Fish and Benthic Faunal Surveys of the Leschenault and Peel-Harvey Estuarine Systems of South-Western Australia

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Fish and benthic faunal surveys of the Leschenault and Peel-Harvey estuarine systems of south-western Australia in December 1974

P.N. Chalmer[1] and J.K. Scott[2]
Department of Conservation and Environment,
1 Mount Street, Perth, Western Australia 6000.

[1] Present address: LeProvost, Semeniuk & Chalmer,
181 York Street, Subiaco,
Western Australia 6008.

[2] Present address: C.S.I.R.O. Biological Control Unit,
335 Avenue Abbe Paul Parguel,
34100 Montpellier,
France.

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CONCLUSIONS

The fish and benthic fauna of the Leschenault and Peel-Harvey estuarine systems were surveyed during December 1974. The estuaries contained a range of benthic fauna dominated by bivalve molluscs, polychaete worms and amphipods. Essentially the same groups of benthic species were present in both Leschenault and Peel-Harvey estuaries. The difference in composition between Leschenault and Peel-Harvey estuaries appeared to be related to the presence of extensive beds of the seagrass Halophila in Leschenault Inlet and the relatively more marine nature of Leschenault Inlet. Leschenault Inlet contained a fauna in which epibenthic amphipods were abundant while Peel Inlet and Harvey Estuary were dominated by burrowing infaunal bivalves and polychaetes. Leschenault Inlet contained a greater number of benthic species, close to its connection to the sea, than did Peel Inlet. This difference was ascribed to Leschenault Inlet being more subject to marine influence than Peel Inlet, and thus being colonised by a wider range of benthic species of marine affinity. For both Leschenault and Peel-Harvey estuaries, the number of species of benthic fauna was greatest closest to the mouth of the estuaries where the salinity approached that of seawater, and lowest toward the upper end of the estuaries where more extreme salinities prevailed. The shallow marginal platforms around the edges of Peel Inlet, Harvey Estuary and Leschenault Inlet were particularly important habitats for benthic fauna. The highest densities of benthic fauna were observed in Harvey Estuary.

As with the benthic fauna, the common species of fish were present in both Leschenault and Peel-Harvey estuaries, with more species of fish recorded close to the mouths of the estuaries than in the rivers which fewer species entered. The diet of the fish suggested that there were at least four feeding patterns (herbivores, omnivores, and lower and higher order carnivores). These patterns emphasised the importance of benthic invertebrate fauna as a food resource.

INTRODUCTION

The estuaries of south-western Australia are considered unusual because the extreme seasonality of river flow causes the hydrological character of the estuary water to differ grossly between summer and winter (Hodgkin, in Riggert, 1978). These estuaries are influenced by freshwater from river flow in winter and marine water entering the estuary from the sea in summer. Evaporation during the summer may result in hypersaline conditions in parts of the estuaries. Thus, as in all estuaries, there is a gradient from marine water where the estuary enters the sea to fresh at the riverine end of the system, and perhaps with local areas of hypersalinity. The distinctive character of the estuaries of south-western Australia arises from the high seasonal mobility of this gradient.

While the south-west estuaries have this hydrological feature in common, many of their geomorphic characteristics vary, and these variations impose individuality onto each estuary (Hodgkin et al., 1979). For example, the Swan River and Oyster Harbour have basin depths greater than 5m whereas most other estuaries in south-western Australia are substantially shallower. These variations in estuarine geomorphology obviously influence the hydrology and salinity gradients of the estuaries. Salinity is the single most important factor that determines the biota present at any location in the estuary. The different salinity regimes between the estuaries are likely to result in variations in the composition and the abundance of the biota between the estuaries, and each estuary may be expected to have a distinct complement of biota with different dynamic responses to seasonal conditions.

In the early 1970's, aspects of the biology of many of the estuaries on the south coast of Western Australia had been investigated, principally by the Western Australian Department of Fisheries and Wildlife. In contrast, the estuaries on the west coast, with the exception of the Swan River Estuary, had received little attention. This short study of the fish and benthic fauna and flora of the Leschenault and Peel-Harvey estuaries (Figure 1) was conducted in December 1974 in order to provide a preliminary comparison between the estuarine systems, which might highlight the factors that are important in determining the ecology of the estuaries of south-western Australia. Secondary objectives of this study were:

(i) to provide preliminary data on the densities of the benthic infauna of the Peel-Harvey System where eutrophication was suspected to be a potential problem. Eutrophication has subsequently been shown to have had severe effects on the ecology of the Peel-Harvey System (Hodgkin et al., 1980);

(ii) to investigate the fauna which colonized areas which had previously been subject to dredging activities to form navigation channels for small boats.

Subsequent to this survey, the biota, particularly the molluscs and fish, of some of the west coast estuaries, including the Peel-Harvey System, have been studied in detail (Wells and Threlfall, 1980, 1981, 1982a,b; Wells *et al.*, 1980; Potter, *et al.*, 1983a,b,c; Lenenaton *et al.*, in press). However, it appears that the composition, abundance and distribution of some elements of the biota may have changed since this survey was conducted. Consequently, the data presented in this report, although limited, form the earliest biological description of two estuarine systems which are being subjected to increasing human pressure and which may be changing rapidly.

In this paper, the term estuary refers to the tidal portion of a river, with its bays and lagoons. Leschenault Inlet, Peel Inlet and Harvey Estuary are the accepted names which refer to the extensive water bodies in the shallow lagoons and interdunal depressions as shown in Figure 1.

METHODS

Five days of field time were spent at each of the three inlets, so that the effort in compiling species lists for each inlet was similar.

Within each estuary, sampling sites and transects were located to cover the range of environmental conditions (salinity, depth, substrate, etc.) considered to be important to the biota. At each site inspected, samples were taken so that they included the range of environmental conditions. At each site where fish or benthic fauna were sampled, the depth, substrate type, salinity, temperature and vegetation type were recorded. Details of recording salinity and fauna are described below.

Hydrology

Salinity and temperature records were made using an "Electronic Switchgear (London)" portable temperature-salinity bridge. Measurements were recorded on the surface and at 1m depth intervals, and the 0.5m depth nearest to the estuary floor. The locations of the stations at which salinity and temperature measurements were recorded are shown in Figures 2A, 3A and 4A.

Benthic fauna

The benthic fauna was sampled quantitatively by either a cylindrical corer or a grab (Ekman-Berge Dredge). The corer extracted a substrate sample with a surface area of $80cm^2$ and a depth of approximately 15cm. The grab sampled a surface area of $400cm^2$ to a variable depth (not more than 15cm) depending on the substrate type. The only replicated samples were collected from four sites in Leschenault, two in Peel and four in Harvey estuary. The sites at which the benthic fauna were sampled are shown in Figures 2B, 3B and 4B. A description of each station, the depth, substrate type and vegetation type are described in Tables 2, 3 and 4.

After collection, the samples were washed through a 1mm sieve, and the residues retained and analysed later in the laboratory. The benthic fauna were sorted to as low a taxonomic unit as possible. Molluscs were identified to species level as were some of the polychaetes. Identification of other polychaetes, crustaceans and other groups, where difficult, was left at generic or higher taxonomic levels. Only polychaetes with intact heads were identified and counted.

Fish

Both gill nets and a small beach seine net were used to capture fish. Gill net stretched mesh sizes were 41mm, 51mm, and 83mm. Gill nets were set after sunset and retrieved after daybreak. The beach seine consisted of two wings, each 18.5m long, of 12.7mm mesh with a bunt of 9.5mm mesh.

The areas in which fish were sampled are shown in Figures 2C, 3C and 4C. The sampling effort (number of seine shots, number of nights gill nets set) is shown in Table 1. Identification of fish specimens was made using Munro (1956-61) and Scott (1962). Nomenclature follows that used in Lenanton (1974), Chubb et al. (1979) and Hutchins (1979). The larger fish were measured to the nearest cm (total length) and the catch weighed to the nearest g within two hours of being caught. However, the smaller fish and cobblers were preserved whole in 10% Formalin and subsequently measured and weighed in the laboratory. The stomach was taken from every individual of a subsample of fish in many catches. The stomachs were preserved in 10% Formalin and subsequently examined in the laboratory. The contents of the gut were scored by a system described by Godfriaux (1974). Each gut was given a rating out of 10 for fullness and then the fullness rating was subdivided for each prey component.

Other collections

Collection of fish and benthic fauna by hand-net, beam trawl and hand were incidental to the above methods and occurred opportunistically when species not recorded by the methods described above were observed.

Museum records

The catalogues of the Western Australian Museum were searched to obtain records of fauna collected from Leschenault and Peel-Harvey estuaries prior to January 1974.

RESULTS

Leschenault Estuary

Geomorphology: The geomorphology of Leschenault Inlet has been described by Semeniuk and Meagher (1981). Leschenault Inlet is a lagoon some 14km long and between 1.5km and 2.5km in width, and mostly 0.3m to 3m in depth (Figure 2). The lagoon lies parallel to the coast and is separated from the Indian Ocean by a narrow (0.8-1.5km) barrier of sand dunes. Shallow sand shoals and sand platforms occur around both sides of the Inlet to a depth of 0.2m below MLLW. At the edge of the shoals and platforms, there is often a marked slope which falls from 0.2m to 1.0m below MLLW into the interior basin (maximum 3m deep). The basin floor consists largely of mud, with some local areas of muddy sand.

Two rivers, the Collie and the Preston, empty into Leschenault Inlet near its southern end. The Collie River is the larger, and has a muddy to sandy floor and an average depth of approximately 2m with deeper pockets of 5-6m at distances up to 11km upstream from the Inlet (Meagher, 1971).

Until 1951, Leschenault Inlet opened to the sea at its extreme southern end opposite Bunbury townsite. The southern outlet was plugged in 1951, and the new "Cut" made through the dunes almost opposite the mouth of the Collie River. The southern end of Leschenault Inlet has been further modified by construction of port facilities and is now completely isolated from the main water body. It is not considered further in this paper.

Hydrology: The hydrology of the Leschenault estuary has been described by Hodgkin and Smith (1971) and the following summary is based on that description. Daily (astronomic) tides in the Inlet are only about half those of the open sea, probably seldom exceeding 0.3m; nevertheless tidal exchange is great because of the very shallow water. Barometric tides have periods of days and therefore are much less damped; they also have a range of about 0.3m. Freshwater discharge to the Inlet is confined to the winter-spring period, from June to about November. The Collie River is the main source of freshwater and this and the Preston both enter the Inlet almost opposite the "Cut" at the extreme southern end of the Inlet (Figure 2). River water only enters the main part of the Inlet by tidal mixing. However, freshwater drainage from coastal swamps flows into the head of the Inlet. From November to May there is little or no freshwater discharge and the Inlet water becomes progressively more marine until it is more saline than the sea. Near the "Cut", daily salinity changes are great in winter, at times ranging from fresh to seawater salinity (35^{o}/oo), but in the summer salinity stays fairly constant around seawater salinity. From Australind northwards there is little daily variation but large seasonal change, although this was much less in 1958-69 (16 to 45^{o}/oo S) than in 1945-52 (3 to 45^{o}/oo S), i.e. after opening of the "Cut" and construction of Wellington Dam. Temperature fluctuations, both daily and seasonal, are least near the "Cut" and greatest at the northern end (about 11°C to 28°C) because of the shallow water there and minimal exchange with the sea. Another significant variable from the biological point of view is the duration of the low salinity period. In a wet winter salinity is likely to be below 10°/oo for five months (June to October), while in a dry winter salinity does not drop much below 20°/oo S at any time in the northern half of the Inlet.

The salinities and temperatures recorded in December 1974 are shown in Table 5, and the sites sampled in Figure 2A. The salinity of the water in the inlet was similar to that of seawater. The Collie River was stratified with the surface water being fresh and a tongue of saline marine water underlying the freshwater. The water temperatures of the estuary ranged from 19.6°C to 25.6°C depending on the location and depth at which the temperature was recorded. The water temperature in a creek running into the Inlet (Station 5) was particularly warm with a temperature of 32.2°C.

Substrates: The sites where the substrate was sampled are shown in Figure 2B. The Inlet floor in the region of the "Cut" (Stations 1-7) was generally sandy and dominated by a large sandbank. In the shallow waters of the Inlet (Stations 10-14), the floor consisted of mud mixed with sand whereas the deeper waters (Stations 9 and 15) had a fine mud floor (Table 2). In the shallow northern end of the Inlet there was no deep channel (Stations 16 and 17) and the floor consisted of mud mixed with sand. Stations 19 and 21 in the Collie River were fine mud while Station 20 had a coarse sand floor. The river banks generally consisted of this mud with sand from the adjoining hills reaching the edge of the river in places.

Vegetation: The marine angiosperm Halophila ovalis covered most of the floor of the Inlet in water less than 2m deep (Table 2 and Figure 2B; Hodgkin and Smith, 1971; Meagher, 1971). Associated with the Halophila were various marine algae, which in places were sufficiently dense to cover the Halophila. No macroscopic flora were recorded either from those parts of the Inlet that were deeper than 2m, or from the Collie River.

Benthic fauna: The distribution and density of the benthic fauna for each sample site are shown in Table 6, and the sites sampled in Figure 2B. These data show that many species of biota were only present in low numbers, and at a few stations. However, for the more common species, Mysella, Arthritica semen, Ceratonereis, Haploscoloplos, Prionospio sp. 1, and the amphipods, it was apparent that their abundances varied in relation to the habitat. The bivalve Mysella was the only species that was more abundant in the deeper and more muddy substrates than on the marginal platforms of the Inlet. The other common species, the bivalve Arthritica semen, the polychaetes Ceratonereis, Haploscoloplos and Prionospio sp. 1, and the amphipods occurred in both deep and shallow water, and in mud and sand substrates, but were most abundant on the shallow marginal sandy platforms of the Inlet. The shallow sandy margins of the Inlet supported a greater total abundance of benthic fauna than did either the deeper basin or the Collie River.

The distribution and maximum recorded density of the benthic fauna is summarised for broader areas (i.e. southern and central part, and northern end of Leschenault Inlet, and the Collie River) in Table 7. These data show that a total of 28 species were recorded from the southern and central part of Leschenault Inlet where the salinity approached that of seawater. Eleven of these species were also recorded from the northern end of Leschenault Inlet. The two gastropod species, Hydrococcus brazieri and Potamopyrgus sp., which are probably exclusively estuarine (Chalmer et al., 1976), were restricted to the northern end where marine influences were less. Potamopyrgus sp. and the amphipod Melita sp. were the only benthic species recorded in the brackish creek at the northern end of the inlet. Only six species were recorded from the Collie River. Of these, the bivalve Anticorbula amara, and the single isopod and hemipteran species were not also recorded in Leschenault Inlet. Anticorbula amara is an exclusively estuarine species (Chalmer et al., 1976) and the isopod also is believed to be an estuarine species (P.N. Chalmer, pers. ob.).

The effects of dredging operations were examined in the area around Sites 9-15. In this area a channel for boats had been dredged some years previously. The channel floor (Site 15) was muddy and had been colonised by a fauna similar to that present in the muddy floor of the deeper waters of the Inlet basin (Site 9). The area surrounding the channel appeared to have been raised through deposition of sand during the dredging activities. While this area (Stations 13 and 14) had been disturbed, the fauna was similar to that at nearby sites (Stations 10-12). In creating the channel, the dredging operation has formed a new habitat in the marginal platform, however the effects on the benthic fauna appeared to be minimal and restricted to the actual dredged area where a different habitat was created.

Nekton: The abundance, distribution and size range of fish and crabs recorded from Leschenault Inlet are shown in Table 8, the sites sampled in Figure 2C, and the distribution of the fish is summarised in Table 9.

A total of 24 species were recorded during this survey and a further seven had previously been recorded by the Western Australian Museum. Only one of the eight species of fish included in the museum records were collected during this survey, perhaps because only those fish which were considered unusual, or which were caught infrequently in this area, were taken to the museum for identification.

Twenty species of fish were recorded in the area close to the mouth of the estuary during this survey as opposed to six fish species from the northern end of the Inlet. Six fish species were found in both the Inlet and the Collie River, while the three estuarine species, Nematalosa vlaminghi, Amniataba caudavittatus and Acanthopagrus butcheri, were recorded only in the Collie River.

The blue manna crab, Portunus pelagicus, was frequently caught in Leschenault Inlet, where its biology has been described previously in detail by Meagher (1971).

Peel Inlet

Geomorphology: The geomorphology of the Peel Inlet and its tributaries has been described by Hodgkin *et al.* (1980). Peel Inlet is a shallow lagoon, roughly circular in shape with a diameter of approximately 10km (Figure 3). It has a central basin about 2m deep which is surrounded by a wide marginal platform, large areas of which are emergent during LLW, especially in the southeast. The floor of the basin is composed largely of sandy to silty mud while the marginal platform is a fine quartz sand. An organic mud of recent origin is present throughout much of the Inlet, particularly in the basin.

Peel Inlet is connected to the sea by a narrow 5km long channel, termed the Mandurah Channel (Figure 3). The channel is restricted at both ends; at the ocean by a sand bar which tends to close, and at the Inlet by a tidal delta. A channel 2km long has been dredged to a depth of 1.9m across the tidal delta.

The Murray River discharges into Peel Inlet through the six distributaries of the Yunderup delta; one of the distributaries is dredged for navigation, but the mouths of the others are obstructed bars which are emergent at LLW. The Murray is tidal upstream to the weir at Pinjarra and is scoured to a depth of 5m in the narrower reaches. The Serpentine River discharges into the north side of the Yunderup delta.

Narrow reaches of the Serpentine River are also relatively deep, however Goegrup Lake which it traverses is very shallow. Three agricultural drains discharge at points along the eastern and southern perimeter of Peel Inlet.

Hydrology: The hydrology of the Peel-Harvey estuary has been described briefly by Wells *et al.* (1980), and the following summary is based on that description. As for Leschenault Inlet, daily tidal variations are greatly less than that of the open sea and are less than 0.1m, although meteorological conditions can cause changes of up to 0.5m over periods of 5-15 days. Freshwater discharge from the Murray and Serpentine Rivers is highly seasonal and largely confined (95%) to the winter (June-September) period. The seasonal freshwater input results in large changes in salinity of Peel Inlet ranging from $5^{o}/oo$ during winter to hypersaline conditions approaching $50^{o}/oo$ in summer as a result of evaporation and lack of freshwater input.

The salinities and temperatures recorded in December 1974 in the Peel estuary are shown in Table 10 and the sites sampled in Figure 3A. The salinity of Peel Inlet ranged between $19^{o}/oo$ and $27^{o}/oo$. The salinity rapidly decreased in the Murray River where at Yunderup (Station 7), the salinity was less than $8^{o}/oo$. In the Serpentine River, the salinity was less than $5^{o}/oo$ at Station 8.

Substrates: The sites where the substrate was recorded are shown in Figure 3B. The shallow-water areas (Stations 2,3,4,7,9) and the Mandurah Channel were sandy while the deep water of the estuary

(Station 5) and the river mouth (Station 8) had a bottom of fine mud (Table 3). The bed of the river at Yunderup (Station 10) consisted of coarse sand while the banks were thick mud.

Vegetation: The seagrasses Halophila ovalis and Ruppia megacarpa are widespread around the marginal platforms of Peel Inlet (Hodgkin et al., 1980). Halophila occurs in the deeper water of the shelves while Ruppia is restricted to the shallows. A few species of green algae including Cladophora, Chaetomorpha, Enteromorpha and a red alga, Chondria, are abundant, particularly over the last twenty years, as a result of eutrophication. Periodically, there have been phytoplankton blooms in Peel Inlet, again as a result of eutrophic conditions (Hodgkin et al., 1980).

In December 1974, the shallow, sandy areas of the Inlet had only small, dispersed clumps of Ruppia present (Table 3, Figure 3B). The dredged entrance to Yunderup canals contained large amounts of green algae. No macro-plants were observed on the river bed, except in Goegrup Lake (Site 12, Figure 3B).

Benthic fauna: The distribution and density of the benthic fauna are shown for each sample site in Table 11 and the locations of the sampling sites are shown in Figure 3B. These data show that the most common species of benthic fauna (the bivalves Arthritica semen and Anticorbula amara, the polychaetes Ceratonereis erythraeensis, Haploscoloplos kerguelensis and Prionospio sp. 1, and the amphipod Paracorophium) were found in both shallow and deep, and in mud and sand substrates, however there were differences in abundances of these species between habitats. Only Anticorbula amara was more abundant in the deeper basin and channels with a muddy substrate than in the shallow sandy margins of the Inlet. The other common species, Arthritica semen, Ceratonereis erythraeensis, Haploscoloplos kerguelensis and Prionospio sp. 1 and Paracorophium were all more abundant on the shallow sandy platforms. As for Leschenault Inlet, the shallow sandy margins of Peel Inlet supported a greater total abundance of benthic fauna than did the deeper basin. The shallow lagoon sampled in the Serpentine River (Station 12) also supported a relatively high density of benthic fauna. Few were present on the deeper bed of the Murray River.

The distribution and maximum recorded density of the benthic fauna are summarised for broader areas (i.e. Mandurah Channel, Peel Inlet, Serpentine River and Murray River) in Table 7.

Although the Mandurah Channel was not sampled during this survey, six species not collected in this survey have previously been recorded from the channel. Four of the seven species from the Murray River and all four species from the Serpentine River were amongst the 14 species recorded from Peel Inlet. Of the remaining three species which were recorded only from the Murray River, Xenostrobus securis is an exclusively estuarine mussel (Chalmer et al., 1976); Cherax plebejus is a freshwater crayfish recorded by the Western Australian Museum; while the crab, Macrophthalmus (Mopsocarcinus) sp., may be an occasional visitor to the estuary when conditions are "appropriate".

The density of all species except Xenostrobus securis in the Murray River was greatly lower than that in Peel Inlet, although relatively high densities were observed in the Serpentine River where the habitat was suitable.

The effects of dredging on the benthic fauna were examined at Yunderup where a boat channel had been dredged from the estuarine basin to the shore. The floor of the dredged channel (Station 6) was filled with filamentous green algae and contained little fauna. However Station 7 on the edge of the channel, although immediately adjacent to the dredged channel, contained a similar fauna to that at comparable sites in Peel Inlet.

Nekton: The abundance, distribution and size range of fish and crabs in Peel Inlet and the Murray and Serpentine Rivers are shown in Table 12 and the sites sampled in Figure 3C. The distribution of the fish is summarised in Table 9. Most species (17) of fish were recorded from Areas 1 and 2 which were in, or close to, the Mandurah Channel. These were the areas of highest salinity. Only four species of fish were recorded from the river delta area (Area 3), however this was probably a result of low fishing effort rather than a reflection of the number of fish in the area. Seven species of fish were recorded from the rivers (Areas 4 and 5) where the salinity was lower. A total of 15 species of fish had been recorded from Peel Inlet and the Murray and Serpentine Rivers by the Western Australian Museum, but only four of these were recorded during this survey, again probably because only the unusual species of fish have been taken to the museum for identification.

Harvey Estuary

Geomorphology: The geomorphology of the Harvey Estuary has been summarised by Hodgkin et al. (1980) and the following description is based on that summary. Harvey Estuary is a long narrow body of water which lies parallel to the coast in an interdune depression (Figure 4). It is 20km long, 2-3km wide, and has a 2m deep central trough with narrow marginal platforms on both sides. The marginal platforms are composed of a fine quartz sand and the floor of the basin is an organic grey to black mud. The Harvey Estuary is connected at its northern end to Peel Inlet, although a sill, broken only by a narrow, deep channel (50m x 2-3m), has formed across the opening.

The Harvey River discharges at the southern end of Harvey Estuary through a birdsfoot delta with a number of distributaries, all of which have shallow bars. Three agricultural drains discharge at points along the eastern perimeter of Harvey Estuary.

Hydrology: The hydrology of Harvey Estuary is similar to that previously described for Peel Inlet to which it is connected. However, during winter the water of Harvey Estuary is less saline than that of Peel Inlet although, like Peel, it becomes hypersaline in summer.

Freshwater discharge into Harvey Estuary is from freshwater drains and the Harvey River, however this river has been modified such that the Estuary only receives discharge from the coastal plain part of its catchment.

The salinities and temperatures recorded in December 1974 are shown in Table 13 and the sites sampled in Figure 4A. The salinity ranged from $17^{o}/oo$ at the southern end of the Estuary to $24^{o}/oo$ at the northern end where it is connected to Peel Inlet. The drains (Station 3) and swamps (Station 4) bordering the Estuary were almost fresh. The water of Harvey Estuary was green, presumably due to an abundance of phytoplankton.

Substrates: The sites where the substrate was sampled are shown in Figure 4A. The eastern edge of the Estuary had a coarse sandy bottom with areas of limestone at the northern end (Table 4). The central channel bed consisted of fine mud and the western edge varied between clean sand and muddy patches.

Vegetation: The vegetation of Harvey Estuary has been described by Hodgkin *et al*. (1980) and the following summary is based on that description. The narrow marginal platforms of Harvey Estuary are colonised by the seagrass *Halophila ovalis*. Phytoplankton blooms have recently been common in Harvey Estuary as a result of eutrophication.

In December 1974, sandy areas of Harvey Estuary supported dispersed clumps of *Ruppia* and filamentous green algae grew in the central channel of the estuary.

Benthic fauna: The distribution and density of benthic fauna are shown in Table 14 and the sites sampled in Figure 4B. The number of species collected was relatively low, but several species were present at high density. The bivalves *Arthritica semen*, *Anticorbula amara*, and the polychaetes *Capitella* sp., *Ceratonereis erythraeensis*, *Haploscoloplos kerguelensis* and *Prionospio* sp. 1, were particularly abundant. These species were most abundant in shallow waters with a sandy bottom and were uncommon in deeper water of the central channel which had a mud floor. Chironomid larvae were abundant in the floor of the freshwater Mealup drain.

Nekton: The abundance, distribution and size range of fish and crabs caught in Harvey Estuary are shown in Table 15 and the sites sampled in Figure 4C. The distribution of the fish is summarised in Table 9. A total of 14 species of fish were caught at the northern end of the Harvey Estuary where it was connected to the Peel Inlet, but only seven of these species penetrated to the southern end of the estuary where the salinity was lower. Only one species, the mulloway *Argyrosomus hololepidotus*, was recorded from the Harvey Estuary by the Western Australian Museum and this species was not collected during this survey.

Feeding Habits of the Fish

The diet of the 15 species of fish examined during the survey is shown in Table 16. For most species of fish only a small number were examined and the data from all areas were pooled. These data on the feeding habits of fish were examined in an effort to determine if there were different feeding patterns between the estuaries, in different habitats, and thus in areas with different benthic faunas. It was not possible to substantiate even gross differences in feeding patterns, because of the relatively small number of fish sampled, and the variations in food eaten by individual fish of the same species. Consequently the data for fish from different habitats and estuaries were combined for the following analysis.

The stomachs of all individuals of two species (Nematalosa vlaminghi and Acanthopagrus butcheri) were empty and these species are not considered further. Similarly for Mugil cephalus, all but one individual which only contained sand, had nothing in their stomachs.

Of the aquatic plants, green algae was an important item of the diet of Hyporhamphus melanochir, Pelates sexlineatus, Aldrichetta forsteri, and possibly also Amphitherapon caudavittatus. Brown algae were found only in the stomachs of Pelates sexlineatus, and the seagrass Halophila was probably an incidental item of diet.

Bivalve molluscs were eaten by a wider group of fish. Fish which contained a large proportion of bivalves were Cnidoglanis macrocephalus, Gerres subfasciatus, Aldrichetta forsteri and Torquigener pleurogramma. Pelates sexlineatus also contained a small amount of bivalves, but these were probably ingested incidentally with algae. Gastropod molluscs, Hydrococcus graniformis and Potamopyrgus, were also an item of diet for two species of fish, Aldrichetta forsteri and Torquigener pleugoramma.

Polychaete species, including Ceratonereis erythraeensis and Haploscoloplos kerguelensis were were another common item of diet, particularly for Sillaginodes punctatus, Sillago schomburgkii, Arripis georgianus and Aldrichetta forsteri.

Small crustaceans such as amphipods and isopods were eaten by Cnidoglanis macrocephalus, Amniataba caudavittatus, Aldrichetta forsteri and Torquigener pleurogramma. Melita spp, Corophium sp. and Paracorophium sp. were the amphipods identified from the stomach contents. The larger crustaceans Alpheus sp., and Palaemonetes australis were eaten by Amniataba caudavittatus, Sillago schomburgkii, Pomatomus saltatrix and Argyrosomus hololepidotus.

Chironomid larvae were an important item of diet for only one fish, Aldrichetta forsteri. A small volume of forams were ingested by the same species of fish.

Small fish, including Engraulis australis fraseri were an important item in the diets of the larger predatory fish such as Pomatomus saltatrix and Argyrosomus hololepidotus.

The importance of the different algal and faunal groups as food sources to each species of fish can be assessed based on the stomach contents. The fish can be divided into the following feeding patterns:

(i) Herbivores: Hyporhamphus melanochir and Pelates sexlineatus fed mainly on green algae, but also on some brown algae.

(ii) Omnivores: Amniataba caudavittatus and Aldrichetta forsteri ate not only green algae, but also a range of invertebrate fauna.

(iii) Lower order Carnivores: These fish ate small invertebrate benthic prey. Cnidoglanis macrocephalus, Sillaginodes punctatus, Sillago schomburgkii, Arripis georgianus, Gerres subfasciatus and Torquigener pleurogramma all ate the small benthic invertebrates.

(iv) Higher order Carnivores: These fish ate active prey such as shrimps and small fish. Pomatomus saltatrix and Argyrosomomus hololepidotus were the two large predators of fish and shrimps.

While algae were an important item of diet for some fish, the seagrass Halophila, which was extensive in Leschenault Inlet, was not and apparently was only ingested incidentally. The small benthic invertebrate fauna were an extremely important item of diet for many species of fish. In particular, the small bivalves (such as Arthritica) and gastropods, many of which ranged in size from 1-3mm, were abundant in the stomach contents, and the fish must have selected them from amongst the similar-sized sand grains in which they occurred.

DISCUSSION

Comparisons between Estuarine Systems

Physical characteristics: There are some similarities between the geomorphology of the Leschenault estuary and that of the Peel-Harvey system that are important to the biota inhabiting the estuaries. Both systems have large, shallow lagoons (Leschenault, 25km^2; Peel, 70km^2; Harvey, 60km^2) into which flow rivers with a seasonal (winter) freshwater flush. The lagoons have central basins that are deeper relative to the extensive shallow margins. The basins tend to be muddy whereas the shallow margins are sandy. Thus both systems contain a similar range and distribution of habitats. The major differences between the systems appear to lie in the shapes of the water bodies and, in particular, the connection of the inlets with the sea and the location of the points where the rivers discharge into the lagoons.

Marine water has to pass through a long (5km) constricted channel to enter Peel Inlet, after which it may then penetrate into Harvey Estuary. In contrast, marine water has direct entry to Leschenault Inlet through the relatively short, and artificially-made "Cut". This suggests that the influence of marine waters is likely to be less in the Peel-Harvey system in comparison to Leschenault Inlet. Further, the Murray and Serpentine Rivers discharge into Peel Inlet at a point 5km distant from the channel to the sea. Similarly in Harvey Estuary, the Harvey River discharges into the southern end of the elongate lagoon and freshwater then passes along it, a distance of over 17km, to its northern end where it is connected with Peel Inlet. In contrast, the Collie River discharges into Leschenault Inlet opposite the "Cut", a distance of less than 1km. Thus freshwater discharged into Leschenault Inlet may pass out directly through the "Cut" without traversing Leschenault Inlet, thus leaving the northern end of the Inlet relatively unaffected. The longer distance that freshwater has to traverse Peel Inlet and Harvey Estuary is likely to ensure that any freshwater input becomes mixed into the main estuarine water body with consequent lowering of the salinity throughout Peel Inlet and Harvey Estuary. Thus freshwater input from the rivers is generally likely to have a greater impact on Peel Inlet and Harvey Estuary than on Leschenault Inlet. The exchange and mixing between marine water, and freshwater from the rivers, determines the salinity regimes of the Peel-Harvey and Leschenault systems, one of the most important factors influencing the biota of the estuaries.

The salinity patterns observed in December 1974 during this survey were not static, and the boundaries and mixing zone of the freshwater and seawater masses change seasonally in response to the concentrated winter rainfall and long dry summers of the region. While acknowledging that the salinity regimes of the estuaries were dynamic, the salinity of Leschenault Inlet approached that of seawater (25.7-34.4^{o}/oo) whereas the salinity of Peel Inlet and Harvey Estuary was substantially lower (17.5-26.8^{o}/oo) at the time of the survey. It is also important to note that this survey followed a relatively wet winter with a May-August rainfall of 840mm, which is above the average

May-August rainfall of approximately 750mm (see Figure 2 in Chalmer et al., 1976). Thus it is likely that the estuaries were more subject to freshwater influences in this year than they are normally.

Benthic fauna: The distribution and maximum recorded density of benthic fauna, both within and between the Leschenault and Peel-Harvey estuaries, are summarised in Table 7, and the following information is based from that Table.

Although there are many estuaries in south-western Australia, the benthic fauna of only the Swan River and the Blackwood River (Hardy Inlet) estuaries have been more thoroughly surveyed (Chalmer et al., 1976; Wallace, 1976a, 1977). Those estuaries show the following features in common with the Leschenault and Peel-Harvey estuaries.

(i) The number of benthic species is greatest close to the sea where the salinity varies least from seawater, and the number of benthic species is least at the upper end of the estuary where freshwater persists for some months each year.

(ii) The more abundant benthic species occur in all four of the estuaries. For example, the bivalves Arthritica semen, Spisula trigonella and Anticorbula amara, the polychaetes Capitella spp, Ceratonereis erythraeensis, Haploscolopolos kerguelensis and Prionospio spp, and the amphipods Corophium spp, Paracorophium spp and Melita spp are abundant in all of the four estuaries.

Wells and Threlfall (1981) have provided data on the distribution of estuarine molluscs in south-western Australia. They considered that there were 11 exclusively estuarine molluscs. These species were widespread and occurred in a large proportion of the 12 estuaries for which they had data.

While the estuaries of south-western Australia have many benthic faunal species in common, some differences do exist between the benthic faunal complements of the estuaries. These differences arise through a variety of factors, the most obvious of which are:

(i) the configuration of each estuary, and its effect on the salinity regime;
(ii) the range and distribution of habitats in each estuary; and
(iii) the type of benthic vegetation.

Some of the effects of each of these factors on the benthic fauna of the Leschenault and Peel-Harvey systems are discussed below.

The southern end of Leschenault Inlet is most strongly influenced by marine waters because of its direct connection to the sea through the "Cut". Species of marine affinity comprise 92% of all benthic faunal species in the Swan River Estuary (Chalmer et al., 1976) and the dominating marine influence in southern and central Leschenault Inlet is reflected in the high number (28) of species recorded there, in comparison with the northern end of Leschenault (13 species), Peel

Inlet (14 species) and Harvey Estuary (13 species) (Table 7). Northern Leschenault, and the Peel Inlet and Harvey Estuary were similar in species composition. Of the 13–14 species recorded in each area, eight were found in all three areas, and 11 were found in both Peel Inlet and Harvey Estuary. Either the relatively low salinities, or range in salinities, experienced in these three areas probably prevented the more marine species colonising. The rivers flowing into the lagoons are most subject to freshwater influences over several months each winter, and accordingly contained the least number of benthic species: six species in the Collie River, four species in the Serpentine and seven species in the Murray River.

The habitat type and distribution also had a strong influence on the benthic biota. The most marked variation in habitat within the lagoons was the differentiation between the deeper muddy basins in the centre of the lagoons, and the marginal sandy platforms around the edges. A few species were more abundant in the basins (e.g. the bivalve Mysella in Leschenault and Anticorbula amara in Peel). However most species, including the bivalve Arthritica semen, the polychaetes Ceratonereis erythraeensis, Haploscoloplos kerguelensis and Prionospio sp. 1, and the amphipod Paracorophium, were most abundant on the marginal platforms.

The benthic vegetation also varied with the habitat type in the lagoons. Seagrass with algae attached to it occurred on the marginal platforms, particularly in Leschenault Inlet where it was very dense. The presence of these dense stands of Halophila in Leschenault possibly contributed to the greater abundance of amphipods (Corophium and Paracorophium) recorded there as the Halophila would have provided a refuge for the amphipods. However, the highest total densities of benthic fauna, particularly the bivalve Arthritica semen which was present at densities of up to 804 individuals per $80cm^2$, were observed in Harvey Estuary.

Fish: Although this survey was of short duration, and the species list in Table 9 is not complete, it is possible to draw some general conclusions about the distribution of fish in these estuarine systems at the time of the survey. The records of fish from these estuaries contained in the Western Australian Museum catalogue are biased towards unusual fish, and the fish which are apparently most common in the estuaries are not included in the museum records. Thus the fish recorded by the museum are probably those species which only occasionally occur in the estuaries and are not a major component of their fish faunas.

Of the total of 28 species of fish collected during this survey, 17 were collected in both Leschenault and Peel-Harvey estuarine systems, showing the overall similarity of the two systems. The presence of most of the other 11 species in one estuarine system only is of little significance as it was probably due to the limited sampling effort. However, the mulloway Argyrosomus hololepidotus was one species which was common in one estuary (Leschenault) but was not recorded from the other (Peel-Harvey).

The largest numbers of species of fish were recorded from the areas closest to the sea and where salinities were highest. Twenty species of fish were recorded from the southern end of Leschenault Inlet and 19 species were recorded from a corresponding area of Peel-Harvey estuary, consisting of the Mandurah Channel, Peel Inlet and northern end of Harvey Estuary. The number of species which penetrated the northern end of Leschenault Inlet (six species) and the southern end of Harvey Estuary (eight species) were also similar as were the numbers of species recorded from two of the rivers with eight species from the Collie River and six from the Murray River. However, only two species were recorded from the Serpentine River.

Three species of fish (*Conger wilsoni*, *Muraenichthys tasmaniensis*, and *Strongylura leiura*) have not previously been reported from the estuaries of south-western Australia (Lenanton, 1974, 1977, 1978; Chubb *et al.*, 1979). However, none of these species were abundant and it is likely that they occasionally invade the estuaries from marine areas during summer when salinities are high.

Feeding habits: The feeding habits of estuarine fish of south-western Australia have been described in two other studies, both of which analysed much larger numbers of fish than was done here. Wallace (1976b) examined the diet of fish in the Blackwood River Estuary and Thompson (1957) examined the diet of fish from a range of estuaries, although fish from Leschenault Inlet comprised a large proportion of his samples. Both of these studies suggest that the diet of the fish examined here is relatively consistent with those in other estuaries and through time.

Further, the four feeding patterns observed here (herbivores, omnivores, carnivores and predators = highest carnivores) match exactly those described by Wallace (1976b). Wallace also described two feeding patterns not observed here. These were zooplankton (blue and sandy sprat) and detritus feeders (sea mullet). Sprats were not examined in this study and all but one of the sea mullets examined had empty stomachs.

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ESTUARY	SAMPLE AREA No.	NUMBER OF SEINE SHOTS	NUMBER OF NIGHTS WHEN GILL NETS WERE SET
LESCHENAULT	1	2	1
	2	1	1
	3	0	1
PEEL	1	1	0
	2	0	2
	3	1	0
	4	0	1
	5	0	1
HARVEY	1	1	1
	2	1	1

TABLE 1 : Fishing effort in each area in Leschenault, Peel and Harvey estuaries. The locations of all sample areas are shown in Figures 2-4.

STATION	DETAIL OF LOCATION	DEPTH m	SUBSTRATE	VEGETATION
1	Edge of artificial channel	0.3	Sand	Absent
2	Centre of artificial channel	2	Sand	Absent
3	Edge of artificial channel	0.3	Sand	Posidonia detritus
4	Tidal delta	0.5	Sand	Halophila
5	Marginal platform	0.5	Sand	Halophila
6	Riverine delta	0.3	Sand	Absent
7	Channel in riverine delta	2	Mud	Absent
9	Inlet basin	2.5	Mud	Absent
10	Marginal platform	0.5	Sand/Mud	Halophila
11	Marginal platform	0.3	Sand/Mud	Halophila
12	Marginal platform	0.3	Sand	Halophila
13	Edge of dredged channel	0.3	Sand	Absent
14	Bank of dredged channel	0.5	Mud	Halophila
15	Centre of dredged channel	2	Mud	Absent
16	Marginal Platform	0.5	Mud/Sand	Halophila
17	Marginal platform	0.3	Sand/Mud	Halophila
18	Creek (brackish)	0.3	Mud	Absent
19	Edge of river	0.3	Sand/Mud	Absent
20	Centre of river	2.5	Sand	Absent
21	Edge of river	0.3	Mud	Absent

TABLE 2 : Description of the stations where benthic fauna were sampled in Leschenault estuary. Locations of the stations are shown in Figure 2B.

STATION	DETAIL OF LOCATION	DEPTH m	SUBSTRATE	VEGETATION
1	Centre of channel	3	Coarse sand	Absent
2	Bank of channel	0.5	Mud/sand	<u>Ruppia</u>
3	Edge of channel	0.3	Sand/mud	Absent
4	Marginal platform	0.5	Sand/mud	Absent
5	Inlet basin	1.5	Mud	Green algae
6	Centre of dredged channel	1	Mud	Green algae
7	Edge of dredged channel	0.5	Sand/mud	Absent
8	Centre of channel	1.5	Mud	Green algae
9	Edge of channel	0.3	Sand	Absent
10	Centre of river	2	Coarse sand	Absent
11	Edge of river	0.5	Mud	Absent
12	Edge of river	0.3	Mud/sand	Absent

TABLE 3 : Description of stations where benthic fauna were sampled in Peel Estuary. Locations of the stations are shown in Figure 3B.

STATION	DETAIL OF LOCATION	DEPTH m	SUBSTRATE
1	Marginal platform	0.3	Muddy sand
2	Inlet basin	2	Mud
3	Marginal platform	0.3	Sand and rock
4	Marginal platform	0.3	Sand/mud
5	Inlet basin	2	Mud
6	Marginal shelf at mouth of Mealup Drain	0.3	Sand/mud
7	Marginal shelf 200m south of Mealup Drain	0.3	Sand/mud
8	Mealup Drain	0.3	Coarse sand
9	Marginal platform	0.3	Mud/sand
10	Marginal platform/ basin	1	Sand/mud
11	Marginal platform	0.3	Sand

TABLE 4 : Description of stations where benthic fauna were sampled in Harvey estuary. Locations of the stations are shown in Figure 4B.

STATION	DATE	TIME (hrs)	Salinity ($^{o}/oo$)								Temperature (^{o}C)							
			Sur-face	-1m	-1.5m	-2m	-2.5m	-3m	-4m	-4.5m	Sur-face	-1m	-1.5m	-2m	-2.5m	-3m	-4m	-4.5m
1	4.12.74	1000	34.4	34.4	-	34.4	-	-	-	-	21.0	21.0	-	21.1	-	-	-	-
2	2.12.74	2030	35.1	35.4	34.4	-	-	-	-	-	19.9	19.9	19.6	-	-	-	-	-
3	5.12.74	-	33.9	33.9	-	-	-	-	-	-	22.8	22.7	-	-	-	-	-	-
5	3.12.74	1520	8.7	-	-	-	-	-	-	-	32.2	-	-	-	-	-	-	-
6	4.12.74	1300	29.5	34.0	-	25.7	-	-	-	-	24.4	22.7	-	22.5	-	-	-	-
7	2.12.74	2045	31.0	33.8	-	34.7	-	-	-	-	23.3	22.5	-	21.2	-	-	-	-
8	4.12.74	-	25.1	30.5	-	32.0	-	-	-	-	25.1	24.6	-	23.4	-	-	-	-
9	3.12.74	1210	2.6	29.7	-	31.2	31.2	-	-	-	25.0	25.6	-	24.5	24.5	-	-	-
10	4.12.74	-	2.8	4.1	-	30.2	-	-	-	-	25.0	24.8	-	24.7	-	-	-	-
11	4.12.74	-	1.8	18.6	-	27.5	-	27.7	27.8	27.7	23.9	23.4	-	23.0	-	22.7	22.9	23.1

TABLE 5 : Salinity and temperature measurements recorded in Leschenault estuary. The locations of the stations are shown in Figure 2A.

TAXA	Number of benthic fauna per 80cm² at Stations 1-21																				Other locations where benthic fauna collected	Museum Records	
	1	2*	3	4	5	6	7*	9*	10	11	12	13	14	15*	16	17	18	19	20*	21		Location	Date
MOLLUSCA																							
BIVALVIA																							
Arthritica semen	0	0	0	3	0	43	67.0	0	0	3	202	2,14,12,12,52	46,88,76,50,54	0,8.6	1	73	0	0	1.6	3	-	-	-
Mysella sp.	0	0	0	0	0,+	0	0	2.2	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	11.2,0	10	0	0	0	0	0	-	-	-
Spisula trigonella	0	0	0	0	0,+	0	0.2	0	1	0	0	0, 0, 2, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	-	-	-
Tellina deltoidalis	0	0	0	2	1	0	0	0.2	0	0	0	0, 0, 0, 0, 0	1, 1, 0, 1, 1	0,0	1	1	0	0	0	0	-	-	-
Tellina sp.	0	0	0	0	0	0	0.2	0.2	1	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0.4,0.2	0	0	0	0	0	0	-	-	-
Theora lubrica	0	0	0	0	0,+	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	-	-	-
Anticorbula amara	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	1	-	-	-
GASTROPODA																							
Bembicium melanostomum	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	-	mangroves	1958, 1962, 1963, 1971
Hydrococcus brazieri	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	2, 0, 0, 0, 1	0,0	0	1	0	0	0	0	-	-	-
Potamopyrgus sp.	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 1, 0	0,0	0	0	3	0	0	0	-	-	-
Nassarius burchardi	0	0	0	7	2	0	0	0.2	0	0	0	0, 0, 0, 0, 0	0, 0, 1, 0, 0	0,0.2	0	0	0	0	0	0	-	-	-
POLYCHAETA																							
Capitella spp	0	0	0	8	6	0	0.6	19.2	4	5	0	16,0, 2, 0, 0	5, 3, 1, 2, 4	9.2,8.4	43	21	0	0	0	0	-	-	-
Ceratonereis erythraeensis	1	0	3	6	6	26	6.6	2.6	4	0	71	57,22,3,26,30	9,21,33, 4,10	4.2,2.8	3	34	0	1	6.6	2	-	-	-
Eunereid sp.	4	0	0	0	0	0	0	0	0	0	0	4, 4, 1, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	-	-	-
Haploscoloplos kerguelensis	5	0	1	7	2	9	3.6	3.4	6	8	9	21,13,6, 6,19	10, 2,11,11, 7	1.0,0.4	0	5	0	0	6.0	0	-	-	-
Prionospio sp. 1	2	0	1	1	0	2	1.2	0	49	0	0	12,15,28,8, 4	7, 8, 5, 0,10	0,0	0	0	0	0	0	0	-	-	-
Prionospio sp. 2	0	0	0	0	8	0	4.4	3.2	0	0	0	0, 1, 2, 0, 6	0, 0, 0, 1, 0	1.8,3.2	2	0	0	0	0	0	-	-	-
Unidentified polychaete sp.	0	0	0	0	0	0	0.4	0	0	0	0	8, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	-	-	-
TURBELLARIA sp.	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 1, 0	0,0	0	0	0	0	0	0	-	-	-
NEMATODE sp.	0	0	0	0	0	0	0	0	3	0	0	0, 0, 1, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	-	-	-
CRUSTACEA																							
AMPHIPODA																							
Corophium spp	2	0	0	4	0	0	0.8	3.0	4	4	3	5, 1, 1, 4, 6	5,10,14,11,10	0,0	0	68	0	0	0	0	-	-	-
Melita spp	0	0	0	2	0	0	0	0	1	0	0	1, 0, 0, 0, 0	4, 0, 4, 8, 5	0,0	1	14	1	0	0	0	-	-	-
Paracorophium sp.	1	0	0	42	1	0	0.2	1.8	1	4	39	24,12,5, 0, 9	44,51,10,39,62	0,0	9	38	0	0	0	0	-	-	-
ISOPOD sp.	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	5	-	-	-
MYSID sp.	0	0	0	0	0	0	0	0	0	0	1	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	-	-	-
DECAPODA																							
Alpheus euphrosyne	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	Area 1 (Fig. 2C)	-	-
Halicarcinus bedfordi	0	0	0	0	0,+	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	-	-	-
Macrobranchium intermedium	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	Area 1 (Fig. 2C)	-	-
Palaemon serenus	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	Area 1 (Fig. 2C)	-	-
Palaemonetes australis	0	0	0	0	0,+	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	0	Area 1 (Fig. 2C)	-	-
Unidentified crustacean sp.	0	0	0	1	0	0	0	0	0	0	2	0, 0, 1, 1, 1	30,12,20,17,52	0,0	5	44	0	0	0	0	-	-	-
INSECTA																							
HEMIPTERAN sp.	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0,0	0	0	0	0	0	1	-	-	-
CHIRONOMID LARVAE	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 1	0,0	0	0	0	0	0	0	-	-	-
FISH																							
Gymnapistes marmoratus	0	0	0	0	0	0	0	0	0	0	0	0, 0, 0, 0, 0	0, 0, 0, 0, 1	0,0	0	0	0	0	0	0	-	-	-
TOTAL NUMBER OF ALL FAUNA PER 80cm²	15	0	5	83	26	80	85.2	36.0	74	24	327	150,82,64, 57,121	161,196,278 146,218	27.8, 23.8	75	299	4	1	14.2	12			

TABLE 6 : Distribution of benthic fauna recorded from Leschenault Estuary. An asterisk (*) indicates that the sample was collected by the grab and had an area of $400cm^2$; otherwise all samples were collected by the corer and had an area of $80cm^2$. A plus (+) indicates that the species were collected from that station, but were not present in the core sample. Duplicate samples were collected from Station 5 and five replicate samples at Stations 13 and 14. Locations of the sample stations are shown in Figure 2B.

TAXA	MAXIMUM RECORDED NUMBER OF FAUNA PER 80cm²							
	LESCHENAULT ESTUARY			PEEL-HARVEY ESTUARY				
	Southern end and centre of Leschenault Inlet	Northern end of Leschenault Inlet	Collie River	Mandurah Channel	Peel Inlet	Harvey Estuary	Serpentine River	Murray River
	n = 23	n = 3	n = 3	n = 3	n = 14	n = 15	n = 1	n = 2
MOLLUSCA								
BIVALVIA								
Mytilus edulis planulatus (Lamarck)	0	0	0	*	0	0	0	0
Xenostrobus securis (Lamarck)	0	0	0	-	0	0	0	2
Arthritica semen (Menke)	88	73	3	-	99	804	37	0
Mysella sp.	11.2	10	0	-	0	0	0	0
Spisula trigonella (Lamarck)	2	0	0	*	0	0	0	0
Tellina deltoidalis (Lamarck)	2	1	0	-	0	0	0	0
Tellina sp.	1	0	0	-	0	0	0	0
Theora lubrica (Gould)	+,0	0	0	-	0	0	0	0
Anticorbula amara (Laseron)	0	0	1	-	61.6	47	0	0
GASTROPODA								
Bembicium melanostromum (Gmelin)	*,0	0	0	-	0	0	0	0
Hydrococcus brazieri (Tenison Woods)	0	1	0	-	*,0	0	0	0
Potamopyrgus sp.	0	3	0	-	5	4	0	0
Nassarius burchardi (Philippi)	7	0	0	-	0	0	0	0
Nassarius pauperatus (Lamarck)	0	0	0	*	0	0	0	0
Nassarius pyrrhus (Menke)	0	0	0	*	0	0	0	0
Salinator fragilis (Lamarck)	0	0	0	*	0	0	0	0
POLYCHAETA								
Capitella spp	19.2	43	0	-	2.2	84	6	0.4
Ceratonereis erythraeensis (Fauvel)	57	34	6.6	-	72	81	6	1
Eunereid sp.	4	0	0	-	0	0	0	0
Haploscoloplos kerguelensis (McIntosh)	21	5	6	-	66	29	0	0
Prionospio sp. 1	49	0	0	-	78	314	48	0.8
Prionospio sp. 2	8	2	0	-	0	0	0	0
Polychaete sp. (unidentified)	8	0	0	-	1	0	0	0
TURBELLARIA sp.	1	0	0	-	0	0	0	0
NEMATODE sp.	3	0	0	-	0	0	0	0
CRUSTACEA								
AMPHIPODA								
Corophium spp	14	68	0	-	4	1	0	0
Melita spp	8	14	0	-	14.4	0.2	0	0
Paracorophium spp	112	38	0	-	18.8	11	0	0
ISOPOD sp.	0	0	5	-	0	0	0	0
MYSID sp.	1	0	0	-	0	0	0	0
DECOPODA								
Alpheus euphrosyne DeMan	+,0	0	0	-	0	0	0	0
Cherax plebejus Hess	0	0	0	-	0	0	0	*,0
Halicarcinus bedfordi (Montgomery)	+,0	0	0	-	0	0	0	0
Macrobranchium intermedius (Stimpson)	+,0	0	0	-	0	0	0	0
Macrophthalmus (Mopsocarcinus) sp.	0	0	0	-	0	0	0	*,0
Palaemon serenus (Heller)	+,0	0	0	-	0	0	0	0
Palaemonetes australis Dakin	+,0	0	0	-	2	+,0	0	*,0
Squilla laevis Hess	0	0	0	*	0	0	0	0
CRUSTACEAN sp. (unidentified)	52	44	0	-	0	0	0	0
INSECTA								
CHIRONOMID LARVAE	1	0	0	-	12.2	227	0	0
INSECT sp. (unidentified)	0	0	0	-	0	2	0	0
HEMIPTERAN sp.	0	0	1	-	0	0	0	0
MAXIMUM OBSERVED NUMBER OF ALL FAUNA PER 80cm²	278	299	14.2	-	286	859	97	3
NUMBER OF TAXA RECORDED	28	13	6	6	14	13	4	7

TABLE 7 : Distribution of benthic fauna within and between Leschenault and Peel-Harvey estuaries. A plus (+) indicates that the species was present at a site during this survey, an asterisk (*) indicates that the species is listed in the Western Australian Museum records, and a dash (-) indicates that quantitative data were not collected from that site. The number of samples from which the maxium abundance is drawn is shown as n.

SPECIES OF NEKTON		Nekton caught by gill net: Number per set, Area 1	Area 2	Area 3	Size of nekton: Size range (cm)	Number measured	Nekton caught by seine net: Number per shot, Area 1	Area 2	Size of nekton: Size range (cm)	Number measured	Nekton recorded by by W.A. Museum: Location	Date
FISH												
GEOTRIIDAE	Geotria australis Gray	.	.	.	.	.	.	.	.	.	Collie River	1916, 1937
MYLIOBATIDAE	Myliobatis australis Macleay	2	.	.	.	.	.	.	.	.	.	.
ELOPIDAE	Elops machnata (Forskaal)	.	.	.	.	.	.	.	.	.	Leschenault Inlet	1943
OPHICHTHIDAE	Muraenichthys tasmaniensis McCulloch	.	.	.	.	.	.	.	.	.	Leschenault Inlet	1945
	Ophisurus serpens (Linnaeus)	.	.	.	.	.	.	.	.	.	Leschenault Inlet	1943
CLUPEIDAE	Hyperlophus vittatus (Castelnau)	.	.	.	.	.	12	.	2– 3	23	.	.
	Nematalosa vlaminghi (Munro)	.	.	47	20–30	47	.	.	.	.	.	.
ENGRAULIDAE	Engraulis australis (Shaw)	1	.	2	9–10	3	8	.	7– 9	16	.	.
PLOTOSIDAE	Cnidoglanis macrocephalus (Valenciennes)	1	.	.	33	1	.	.	.	.	.	.
HEMIRAMPHIDAE	Hyporhamphus melanochir (Valenciennes)	.	.	.	.	.	1	.	13	1	.	.
ATHERINIDAE	Atherinid spp	1	.	.	10	1	3	78	3– 7	83	.	.
SYNGNATHIDAE	Stigmatopora argus (Richardson)	.	.	.	.	.	.	.	.	.	Leschenault Inlet	1944
SCORPAENIDAE	Gymnapistes marmoratus (Cuvier)	.	.	.	.	.	6	.	2– 4	11	Leschenault Inlet	1943
TERAPONIDAE	Amniataba caudavittatus (Richardson)	.	.	4	16–23	4	.	.	.	.	.	.
	Pelates sexlineatus (Quoy & Gaimard)	12	.	.	16–21	12	2	.	19	3	.	.
KUHLIIDAE	Edelia vittata Castelnau	.	.	.	.	.	.	.	.	.	Collie River	1961
SILLAGINIDAE	Sillaginodes punctatus (Cuvier)	8	.	.	24–27	8	2	.	6	1	.	.
									21–25	2		
	Sillago schomburgkii Peters	.	.	.	.	.	1	.	27	1	.	.
POMATOMIDAE	Pomatomus saltatrix (Linneaus)	3	.	16	15–31	19	.	1	14	1	.	.
ARRIPIDAE	Arripis georgianus (Valenciennes)	2	.	.	20	2	.	.	.	.	.	.
SPARIDAE	Acanthopagrus butcheri (Munro)	.	.	1	21	1	.	.	.	.	.	.
SCIAENIDAE	Argyrosomus hololepidotus (Lacepede)	4	1	6	18–38	11	.	.	.	.	.	.
MUGILIDAE	Aldrichetta forsteri (Valenciennes)	13	1	1	20–22	8	97	34	4–10	133	.	.
					24–31	7			20–28	5	.	.
	Mugil cephalus (Linnaeus)	.	.	21	20–28	21	7	.	6– 8	13	.	.
BLENNIIDAE	Pictiblennius tasmanianus (Richardson)	.	.	.	.	.	.	.	.	.	Leschenault Inlet	1954
GOBIIDAE	Amoya bifrenatus (Kner)	.	.	.	.	.	11	.	4– 7	7	.	.
									10–15	15	.	.
	Favonogobius lateralis (Macleay)	.	.	.	.	.	99	.	2– 7	197	.	.
	Pseudogobius olorum (Sauvage)	.	.	.	.	.	20	.	3– 6	40	.	.
BOTHIDAE	Pseudorhombus jenynsii (Bleeker)	.	1	.	15	1	.	.	.	.	.	.
TETRAODONTIDAE	Contusus richei (Freminville)	.	.	.	.	.	1	1	10–17	3	.	.
	Torquigener pleurogramma (Regan)	30	.	.	15–19	30	57	.	12–18	114	.	.
CRABS												
PORTUNIDAE	Portunus pelagicus (Linnaeus)	5	95	.	6–13	99	2	.	7– 8	3	.	.

TABLE 8 : Distribution and size of nekton recorded from Leschenault Inlet and the Collie River. Locations of the sampling areas are shown in Figure 2C. The gill nets were set for one night in each area and one seine shot was in Area 2 and two seine shots in Area 1.

SPECIES OF FISH			LOCATIONS FROM WHICH EACH SPECIES RECORDED: Leschenault Estuary			Peel-Harvey Estuary			
FAMILY	SCIENTIFIC NAME	COMMON NAME	Southern end of Leschenault Inlet	Northern end of Leschenault Inlet	Collie River	Mandurah Channel, Peel Inlet and northern end of Harvey Estuary	Southern end of Harvey Estuary	Serpentine River	Murray River
MORDACIIDAE	Geotria australis (Gray)	Wide-mouthed Lamprey	-	-	*	*	-	-	-
MYLIOBATIDAE	Myliobatus australis Macleay	Eagle Ray	+	-	-	-	-	-	-
ELOPIDAE	Elops machnata (Forskaal)	Giant Herring	*	-	-	*	-	-	-
CONGRIDAE	Conger wilsoni (Bloch and Schneider)	Conger Eel	-	-	-	*	-	-	-
OPHICHTHYIDAE	Muraenichthys tasmaniensis (McCulloch)	Southern Worm Eel	*	-	-	-	-	-	-
	Ophisurus serpens (Linnaeus)	Serpent Eel	*	-	-	*	-	-	-
CLUPEIDAE	Hyperlophus vittatus (Castelnau)	Sandy Sprat	+	-	-	+	-	-	-
	Nematalosa vlaminghi (Munro)	Perth Herring	-	-	+	+	-	-	+
ENGRAULIDAE	Engraulis australis (Shaw)	Southern Anchovy	+	-	+	+	-	-	-
GONORHYNCHIDAE	Gonorhynchus greyi (Richardson)	Beaked Salmon	-	-	-	*	-	-	-
PLOTOSIDAE	Cnidoglanis macrocephalus (Valenciennes)	Cobbler	+	-	-	+	+	-	-
BELONIDAE	Strongylura leiura (Bleeker)	Slender Longtom	-	-	-	*	-	-	-
HEMIRHAMPHIDAE	Hyporhamphus melanochir (Valenciennes)	Sea Garfish	+	-	-	+	-	-	-
	Hyporhamphus regularis (Gunther)	Western River Garfish	-	-	-	-	-	-	*
POECILIIDAE	Gambusia affinis (Baird and Girard)	Mosquito Fish	-	-	-	-	+	+	*
ATHERINIDAE	Atherinid spp	Hardy Head	+	+	-	+	+	-	-
SYNGNATHIDAE	Stigmatopora argus (Richardson)	Spotted Pipefish	*	-	-	-	-	-	-
SCORPAENIDAE	Gymnapistes marmoratus (Cuvier)	Devil Fish	+*	-	-	+	-	-	-
TRIGLIDAE	Chelidonichthys kuma (Lesson)	Red Butterfly Gunard	-	-	-	*	-	-	-
TERAPONIDAE	Amniataba caudavittatus (Richardson)	Yellowtail Trumpeter	-	-	+	-	-	-	*+
	Pelates sexlineatus (Quoy and Gaimard)	Striped Trumpeter	+	-	-	+	+	-	+
KUHLIIDAE	Edelia vittata Castelnau	Westralian Pigmy Perch	-	-	*	-	-	-	-
APOGONIDAE	Apogon rueppellii (Gunther)	Gobbleguts	-	-	-	+	-	-	-
SILLAGINIDAE	Sillaginodes punctatus (Cuvier)	King George Whiting	+	-	-	+	-	-	-
	Sillago schomburgkii (Peters)	Yellow-finned Whiting	+	-	-	+	-	-	-
POMATOMIDAE	Pomatomus saltatrix (Linnaeus)	Tailor	+	+	+	+	-	-	+
CARANGIDAE	Seriola hippos (Gunther)	Samson Fish	-	-	-	*	-	-	-
ARRIPIDAE	Arripis georgianus (Valenciennes)	Tommy Rough (Herring)	+	-	-	-	-	-	-
GERRIDAE	Gerres subfasciatus	Silverbelly	-	-	-	+	-	-	-
SPARIDAE	Acanthopagrus butcheri (Munro)	Black Bream	-	-	+	-	-	-	-
SCIANIDAE	Argyrosomus hololepidotus (Lacepede)	Mulloway	+	+	+	-	-	-	-
MUGILIDAE	Aldrichetta forsteri (Valenciennes)	Yelloweye Mullet	+	+	+	+	+	+	+
	Mugil cephalus Linnaeus	Sea Mullet	+	-	+	+	+	-	+
BLENNIDAE	Pictiblennius tasmanianus (Richardson)	Tasmanian Blenny	*	-	-	-	-	-	-
CLINIDAE	Cristiceps aurantiacus	Yellow Crested Weedfish	-	-	-	*	-	-	*
	Cristiceps australis Valenciennes	Crested Weedfish	-	-	-	*	-	-	-
GOBIIDAE	Favogobius lateralis (Macleay)	Long-finned Goby	+	-	-	+	+	-	-
	Amoya bifrenatus (Kner)	Bridled Goby	+	-	-	-	-	-	-
	Pseudogobius olorum (Sauvage)	Blue Spot Goby	+	-	-	+	-	-	-
BOTHIDAE	Pseudorhombus jenynsii (Bleeker)	Small-toothed Flounder	-	+	-	-	-	-	-
PLEURONECTIDAE	Ammotretis rostratus	Long-snouted Flounder	-	-	-	+	-	-	-
MONACANTHIDAE	Chaetoderma penicilligera (Cuvier)	Prickly Leatherjacket	-	-	-	-	-	*	*
TETRAODONTIDAE	Contusus richei (Freminville)	Prickly Pufferfish	+	+	-	-	-	-	-
	Torquigener pleurogramma (Regan)	Common Blowfish	+	-	-	+	+	-	-
NUMBER OF ALL SPECIES			25	6	10	29	8	3	10
NUMBER OF SPECIES RECORDED DURING THIS SURVEY			20	6	8	19	8	2	6

TABLE 9 : Distribution of fish within and between Leschenault and Peel-Harvey estuaries. A plus (+) indicates a species that was recorded during this survey, an asterisk (*) indicates that the species is listed in the Western Australian Museum records and a dash (-) indicates that the species has not been recorded.

STATION	DATE	TIME (hrs)	Salinity °/oo)					Temperature (°C)				
			Surface	-1m	-1.5m	-2m	-3m	Surface	-1m	-1.5m	-2m	-3m
1	12.12.74	-	26.1	26.8	-	26.8	21.1	25.1	24.2	-	24.4	24.0
2	12.12.74	1100	21.3	24.5	-	-	-	26.0	26.0	-	-	-
4	12.12.74	1215	25.9	27.0	-	-	-	26.3	25.5	-	-	-
5	13.12.74	-	19.5	25.4	24.8	-	-	24.5	25.4	25.3	-	-
6	13.12.74	-	7.3	24.1	-	25.8	-	25.2	27.5	-	26.0	-
7	12.12.74	-	4.6	7.1	-	6.8	-	29.1	28.6	-	28.8	-
8	13.12.74	0710	4.4	-	-	-	-	20.3	-	-	-	-
9	12.12.74	1535	1.2	1.2	-	1.2	-	29.7	25.8	-	26.0	-

TABLE 10 : Salinity and temperature measurements recorded in Peel estuary. The locations of the stations are shown in Figure 3A.

TAXA	Number of benthic fauna per 80cm² at Stations 1-12												Museum Records	
	1*	2	3	4	5*	6*	7	8*	9	10*	11	12	Location	Date
MOLLUSCA														
BIVALVIA														
Mytilis edulis	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	Mandurah Channel	1965
Xenostrobus securis	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	2	0	-	-
Arthritica semen	1.0	99	24	92	1.2	0	20,32,43,19,30	0.8	21,19,13,10,11	0	0	37	-	-
Spisula trigonella	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	Mandurah Channel	1965
Anticorbula amara	0	2	0	4	10.6	0	11,4,11,4,16	61.6	3,7,2,4,1	0	0	0	-	-
GASTROPODA														
Hydrococcus brazieri	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	Mouth of Serpentine River	1970
Potamopyrgus sp.	0	0	0	0	0	0	0,0,0,0,0	0.6	5,5,3,2,3	0	0	0	-	-
Nassarius pauperatus	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	Mandurah Channel	1965
Nassarius pyrrhus	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	Mandurah Channel	1965
Salinator fragilis	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	Mandurah	1925
POLYCHAETA														
Capitella spp	0	10	0	1	2.2	0.2	0,2,0,2,10	0	1,0,0,0,0	0.4	0	6	-	-
Ceratonereis erythraeensis	0	71	60	72	0.2	0.4	6,8,7,1,12	9.2	23,27,12 11,12	0	1	6	-	-
Haploscoloplos kerguelensis	0	0	7	17	0	0	0,0,0,0,0	0	37,12,66,38,26	0	0	0	-	-
Unidentified polychaete sp.	0	1	1	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	-	-
Prionospio sp. 1	0	34	5	78	1.3	0	3,2,5,0,11	0.8	17,37,33,34,39	0.8	0	48	-	-
Prionospio sp. 2	0	0	0	0	0	0	0,0,0,0,0	0	0,5,0,0,0	0	0	0	-	-
CRUSTACEA														
AMPHIPODA														
Corophium spp	0	2	1	4	0.4	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	-	-
Melita spp	0	0	0	0	1.0	0	0,0,0,0,0	14.4	0,0,0,0,0	0	0	0	-	-
Paracorophium spp	0	14	1	18	0	0	0,0,0,0,0	18.8	0,0,0,0,0	0	0	0	-	-
DECAPODA														
Cherax plebejus	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	Mill Island	1972
Macrophthalmus (Mopsocarcinus sp.)	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	Mill Island	1972
Palaeomonetes australis	0	0	0	0	0	0	0,0,0,0,0	0.2	0,0,0,0,0	0	0	0	Mill Island	1972
Squilla laevis	0	0	0	0	0	0	0,0,0,0,0	0	0,0,0,0,0	0	0	0	Mandurah Channel	1972
INSECTA														
Chironomid larvae	0	0	0	0	0	0	0,0,0,0,1	12.2	0,0,0,0,1	0	0	0	-	-
NUMBER OF ALL BIOTA PER 80cm²	1	233	99	286	16.9	0.6	40,48,66,26,70	118.6	107,112,129,99,93	1.2	3	97		

TABLE 11 : Distribution of benthic fauna recorded from Peel Inlet and the Serpentine and Murray Rivers. An asterisk (*) indicates that the sample was collected by the grab and had an area of 400cm²; otherwise all samples were collected by the corer and had an area of 80cm². Five replicate samples were collected at Stations 7 and 9. The locations of the benthic sampling stations are shown in Figure 3B.

SPECIES OF NEKTON		Nekton caught by gill net: Number per set, Area 2	Nekton caught by gill net: Number per set, Area 5	Nekton caught by gill net: Size of nekton, Size range (cm)	Nekton caught by gill net: Size of nekton, # measured	Nekton caught by seine net: # per shot, Area 1	Nekton caught by seine net: # per shot, Area 3	Nekton caught by seine net: # per shot, Area 4	Nekton caught by seine net: Size of nekton, Size range (cm)	Nekton caught by seine net: Size of nekton, # measured	Nekton caught by scoop net	Nekton recorded by W.A. Museum: Location	Nekton recorded by W.A. Museum: Date
FISH													
GEOTRIIDAE	Geotria australis Gray	.	.	.	.	.	.	.	.	.	.	Peel Inlet	1954
ELOPIDAE	Elops machnata (Forskaal)	.	.	.	.	.	.	.	.	.	.	Peel Inlet	1974
CONGRIDAE	Conger wilsoni (Bloch & Schneider)	.	.	.	.	.	.	.	.	.	.	Peel Inlet	1963
OPHICHTHIDAE	Ophisurus serpens (Linnaeus)	.	.	.	.	.	.	.	.	.	.	Peel Inlet	1962
CLUPEIDAE	Hyperlophus vittatus (Castelnau)	.	.	.	.	35	3	.	2- 4	19	.	.	.
									7- 8	19	.	.	.
	Nematalosa vlaminghi (Munro)	1	699	12-16	88	.	.	.	.	.	.	.	.
				19-27	113								
GONORYNCHIDAE	Gonorynchus greyi (Richardson)	.	.	.	.	.	.	.	.	.	.	Murray River	1965
PLOTOSIDAE	Cnidoglanis macrocephalus (Valenciennes)	7	..	19-25	9	6	.	.	9	1	.	.	.
									34-38	5	.	.	.
BELONIDAE	Strongulura leiura (Bleeker)	.	.	.	.	.	.	.	.	.	.	Peel Inlet	1960
HEMIRAMPHIDAE	Hypornamphus melanochir (Valenciennes)	2	.	23-38	4	.	.	.	.	.	.	.	.
	Hyporhamphus regularis (Günther)	.	.	.	.	.	.	.	.	.	.	Murray River	1963
POECILIIDAE	Gambusia affinis (Baird & Girard)	.	.	.	.	.	.	.	.	.	Area 4	Murray River	1973
ATHERINIDAE	Atherinid spp	.	.	.	.	3	54	.	1- 2	23	.	.	.
									4- 6	31	.	.	.
									9	3	.	.	.
SCORPAENIDAE	Gymnapistes marmoratus (Cuvier)	1	.	13	1	.	.	.	.	.	.	Peel Inlet	1963,
													1965
TRIGLIDAE	Chelidonichthys kuma (Lesson)	.	.	.	.	.	.	.	.	.	.	Peel Inlet	1972
TERAPONIDAE	Amniataba caudavittatus (Richardson)	.	12	17-22	12	.	.	.	.	.	.	Murray River	1963
	Pelates sexlineatus (Quoy & Gaimard)	28	1	15-24	56	.	.	.	.	.	.	.	.
APOGONIDAE	Apogon rueppellii Günther	.	.	.	.	1	.	.	6	1	.	Murray River	1963
SILLAGINIDAE	Sillaginodes punctatus (Cuvier)	1	.	23-25	2	1	.	.	8	1	.	.	.
	Sillago schomburgkii Peters	4	.	21-31	7	1	.	.	27	1	.	.	.
POMATOMIDAE	Pomatomus saltatrix (Linneaus)	1	15	16-19	17	.	.	.	.	.	.	.	.
GERRIDAE	Gerres subfasciatus Cuvier	4	.	13-15	8	7	.	.	15-16	7	.	.	.
MUGILIDAE	Aldrichetta forsteri (Valenciennes)	108	14	19-29	230	15	59	1	5- 9	54	.	.	.
									17-24	21	.	.	.
	Mugil cephalus Linnaeus	5	15	23-38	24	8	.	.	8	1	.	.	.
									21-25	7	.	Murray River	1969
CLINIDAE	Cristiceps aurantiacus Castelnau	.	.	.	.	.	.	.	.	.	.	Peel Inlet	1944
	Cristiceps australis Valenciennes	.	.	.	.	.	.	.	.	.	.	Peel Inlet	1961
GOBIIDAE	Favonogobius lateralis (Macleay)	.	.	.	.	40	6	.	3- 8	20	.	.	.
PLEURONECTIDAE	Ammotretis rostratus Günther	.	.	.	.	1	.	.	6	1	.	.	.
MONACANTHIDAE	Chaetoderma penicilligera (Cuvier)	.	.	.	.	.	.	.	.	.	.	Murray River	1917
												Serpentine R.	1964
TETRAODONTIDAE	Torquigener pleurogramma	34	.	12-17	68	51	.	.	10-17	51	.	.	.
CRABS													
PORTUNIDAE	Portunus pelagicus (Linnaeus)	10	.	8-14	20	.	.	.	.	.	.	.	.

TABLE 12 : Distribution and size of nekton recorded from Peel Inlet, Murray River and Serpentine River. Locations of the sampling areas are shown in Figure 3C. In Area 2, gill nets were set on two nights, in Area 5 gill nets were set for one night. There was one seine shot in each of Areas 1, 3 and 4.

STATION	DATE	TIME (hrs)	Salinity °/oo)			Temperature (°C)		
			Surface	-1m	-2m	Surface	-1m	-2m
1	18.12.74	1040	24.0	24.2	24.1	22.4	21.6	22.0
2	18.12.74	-	20.9	21.1	22.2	25.5	24.9	22.7
4	17.12.74	1800	1.7	-	-	-	-	-
5	17.12.74	0900	17.5	19.6	-	21.0	21.0	-

TABLE 13 : Salinity and temperature measurements recorded in Harvey Estuary. The locations of the stations are shown in Figure 4A.

TAXA	NUMBER OF BENTHIC FAUNA PER 80cm^2 AT STATIONS 1-11											Other locations where benthic fauna collected
	1	2*	3	4	5*	6	7	8	9	10*	11	
MOLLUSCA												
BIVALVIA												
Arthritica semen	58	0	390	447,444	1.8	497,349	249,340	0,0	804	251.8	468	-
Anticorbulra amara	4	0	5	19,10	0	47,46	1,12	1,4	4	1.8	7	-
GASTROPODA												
Potamopyrgus sp.	0	0	0	0,0	0	0,0	0,0	0,4	0	0	0	-
POLYCHAETA												
Capitella spp	0	0	84	0,0	0	0,0	0,0	0,0	0	1.6	0	-
Ceratonereis erythraeensis	30	0	31	44,1	0.2	81,70	23,57	0,1	28	0.6	62	-
Haploscoloplos kerguelensis	1	0	4	0,0	0	1,4	29,21	0,0	1	0	7	-
Prionospio sp. 1	7	0.4	314	56,0	0	200,32	18,20	7,12	11	9.2	55	-
CRUSTACEA												
AMPHIPODA												
Corophium spp	0	0	1	0,0	0	0,0	0,0	0,0	0	0	0	-
Paracorophium spp	0	0	0	0,0	0	0,0	0,0	0,1	11	0.4	50	-
Melita sp.	0	0.2	0	0,0	0	0,0	0,0	0,0	0	0	0	-
DECAPODA												
Palaemonetes australis	0	0	0	0,0	0	0,0	0,0	0,0	0	0	0	Seine Site 2 (Figure 4C)
INSECTA												
CHIRONOMID LARVAE	0	0	0	0,0	0	0,0	0,0	61,227	0	0	0	-
UNIDENTIFIED INSECT	0	0	0	0,0	0	0,0	0,0	0,2	0	0.2	0	-
ALL TAXA	100	0.6	829	566,455	2.0	826,501	320,450	69,251	859	265.6	649	

TABLE 14 : Distribution of benthic fauna recorded from Harvey Estuary. An asterisk (*) indicates that the sample was collected by the grab and had an area of 400cm^2; otherwise all samples were collected by the corer and had an area of 80cm^2. Duplicate samples were collected at Stations 4 and 6-8. The locations of the benthic sampling stations are shown in Figure 4B.

SPECIES OF NEKTON		Nekton caught by gill net: No. per set, Area 1	Nekton caught by gill net: No. per set, Area 2	Nekton caught by gill net: Size of nekton, Size range (cm)	Nekton caught by gill net: Size of nekton, # measured	Nekton caught by seine net: No. per shot, Area 1	Nekton caught by seine net: No. per shot, Area 2	Nekton caught by seine net: Size of nekton, Size range (cm)	Nekton caught by seine net: Size of nekton, # measured	Nekton caught by scoop net	Nekton recorded by W.A. Museum: Location	Nekton recorded by W.A. Museum: Date
FISH												
ENGRAULIDAE	*Engraulis australis* (Shaw)	1	.	12	1	2	.	9-10	2	.	.	.
PLOTOSIDAE	*Cnidoglanis macrocephalus* (Valenciennes)	44	30	17-24	72	.	.	.	.	.	.	.
				28	1							
				34	1							
POECILIIDAE	*Gambusia affinis* (Baird & Girard)	.	.	.	.	.	.	.	.	Mealup Drain	.	.
ATHERINIDAE	Atherinid spp	.	.	.	.	16	8	4-7	24	.	.	.
SCORPAENIDAE	*Gymnapistes marmoratus* (Cuvier)	1	.	12	1	.	.	.	.	.	.	.
TERAPONIDAE	*Pelates sexlineatus* (Quoy & Gaimard)	1	1	17-18	2	.	.	.	.	.	.	.
APOGONIDAE	*Apogon rueppellii* Günther	.	.	.	.	3	.	7-8	2	.	.	.
SILLAGINIDAE	*Sillaginodes punctatus* (Cuvier)	1	.	26	1	.	.	.	.	.	.	.
	Sillago schomburgkii Peters	3	.	24	3	.	.	.	.	.	.	.
POMATOMIDAE	*Pomatomus saltatrix* (Linnaeus)	13	.	17-23	13	.	.	.	.	.	.	.
CARANGIDAE	*Seriola hippos* Günther	.	.	.	.	.	.	.	.	.	Harvey Estuary	1970
GERRIDAE	*Gerres subfasciatus* Cuvier	2	.	11-12	1	.	.	.	.	.	.	.
MUGILIDAE	*Aldrichetta forsteri* (Valenciennes)	413	57	19-26	470	349	1	5-11	350	.	.	.
	Mugil cephalus Linnaeus	40	52	19-27	52	9	32	6-10	41	.	.	.
				34-39	30							
GOBIIDAE	*Favonigobius lateralis* (Macleay)	.	.	.	.	1	5	3-6	6	.	.	.
	Pseudogobius olorum (Sauvage)	.	.	.	.	.	.	.	.	Area 1 (Figure 4C)	.	.
TETRAODONTIDAE	*Torquigener pleurogramma* (Regan)	16	39	12-18	55	.	.	.	.	.	.	.
CRABS												
PORTUNIDAE	*Portunus pelagicus* (Linnaeus)	3	11	10-13	14	.	.	.	.	.	.	.

TABLE 15 : Distribution and size of nekton recorded from Harvey Estuary. Locations of the sampling areas are shown in Figure 4C. The gill nets were set for one night in each area and there was one seine shot in each area.

FEEDING PATTERN	SPECIES OF FISH	ESTUARIES FROM WHICH FISH WERE EXAMINED	NUMBER OF FISH EXAMINED	No. OF FISH WITH FOOD ITEMS IN STOMACH	PERCENTAGE COMPOSITION OF STOMACH CONTENTS: PLANT MATERIAL			BIVALVIA					GASTROPODA		POLYCHAETA			AMPHIPODA			ISOPODA	DECAPODS			OTHER CRUSTACEANS	CHIRONOMID LARVAE	FORAMS	FISH				UNKNOWN MATERIAL	SAND
					Green algae	Brown algae	Halophila	Mytilus edulis	Arthritica semen	Mysella sp.	Anticorbula amara	Unid. bivalve species	Hydrococcus brazieri	Potamopyrgus sp.	Ceratonereis erythraeensis	Haploscoloplos kerguelensis	Unid. polychaete species	Corophium spp	Paracorophium spp	Melita spp		Unidentified Crab	Alpheus sp.	Palaemonetes australis				Aldrichetta forsteri	Engraulis australis fraseri	Unidentified Fish Species	Scales		
Data not available	Nematalosa vlaminghi	Leschenault and Peel	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Acanthopagrus butcheri	Leschenault	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Mugil cephalus	Leschenault, Peel & Harvey	47	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100
Herbivores	Hyporhamphus melanochir	Peel	4	4	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pelates sexlineatus	Leschenault, Peel & Harvey	22	22	87	10	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Omnivores	Amniataba caudavittatus	Leschenault and Peel	14	2	11	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	22	0	0	56	0	0	0	0	0	0	0	0	0
	Aldrichetta forsteri	Leschenault	12	11	31	0	0	0	28	0	0	0	0	1	1	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
		Peel	27	13	7	0	0	2	28	1	0	4	1	0	0	0	0	9	14	2	0	0	0	0	12	13	1	0	0	0	0	0	0
		Harvey	20	13	6	0	0	0	17	0	0	0	0	6	14	1	15	0	2	0	0	0	0	0	0	30	0	0	0	0	0	9	0
Lower order Carnivores	Cnidoglanis macrocephalus	Peel & Harvey	2	2	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sillaginodes punctatus	Leschenault and Peel	12	7	0	0	0	0	0	0	0	0	0	0	20	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sillago schomburgkii	Leschenault and Peel	8	7	0	0	0	0	0	0	0	0	0	0	59	0	20	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0
	Arripis georgianus	Leschenault	2	1	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Gerres subfasciatus	Peel	6	1	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Torquigener pleurogramma	Peel	10	5	0	0	0	0	67	0	4	0	19	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
		Harvey	11	8	0	0	3	0	24	0	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	3	0
Higher order Carnivores	Pomatomus saltatrix	Leschenault, Peel & Harvey	34	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	1	0	77	0	0	0
	Argyrosomus hololepidotus	Leschenault	10	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	27	57	0	0	0

TABLE 16 : Diet of fish.

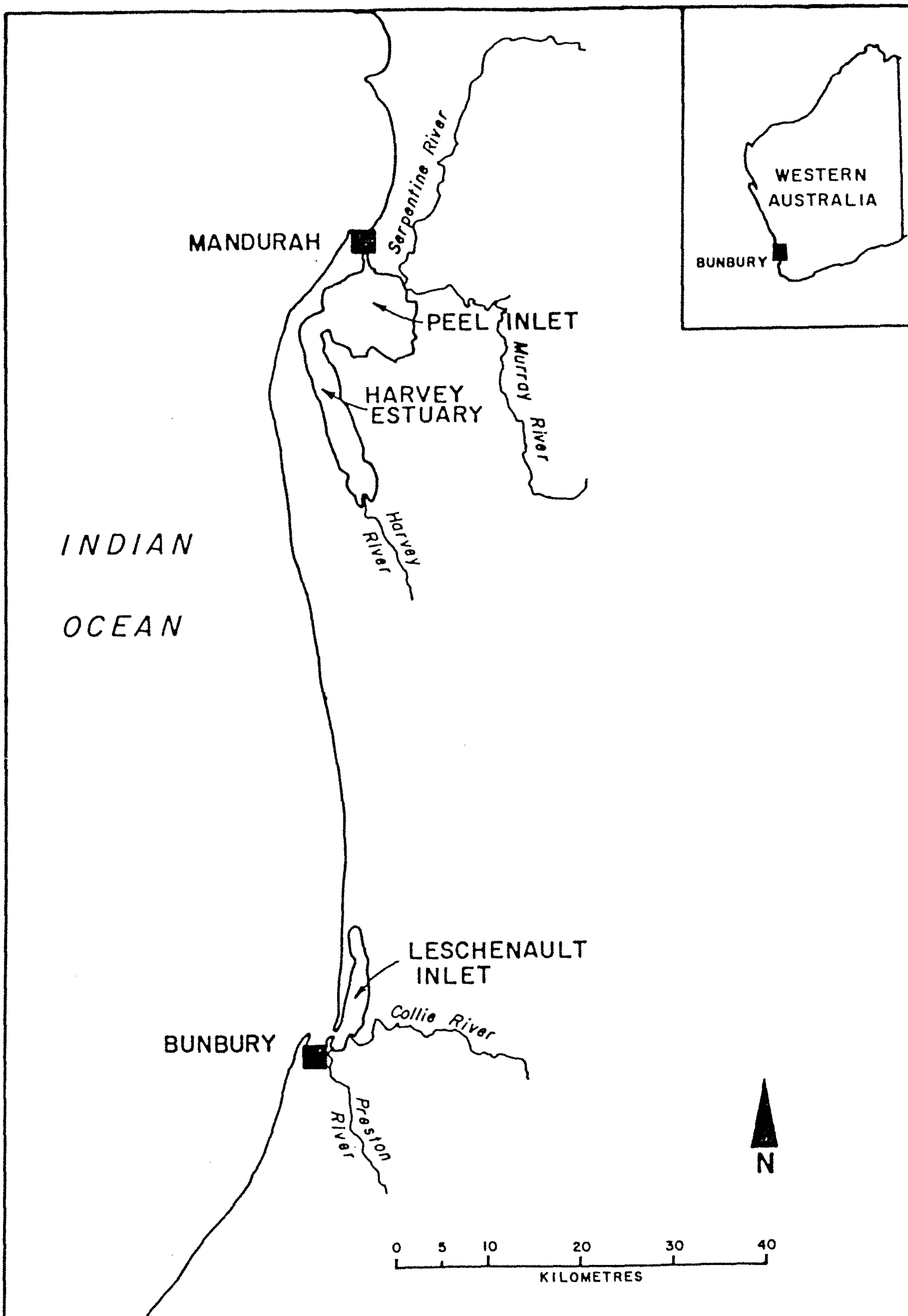

Figure 1 : Location map of Leschenault and Peel-Harvey estuarine systems.

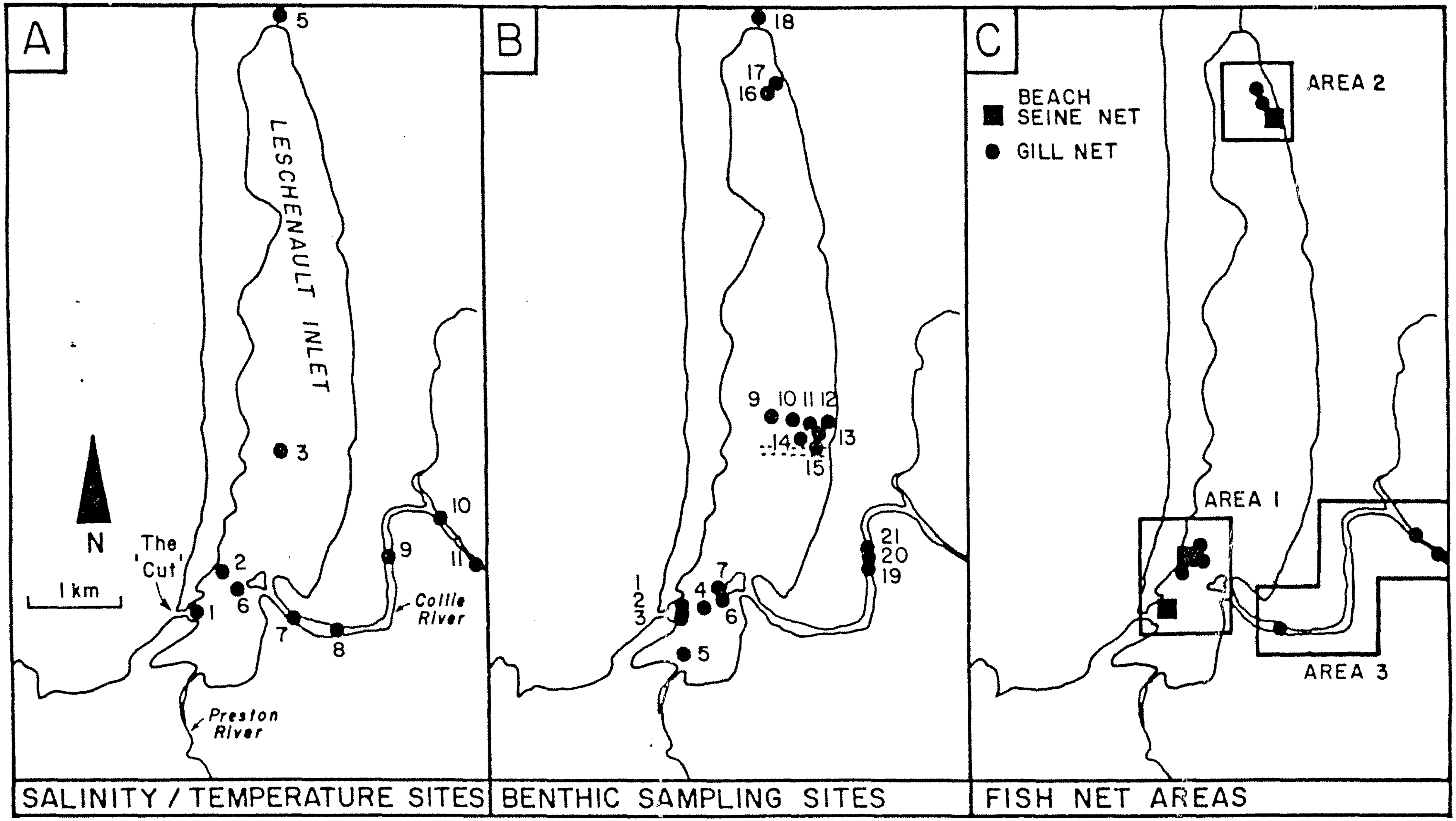

Figure 2 : Locations of salinity/temperature sampling sites, benthic fauna sampling sites and fish sampling areas in Leschenault estuary.

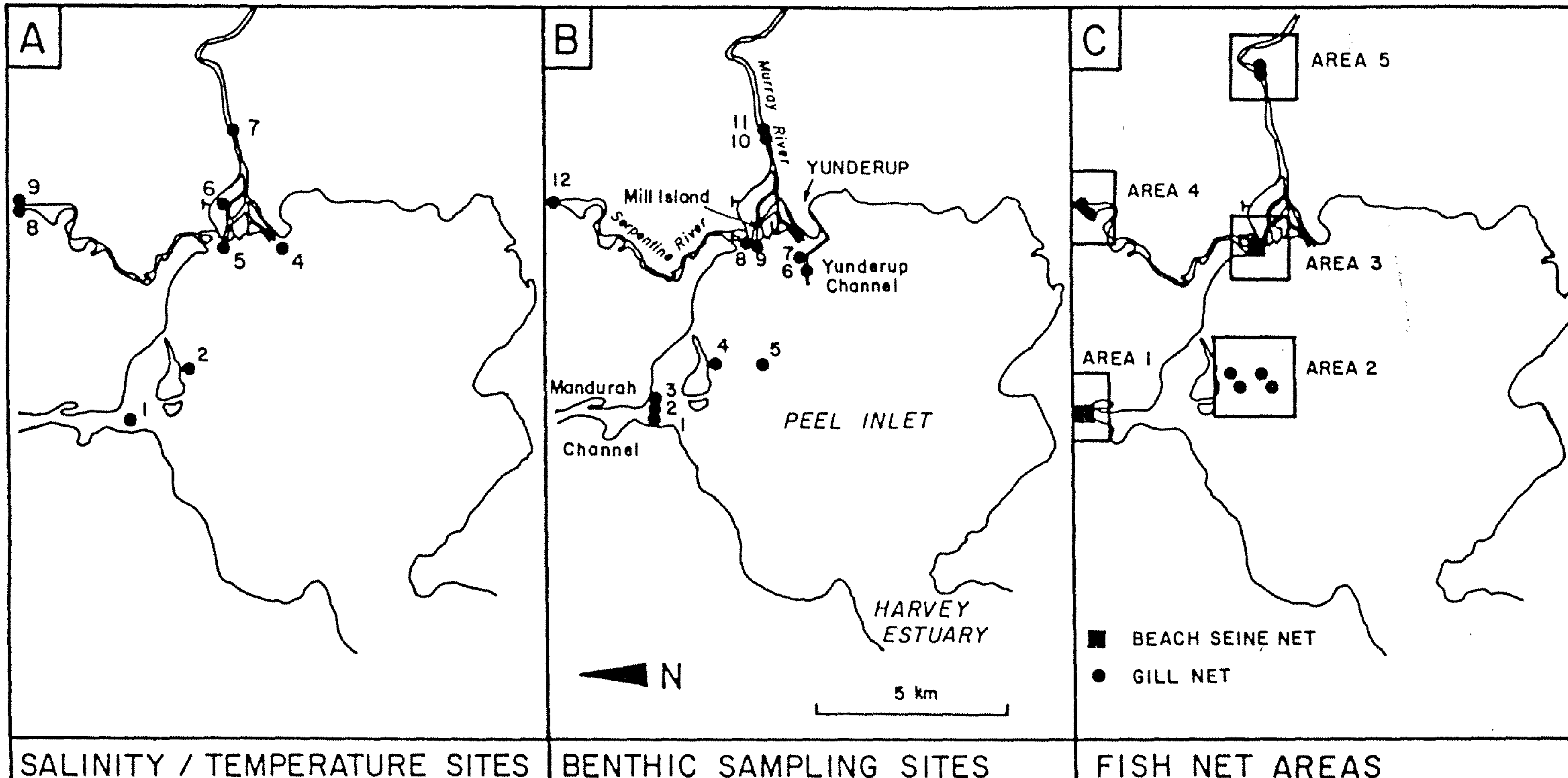

Figure 3 : Locations of salinity/temperature sampling sites, benthic fauna sampling sites and fish sampling areas in Peel estuary.

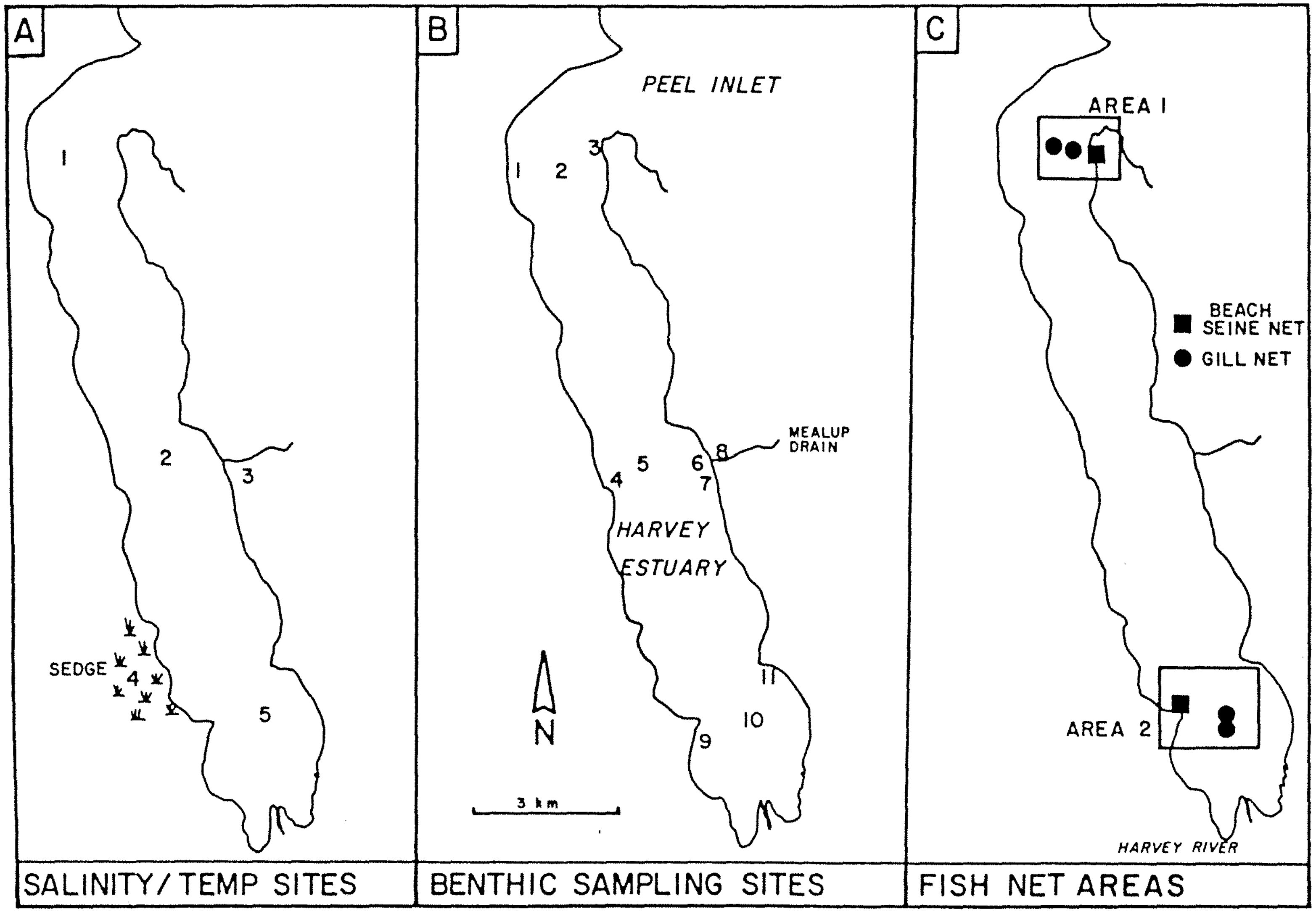

Figure 4 : Locations of salinity/temperature sampling sites, benthic fauna sampling sites and fish sampling areas in Harvey Estuary.