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A SHORT TERM BIOLOGICAL SURVEY
TIN CAN INLET/GREAT SANDY STRAIT

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A SHORT TERM BIOLOGICAL SURVEY - TIN CAN INLET/GREAT SANDY STRAIT

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INTRODUCTION

Estuaries are the nursery grounds and sheltering places for marine life; they are used for aquatic sports, commercial and recreational fishing. They are also used for water transport, dredging and reclamation and as a dumping-ground for sewage. Their sand may be mined and their water used as a heat exchanger in factories. In consequence, they are the centre of a major conflict of use and are among the world's most endangered habitats.

Environmental impact studies are required before major "development" projects are implemented. Such studies should incorporate the preparation of an inventory of the estuarine environment and associated flora and fauna. In the present survey we demonstrate a method which attempts to measure a number of biological parameters, give an inventory of others, and then compare these data with those of a more intensively studied but similar area - Moreton Bay.

The area discussed in this report included Tin Can Inlet and that part of Great Sandy Strait south of the co-tidal line which occurs at Moonboom Islands (Figs. 1, 2, 2a). This represents an area of approximately 35,000 hectares, and, together with the northern part of Great Sandy Strait, makes up the fifth largest enclosed embayment on Queensland's coastline. Data on distribution and abundance of seagrasses, mangroves, juvenile prawns, and certain species of teleosts, as well as hydrological information, have been collected before major ecological disturbances occur. The data were collected in two field trips each of a fortnight's duration in July and December 1973.

MATERIALS AND METHODS

The Study Area

Topographic relief and watershed areas of the hinterland of the study area were outlined from standard topographic maps of the area, 1 : 50,000 scale, Series R.733. Photointerpretation of existing black and white air photographs was used to supplement these data and aid in assessing the present status of the estuary and its surrounds.

Watersheds, Land Form

The hinterland to the south and west of the study area is made up of two major drainage basins; these are the Tin Can watershed and the Boonooroo watershed. Tin Can watershed, as defined for the purposes of this study, includes the watercourses of Teebar Creek, Snapper Creek and a number of smaller creeks which feed into the south-east face of the estuary. We have also included Kauri Creek as a part of the Tin Can watershed (Fig. 1, 2), as it has similar estuarine character to the rest of the watershed. Coldrake (1961) considered Kauri Creek as a separate unit in his geographical study of the area. Topography of the area is undulating, with vegetation being

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chiefly layered woodland, sclerophyll scrub woodland and heath. Vegetation tends to be more open in the western part of the watershed than on the eastern side. The Cooloolah sandmass forms the southeast border of the watershed, and the coastal dunes between Rainbow Beach and Tin Can Bar border the east side (Coldrake, 1961).

The Boonooroo watershed extends north-south between Tinnanbar and Shoulder Point. It is characterized by broad ridges and low, gently undulating country covered with layered woodland. Mangrove areas are rather more extensive on tidal flats in this section than in the Tin Can drainage system.

On the northeastern face of the study area, there is a small watershed on Fraser Island (Fig. 1). This watershed is characterized by the presence of high sand dunes; much of this area is higher than 300 m, and some peaks reach 600 m.

Climate

Climate of the region is subtropical and coastal. Seasonal influences are derived from the tropical zone to the north, the temperate zone to the south, and the thunderstorm breeding area to the southwest, between Tewantin, Bauple and Gympie. Mean annual rainfall varies between 1,275 mm and 1,725 mm in the watersheds adjacent to the study area. The most consistent feature of the climate is the dry period between May and August. In most years this provides a pronounced dry period which becomes more acute through winter into spring, and which may possibly cause hypersalinity in some parts of the study area. Rainfall is greatest between November and March.

BIOLOGICAL SURVEY - METHODS

Selection of Sample Sites

To enable representative sample sites in the study area to be chosen, an attempt was made to divide the area into zones which might represent each major habitat type present. Rochford (1951) recognized four horizontal zones within a "typical" East Australian estuary, and gave data to support his hypothesis that each zone could be considered as a more or less separated ecological unit. Rochford's zones were separated largely on the basis of gradients of chlorinity, tidal exposure, bottom sediment composition and nutrient availability within the estuary. Many ecologists have divided complex areas according to the distribution of certain species and plants, and have found that this leads to a satisfactory and stable method of defining different habitats (e.g. Potts and Jackson, 1953). If this approach is taken, and the Great Sandy Strait - Tin Can Inlet complex is considered in terms of distribution of marine angiosperms, six major horizontal habitat types are recognizable. These have been recognized in other southeast Queensland estuaries (Dredge, m.s.). Features of these habitat types are given in Table 1 and Table 2 lists areas of each habitat type. Approximate boundaries in the study area are set out in Figs. 3, 3a. These boundaries are artificial, as there is no cut off point between one habitat type and the next, there being a gradient existing between them. Vertical zonation of all habitat types except the "Channel" type can be recognized by the distribution of various seagrass or mangrove species according to the amount of aerial exposure to which they are liable.

Hydrological Samples

Water samples from the top and bottom of the water columns were taken from each of the habitat types on a single day in December 1973. Salinities and temperatures were recorded at all stations at depth intervals of 3 m between top and bottom to show if saline wedges or temperature variations were present. Other hydrological measurements included levels of dissolved oxygen, inorganic phosphate, dissolved nitrates, particulate phosphates and nitrates, ammonia, particulate carbon and chlorophylls *a*, *b*, and *c*. The methods given by Major *et al* (1972) were used for all chemical determinations.

Seagrass Survey

Seagrass areas were mapped from aerial photographs, and corrected after detailed transects had been made adjacent to the major sample sites, marked A - Y on Figs. 3, 3a. During the course of these transects, seagrass species were identified (den Hartog, 1970) to allow community structure and vertical zonation of seagrass beds to be described. At the major sample sites ten $1/16m^2$ quadrats were thrown. All seagrass lying in these quadrats and all rhizomes growing in the upper 10 cms of substrate below the quadrat were collected, sorted by species, cleaned, dried to constant weight (over silica gel at 105°C for 24 hours), and weighed. This method of measuring seagrass density has been used in Moreton Bay by one of us (H.K.) and our present data can be compared directly with these earlier data collected in Moreton Bay.

Mangrove Surveys

Mangrove areas were defined from black and white aerial photographs and topographic maps to provide assistance in the selection of sample sites. Transects were made through five sites to collect data on species presence and associations in various areas of the study area. The sites on which transects were made are shown as ringed numbers on Figs. 2, 2a.

Penaeid Prawn Samples

A one metre beam trawl fitted with 1 mm mesh was used to capture juvenile prawns at the major sample sites A - Y (Figs. 3, 3a) in December 1973. Duplicate trawls were made over a distance of 50 m, into the tide flow, within one hour of high tide, at night. All penaeids caught were identified as to species and counted according to the technique of Young (1975) (Table 6).

Distribution of Juvenile Fish - Commercial Fisheries

Queensland Fish Board records (1971-1974) indicated which species of fish are of commercial significance in the Tin Can Inlet - Great Sandy Strait area. Sampling to show distribution of juveniles of seven of these species (Table 8) was conducted with a 3 m beam trawl and an 80 m beach seine. Both nets were made of 3 mm stretched mesh net. Beam trawl shots were made at 20 locations in July 1973 (day time only) and at 17 locations in December 1973 (day and night replicates). These shots were of 20 minute duration, at a speed of approximately two knots, and were made into the tide within one and a half hours of high water. Beach seine samples were taken at four sites in July and six sites in December. All beach seine shots were conducted in daylight hours, within two hours of low water. From each net shot, all fish were identified and counted, and any specimens of the seven species listed in Table 9 were measured. Data on length at first spawning given by Kesteven (1949) for mullet (*Mugil cephalus* L.), Munro (1949) for bream (*Acanthopagrus australis* Gunther), MacLean (1969) for winter whiting (*Sillago maculata* Quoy and Gaimard), Lenanton (1970) for yellow finned whiting (*Sillago analis* Whitley), and Dredge (unpublished data) for summer whiting (*Sillago ciliata* Cuvier) and flathead (*Platycephalus fuscus* C. & V.) were used to distinguish which of these fish were juveniles.

Fisheries

Fisheries in the area were assessed from Queensland Fish Board records, log bookskept by trawler skippers, and from information gathered in personal interviews with professional fishermen and anglers.

RESULTS

Hydrology

Hydrological data are given in Appendix 1. The measurements of temperature and salinity taken in December 1973 show that there was an appreciable saline wedge in Tin Can Inlet at that time, and that the southern waters of the estuary were of lower salinity than those adjacent to Tin Can Bar. There had been no significant rainfall in the catchment areas of the inlet for three weeks prior to the day water sampling was carried out.

Seagrass

The following six species of seagrass were collected from the survey area:

Zostera capricorni Aschers.
Halodule uninervis (Forsk.) Aschers.
Cymodocea serrulata (R.Br.) Aschers and Magnus.
Syringodium isoetifolium (Aschers.) Dandy.
Halophila ovalis (R.Br.) Hook. f.
Halophila spinulosa (R.Br.) Aschers.

These species were associated in characteristic communities or stands. *Z. capricorni*, *H. ovalis*, and *H. uninervis* formed one such community, and a sparse cover of *H. uninervis* and *H. ovalis* formed another. *C. serrulata* and *S. isoetifolium* grew in monospecific stands, and *H. spinulosa* grew in subtidal areas adjacent to stands of *Z. capricorni*, *H. ovalis*, and *H. uninervis*. Are. covered by each community are given in Table 3.

Specific measures of seagrass biomass made on those sample sites shown in Figs. 3, 3a which had seagrass growing on them are given in Table 4. These figures are considered representative of each type of community. Comparative data from similar communities in Moreton Bay are given in Table 5.

A more general description of seagrass communities in the area is as follows.

The shallow lagoon-like area south and west of Poverty Point, and shallow banks as far north as Tin Can township, support a sparse *H. uninervis*/*H. ovalis* community. Seagrass does not blanket the substrate surface, and the dry weight of plant material is approximately 20 g m^{-2}. This is low by comparison with other seagrass communities in the area. Near Carlo Creek and Carlo Point, a much denser stand of *Z. capricorni*, *H. uninervis* and *H. ovalis* grew over muddy sand in intertidal areas. *H. spinulosa* occurred in a thin fringe just below low tide limits. Large banks running parallel to the main channel near Teebar Creek, both east and west of this channel, supported similar communities, which have a dry-weight biomass of between 100 and 150 g m^{-2}.

S. isoetifolium was found in only one area, a little south of Tin Can Bar, where it grew in the sublittoral zone. Salinity fluctuations in this area would be of a smaller magnitude than in the rest of the estuary. *Z. capricorni* and *H. ovalis* were found associated near the *S. isoetifolium* stand.

North and west of Tin Can Bar extensive beds of *C. serrulata* were found. Dry-weight biomass of the community (approximately 400 g m^{-2}) was higher than for comparable communities in Moreton Bay, and dugong and turtles were seen on the beds, apparently whilst they were feeding.

A dense, monospecific stand of *Z. capricorni* was found on muddy sand inside the mouth of Kauri Creek. Dry-weight biomass of this bed is 170 g m^{-2}, which is higher than any other *Zostera* bed we know of in south-eastern Queensland.

Further upstream from this bed, *Z. capricorni*, *H. ovalis* and *H. uninervis* were found in narrow beds on the edge of the main channel.

On the western shore of Fraser Island, near the Bluff, a thin bank of *Z. capricorni*, *H. uninervis* and *H. ovalis* had an overall dry weight density of 100 g m^{-2}, although isolated lagoons and depressions which carried a much higher density were found. Further north the main channel approaches Fraser Island, and consequently seagrasses were found only on the western side of the channel. Between Tinnabar and Boonooroo Point, there are extensive but sparse beds of *H. uninervis* and *H. ovalis* growing over coarse sand. A strong tidal current may be a limiting factor to other species establishing in this area.

From Boonooroo to the tidal interface at Moonboom Islands, the substrate became sandier. Between the numerous deltaic islands, extensive beds of *Z. capricorni*, *H. uninervis* and *H. ovalis* grew with a maximum dry weight density of 100 g m^{-2}. From the co-tidal line north, no seagrass beds were found in December 1973. In an earlier survey (July 1973) a sparse fringe of *Z. capricorni* was observed south of River Heads, but this had apparently disappeared by December of the same year.

Mangrove Survey

Eight species of mangrove have been collected and identified in the course of the survey. Mounted specimens of these species, listed below, were retained for identification:

Aegiceras corniculatum (L.) Blanco
Avicennia marina var. *resinifera* (Forst.f) Bakh.
Bruguiera gymnorhiza (L.) Lam.
Ceriops tagal var. *australis* C.T. White
Excoecaria agallocha L.
Lumnitzera racemosa Willd.
Osbornea octodonta F. Muell.
Rhizophora stylosa Griff.

Mangrove swamps and associated saltpans cover approximately 19% (6,700 ha) of the estuarine area between Moonboom Islands and Teebean Point. A breakdown of mangrove area by habitat type and geographical location is given in Table 2.

In the brackish water area at Poverty Point small areas of mangrove occur in isolated stands, with fringes of *A. marina* var. *resinifera* extending between most stands. Stands consisted principally of *A. marina, R. stylosa, B. gymnorhiza,* and *A. corniculatum.* No clear zonation was evident in these stands.

Turkey Island was selected as an area which has mangrove swamps typical of much of the deltaic habitat type. This site had the greatest variety of mangrove species, as well as the greatest area (Table 2) and a number of communities were evident. In areas where banks rose steeply, the mangrove cover consisted of a narrow fringe of *A. marina, R. stylosa* and *B. gymnorhiza.* On flatter areas nearest open water extensive swamps of *A. marina* and *R. stylosa* formed a seaward zone, with an inner zone of *C. tagal* var. *australis. A. corniculatum* was present as shrubland, while *L. racemosa* was only found on sandy substrates within the shoreward parts of the swamps.

Pannikin Island was selected as the sample site for our "bank" habitat type. The island is principally composed of *A. marina,* closed and open scrub, with occasional *R. stylosa* occurring on the seaward fringe.

The "fringe" habitat type, by definition, has a fringe of mangrove on the shoreline, the species being generally *A. marina,* in the more seaward reaches of the estuary.

Juvenile Prawns - Distribution and Abundance

Numbers of juvenile penaeid prawns taken in one metre beam trawl shots are listed in Table 6 for comparative purposes, catches of juvenile prawns from littoral and sub-littoral areas in various parts of Moreton Bay which have similar vegetation forms to those of the Tin Can Bay - Great Sandy Strait area are given in Table 7. These Moreton Bay samples were collected using identical techniques in December 1972.

South of the co-tidal line at Moonboom Islands numbers of juvenile prawns in the Tin Can Inlet - Great Sandy Strait area were of the same order of magnitude as occurred in similar areas of Moreton Bay.

The distribution of juvenile *Penaeus plebejus* Hess (king prawn) and *Metapenaeus bennettae* Racek and Dall (greasyback prawn) was restricted to seagrass beds and mudflats adjacent to mangrove areas. Juvenile *Penaeus esculentus* Haswell (tiger prawn) were only found in appreciable numbers on seagrass beds. Young (1975) found that juvenile tiger prawns were almost excluded from any habitat apart from seagrass beds in Moreton Bay. He has also found that seagrass substrates support more prawns than bare substrates, despite equal recruitment rates (Young and Carpenter in prep.). Young (in prep.) has shown that the number of prawns surviving in seagrasses is significantly greater than on bare substrates, whilst juvenile king prawns occur on shallow flats and creeks and decrease in numbers as conditions became more estuarine. Survey data confirm these observations.

North of the study area, where the substrate was sandy, juvenile prawns were almost entirely absent.

Juvenile Fish - Distribution

Data on the distribution of juveniles of the seven species being considered have been set down as frequency of occurrence (occurrence/net shot) of each species in each of the habitat types which was sampled (Table 8). No attempt has been made to consider the data in terms of abundance/shot, as catchability of juveniles seems to vary greatly from one habitat form to another.

The data contained in Table 8 indicate that juvenile bream were widespread in the study area, but were most frequently taken in deltaic areas. Juvenile winter whiting were also widespread in the estuary although they did not occur in the brackish area whereas juvenile yellow finned whiting were found only in this habitat form, as were juvenile sea mullet. Summer whiting were most commonly taken on the fringing mangrove-seagrass beds adjacent to bars, but some were taken on sand banks in the deltaic areas near Tin Can Bay, which is an atypical occurrence for this species (Dredge m.s.). Juvenile flathead were most frequently taken in the deltaic habitat areas but were found also in those parts of the estuary where littoral angiosperms occurred.

Fishery

The fishery of Tin Can Bay - Great Sandy Strait is made up of four components. These are:-

1. an estuarine net fishery aimed at a variety of scale fish species;

2. a recreational hook and line fishery based largely on the species of scale fish caught by net fishermen;

3. a trap fishery for mud crabs (*Scylla serrata* Forskal);

4. an offshore trawl fishery for penaeid prawns and sand crabs.

These fisheries will be discussed separately.

1. At this time there are 25 net fishermen working in the Tin Can Bay - Kauri Creek area, and ten working between Boonooroo and Kauri Creek. We have no counts of numbers of fishermen working between Boonooroo and Pialba, but estimate that 15-20 men would be fully employed in this area.

Queensland Fish Board returns for the years of 1971, 1972 and 1973 (Queensland Fish Board, 1971, 1972, 1973) give a fair estimate of total professional scale fish catches in the Tin Can Inlet - Great Sandy Strait area for those years. These returns are reproduced in Table 10 by species, or species group.

1. Species which are thought to be estuarine dependent, at least for some part of their life cycle, make up 75% - 90% of the annual scale fish landings of the Maryborough and Tin Can Bay Fish Board returns. Catches of all species except sea mullet, *M. cephalus*, have remained relatively stable in the last four years. Mullet catches have steadily declined, but there is no indication of over-exploitation. Rather, fishing effort on the species has been reduced because of the presence of a kerosene-like taint in many fish which makes them unsaleable (O'Connell, 1974). Rather than risk an economic loss through catching such fish, fishermen attempt to take other species.

2. The recreational fishery of Tin Can Inlet - Great Sandy Strait is undescribed in terms of effort or catch per unit of effort. Anglers from the Mary River valley (Gympie and surrounds) make up one component of the recreational fishery, while a proportion of angling is carried out by people from the Brisbane area. Target species for anglers are whiting (mostly *S. ciliata* and *S. maculata*), flathead (*P. fuscus)*, bream (*A. australis*) and, in the small areas of the study area where reefs occur, snapper (*Chysophrys auratus* Bloch and Schneider) and sweetlips (*Lutjanus* spp.).

3. Mud crab landings by professional fishermen for the past three years are given in Table 10. Amateur fishermen also fish for mud crabs, so total crab catch would have been considerably greater than is indicated by the table. Between 10 and 15 persons are seasonally employed taking mud crabs. Landings at the Maryborough and Tin Can Bay Fish Boards make up between 25 and 30 per cent of the State's annual Fish Board landings.

4. Prawn landings at Tin Can Bay from 1957 to 1973, which are given in Table 11, show considerable fluctuations. However, these landing figures are not truly representative of either abundance or total catch of prawns. Early in the 1960s upgrading of the port of Mooloolaba and the discovery of new trawling grounds south of Noosa Heads brought about a reduction of the trawling fleet from about 50 to only 12 boats. But at certain times of the year trawlers working from Mooloolaba, Brisbane and Southport work the Tin Can Bay grounds and in most cases return to their home port to dispose of their catch. Log book data indicates that as much as half of the Tin Can Bay catch may be landed at other ports. This same set of log book data shows that trawling grounds north of 23°20S have been little utilized by fishermen in recent years. A recent survey conducted by Queensland Department of Primary Industries officers (August 1973) rediscovered a large stock of prawns east of the *Maheno* wreck, on Fraser Island, and approximately 45,000 kgms of prawns were taken in four nights fishing by 60 trawlers immediately after the survey. Sustained fishing effort had been applied to these grounds from that time until April 1974.

At the time this survey was done there was no prawn fishery of significance in the southern end of Hervey Bay because an otter trawling closure had been in effect for a number of years. However, there was a significant fishery in the past (Anon. 1957).

A series of test trawls was conducted at a number of sites in the southern end of Hervey Bay in December 1973. The results of these trawls are given in Table 12, together with depth of the stations and estimated catch per hour for vessels towing 8 fathom headrop trawls. These trials were undertaken with no prior knowledge of the area, but at all stations, the bottom proved to be good trawling ground.

DISCUSSION

We established the feasibility of undertaking a short term biological survey. Although not all species or areas were studied, enough useful data were obtained to make a comparison of Tin Can Bay - Great Sandy Strait with Moreton Bay where data had been obtained at the same time of year and in similar areas.

In this short study several points of interest have been raised. Physically, the estuary and its surrounds have been little disturbed by human activity. In the U.S.A. 50% of the nation's estuaries have been moderately altered by human activity and 23% have been severely modified (U.S. Fish and Wildlife Service, 1970). Whilst development has not reached this extent in Queensland, the fact remains that in a state with a history of industrial development, estuaries are among the first ecosystems to be altered.

Hydrology of the southern arm of Tin Can Inlet may be influenced by the presence of what appears to be a wedge of low salinity water, originating from drainage of the low dunes which have formed the heath downs and peaty swamps between Carlo Point and Teebean Point. Springs of fresh water continually flow from the base of beach dunes south of Rainbow Beach, and springs from this watertable could also feed into Tin Can Inlet. If this is the case, alteration of the height of this watertable could be expected to have marked effects on the hydrology of the southern end of Tin Can Inlet.

In the remainder of the estuary, water exchange rates with the open ocean are rapid, owing to the presence of a deep main channel and the absence of mobile, unstable sand bars. In the last fifty years there has been virtually no alteration in the position of any bank or bar in the estuary, according to local fishermen. This in itself is an unusual feature, as bar built estuaries are characterized by their instability (Pritchard, 1967).

From a biological point of view, one of the most interesting features of this estuary is the wealth of seagrass in the area, both in terms of diversity and area. There is more seagrass/unit of estuarine area in the Tin Can Bay - Great Sandy Strait complex than in any other Queensland estuary south of Bowen, which is as far north as we have surveyed. The monospecific stand of *C. serrulata* adjacent to the Tin Can Bay Bar is one of two known such communities which exist in Queensland, the other being in Moreton Bay. *C. serrulata* is more commonly found as part of mixed communities in northern waters and these monospecific stands may be botanical relicts from periods when warmer waters occurred in the area.

Seagrasses can provide the basis of estuarine food chains under certain conditions (Taylor and Saloman, 1968) and provide shelter for small and juvenile fish and other organisms, although little literature on this subject is available.

The study area contains extensive seagrass beds and stands of mangroves. Mangroves were found to be the major producer in the only recently published study of a tropical estuarine food web (Odum and Heald, 1972), and Wyatt and Quazim (1973) have suggested that leaf detritus may be the major energy source in the food webs of tropical estuaries. If this is the case, and area of intertidal angiosperms can be related to primary productivity, then the Tin Can Inlet - Great Sandy Strait complex may have a primary productivity approximately one half that of Moreton Bay (approximately 11,500 hectares compared with 25,000 hectares of intertidal angiosperms).

Conversely, disturbance of seagrass beds or mangroves would have a severe effect on both primary production and fisheries products in the area. Taylor and Saloman (1968) estimated that the dredging of 1,400 hectares of shallow estuarine water predominantly vegetated with seagrass caused an annual loss of 73 tonnes of fishery products per annum. Tin Can Inlet - Great Sandy Strait has marked similarities to this estuary.

The major fishery in the waters adjacent to Great Sandy Strait and Tin Can Inlet is the trawl fishery for prawns. Potter (unpublished data) and Lucas (1974) have tagged more than 80,000 prawns in and adjacent to Moreton Bay in the last five years, and the overall return has been 13,900 (15%). Of these, only 20 have been taken on the Tin Can Bay trawling grounds. Therefore, the majority of recruits to the Tin Can Bay fishery are coming from an alternative nursery ground - in all probability the Tin Can Inlet - Great Sandy Strait estuary.

Little fished prawn stocks in commercial quantities exist in the southern end of Hervey Bay (see page 8). In the absence of data on abundance of juvenile penaeids in the Mary River mouth and on the northern flats of Hervey Bay, it is not possible to delineate the nursery grounds of this stock. But we suggest that the Tin Can Inlet - Great Sandy Strait complex could be a possible source of recruits, as our data indicate few juvenile prawns occur in the northern end of Great Sandy Strait.

The professional scale fish and mud crab fisheries in the Tin Can Bay Estuary are operating at a relatively stable level, and we expect recreational fisheries to increase. Beverton and Holt (1957) have discussed the principle that total catch will decrease upon the application of excessive effort. In the absence of population parameters and catch/effort data for all species being taken by fishermen in the area, the point at which this decline will occur cannot be estimated. Dredge (m.s.) has established that juvenile bream (*A. australis*) summer whiting (*S. ciliata*) and flathead (*P. fuscus*) are found in shallow estuarine areas, and that their principal food items come from shallow sublittoral or littoral areas. Survey data given above agree with these findings. Hence recruitment of these three species, at least, is dependent on the maintenance of suitable habitat forms for the juveniles of the species.

CONCLUSION

The Tin Can Bay - Great Sandy Strait complex has been shown to support a diverse and stable estuarine fishery. It is suggested that recruits to an oceanic prawn stock which is not heavily exploited and may be more intensively utilized in the future come from this estuary. Leaf litter from seagrass beds and mangroves is thought to act as the base of the food chain for juveniles of commercially utilized fish species and penaeid prawns. Seagrass beds and mangrove swamps in the estuary are extensive, and hence potential production is high. The presence of large areas of seagrass may be related to the lack of disturbance of surrounding watershed lands and hence the absence of silt, etc. in the estuary.

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Mr F. Olsen prepared maps 1, 2, 2a, 3 and 3a and discussed presentation of mangrove data with the authors.

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TABLE 1

Zone	Vegetation	Approx. Proportions of Substrate Grain Size (C.S.: F.S. : S : C)	Salinity
(1) Bar	NIL	90 : 7 : <2 : <2	Only drops below that of open sea in extensive flooding
(2) Fringe	Abundant seagrasses on steep banks close to Bar	65-75 : 18-35 : 2-4 : 4	Only drops below that of open sea in extensive flooding
(3) Channel	None - too deep	NO DATA	Often remains high in flooding - owing to saline wedge effect
(4) Island - Bank	Seagrasses, some mangrove islands intact in channels	30-55 : 15-50 : 1-9 : 2-11	Drops appreciably after minor run off
(5) Delta	Extensive mangroves, c̄ creeks, etc., sometimes c̄ seagrasses, often mud flats		Drops appreciably after minor run off usually below oceanic salinity
(6) Brackish	Fringing mangroves, often "odd" species, some sparse seagrasses. Sometimes a lake system.	40-60 : 20-30 : 2-4 : 2-8	Generally below that of oceanic systems

C.S. = Coarse Sand; F.S. = Fine Sand; S. = Silt; C. = Clay

Grain Size description and methods of selection are those of the International Soil Science Conference.

TABLE 2

Location	Hook Pt. to Inskip Pt.		Kauri Creek to Boonooroo		Boonooroo to Moonboom I.		Tin Can Inlet and Teebar C.		Poverty Pt. and Teebean Pt.		Total Estuary	
Zone	Bar		Deltaic and Channel		Deltaic, Bank and Channel		Deltaic and Channel		Brackish Water		-	
Area (ha)	3 000		12 900		11 000		6 100		1 500		34 500	
% of Estuary	9.0		37.5		32.0		17.0		4.5		-	
	Area	*%	Area	*%	Area	*%	Area	*%	Area	*%	Area	*%
Submerged Land	2 500	83	6 400	49	3 500	32	2 000	33	500	33	14 900	43
Inter-Tidal Land	500	17	6 500	51	7 500	68	4 100	67	1 000	67	19 600	57
Seagrass	NIL	-	1 900	15	2 000	18	700	16	200	14	4 800	17.3
Mangroves	NIL	-	1 900	15	3 200	30	1 400	23	200	14	6 700	19.3

*Percentage of each zone

TABLE 3

TIN CAN INLET AND GREAT SANDY STRAIT SEAGRASSES.
AREA OCCUPIED AND SPECIES COMPOSITION

Seagrass Community	Area (Hectares)	% of Study Area
Z. capricorni, H. ovalis H. uninervis	2700	7.8
H. ovalis, H. uninervis	1500	4.4
C. serrulata	600	1.7
S. isoetifolium	<5	<.1
H. spinulosa	Unknown	Unknown
TOTAL	>4800	>14.0

TABLE 4

TIN CAN INLET AND GREAT SANDY STRAIT SEAGRASSES

DRY WEIGHT BIOMASS AND SPECIES COMPOSITION

Sample Site	Seagrass Species								Total Dry Weight Biomass
	Z. capricorni		*H. ovalis*		*H. uninervis*		*C. serrulata*		
	g m^{-2}	%	g m^{-2}	%	g m^{-2}	%	g m^{-2}	%	g m^{-2}
A			6.4	36	11.2	64			17.8
G	128.0	86	1.6	1	17.6	12			146.2
J	88.0	77	4.8	4	20.8	18			113.6
M	174.4	99	1.6	1					176.0
N	52.8	60	8.0	9	27.2	1			88.0
O							417.6	100	417.6
P	86.4	98	1.6	2					88.0

TABLE 5

MORETON BAY SEAGRASSES

DRY WEIGHT BIOMASS AND SPECIES COMPOSITION

Location	Seagrass Species								Total Dry Weight Biomass
	Z. capricorni		*H. ovalis*		*H. uninervis*		*C. serrulata*		
	$g\ m^{-2}$	%	$g\ m^{-2}$	%	$g\ m^{-2}$	%	$g\ m^{-2}$	%	$g\ m^{-2}$
Aldershot Banks, Southport (Littoral)	80.0								80.0
Aldershot Banks, Southport (Sublittoral)	230.0								230.0
Amity Point (Littoral)	56.0	50	56.0	50					112.0
Amity Point (Sublittoral)							304.0		304.0
Toorbul Point (Littoral)	144.0	55	17.6	7	100.8	38			262.4

TABLE 6

Location	Seagrass Biomass g m^{-2}	Mean of 2 Trawls				
		King Prawn	Greasyback Prawn	Tiger Prawn	*Metapenaeus endeavouri* (Schmitt)	*Metapenaeus ensis* (de Haan)
A Sparse *H. uninervis* and *H. ovalis*	17.8	50	37	1	1	1
B Bare		92	40			
C Sparse *H. uninervis* and *H. ovalis*		164	178	2		
D Sparse *H. uninervis* and *H. ovalis*		305	9			
E Creek, sandy		100	19			
F Creek, muddy sand, seagrasses		65	128			
G Thick seagrasses	146.2	152	162	26		
H Bare sand		288	16			
J Extensive bed of seagrasses	113.6	312	23	1		
K Humpy sand and seagrass		141	28	2	1	
L Thick seagrass		9	40	12		1
M Thick *Zostera*	176.0	67	153	31		1
N The Bluff, seagrass	88.0	435	12	5		
O *Cymodocea serrulata*	417.6	5	4	2		
P *H. uninervis*, *H. ovalis*	88.0	169	270	19		
Q Bare sand, sublittoral		40	40	4	3	
U Bare sand			1			
V Bare sand		2	2			
W Bare sand		4				
X Bare sand		3				
Y Bare sand		5				

Number of prawns caught as a mean of two 50 metre beam trawls pulled against the tide.

TABLE 7

JUVENILE PRAWNS CAUGHT IN MORETON BAT AT THE SAME TIME OF YEAR

Location		Seagrass Biomass g m^{-2}	Mean of 3 Trawls			
			King Prawn	Greasyback Prawn	Tiger Prawn	School Prawn
Aldershots Littoral	Bare Mud		273	13	1	1
Aldershots Sublittoral	*Z. capricorni*	230	233	38	11	13
Amity Point Littoral	*Z. capricorni* *H. ovalis*	112	467	0	3	3
Amity Point Sublittoral	*C. serrulata*	304	3	0	0	0
Deception Bay Littoral	Bare Mud		83	1	0	0

TABLE 8

FREQUENCY OF OCCURRENCE OF JUVENILES (OCCURRENCE/SAMPLE)

Habitat Type	*Mugil cephalus* (Mullet)	*Pomatomus saltator* (Tailor)	*Acanthopagrus australis* (Bream)	*Sillago maculata* (Winter Whiting)	*Sillago analis* (Yellow Finned Whiting)	*Sillago ciliata* (Summer Whiting)	*Platycephalus fuscus* (Flathead)	Number of Times Sampled
1 - BAR								1
Littoral		N						1
Sublittoral		O						
2 - FRINGE		T						
Littoral			2/7	1/7	0	2/7	2/7	7
Sublittoral			1/7	1/7	0	2/7	3/7	7
3 - CHANNEL		T	0	1/3	0	0	1/3	3
4 - ISLAND BANKS		A						
Littoral		K	1/2	0	0	0	0	2
5 - DELTAIC								
Littoral		E	5/9	1/9	0	1/9	4/9	9
Sublittoral		N	1/8				5/8	8
6 - BRACKISH	3/13		2/13	0	3/13	0	1/13	13

TABLE 9

FISH BOARD RETURNS (Pounds Weight)

Species	Maryborough			Tin Can Bay		
	1971	1972	1973	1971	1972	1973
Barramundi (X)	1164	1212	1547	-	-	-
Bream (X)	35022	40169	33456	12238	18199	15385
Black Bream (X)	1826	711	596	1318	51	31
Cod	1174	397	1915	794	268	322
Dart	4358	2585	2964	4621	1070	3539
Long Tom (X)	-	-	6	7	-	-
Emperor	231	67	579	1107	142	203
Flathead (X)	12903	11065	13967	3375	5902	9333
Garfish (X)	9183	7408	9465	1774	6669	6752
John Dory (X)	440	890	1493	34	6	317
Jew (X)	179	262	235	215	265	136
King (X)	2757	6454	7265	193	45	1211
Mackerel	34102	18753	21994	4066	855	2175
School Mackerel	13743	24555	25866	669	1334	288
Morwong (X)	-	-	-	-	67	49
Mullet (X)	334398	268328	190590	122597	88517	81662
Nannygai	119	74	123	115	24	114
Parrot	177	58	772	438	36	68
Pike (X)	188	1111	298	96	74	105
Ray	6239	4864	7405	3349	1391	2074
Salmon (X)	2758	2470	1849	-	76	140
Sampson (X)	14	43	4	93	38	22
Snapper (X)	270	526	614	1388	232	747
Squire (X)	52	111	149	940	97	1905
Sweet Lip	489	353	1875	5674	282	136
Tailor (X)	10312	16542	37786	49733	34557	5521
Trevally	1254	119	621	380	48	925
Coral Trout	270	24	1187	1506	188	12
Trumpeter (X)	574	305	468	-	-	-
Tuna	221	99	227	31	66	-
Whiting (X)	100281	85602	90960	25220	29616	34282
Yellow Tail	337	85	149	84	-	5
Others	2136	1594	4301	2905	2157	2760
Mixed	2286	1587	1118	5794	8943	8008

Species marked (X) are thought to be estuarine dependent at some stage of their life cycle.

TABLE 10

LANDINGS OF MUD CRABS (*S. SERRATA*)

AT FISH BOARDS (NUMBERS OF BODIES)

Year	Tin Can Bay	Maryborough
1971	5,791	16,136
1972	2,929	25,959
1973	7,507	20,957
1974	12,957	38,078

TABLE 11

TIN CAN BAY PRAWN FISHERY

Year	*Catch Landed at T.C.B. (lbs.)	*Value
1956/57	887	£ 173
1957/58	315,496	59,517
1958/59	489,389	70,189
1959/60	40,827	7,300
1960/61	NO	DATA
1961/62	122,614	21,857
1962/63	219,961	31,953
1963/64	468,709	96,047
1964/65	261,989	50,711
1965/66	206,417	$ 80,584
1966/67	101,140	44,294
1967/68	123,528	59,227
1968/69	319,886	161,363
1969/70	186,524	108,467
1970/71	226,573	115,552
1971/72	162,527	81,263
1972/73	148,883	111,663

*Fish Board Annual Reports and Queensland United Foods Pty. Ltd. Receivals.

TABLE 12

COMMERCIAL PRAWN SPECIES FROM 30 MINUTE SAMPLE TRAWLS IN HERVEY BAY, QUEENSLAND

Station	Depth Fathoms	King (E & W) No.	Tiger No.	Endeavour No.	*Traphypenaeus* Sp. A No.	*Traphypenaeus* Sp. B No.	Tot. Sample Wt.	Estimated Commercial Catch/Hour
1	3	14	23	22	85	-	10 lb.	27
2	6	23	32	16	172	68	13 lb.	35
3	4½	850	6	8	20	-	18 lb.	48
4	5½	216	48	16	41	30	15 lb.	40
*5	7	-	1	-	-	-	-	-
6	9	17	6	9	120	10	8 lb.	21
7	9½	47	2	6	320	-	12 lb.	32
8	10½	12	2	4	650	20	15 lb.	40
9	4½	32	-	-	250	-	7 lb.	19
10	6	40	-	-	380	-	11 lb.	29
11	8	34	-	-	160	-	6 lb.	16
12	10	27	1	-	43	10	3 lb.	8
13	10	12	3	-	37	-	2 lb.	5
14	8	77	4	3	290	90	15 lb.	40
15	5	126	-	-	800	50	18 lb.	48

*Daylight

APPENDIX 1

Site	Depth (m)	Zone	T (°C)	Sal. (PPT)	Comm.	O_2	$InPO_4$	NO_3	Part Phosph.	SiO_4	Chloroph. *a*	Chloroph. *b*	Chloroph. *c*	Part. nit.	NH_3	Chem. O_2 Demand	Nitrites
						P. P. M.											
Hook	23	1 Top	27.7	34.77)	Oceanic	4.80	4.5	4.7	4.8	271	1.42	0.13	0	79.8	42.4	1052	0.9
Point		Bottom	27.3	34.77)		4.70	6.4	6.4	4.6	254	1.05	0	0	58.7	53.6	1003	1.3
Kauri Ck.	4	2 Top	28.5	33.72)	Some	4.39	4.1	20.5	6.0	381	.80	0.10	0	61.4	38.4	897	1.8
Mouth		Bottom	27.9	34.33)	wedging	4.39	3.8	7.2	4.8	321	1.32	0.26	0	51.8	33.6	515	1.1
Tin Can	11	3 Top	28.2	31.12)	Marked	4.78	3.2	2.4	3.9	263	1.57	0.33	0	42.4	22.8	515	1.3
Estuary		Bottom	27.9	34.04)	wedge	4.80	4.1	3.6	3.3	271	1.16	0.25	0	31.3	27.9	633	1.6
Tin Can	11	3-5 Top	28.3	31.6)	Freshw.	4.57	4.1	14.1	4.5	246	1.85	0.43	1.23	45.5	18.4	685	1.5
Inlet		Bottom	18.2	32.4)	influence	4.48	3.5	8.6	2.9	265	1.91	0.21	0	36.4	16.9	550	1.7
Poverty	3	6 Top	29.3	28.5)	Permanent	4.75	3.5	3.4	3.4	196	1.32	0.06	0	56.7	23.5	848	1.6
Point		Bottom	28.5	28.8)	Dilution?	4.72	2.9	2.2	4.3	241	1.44	0.37	0	45.6	16.7	935	1.0

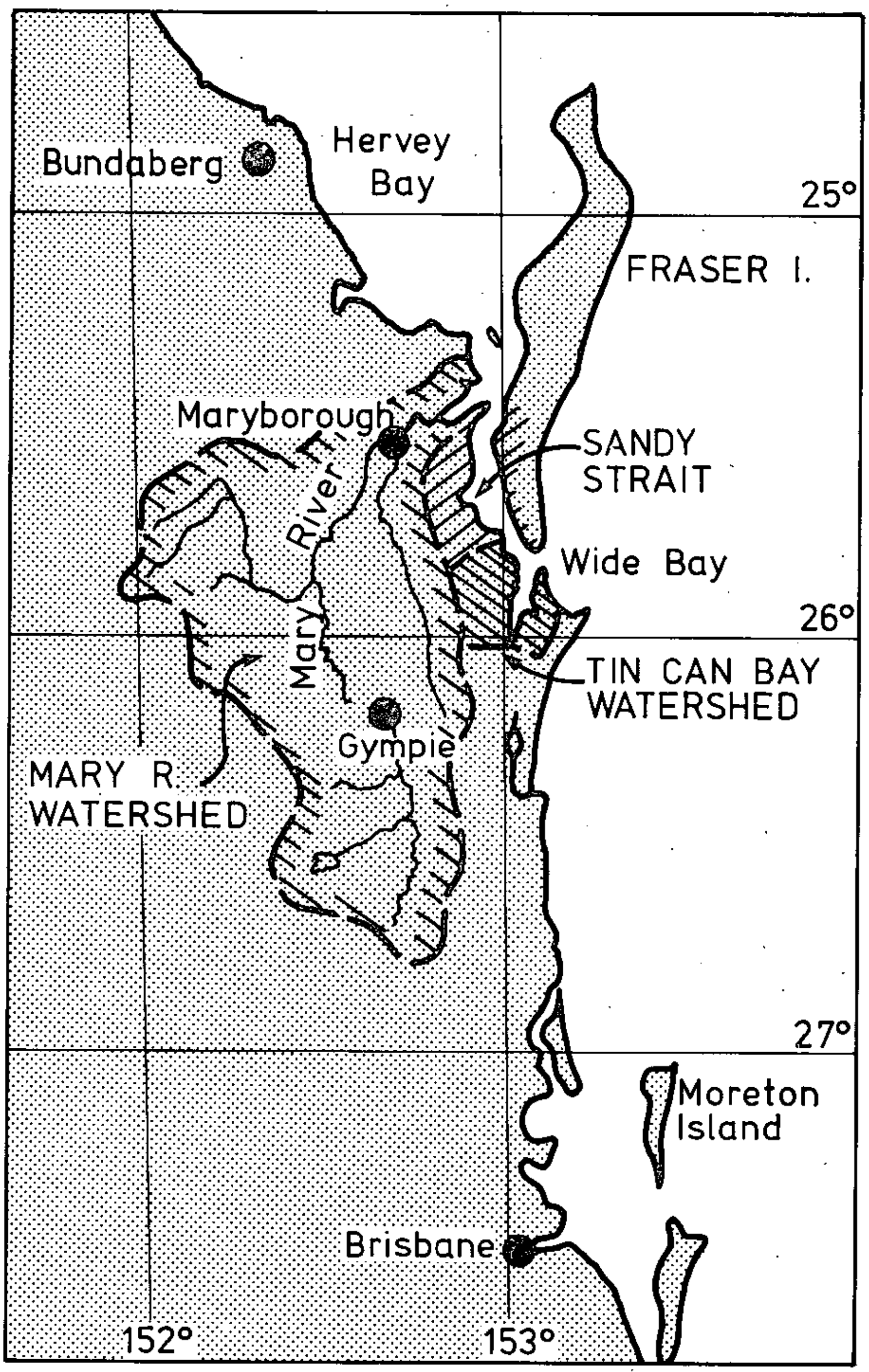

Fig. 1. The Tin Can Bay system and associated watersheds

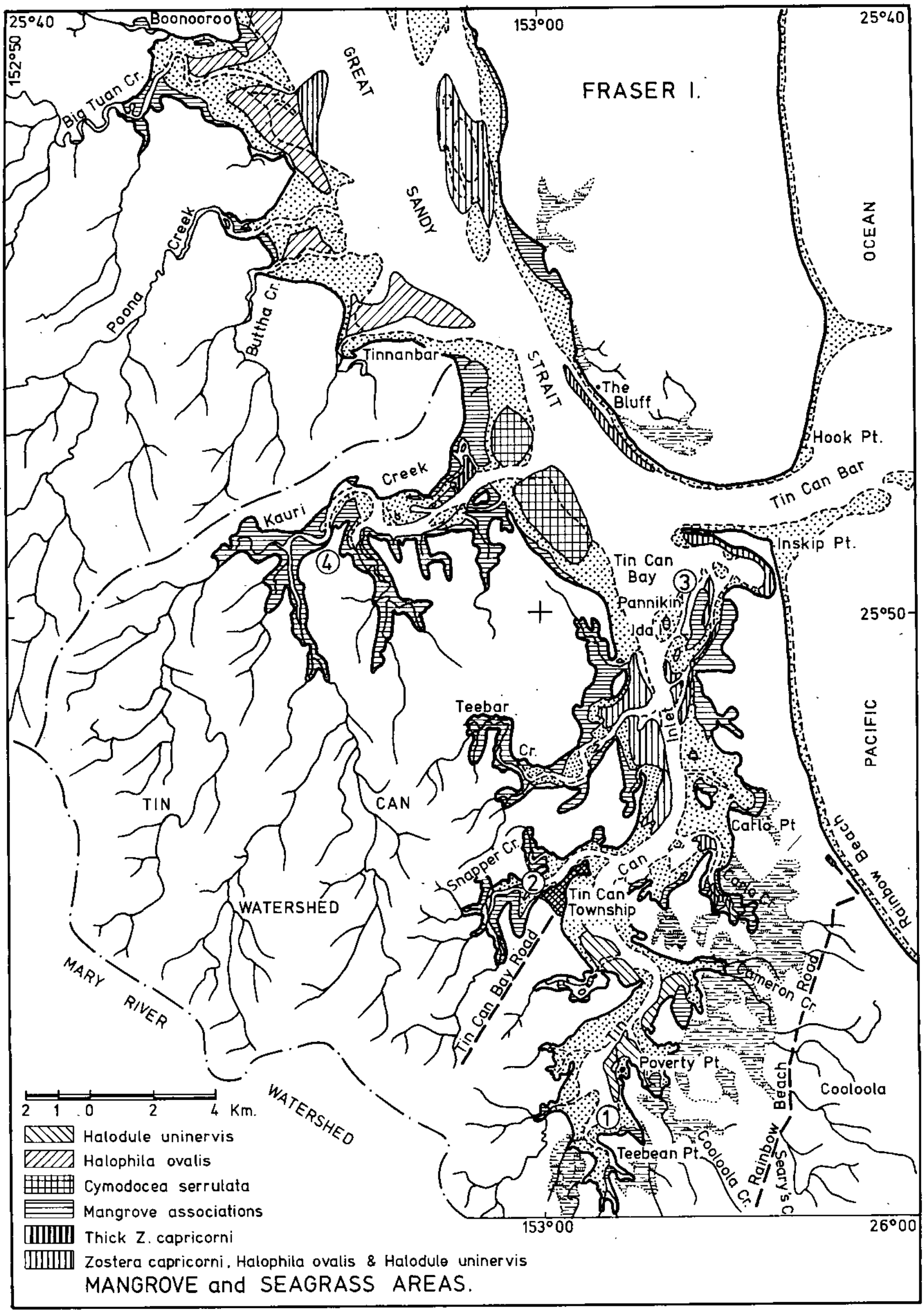

Fig. 2. Mangrove and seagrass areas, 25° 40 to 26° 00

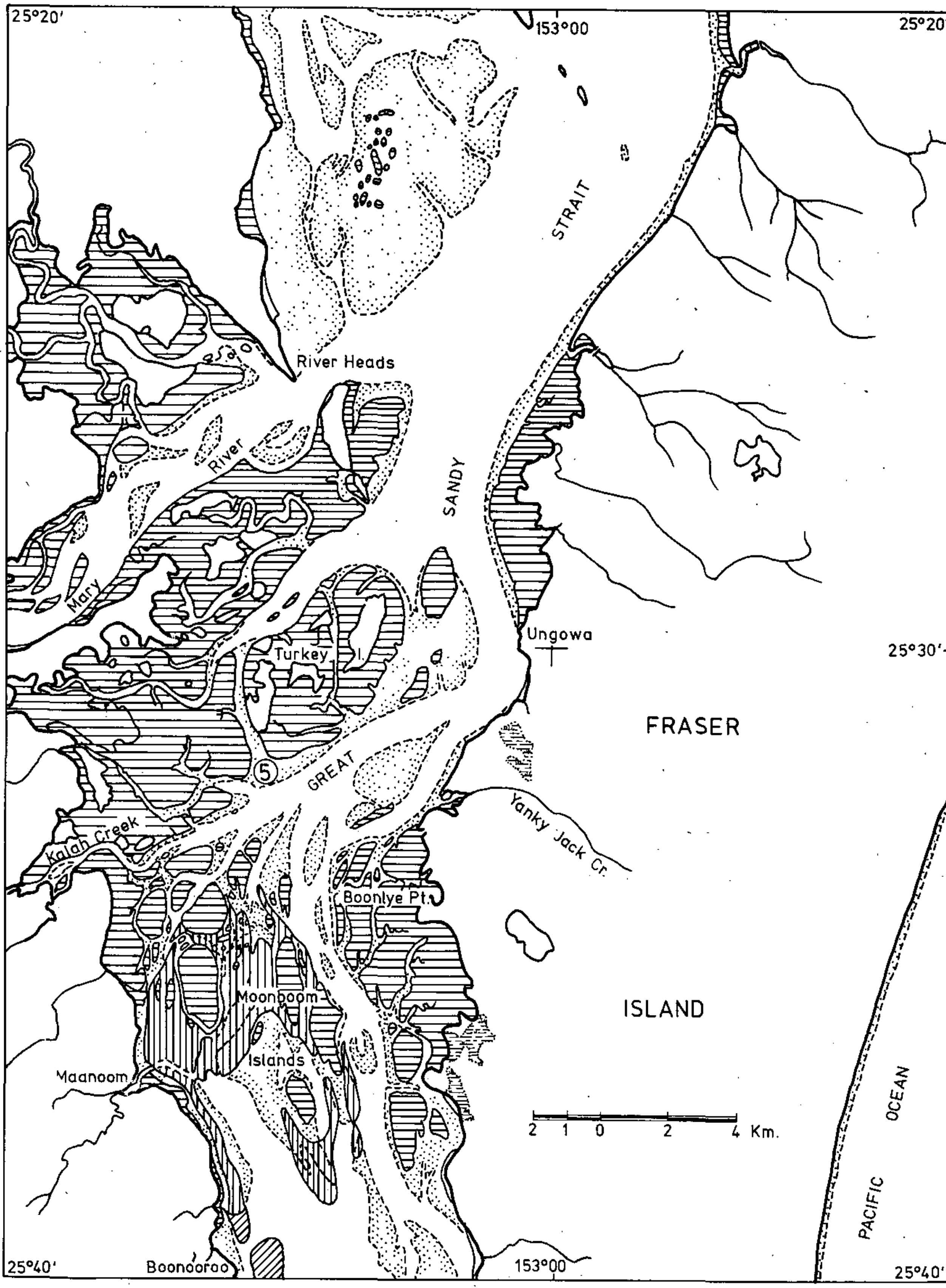

Fig. 2a Mangrove and seagrass areas, 25° 20 to 25° 40

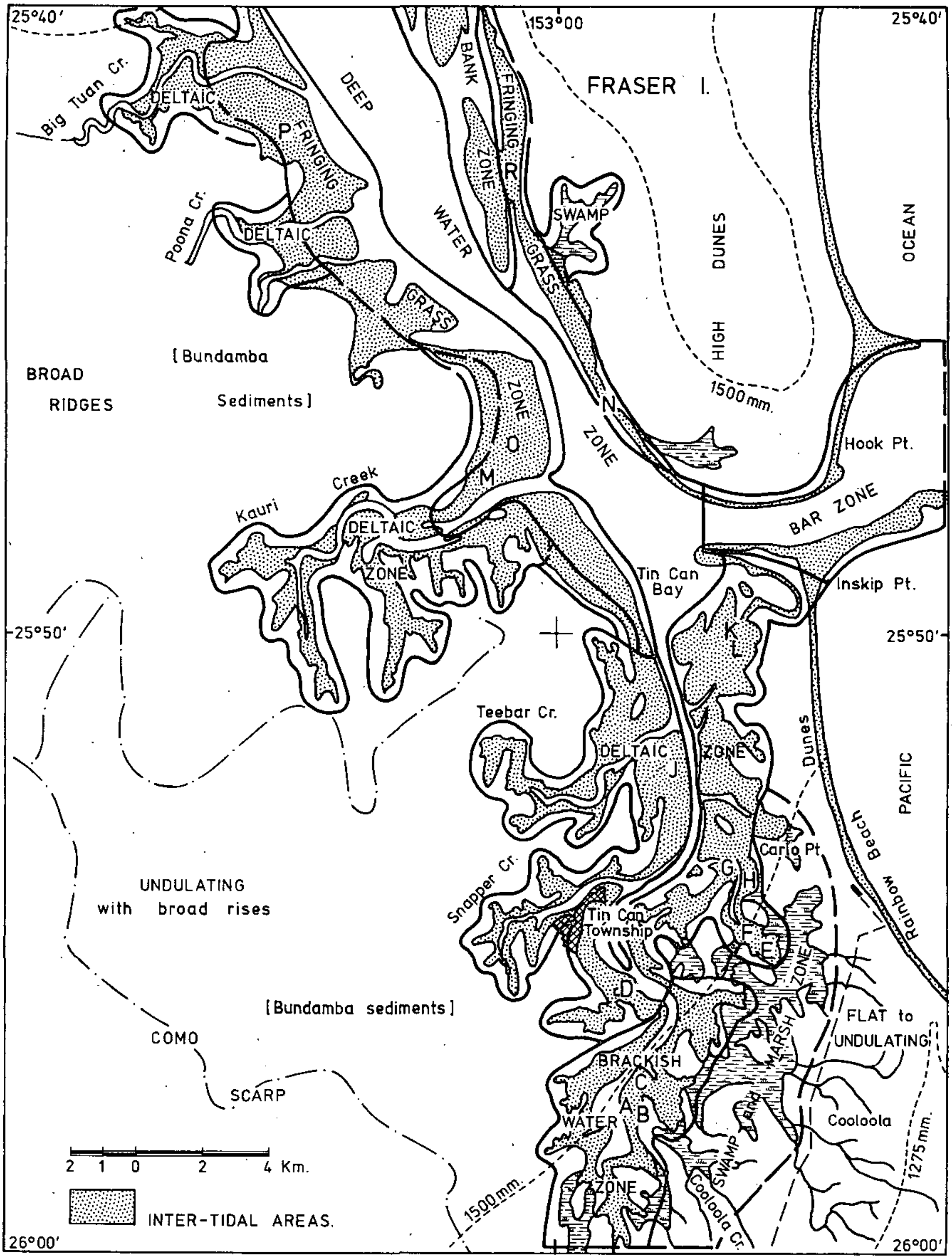

Fig. 3. Zonation and location of sampling stations, 25° 40 to 26° 00

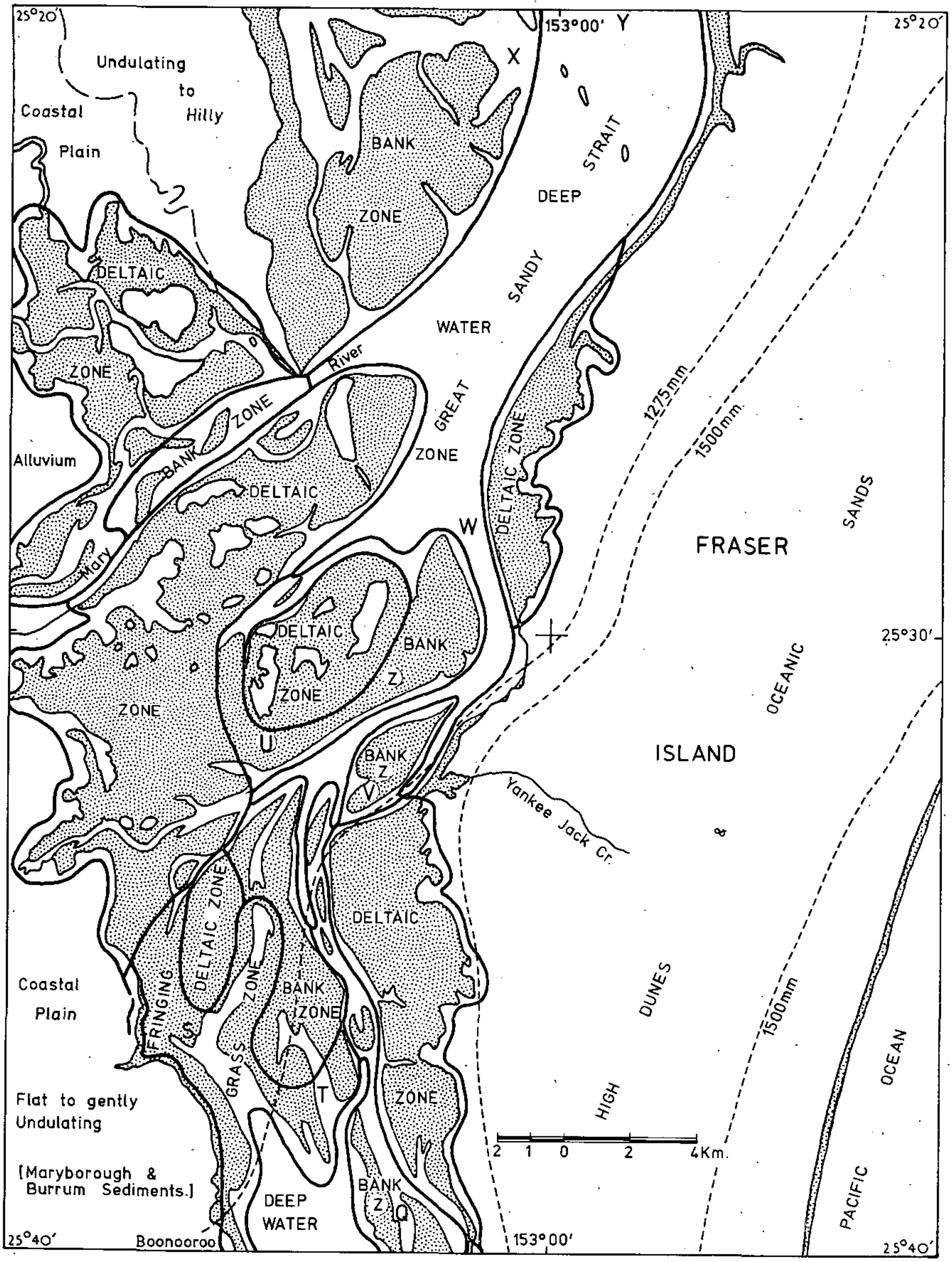

Fig. 3a Zonation and location of sampling stations, 25° 20 to 25° 40