the later part of premonsoon (August) 1985-86, and during monsoon in 1986-87.

Population densities of benthic macrofauna for stations I and II are given in Fig. 4. At station I, the population density fluctuated from 50 individuals m^{-2} (Mar. 1986) to 1526 individuals m^{-2} (Mar. 1987). At station II, the population density varied between 236 individuals m^{-2} (Dec. 1986) and 2500 individuals m^{-2} (Apr. 1986).

Table 1.

Benthic fauna at station I

Polychaetes

1. *Ancistrosyllis constricta*
2. *Axiotella sp.*
3. *Capetellid*
4. *Ceratonereis burmensis*
5. *Diopatra neapolitana*
6. *Eunice gracilis*
7. *Glycera alba*
8. *Goniada incerta*
9. *Heteromastus similis*
10. *Lumbriconereis polydesma*
11. *L. simplex*
12. *Marphysa graveli*
13. *Nephtys polybranchia*
14. *Nereis kauderni*
15. *Pectinaria crassa*
16. *Phyllodoce malmgreni*
17. *P. polybranchiata*
18. *Polydora armata*
19. *Prionospio cirrifera*
20. *P. granii*
21. *P. pinnata*
22. *Sternaspis scutata*
23. *Terebellides stroemi*

Bivalves

24. *Anadara rhombia*
25. *Meretrix meretrix*
26. *Solen kempi*
27. *Tellina ala*
28. *T. cuspis*
29. *T. nobilis*

Gastropods

30. *Hemifusus sp.*
31. *Nassa planocastata*
32. *N. dorsata*
33. *Natica macrochinensis*
34. *N. tigrina*
35. *Turitella attennuates*
36. *Umbonium vestiarium*

Crustaceans

37. *Alpheus malabaricus*
38. Amphipods
39. *Apseudes chilkensis*
40. *A. gymnophobia*
41. Crab
42. Hermit crab
43. Isopod
44. *Metapenaeus dobsoni*
45. *Macrobrachium idae*
46. *Penaeus indicus*
47. *P. monodon*
48. *P. semisulcatus*

Other taxa

49. Brittle star
50. Nematode
51. *Virgularia sp.*
52. *Phoronis architecta*
53. *Cypridina sp.*
54. Star fish
55. Nemertines
56. Sea anemone
57. Sipunculans
58. Gobid fish (*Trypauchen vagina*)

Benthic fauna at station II

Polychaetes

1. *Ancistrosyllis constricta*
2. *Axiotella sp.*
3. *Ceratonereis costae*
4. *Cossura delta*
5. *Dendronereis aestuarina*
6. *Diopatra neapolitana*
7. *Glycera alba*
8. *Glycera sp.*
9. *Goniada incerta*
10. *Heteromastus similis*
11. *Lumbriconereis polydesma*
12. *L. simplex*
13. *Nephtys polybranchia*
14. *Nereis cultrifera*
15. *Nereis kauderni*
16. *Pectinaria crassa*
17. *Phyllodoce malmgreni*
18. *P. polybranchiata*
19. *Prionospio pinnata*
20. *Polydora armata*
21. *Terebellides stroemi*

Bivalves

22. *Anadara granosa*
23. *Anadara rhombia*
24. *Solen kempi*
25. *Tellina ala*
26. *Tellina cuspis*
27. *Tellina nobilis*

Gastropods

28. *Cerithidea fluviatilis*
29. *Nassa dorsata*
30. *N. planocostata*
31. *N. stolata*
32. *Natica lineata*
33. *Umbonium vestiarium*

Crustaceans

34. *Alpheus malabaricus*
35. *Apseudes chilkensis*
36. *A. gymnophobia*
37. Amphipods
38. Crab
39. *Halmyraapseudes chilkensis*
40. Prawn juveniles

Other Taxa

41. Fish larva
42. Mysis
43. Nematode
44. Polyclad
45. Sea anemone
46. Star fish
47. Sipunculans
48. Gobid fish (*Trypauchen vagina*)
49. Nemertines
50. Brittle star

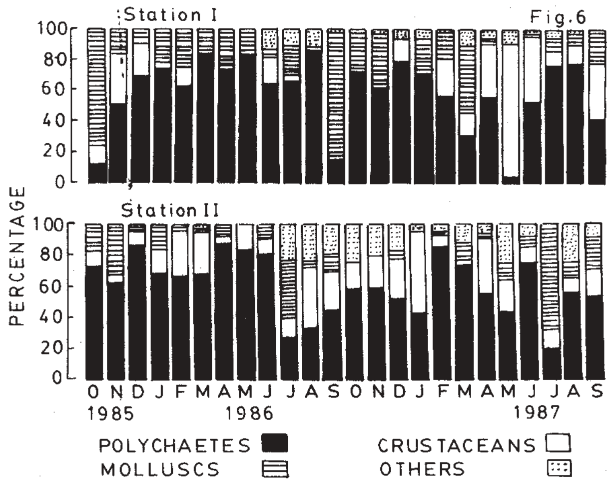

Figure 2. Percentage composition of benthic fauna at stations I and II

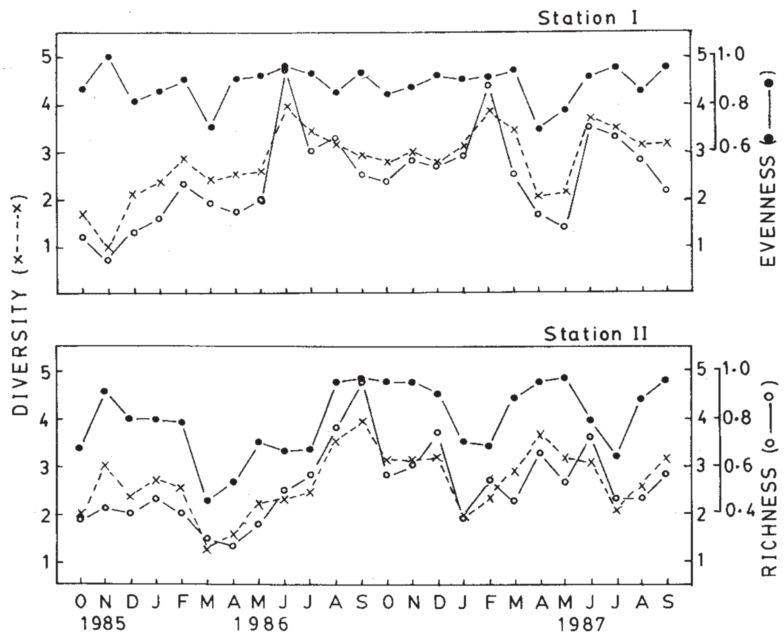

Figure 3. Species diversity, richess and evenness of benthic fauna at stations I and II

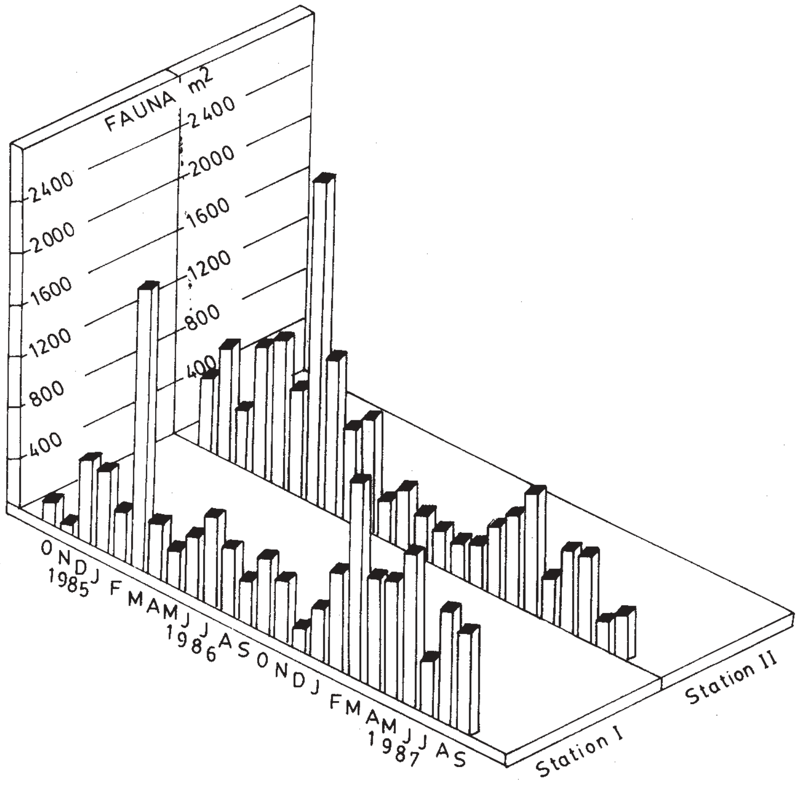

Figure 4. Population density of benthic fauna at stations I and II

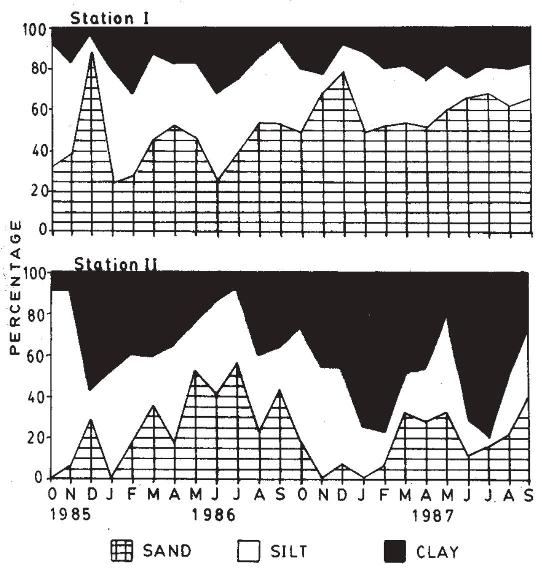

Figure 5. Cumulative percentage of sediment composition at stations I and II

The correlation co-efficient analysis between benthic fauna and organic carbon showed significant correlations ($P < 0.05$) and no significant correlations were obtained with sand, silt and clay. The analysis of variance did not yield significant results between the two stations.

Sediment composition

The data for sediment composition obtained for stations I and II are given in Fig. 5. At station I, the percentage of sand, silt and clay varied between 24.0 % and 87.9 %, between 10.3 % and 59.8 %, and between 1.8 % and 32.4 %, respectively, for the 1985-86 period. During 1986-87, it varied from 49.3 % to 78.2 % for sand, from 9.0 % to 38.7 % for silt and from 7.7 % to 24.8 % for clay. At station II, the composition of sand, silt, and clay values varied from 0.6 % to 52.6%, from 13.8% to 90.6%, and

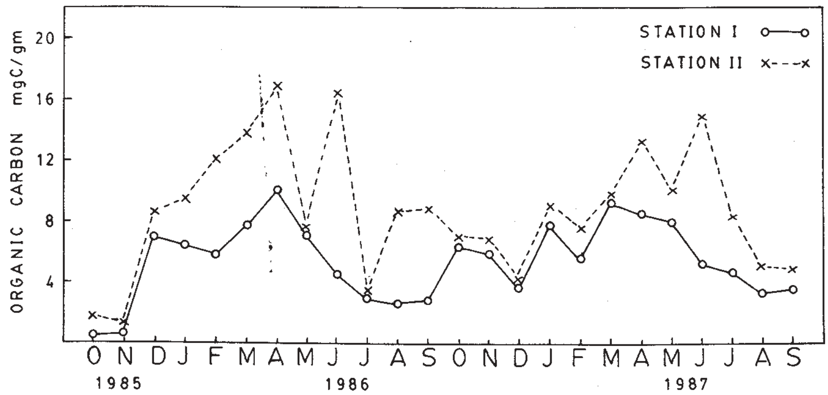

Figure 6. Organic carbon in sediments at stations I and II.

from 8.4 % to 57.4 %, respectively, for the period 1985-86. During 1986-87 the percentage composition varied between 1.3 % and 39.0 %, between 4.5 % and 72.5 % and between 8.8 % and 79.5 %, respectively.

Sediment texture data showed that during 1985-86, station I was dominated by a silty sand substratum whereas it was by clayey-sand substratum during 1986-87. Station II was dominated by a sand-silt-clay substratum throughout the study with small fluctuations in its composition.

Total organic carbon

The total organic carbon values obtained for station I and II are given in Fig. 6. At station I, the total organic carbon content ranged from 0.59 mg C g^{-1} (Oct. 1985) to 10.16 mg C g^{-1} (Apr.1986). At station II, the total organic carbon content varied between 1.39 mg C g^{-1} (Nov.1985) and 16.9 mg C g^{1} (Apr.1986)

Analysis of variance of total organic carbon between stations showed significant correlations ($P < 0.01$).

Environmental parameters

The result of bottom water analysis are given in Table 2.

The temperature at station I varied between 24.0 and 30.0° C and at station II from 25.0 to 30.5° C. The salinity ranged from 21.72 to 35.85 ppt at station I, and from 20.71 to 35.59 ppt at station II. The dissolved oxygen content for station I ranged from 3.05 to 3.86 mlO_2l^{-1}

DISCUSSION

Estuaries are dynamic in nature and are influenced much by the annual climatologic changes. Monsoon in general and northeast monsoon in particular cause great fluctuations in the hydrobiological parameters in the Coleroon estuarine ecosystem. Panikkar (1969) observed partial or complete destruction of estuarine fauna during the southwest monsoon in Kerala followed by an annual repopulation during the post monsoon. Likewise, in the Coleroon estuary, there was almost a depletion of benthic fauna during northeast monsoon; initial colonization during post monsoon period followed by a secondary colonization, growth and structural development of benthic communities in the summer season showing an annual cyclic pattern. Reports similar to this were made by Parulekar et al. (1980) from Goa estuaries, and Chandran (1987) from Vellar estuary.

There are several hypotheses regarding seasonality and relative abundance of macrobenthic communities in estuaries, *viz.* a decrease in fanunal

Table 2. Variations in mean monthly values of environment parameters of bottom water at stations I and II.

Months	Station I			Station II		
	Salinity (ppt)	Dissolved oxygen (ml/l)	Temperature (°C)	Salinity (ppt)	Dissolved oxygen (ml/l)	Temperature (°C)
October-'85	33.08	3.95	26.5	28.28	3.7	26.0
November	26.26	4.05	24.0	20.71	4.5	27.0
December	28.39	4.13	26.25	27.02	4.52	27.5
January-'86	30.05	3.45	26.0	29.04	3.84	25.0
February	34.34	4.07	27.0	31.31	4.58	26.75
March	34.85	3.79	27.0	30.55	3.56	28.0
April	35.85	4.01	30.0	34.09	4.30	28.75
May	35.85	3.39	29.5	33.84	3.39	28.0
June	35.85	3.05	30.0	32.83	3.39	28.0
July	34.34	3.5	29.0	33.84	3.50	27.0
August	35.85	3.39	30.0	34.34	3.62	29.0
September	33.33	3.62	29.0	32.32	3.39	29.0
October	21.72	5.09	30.0	21.21	5.80	29.0
November	24.75	4.86	27.0	24.24	5.86	26.0
Devember	26.77	4.63	26.5	25.76	4.52	26.5
January-'87	31.82	4.29	26.0	29.29	4.41	26.0
February	32.83	4.18	29.0	30.81	4.75	29.0
March	33.33	4.06	29.0	32.83	3.84	29.5
April	35.85	4.18	29.5	34.59	3.39	30.5
May	35.85	3.39	29.0	35.59	3.5	28.5
June	35.85	3.16	29.5	35.59	3.39	30.5
July	34.34	3.39	27.0	33.84	3.62	28.5
August	34.34	3.39	29.5	34.34	3.5	29.0
September	33.33	3.39	30.0	33.84	3.39	30.0

abundance with increase in depth (Moore, 1972), availability of food (Humprey, 1972), rate of primary production (Nair *et al.*, 1983), and the presence of organic carbon (Kurian, 1971; Prabhu and Reddy, 1987).

The present study revealed that high macrobenthic faunal density was associated with moderate salinity, high primary production, high organic carbon content of sediment, while low density or total depletion of macrobenthos was mainly associated with heavy river run off and the shifting of bottom sediment into the sea.

Kurian (1967) observed that dissolved oxygen may not act as a limiting factor for benthic faunal abundance in Cochin backwater. This was due to constant flushing and the shallow nature of the water column. The above statement agrees with observations made by Parulekar and Dwivedi (1975) in Mandovi and Zuari extuaries of Goa, and Calder *et al.* (1977) in South Carolina estuaries, USA, who found that oxygen did not seem to govern the distribution of benthic fauna in shallow water estuaries. The present investigation in Coleroon estuary affirms the views of the above investigators as the dissolved oxygen did not act as a limiting factor in the distribution and relative benthic faunal abundance.

High species diversity was recorded in the present study during summer (Jun. 1986) and post monsoon (Feb. 1987) at station I, and premonsoon (Sep. 1986) and summer (Apr. 1987) at station II and it may be attributed to the more or less stable environmental conditions and high population density during the above seasons. The low diversity during monsoon and post monsoon seasons may be attributed to the sudden changes in the substratum due to the flushing of bottom by monsoonal freshwater from the upstream of the river.

Between the two stations studied, station II showed a higher faunal density than station I. The high faunal density at this station coincided with the rich organic carbon content and the nature of sediment. Eventhough no significant differences in species diversity were found between stations I and II, low species diversity was found to exist at station I which may be due to the interaction of environmental factors.

Another important factor for faunal distribution and abundance is sediment texture (Muus, 1967; Vanucci, 1969; Polgar, 1975). Sediment texture in the present study was silty-sand and clayey-sand at station I, and sand-silt-clay at station II. However, the abundance was high during 1985-86 at both stations. Parulekar *et al.* (1975) observed that the polychaetes contributed more than 90 % of the total population in areas having a mixture of sand-silt-clay. Such abundance of polychaetes in sand-clay substrate was observed in station II in the present investigation.

A low population density was obtained at station I when the substratum was sandy silt in nature and when it was silty in nature at station II. Parulekar and Dwivedi (1975) also observed low population levels in the middle reaches of Goa estuaries, where the substratum was similar to the present findings. Postma (1982) and Chizmadia *et al.* (1984) observed that the nature of the sediment and the sedimentation process in an area, and particularly in estuaries, are governed by many factors such as the topography, currents, water transport, tides and physical and chemical nature of water influencing the area.

The organic carbon content of sediment is an important parameter for benthic populations (Prabhu and Reddy, 1987). The abundance of benthic fauna and carbon in the sediment showed significant positive relationships.

The population density at station I was higher during 1985-86 than in 1986-87. It was due to the high organic carbon present in the sediment and percentage composition of sediment and availability of rich organic matter as food.

It is also inferred from the present study that the construction of a fishing harbour may have influencend the numerical abundance of benthic macrofauna which showed a rapidly declining trend compared with Jegadeesan (1986) who made observations prior to the construction of the fishing harbour. It will be worthwhile to investigate to what extent it will affect the fishery resources of the Coleroon estuary and adjoining coastal waters.

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