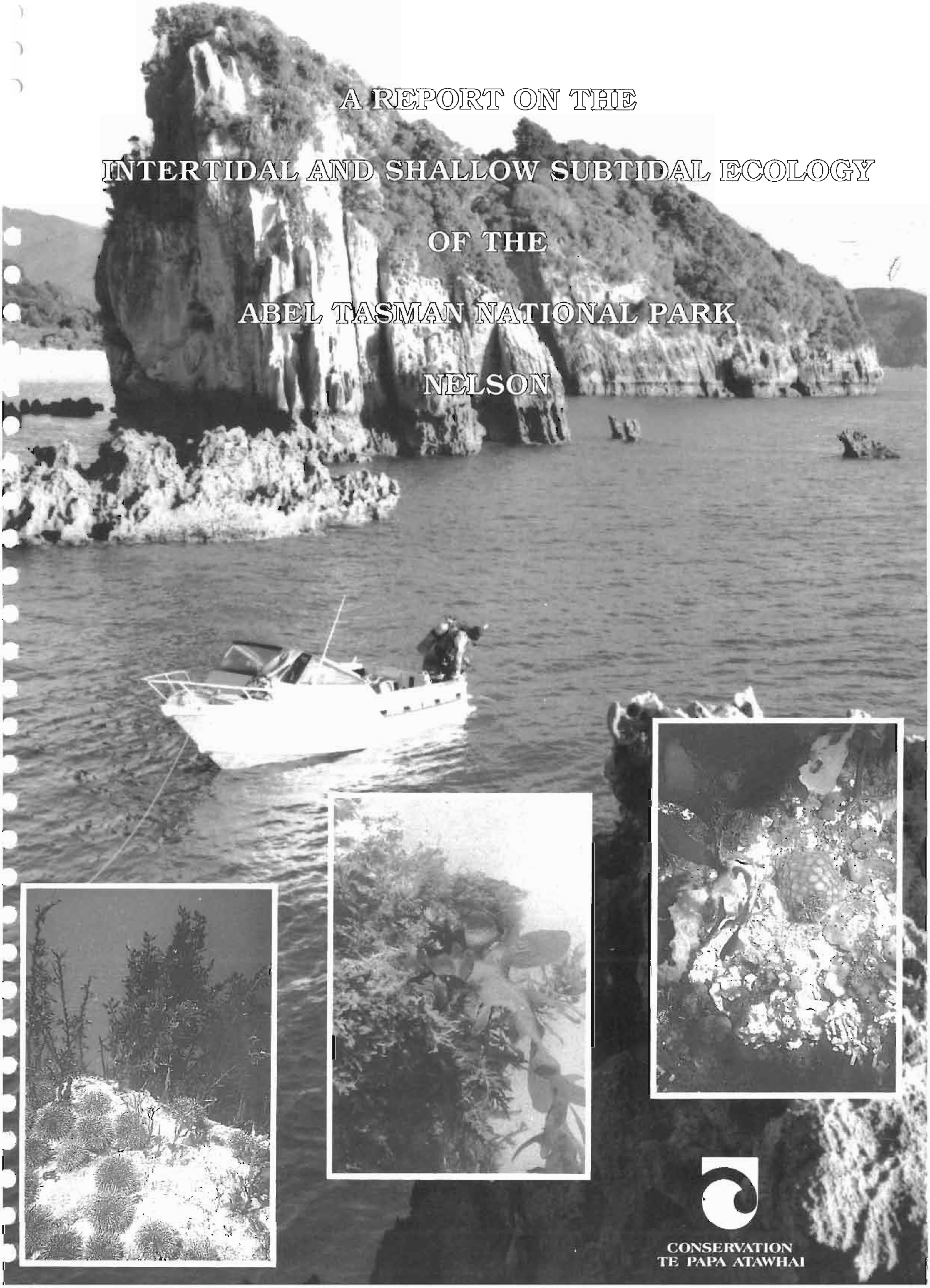
A REPORT ON THE INTERTIDAL AND SHALLOW SUBTIDAL ECOLOGY OF THE ABEL TASMAN NATIONAL PARK NELSON



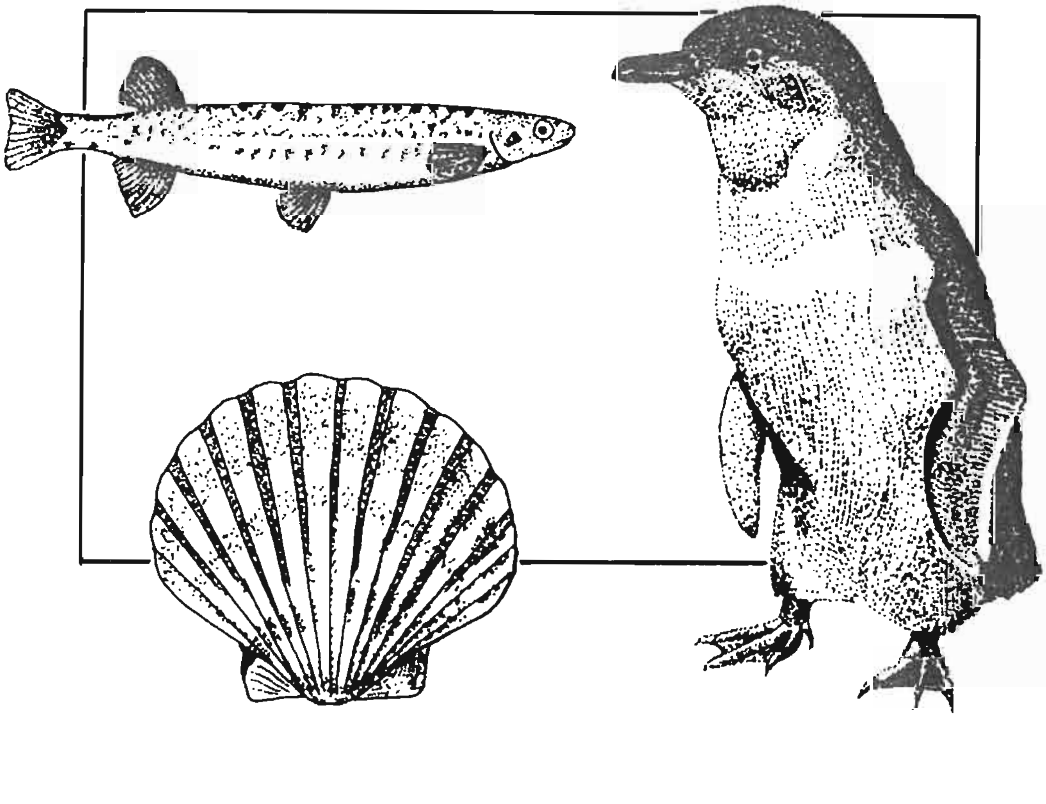
CONSERVATION
TE PAPA ATAWHAI

A REPORT ON THE INTERTIDAL AND SHALLOW SUBTIDAL ECOLOGY OF THE ABEL TASMAN NATIONAL PARK NELSON

1992

Robert J Davidson

Contributions from: Gail Quayle (birds);
Doug Latham (habitat maps); Steve Bagley (archaeological)



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Occasional Publication No. 4

No creature other than man has the ability to destroy fragile marine communities so thoroughly and completely that there becomes a desperate need for marine reserves ... it is only with their establishment that we will see the magnitude of our atrocity.......(RJD)

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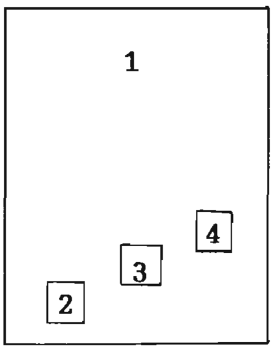

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2. Malcolm Francis
3. Rob Davidson
4. Lindsay Chadderton

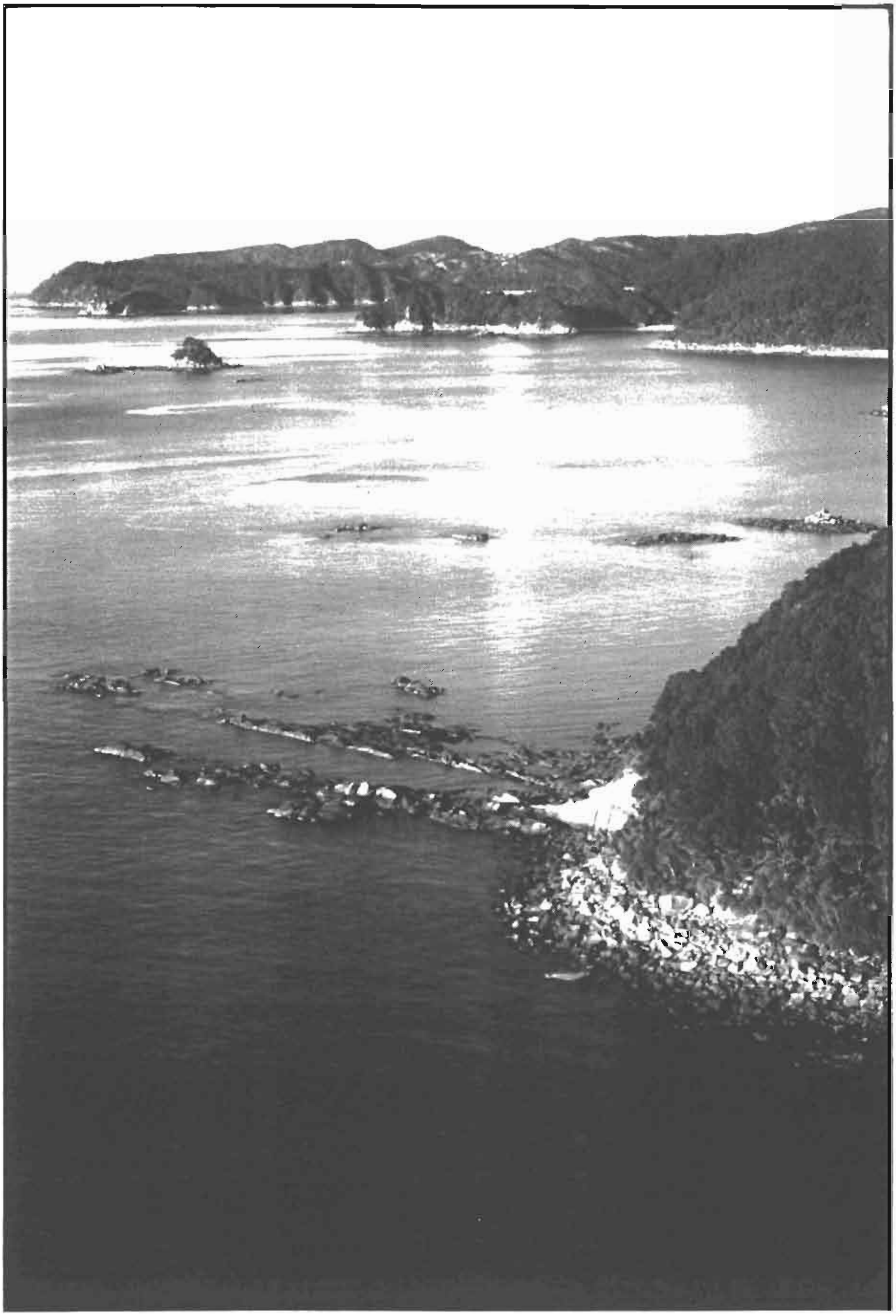

Photo 1. Abel Tasman coastline, Foul Point to Pitt Head.

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ABSTRACT

Measured along the high tide mark, the Abel Tasman National Park coastline is 91.6 km in length and is characterised by golden sand beaches, sandy estuaries and granite coastline. The ecology of these marine areas, although adjacent to a National Park, were previously poorly understood.

Following an ecological investigation of the estuaries, intertidal and shallow subtidal environment along the Abel Tasman National Park between October 1990 and July 1991, eight intertidal and 12 subtidal habitats and substrates were recognised. These were mapped at a 1:15000 scale.

A combination of quantitative and qualitative sampling techniques revealed typical community types associated with these substrates and habitats. The community patterns appeared to be influenced by various environmental constraints including depth, exposure, and substrate.

Intertidal and subtidal core samples from 26 sites (n=130 cores) were collected from soft shores. Communities from 37 intertidal and subtidal rocky sites were also investigated.

These preliminary data suggest little variation of invertebrate and fish communities along the granite and soft shores along the Abel Tasman coastline. Differences in the biota were recorded between limestone and granite shores, exposed and sheltered sites and with increasing depth.

Diversity and density of invertebrates suggested that low productivity/fertility, a characteristic of terrestrial catchments, may influence the marine environment. Reasons for this phenomenon are discussed.

A low biomass of macroalgae was recorded along most of the coastline. This may also contribute to low productivity for the shallow inshore areas of the park.

Reef fish diversity appeared relatively high, but numbers and size of edible species were very low. Loss of juvenile habitat through dredging and recreational fishing pressure may limit recovery of reef fish stocks. The first South Island record for the crested blenny was recorded for Taupo Point.

Bird data were compiled from existing information, expert sources and field visits. The Abel Tasman coastline is important to the threatened banded rail and vulnerable reef heron. An unknown number of blue penguin breed along this coast.

The Abel Tasman coastline is representative of a granite dominated shore in a relatively sheltered aspect. Notable features are low biomass of algae, large subtidal barren zones, relatively unmodified estuaries, limestone outcrops and the large areas of bryozoan 'corals'.

The terrestrial environment of the Abel Tasman National Park has been seriously modified by human activities including logging, burning and farming. Poor fertility has slowed the regeneration process and many areas are still dominated by gorse and scrub (Dennis, 1985).

Results from the present investigation of the marine environment suggests the shallow subtidal environment is highly modified and continues to be influenced by human activities. The few areas that remain undisturbed are therefore of high ecological value.

Twenty seven areas with biological significance were recognised in the present investigation. Particular marine features along the park are internationally recognised (Separation Point bryozoans), while others are nationally or regionally important.

A programme designed to monitor changes in marine communities inside and outside protected areas is suggested.

Recommendations for the management of the coastal and marine zone of the Abel Tasman National Park conclude the report.

1. INTRODUCTION

On 19 December 1942, 300 years to the day after Abel Janzoon Tasman's tragic skirmish west of Separation Point, the Abel Tasman National Park was established. The park has steadily grown from its initial 15,210 ha and now covers 24,500 ha. Although the park boundary extends 2.41 km offshore, no coastal environment below mean high water is fully protected. This effectively means that much of the estuarine area, a large portion of the sand beaches and rocky shores, and all of the shallow subtidal areas along the Abel Tasman coastline are not protected under the National Parks Act.

Various authors have suggested that the protection available to the terrestrial environments of the Abel Tasman should be extended into the adjacent coastal and marine areas (Rennison, 1978; Dennis, 1985; Rushton, 1987). The argument is the strong relationship between the terrestrial coastal zone and the adjacent marine areas. Indeed, the strongest impressions of the Abel Tasman are the coastal areas. The concept that these areas are not protected is of frustration to those who know and love the park.

In 1987, MAF Fisheries published a report on the Abel Tasman coastline which discussed the potential for marine reserve status and other protection options (Rushton, 1987). The main objective of this study was to investigate the ecology of the intertidal and shallow subtidal environment adjacent to the National Park. This information will then be used to direct and support legal protection along the abel Tasman coastline.

2. ABEL TASMAN COASTLINE

The Abel Tasman National Park is located 35 km north-west of Nelson, in the northern part of the South Island, New Zealand. The coastline of the park stretches 91.6 km from Wainui Inlet in the north to Marahau Estuary in the south (Fig. 1). Ngaio Island 3.3 km south of the Park, the Tata Islands and Abel Tasman Memorial 3 km and 4.2 km to the east are also part of the National Park.

The coastline separates Tasman Bay from Golden Bay. Both bays and the Abel Tasman are sheltered from ocean swells by the Marlborough Sounds, Farewell Spit and the South Island. Both Tasman Bay and Golden Bay are shallow (<45m depth), and dominated by soft sediments and alluvial gravels.

Granite boulder and rock substrates exposed during a period of uplifting during the Rangitata orogeny dominate the Abel Tasman coast. This granite feature is known as the Separation Point Batholith and stretches from Murchison to the south of the Taranaki coast (M. Johnston, pers. comm.). An overlying layer of limestone formed during the Oligocene 30 million years ago has since eroded leaving isolated limestone outcrops at Taupo Point and Tata Islands. The eroding power of the sea has gradually shaped the Abel Tasman coastline creating all of the offshore reefs and islands. The sand beaches are dominated by coarse sands and pebble material derived from local granite washed down the numerous streams. This material has also formed sand bars and spits forming estuarine and lagoon areas.

Estuarine areas range in size from 0.45 ha to 289.7 ha at Awaroa Inlet. All estuaries in the park are dominated by coarse substrates such as sand, coarse sands and small pebbles. This feature differentiates the estuaries of the Abel Tasman from most others in the Nelson/Marlborough region. The dominance of coarse substrates appears to have a significant impact on the biological productivity of these areas (chapter 4.4).

The presence of food in estuaries and inshore waters was utilized by the Maori. Archaeological evidence of Maori occupation is spread fairly evenly along the coastline in the form of middens, kumara storage pits, hut terraces, work sites and defensive ditches (Dennis, 1985). Archaeological evidence suggests that permanent occupation occurred at few sites along this coastline (Awaroa, Wainui) (Fig.2, Appendix 2). Storage pits are generally small and scattered, suggesting that the number of Maori living at any one time was relatively low.

First European visit was in December 1642 by Abel Janzoon Tasman. Their visit was short as four of Tasman's men were killed by local Maori. The area was not visited again by Europeans until Sebastian Caesar Dumont D'Urville in the corvette Astrolabe anchored in 1827. D'Urville described the coast as "a most picturesque landscape with hilly country, cool dark forests and lovely sandy beaches". He went on to say how the lowland coastal forests reminded him of the many sights of New Guinea with ferns of every kind.

European colonisation of the Abel Tasman coastline began in the 1840's. Early boat-builders at Torrent Bay and Awaroa Inlet were soon joined by leaseholders farms or homesteads which were established at Whariwharangi, Mutton Cove, Totaranui, Wainui, Awaroa, Bark Bay, Torrent Bay and Marahau. Farms still remain at Awaroa, Wainui and Marahau on the alluvial flats adjacent to these estuarine areas. Farming along most of the coast failed largely because of low soil fertility. Infertile land and depletion of natural resources through saw-milling at sites such as Awaroa, Waiharakeke and Totaranui lead to the end of infant settlements like Awaroa. By 1932, the community at Awaroa was too small to support a local school as the local population slowly drifted away (Dennis, 1985).

Through this period of human modification, small areas of land were reserved (Bark Bay and Sandfly Bay in 1897, Falls River in 1906), and in 1920-21, large parts of the difficult interior had been made into forest reserves. In 1937 the Lands Department suggested the creation of a scenic reserve of some 14,000 ha. About this time, a campaign by Perrine Moncrieff of Nelson was launched to establish a national park. The establishment of the Abel Tasman National Park on 19 December 1942 was timed 300 years to the day after Abel Tasman's tragic skirmish west of Separation Point. The park has steadily grown since its initial 15,210 ha and now encompasses at a total of 24,500 ha. The seaward boundary of the park is 2.41 km offshore from Separation Point, south to Gilbert Point. The offshore boundary encompasses most of the islands and stacks, however, protection does not extend below mean high water (3.6 m above chart datum). Furthermore, this seaward boundary does not cover the Tinline, Marahau, Whariwharangi, Taupo Point and Tata Islands areas.

2.1 THE ECOLOGICAL PAST

Terrestrial

Many Maori names along the Abel Tasman coastline refer to the past vegetation cover. "Totaranui" means "big, or many totara"; Rakauroa (Torrent Bay) means "tall trees"; Whariwharangi is a tall tree; Waiharakeke means "stream or river with flax"; Pukatea (Te Pukatea Bay) is the large New Zealand laurel tree and Ngaio (Ngaio Island) is a native coastal species. Descriptions of the terrestrial environment by D'Urville in 1827 suggested the luxuriant forests immediately adjacent to the coastal zone were full of birds, while the vegetated areas on the upper ridges had an air of funeral silence. D'Urville commented about these inland areas, "without doubt, the natives are not anxious to quit the food-producing coasts to wander in these sad and sterile deserts". Logging in the Awaroa, Totaranui, Mutton Cove, Whariwharangi areas also suggest that considerable stands of lowland alluvial forests once existed in these coastal areas. These forests have disappeared and are now in the slow process of regeneration. In contrast with these flat alluvial areas, the surrounding hills are extremely infertile and largely covered in various stages of scrub vegetation which is recovering from past farming practices.

A survey of the botanical features of the National Park by Elser (1962), suggested that almost all of the park was once forested. Elser states that red beech (*Nothofagus fusca*) forest covered the greatest area. Nearer the coast it was replaced by black beech (*N. solandri*) and hard beech (*N. truncata*) and in more fertile parts by podocarp/broadleaf forest.

Estuaries, Beaches and Intertidal Rocky Coastline

Little historical information is available on the biology of the estuaries, beaches and the rocky intertidal zone of the Abel Tasman National Park. Examination of old photographs and early paintings reveal some interesting information. In a sketch by De Sainson in 1827

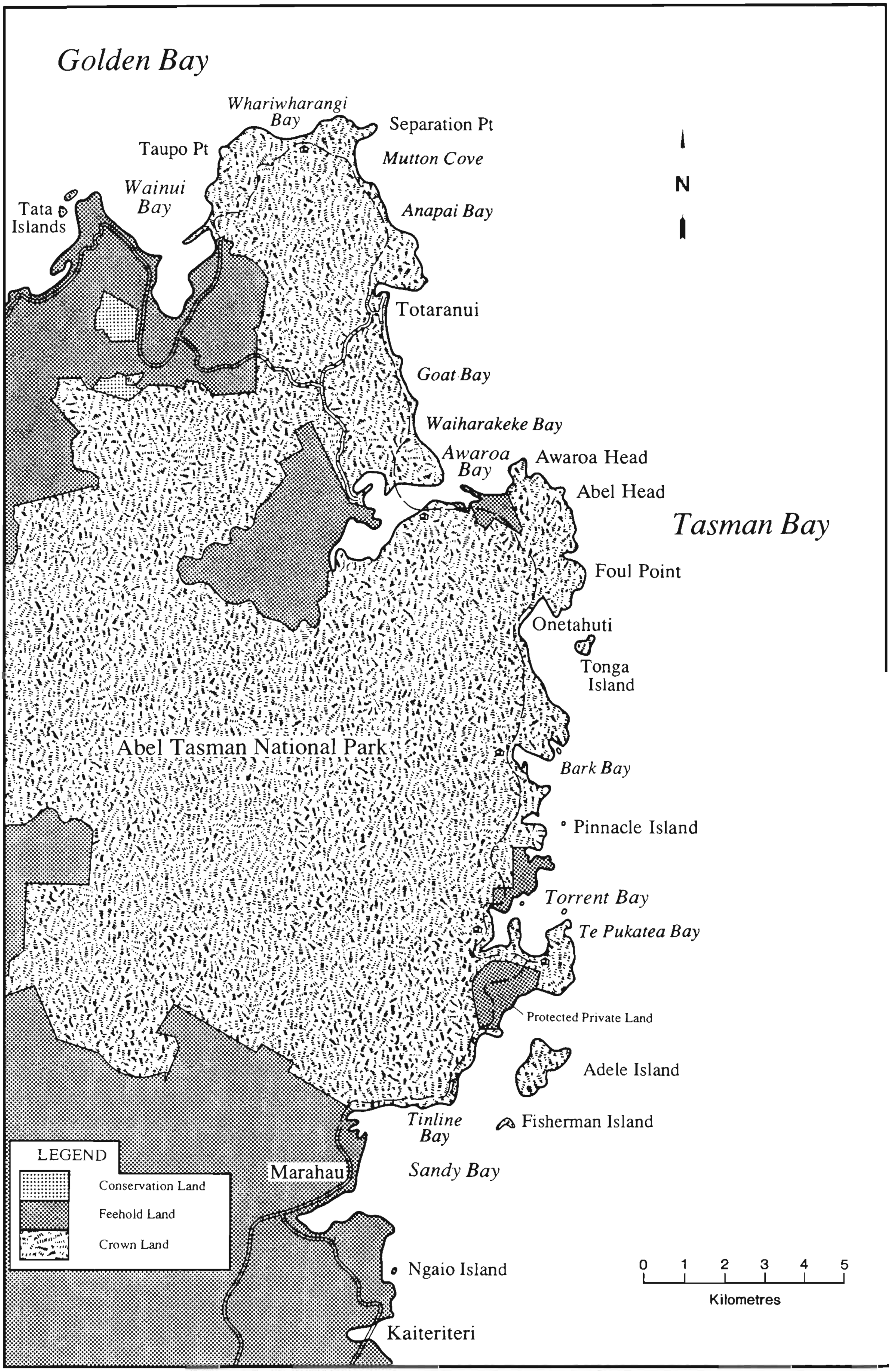

Fig. 1 LAND TENURE

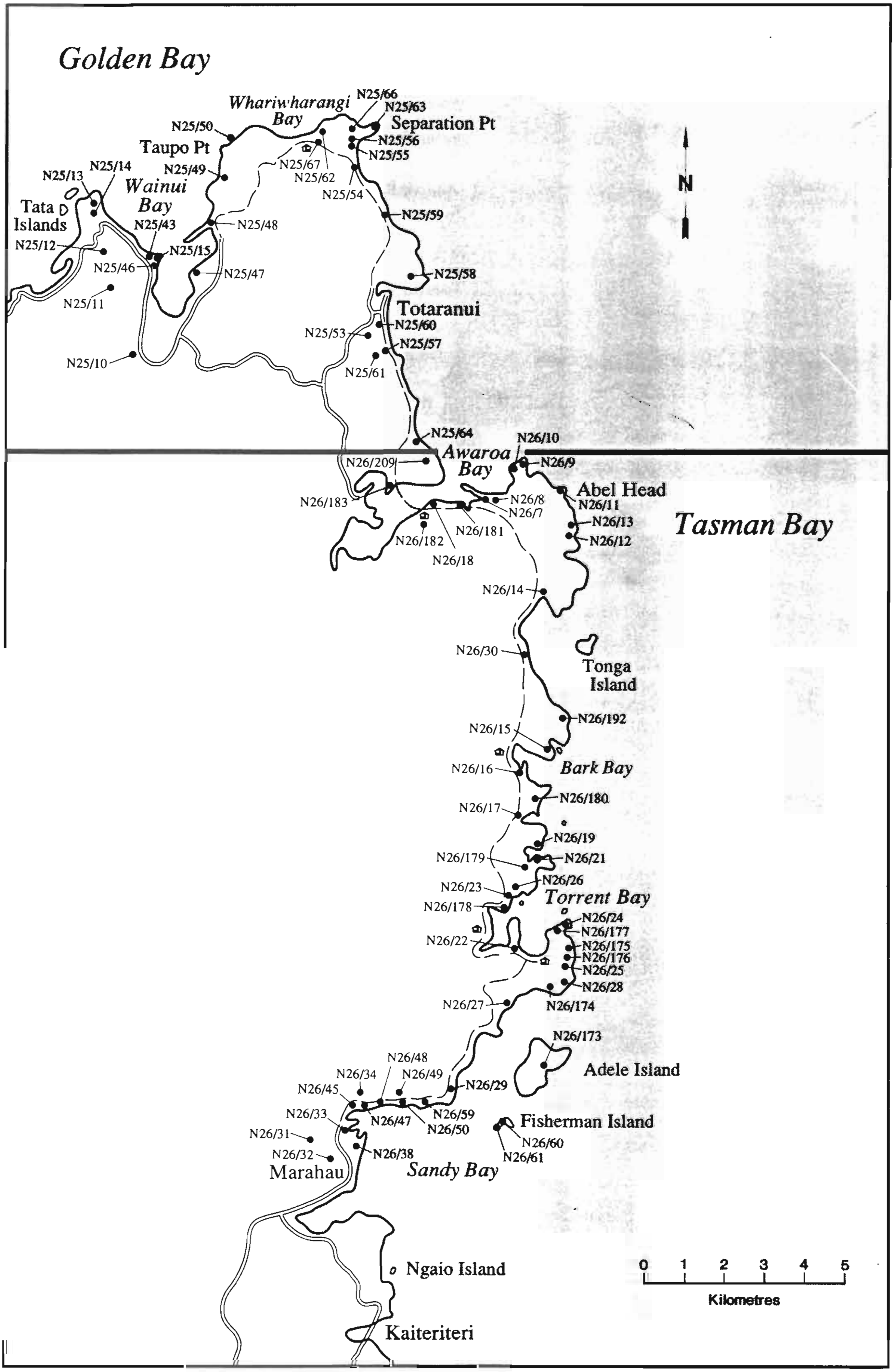

Fig. 2 ARCHAEOLOGICAL - HISTORICAL SITES

of Adele Island, as viewed from Observation Beach (reproduced on page 100 in: Dennis, 1985), the beach appears to be colonised by the native sand-binder *Spinifex sericeus*. This plant is now restricted to small patches in Mutton Cove and the beach north of Taupo Point. The photograph of the mouth of Totaranui Inlet, 1884 (page 41 in: Dennis, 1985) shows large numbers of what appears to be blue mussel (*Mytilus edulis*). Proliferation of mussels are now restricted to exposed headlands where access is difficult.

The Abel Tasman coastline is internationally renown for its golden sandy beaches. These sands are derived from the erosion of local granite into grains of quartz, feldspar and mica. Most of this beach material is derived from the immediate catchment and examination of stream beds show the dominance of these same sand grain sizes. Movement of sand materials along the coastline appears to occur where the adjacent subtidal areas are shallow. Major interruptions to the long-shore drift, therefore, appear to be Separation Point, Totaranui headlands, Abel Head area, North Head and Pitt Head. This sand material forms bars and beaches enclosing the numerous estuaries and inlets of the coast. This sand material is most noticeably introduced to the coast and estuarine areas during periods of heavy rainfall. The sand bars which enclose estuaries are in a continual state of change. Most of this change is minor. However, large scale change occurs periodically. For example, over the past ten years the mouth of Falls River has alternated between the north and south sides of the bay, while the outlet to Awaroa inlet has steadily moved west in the past decade.

Almost all estuarine areas contain a proportion of these coarse sands. In many parts of estuaries, this coarse substrate portion dominates the benthos. This phenomenon is unusual in the Nelson/Marlborough region, as estuaries are typically dominated by muds, silts, and clays (Davidson, et.al., 1990). It is unclear whether the deposition of sands into the coastal zone from land catchments increased with the clearance of forests, however, locals believe that the sand bars in some areas have been steadily growing. Observations of estuarine areas inside the park compared with estuaries in adjacent catchments outside the boundaries suggest that deposition of sands is greater in unforested catchments, eg. Kaiteriteri and Otuwhero Inlets. This suggests that sediment deposition within the park has probably declined since the retirement of land.

Subtidal Areas

Little or no information exists on the subtidal areas of the Abel Tasman coastline. D'Urville commented on "the excellent fish which it can furnish each day", while place names indicate grouper or hapuku and snapper were caught along this coast. D'Urville named 'Fisherman Island' in response to the fishing enjoyed in the area. An early photograph of two young fishers in Awaroa Inlet (page 141 in: Dennis, 1985) depict a snapper catch which appears considerably larger than most recreational catches today. In her book 'People Came Later', Perrine Moncrieff stated that prior to the second world war "a large frying pan was an absolute must in that fish was the main diet down the bay".

Bryozoan 'Coral Beds'

Early records noted an association between juvenile fish and 'foul ground' dominated by clumps of coral (Vooren, 1975; Bradstock and Gordon, 1983). Commercial trawling activities in Tasman Bay began in 1946, and it was soon discovered that large areas of the bay were 'foul ground'. Two coral areas were defined: the Torrent Bay coral beds (some

80 square nautical miles) and the Separation Point coral beds (some 40 square nautical miles) (Saxton 1980). Fishermen recorded good catches of fish with large numbers of juveniles of tarakihi and snapper, but their trawling gear was ripped whenever it encountered coral. A fisheries survey of these juvenile fisheries areas in Tasman Bay recorded 39 fish species, and catches as high as 540 tarakihi per hour of trawling (Vooren, 1975). With the appearance of synthetic materials, fishermen devised techniques such as covering the cod end with cow hide for protection or using extra floats to keep it above the coral (Saxton, 1980). Other practices included the use of sledges to hold the ground rope off the bottom, and tickler chains well ahead of the net. These technique tended to smash mounds lowering snagging rates and became known as 'breaking in' an area. Slowly the 'breaking in' of the coral bed proceeded until the 1960's, when the Torrent Bay bryozoan bed was virtually destroyed.

The Separation Point Coral bed was dominated by a heavier more robust species than fragile *Hippomenella vellicata*, which dominated the Torrent Bay beds. At Separation Point the dominant species of bryozoan, *Celleporaria agglutinans*, grows in clumps at depths, between 10 to 35 m. Saxton reported that between 1946 and 1975, the boundaries of the Separation Point beds decreased by unintentional encroachments by trawlers. Trawling did not begin activity on this bed until the mid 1970's. Large quantities of juvenile fish were captured by these efforts and were reportedly discarded overboard. In 1983, following calls from some local fishermen, the coral beds were protected in Fisheries legislation (Mace, 1981).

Tasman Bay Slime

The occurrence of a thick layer of yellow, grey or brown slime has been reported from the Golden/Tasman Bay areas since the 1860's. Washbourn reported that, "In the sixties, Golden Bay was covered with a yellow-looking slime so thick that the breakers rolled backwards and forwards without breaking. There were plenty of fish to be obtained as they swam ashore with their heads out of the slime. With a jar of methylated spirits, one could have made a wonderful collection of small fish and a great variety of oddities." The 'Nelson Slime' was again recorded in 1901 from Tasman and Golden Bays. L.F. Ayson, an Inspector of Fisheries reported the wholesale destruction of fish from Separation Point to Collingwood. So numerous were the fish, that the residents along the coast had to spend days in burying them to avoid the offensiveness of the decaying quantities. At the same time, investigators of the slime in Tasman Bay revealed that shellfish and fish were unaffected. The slime was not reported again in the Nelson area until 1960, however, reports of slime from Hawke Bay in 1910-11, 1916 and 1936, and from the Hauraki Gulf in 1938 and 1954 were recorded (Hurley, 1982). The slime returned to Tasman Bay in 1960, and appeared to have no effect on fish or shellfish, but made life for fishermen difficult as the slime fouled fishing gear. The last recorded outburst in Tasman Bay occurred in 1981. Bradstock and Mackenzie (1981) suggested the slime consisted of an opaque grey layer of slime at 20 m depth with large masses of the slime at 30 m depth on the bottom rolled up into coils. Investigation of scallop and oyster beds revealed these shellfish were unaffected.

Investigations by Hurley (1982) and Bradstock and MacKenzie (1981) have suggested that the slime is a bloom of a phytoplankton. The slime first appears in August, but the heavy 'slime season' is in November and December. Chang (1983) showed the bloom was caused by the mucilage-producing colonial form of *Phaeocystis pouchetii*. He reported that after nine to ten weeks of culture, many spherical 'bubbles' started to appear among other phytoplankton in the culture. 'Slime' in the form of a thick jelly-like mass started to appear in the culture about four months after the inoculation. The *Phaeocystis* colonies are delicate and the mucilage envelope where vegetative cells are embedded can be destroyed even with moderate agitation in a water bath shaker (Guillard and Hellebust, 1971). This may account for the disappearance of blooms after strong winds.

In the present survey of the Abel Tasman coastline, observations of what appeared to be the 'slime' were made on Six Foot Rock at 12 m depth in July, 1991. The material was observed covering the rocks and macroalgae.

Kina (Photo 2)

During 1967-68, studies on sea urchin or kina (*Evechinus chloroticus*) were carried out at Kaiteriteri by T.G. Dix (University of Canterbury). Results showed that kina density at Kaiteriteri was 3.5 per m^2 averaged from four transects made over a 30 m by 2 m strip. This compared with 2.2 kina per m^2 at Snake Point, Queen Charlotte Sound and 2.65 and 6.05 at Wakatu Point and Sharks Tooth Point at Kaikoura respectively. The author reported kina chiefly consumed algae, however, when macroscopic algae is scarce, as at Kaiteriteri, they predominantly browsed microscopic materials from the rock surface. He suggested a shortage of large quantities of food may influence the small size of urchins at Kaiteriteri, and slow growth rates and shortened life span observed (Dix, 1972). Interactions between kina and seaweed are discussed in Section 4.3.1, and Davidson and Chadderton (in press).

Seaweed

No historic quantitative data exists for the density and distribution of seaweed around the Abel Tasman coastline. Examination of aerial photographs taken in 1966 suggest that in particular areas, seaweeds once covered larger subtidal areas than recorded in the present study (Plates 1 to 5). Reasons for this decline are probably related to physical and environmental factors, particularly grazing by kina and herbivorous molluscs (see section 4.3.1).

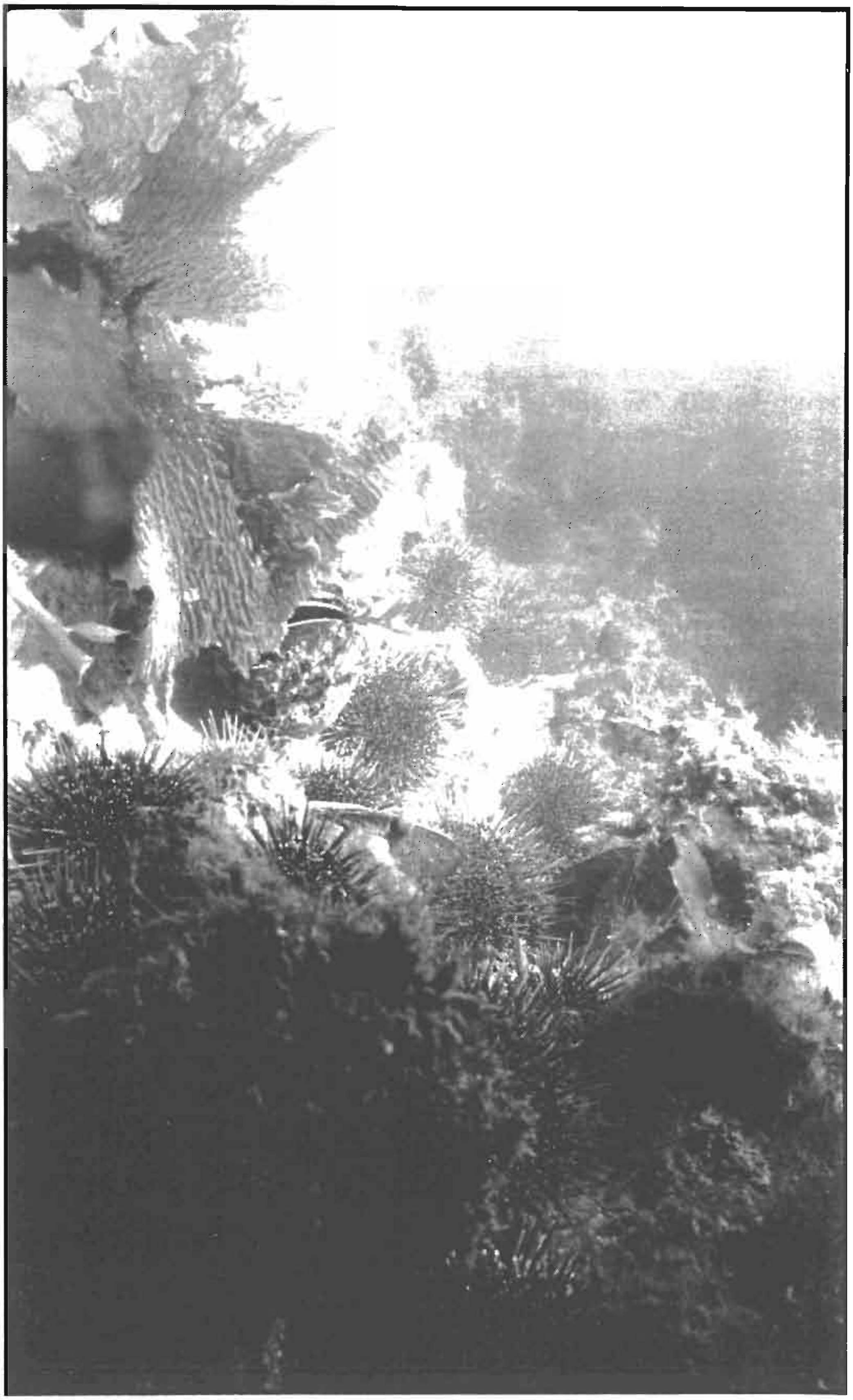

Photo 2. Kina (*Evechinus chloroticus*) aggregation on Taupo Point limestone.

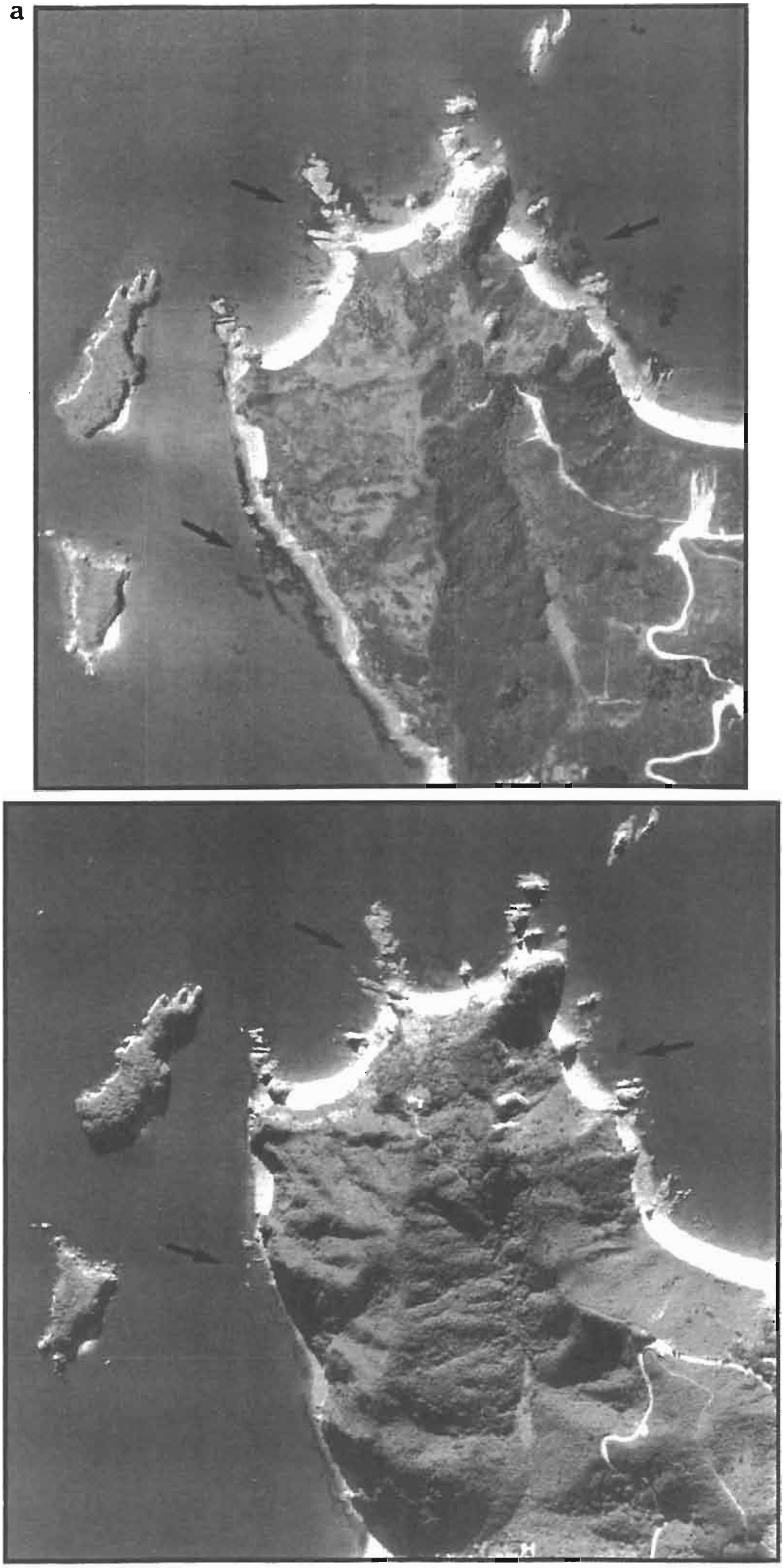

Plate 1 Aerial photos of Tata Islands and adjacent coastline. Dated (a) October, 1966 and (b) May, 1988. Scale 1:10000.

a

b

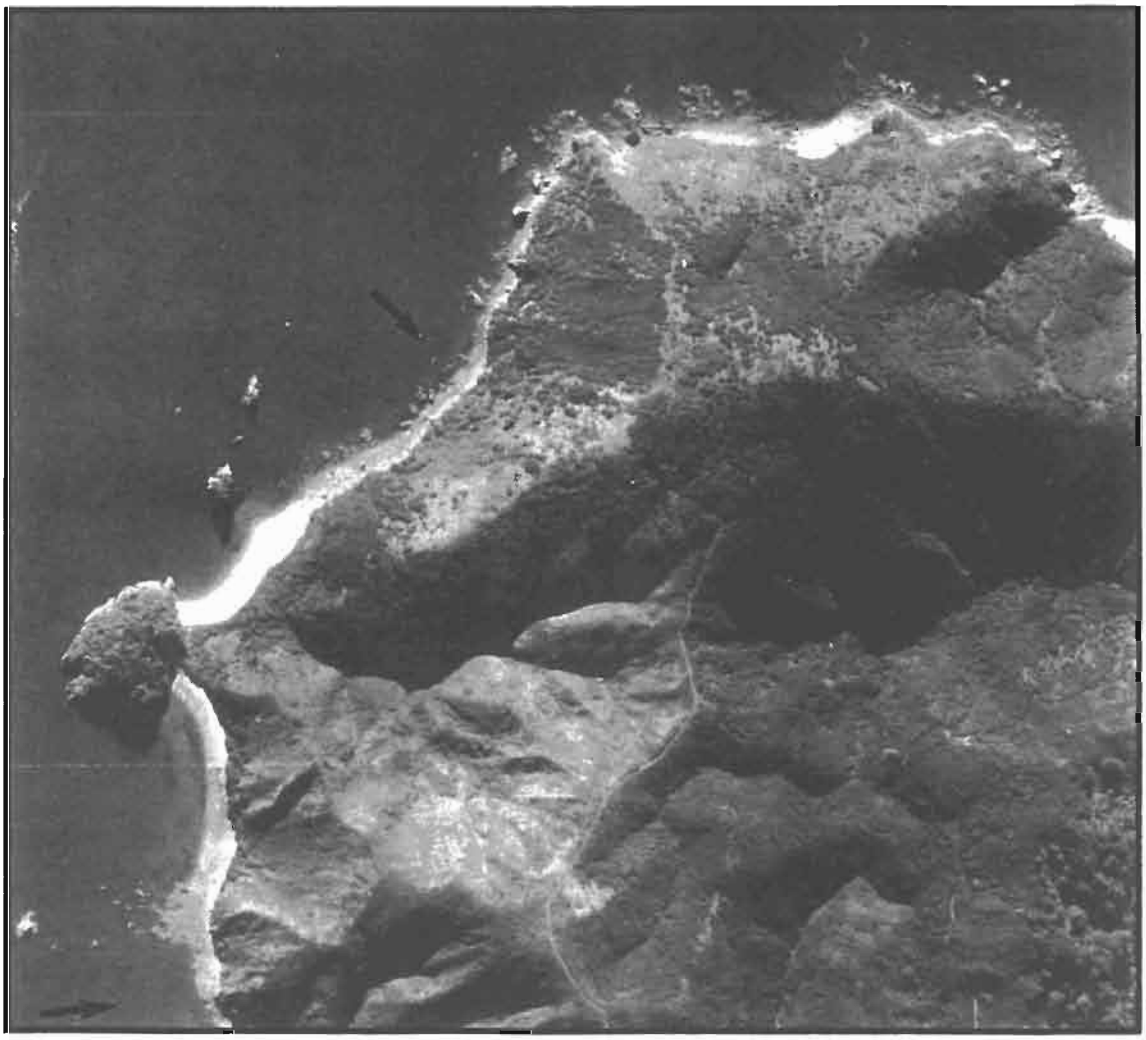

Plate 2 Aerial photos of Taupo Point and adjacent coastline. Dated (a) October, 1966 and (b) May, 1988. Scale 1:10000.

a

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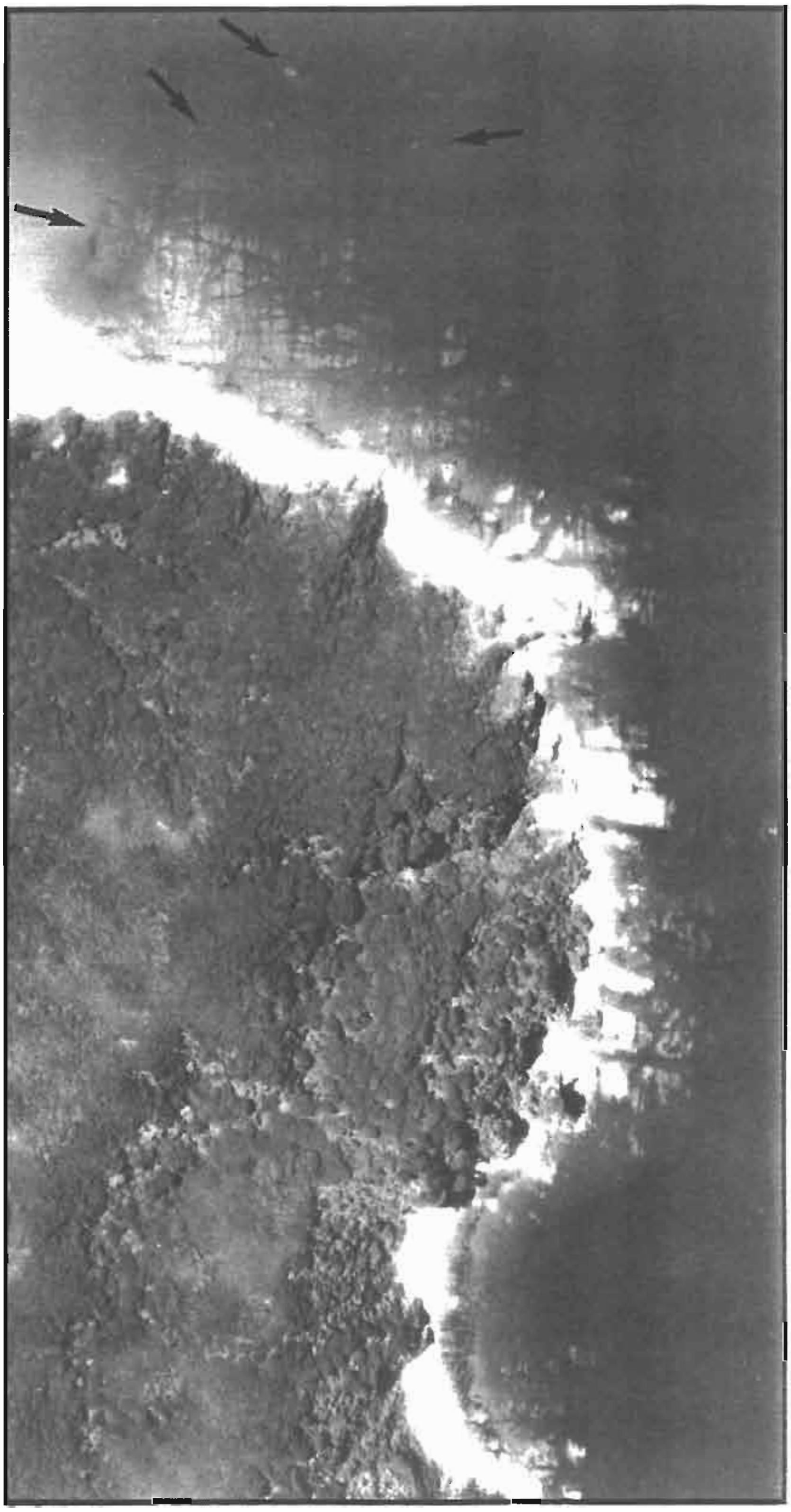


Plate 3 Aerial photos of the headland immediately south of Anapai Bay. Dated (a) October, 1966 and (b) January, 1988. Scale 1:10000 and 1:5000 respectively.

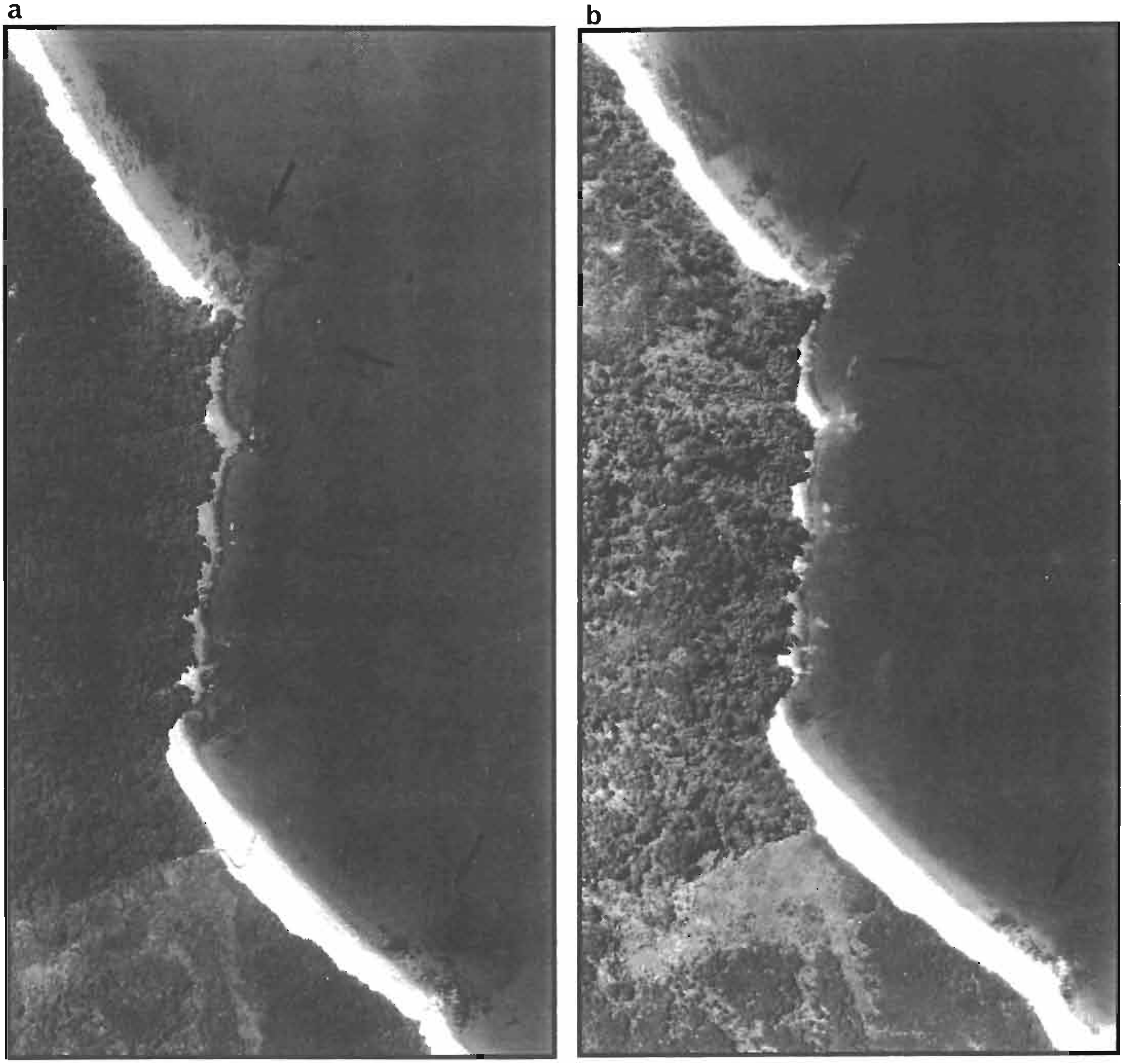


Plate 4 Aerial photos of coastline north of Cave Point. Dated (a) October, 1966 and (b) January, 1988. Scale 1:10000.

a b

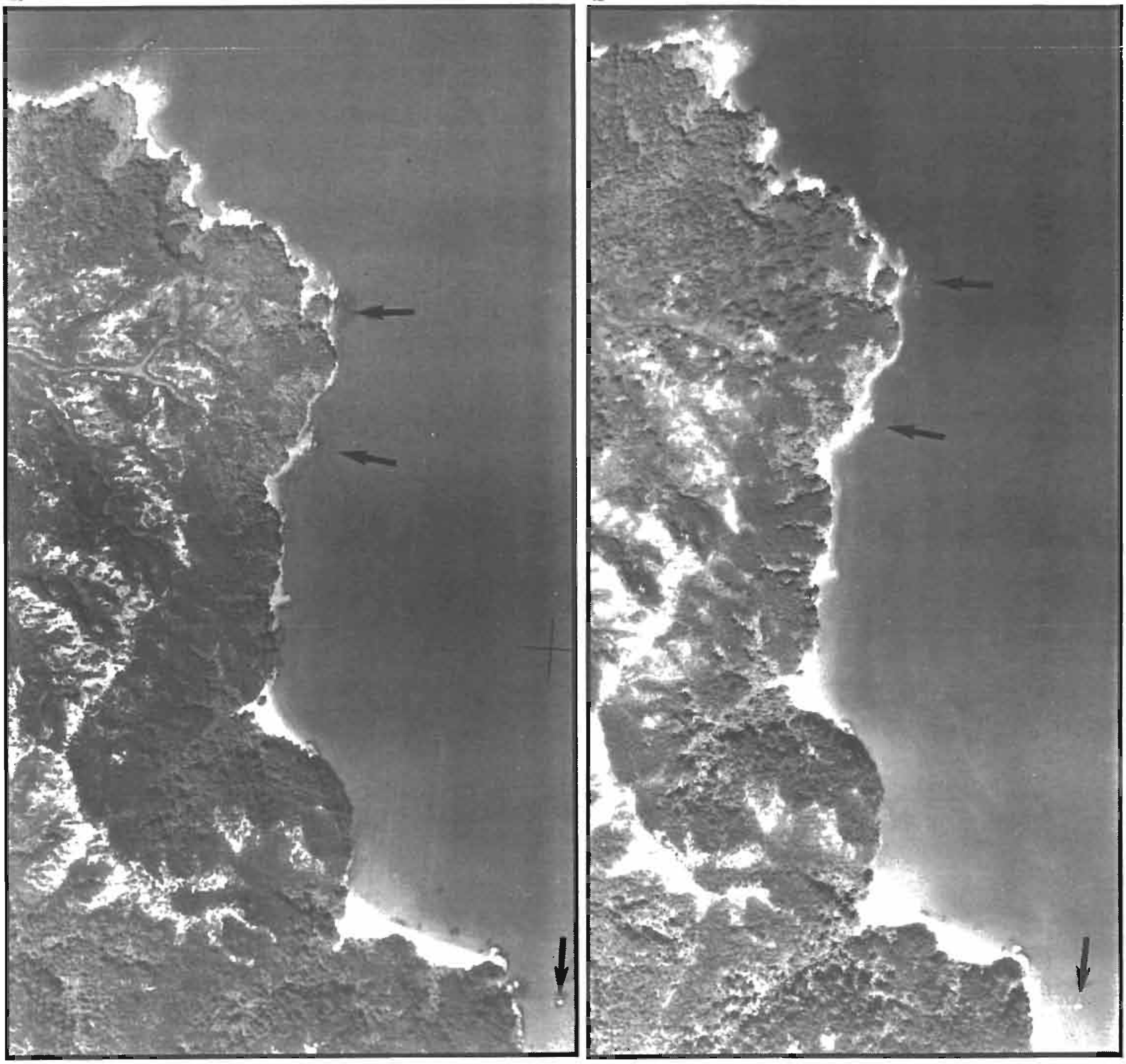


Plate 5 Aerial photos of Watering Cove to Te Karetu Point, Astrolabe Roadstead. Dated (a) October, 1966 and (b) January, 1988. Scale 1:10000.

3. SUBSTRATES, HABITATS AND MAPPING

A total of eight intertidal and 12 subtidal habitats and substrates were recognised along the Abel Tasman National Park coastline. In many areas, substrate or habitat types were located in close proximity, eg. boulder substrate overlying bedrock substrate. In these cases, maps of substrates and habitat types display both substrates as a combination.

3.1 Intertidal Substrate and Habitat Types

Coarse Sand

Coarse sand forms large areas of beach between headlands, often forming sandspits, eg. Totaranui, Onetahuti, Bark Bay. Coarse sand constitutes predominantly granite derived sediments and along the Abel Tasman have a characteristic golden appearance. Coarse sand grain size ranges from 0.5 mm diameter to 2.0 mm diameter.

Sand

Beaches dominated by sand (0.5 mm - 0.25 mm in diameter) were relatively uncommon along the Abel Tasman. These beaches form along the sheltered sides of islands where wave action is minimal. Good examples of these sand dominated beaches are located on the western side of Adele Island (Photo 3).

Fine Sand

Fine sand flats (0.25 mm - 0.063 mm diameter) were located in estuarine areas along the park. Fine sand appears similar to mud flats, however, fine sand is distinguished by a granular texture and the ability to support the weight of an adult human.

Mud

Mud constitutes a combination of silts and clays < 0.063 mm in diameter. This habitat is easily recognised by a glutinous appearance and black anaerobic layer close to the surface. Relatively few intertidal mud areas were located around the Abel Tasman coastline, all are located within estuarine areas.

Zostera novazelandica (eelgrass)

Eelgrass was relatively uncommon along the Abel Tasman coastline. Only small patches of eelgrass were located within estuarine areas. At Sandy Bay eelgrass was also located on open sand flats. This phenomenon is common in Golden Bay, but absent in Tasman Bay (Davidson et. al., 1990).

Native Rushes, Sedge and Herb Field

Two rush species (*Juncus maritimus, Leptocarpus similis*) and one sedge species (*Schoenoplectus pungens*) were the commonest marine vascular plants along the park. These plants were generally restricted to estuarine areas, however, *Leptocarpus* was recorded from open coastal situations where freshwater and salt spray combine to provide suitable environmental conditions.

Turf or herb field plants recorded were the sea primrose (*Samolus repens*), remuremu (*Selliera radicans*), glasswort (*Sarcocornia quinqueflora*), button weed (*Cotula coronopifolia*) and bucks-horn plantain (*Plantago coronopus*).

Largest areas of salt marsh were located in Awaroa Inlet, Torrent Bay Estuary, Bark Bay Estuary, Wainui Inlet and Marahau Estuary. A number of small estuaries were also located along the coast (Photo 4).

Granite Boulders, Bedrock and Cliffs

Granite boulders, granite bedrock and cliffs substrates were most often found as combinations of bedrock with overlying boulders, often bounded on the landward side by granite cliffs (Photo 5 & 6). These substrates dominated the intertidal shoreline of the Abel Tasman National Park.

Limestone Bedrock

Limestone was uncommon along the Abel Tasman coastline. Only three small areas exist, Tata Islands, Abel Tasman Monument and Taupo Point. Intertidal areas at these sites were small as the shore rises steeply, often forming cliff faces (Photo 7).

3.2 Subtidal Substrate and Habitat Types

Mud

Mud was recognised by a glutinous appearance and its ability to stick to wetsuit material and clouds water in the immediate vicinity. Large areas of glutinous mud dominate the benthos below 20 m depth along the park and in many areas throughout Tasman and Golden Bays.

Sand Mix

Sand mix is primarily composed of clean sand with various proportions of broken and dead shell. Sand mix was located in areas less than 6 m depth, but in beach areas exposed to direct wave action, eg. Mutton Cove, Wainui Inlet, Whariwharangi Bay, the sand mix substrate may extend to the 12 m depth contour.

Shelly/Sandy Mud; Sandy/Shelly Mud; Shelly Mud

In areas below the sand mix zone and above mud substrates, a zone of substrates which have various proportions of dead shell, broken shell, coarse sand and sand. These areas were most often located in depths between 6 and 20 m. The proportions of shell (whole or broken), sand (sand, coarse sand) and mud vary depending on depth, aspect, wave action or water currents, however, mud was always the dominant substrate. A combination of wave action and current ensure that shelly/sandy mud areas do not become dominated solely by mud. Generally, the greater the currents and wave action the greater the proportion of coarse sand and shell. These areas were generally located on the seaward side of islands and headlands and in areas where relatively strong currents carry away finer sediments such as silts, clays and fine sand, eg. Separation Point, Taupo Point, Abel Head, Adolphe Point, Jules Point, Fisherman Island. On the leeward sides of islands and headlands, the fraction of coarse sand declines and an increase in sand and broken shell was recorded over a base of predominantly mud.

Boulders

Subtidal granite boulders were located around much of the Abel Tasman coastline and were usually an extension of substrates located intertidally (Photo 8). Boulders ranged in size from 250 mm in diameter to over 3 m in diameter. Many boulder areas created cave or crevice habitats.

Bedrock

Bedrock was usually restricted to headland areas eroded by sea processes, eg. Pitt Head (Photo 9). Rock is most often associated with overlying boulders deposited as a result of sea erosion.

Limestone

Subtidal limestone was located at the Tata Islands, Abel Tasman Monument, Taupo Point and two stacks at Taupo Point (Photo 11). These areas are relatively shallow, less than 10 m depth. Wave action has eroded these areas unevenly forming a cracked crevice and overhanging topography.

Shallow Granite-Shore Zone

The shallow, granite-shore habitat was located in water depths less than 10 m (Photo 10). This zone varies in depth throughout the park depending on water turbidity. This zone is differentiated by the communities of plants and animals which inhabit this area. This habitat receives high levels of light and may contain macroalgal species. The shallow, granite-shore habitat along the park was comprised of rock or boulder substrates.

Deep Granite-Shore Zone

The deep, granite-shore habitat was restricted to depths greater than 10 m where light levels are very low (Photo 12). The communities of plants and animals inhabiting this zone were occasionally recorded in depths less than 10 m, but only in caves and crevices. Most deep, hard-shore areas along the Abel Tasman coast do not reach depths greater than 18 m.

Bryozoan 'Coral' Bed

Bryozoans are colonial animals encased in a protective covering of calcium carbonate and protein. Large areas of these 'corals' have been recorded offshore Separation Point (Saxton, 1980; Bradstock and Gordon, 1983). The dominant species recorded was *Celleporaria agglutinans* (Bradstock and Gordon, 1983). This species of bryozoan was recorded throughout the Abel Tasman living on rock as small colonies (Davidson, et.al., 1990). Large areas of bryozoans were previously recorded offshore from Torrent Bay (Saxton, 1980).

Rhodolith Beds

Rhodoliths are coralline algae which appear to establish on broken or dead shell or rock. Rhodoliths form finger-like projections and stand between 10 and 40 mm high. A rhodolith bed of unknown extent was recorded along the Abel Tasman coastline in the Totaranui area.

Mixed Algal Fringe and Kelp Forest

An algal zone was deemed to exist when cover of plant material formed a canopy over the underlying substrate (Photo 13). Three species of brown algae dominated the macroalgal zone *(Carpophyllum maschalocarpum, C. flexuosum, Ecklonia radiata).* Although other brown macroalgae species also contributed to this zone depending on location (Nelson, et. al., 1992). The algal zone was limited in size and often formed a narrow strip at extreme low water (Photo 14). This algal fringe zone was usually dominated by *C. maschalocarpum.* Kelp forest habitat was relatively rare and seldom formed large areas (eg. Foul Point, Taupo Stacks, Taupo Point, Snapper Rocks) (Photo 15). Within the duration of field work, one algal bed dominated by *C. flexuosum,* spanning a depth range of six meters, completely disappeared (section 4.4). .

3.3 Mapping

The major estuarine, coastal and subtidal habitats and substrates from the Abel Tasman coastline are displayed on eight A3 and two A4 sheets (maps 1 - 10, Figure 3,4) at a scale of 1:15000. Maps of subtidal soft shores were based on core sample data and depth soundings provided by the Hydrographic Office. These data are therefore large scale and do not necessarily detect small scale variation of sediment type. The extent of subtidal rocky shores was based on diver profiles, aerial photography and underwater soundings. Similarly, this technique does not detect all small scale variation. Maps also display freshwater input, freshwater wetlands, sample sites, depth contours, human structures, settlements, tracks, huts and roads.

3.4 Area Calculations

Area of each habitat or substrate was determined using a planimeter and dot-grids on the 1:15000 maps (Table 1B).

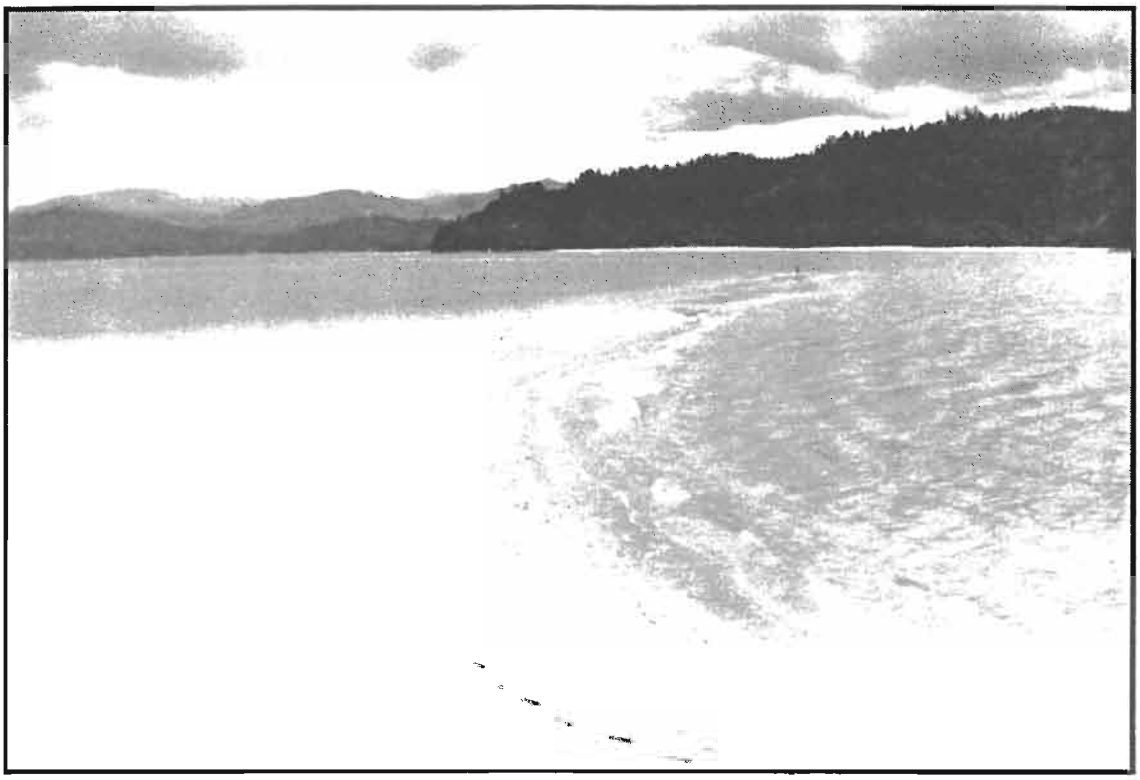


Photo 3. Sandy Point, Astrolabe Roadstead.

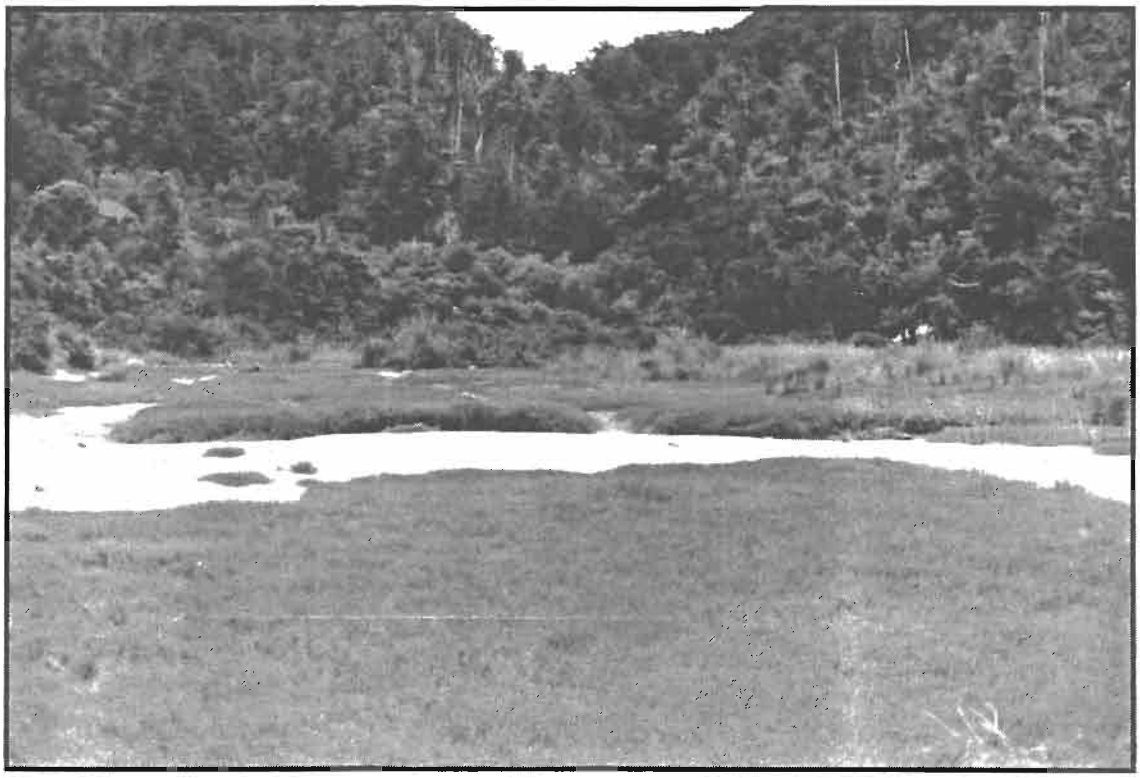


Photo 4. Appletree Bay Estuary.

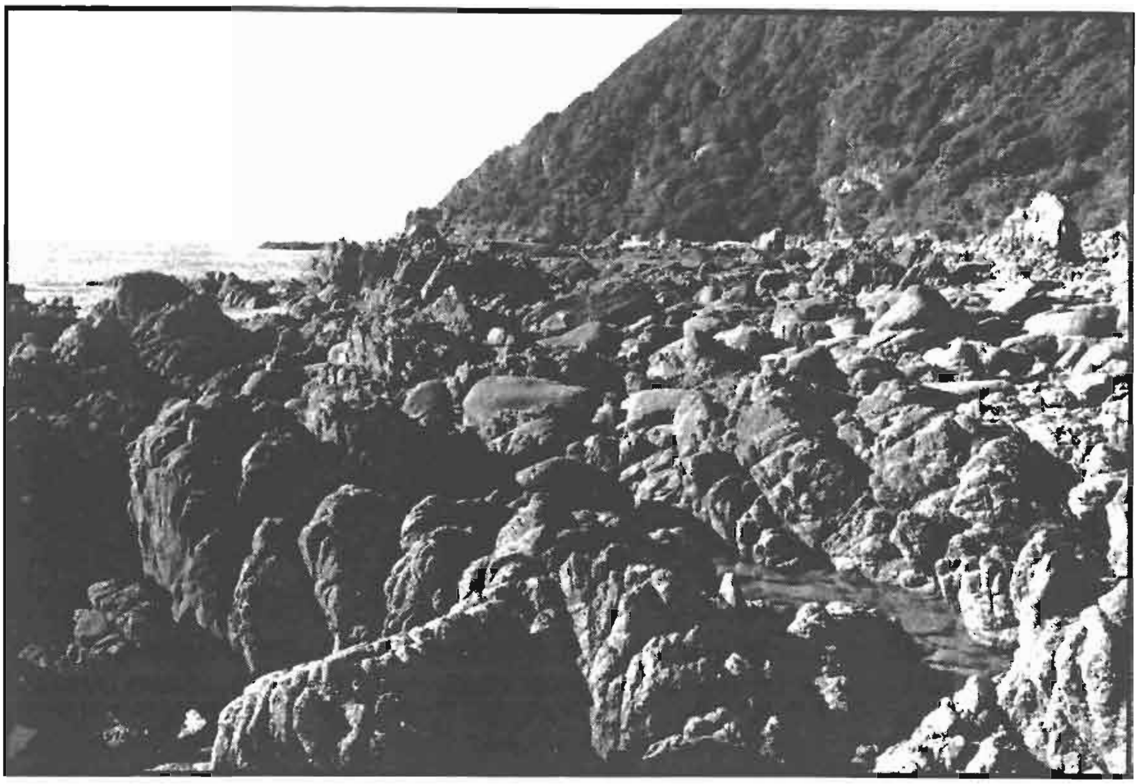
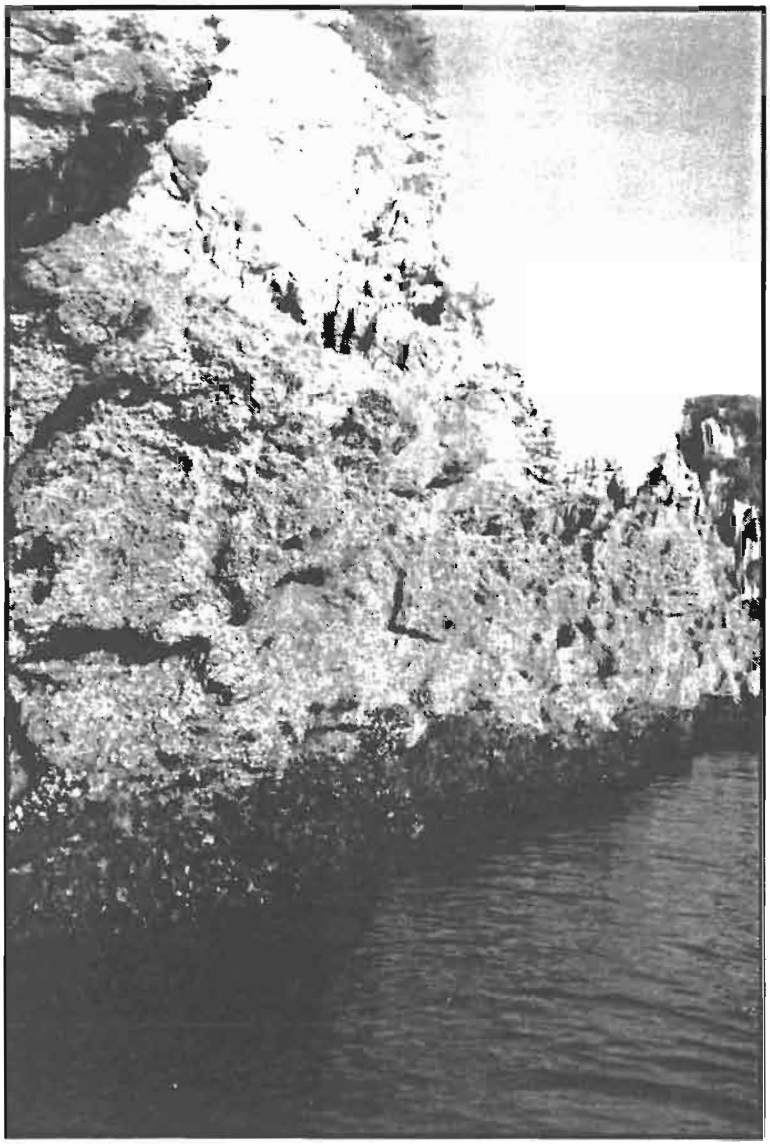


Photo 5. Granite bedrock and boulder beach, Taupo Hill.

Photo 6. Granite bedrock and cliff, Abel Head.



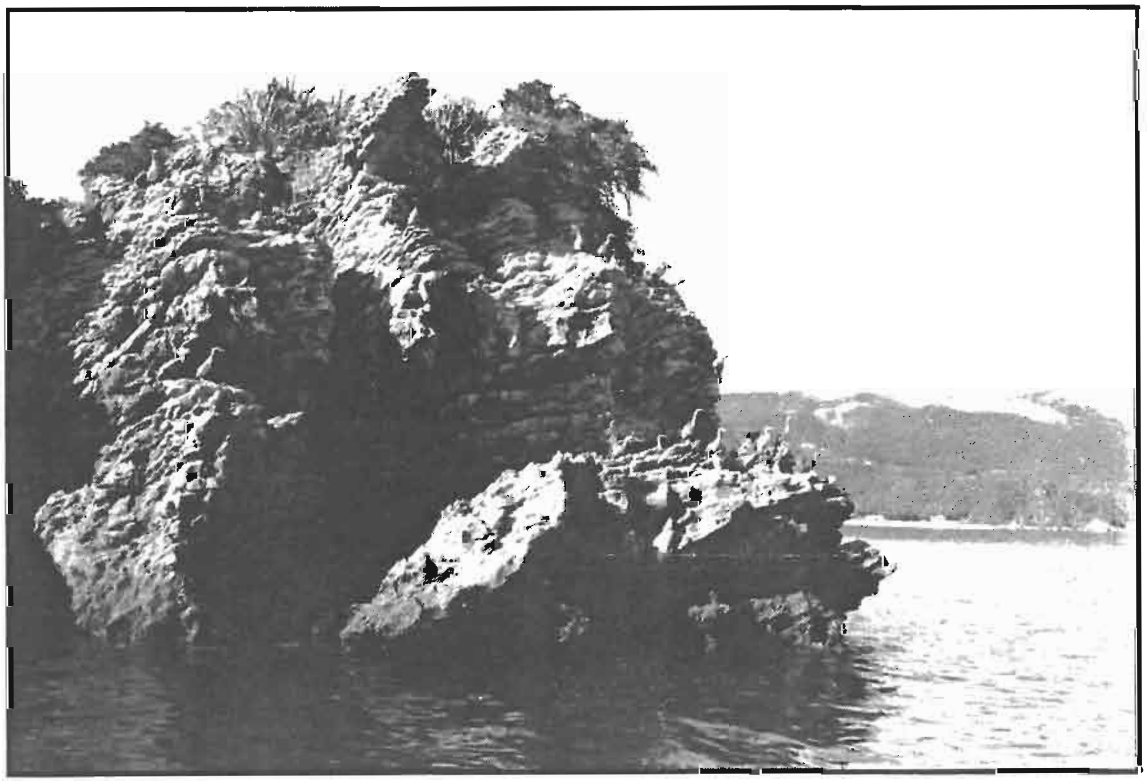


Photo 7. A limestone stack north of Taupo Point (above), Tata Islands (below).

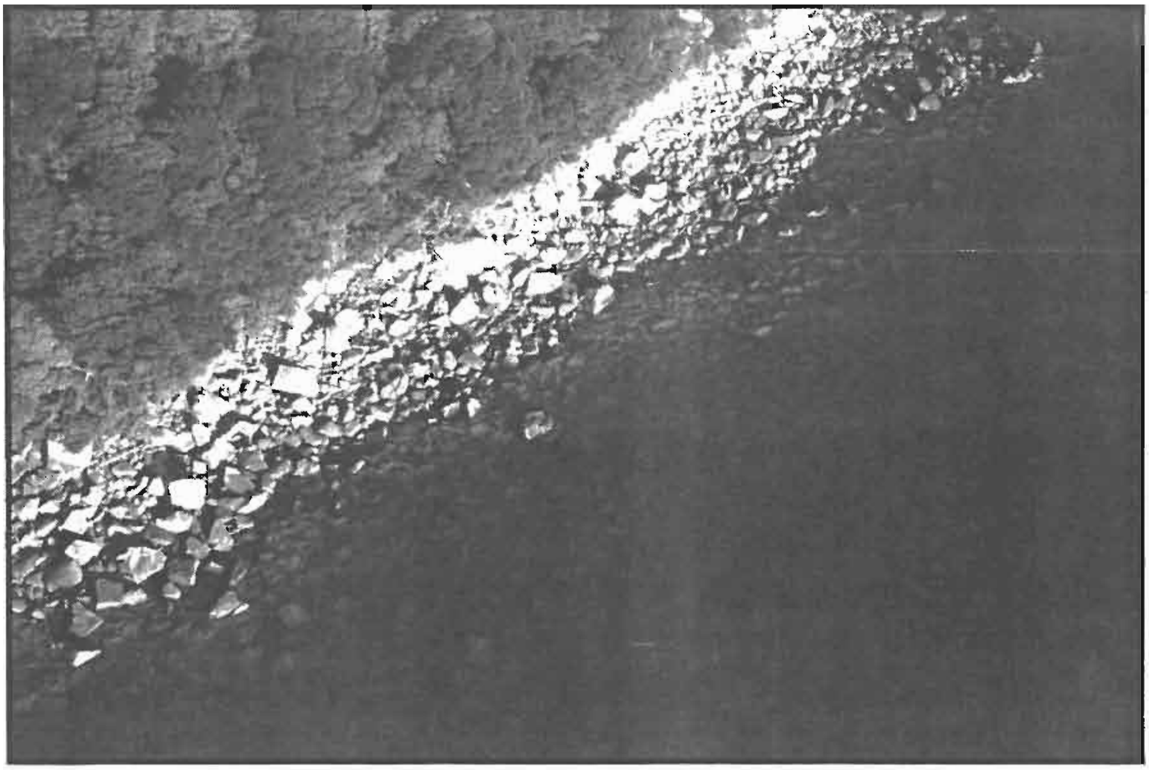


Photo 8. Boulder shoreline south of Pitt Head.

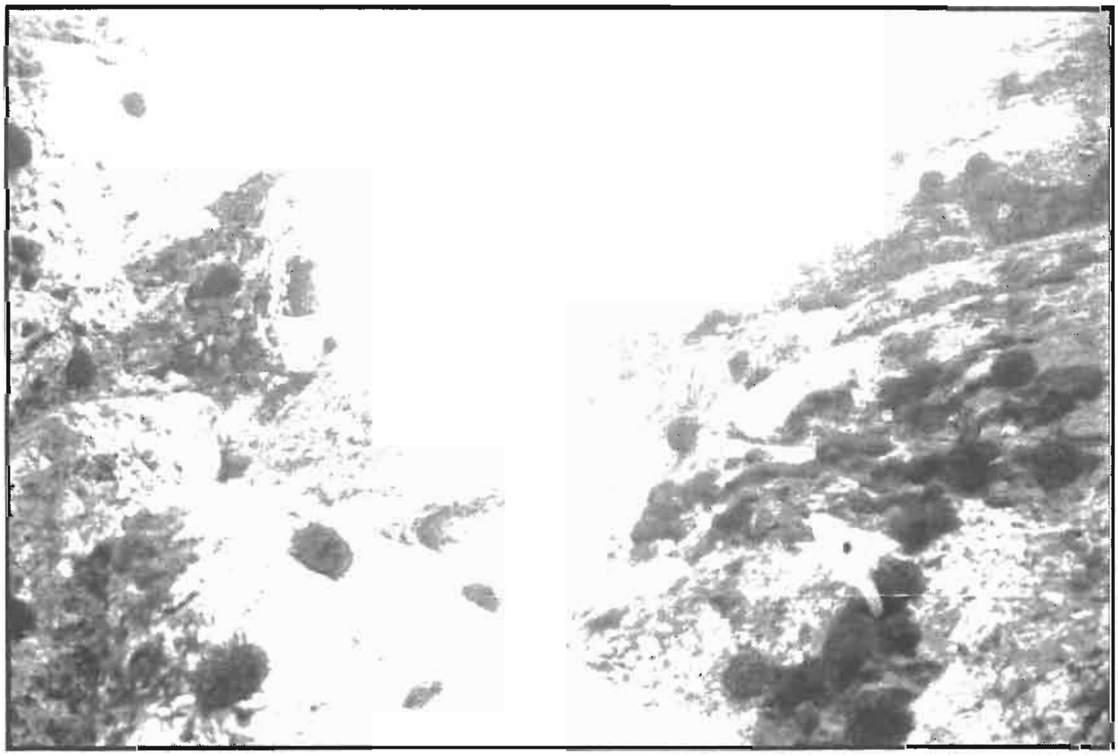


Photo 9. Subtidal granite bedrock in the shallow hard-shore zone.

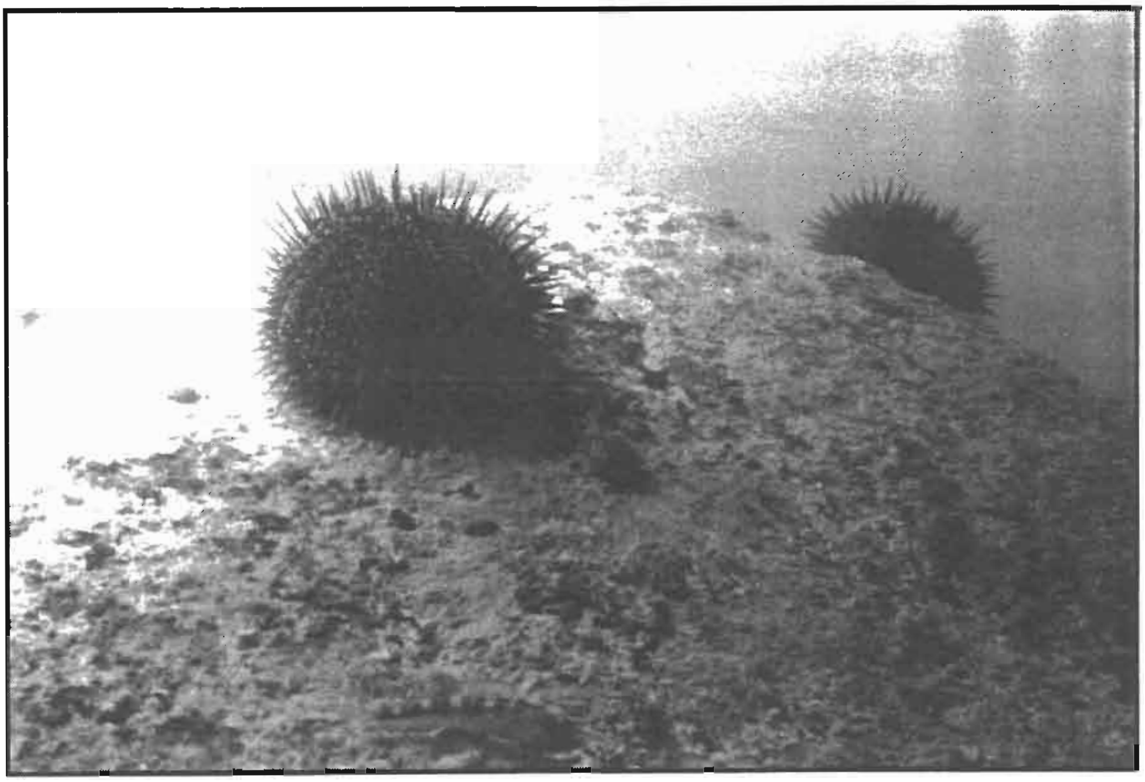


Photo 10. Subtidal granite barren in the shallow hard-shore zone.

Photo 11. Subtidal limestone with a high percentage cover of foliose red algae and *Ecklonia radiata*.

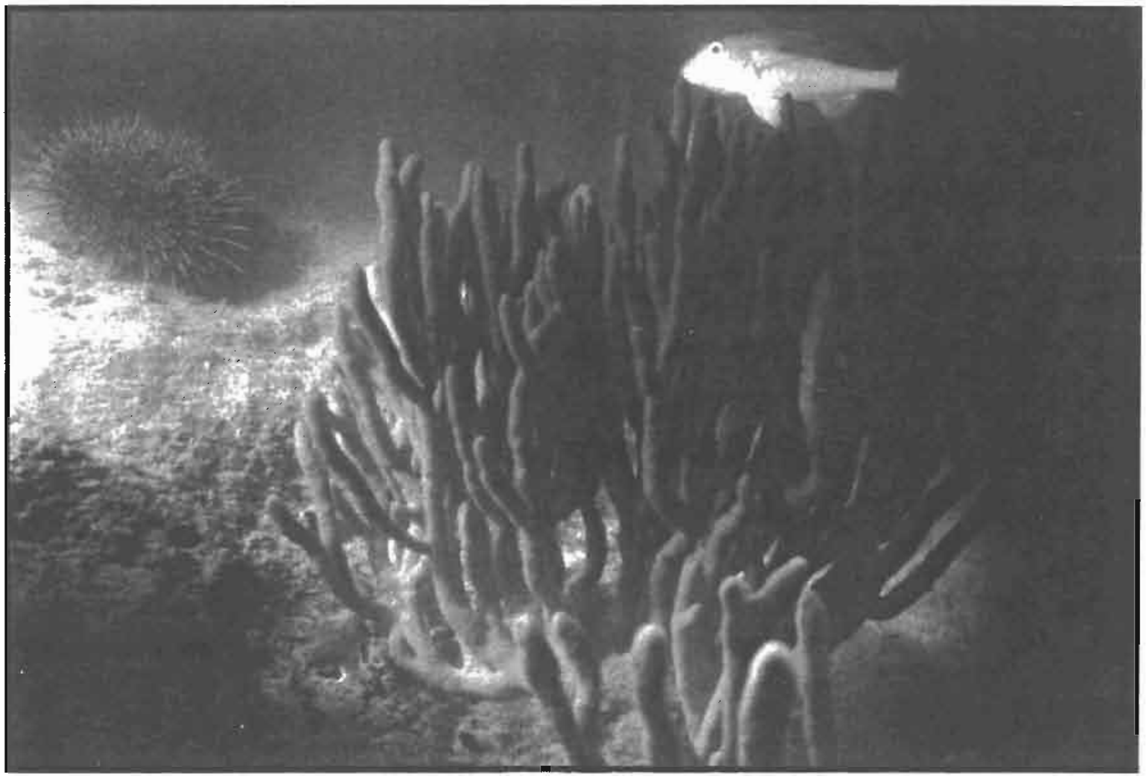


Photo 12. Sponges on granite in the deep hard-shore zone.

Photo 13. *Carpophyllum* fringe on granite.

Photo 14. *Carpophyllum* fringe ending abruptly in the granite shallow hard-shore zone.

Photo 15. *Ecklonia radiata* canopy on limestone at Taupo Point.

TABLE 1B: **Area and percentage of intertidal and rocky substrates for the Abel Tasman National Park.**

SUBSTRATE	HECTARES	PERCENTAGE AREA
Coarse sand	193.96	61.5
Coarse sand/boulders	19.72	6.3
Rock	16.97	5.4
Rock/boulders	64.32	20.4
Boulders/rock	12.74	4.0
Boulders	6.42	2.0
Pebbles/cobbles	0.23	0.07
Reef (subtidal rock) (approximate area)	172.06	54.5
Limestone	1.10	0.35
*Total coastal area (intertidal)	315.42	100
Total estuary area	633.41	
Total coastal area (intertidal)	315.42	
Total intertidal area of Abel Tasman	948.83	

* Excludes subtidal soft shore areas.

TABLE 1: **Area and percentage area of estuaries, estuarine substrates and estuarine vegetation along the Abel Tasman National Park coastline.**

Estuary	Substrate/vegetation	Hectares	Percentage Area
Marahau Estuary	Salt marsh/herb field	20.69	3.27
	Coarse sand	13.06	2.06
	Coarse sand/fine sand	5.40	0.85
	River channel	2.03	0.48
	TOTAL AREA	41.18	6.05
Appletree Bay Estuary	Salt marsh/herbfield	1.01	0.16
	Coarse sand	0.45	0.07
	TOTAL AREA	1.46	0.23
Torrent Bay Estuary	Salt marsh/herbfield	3.03	0.52
	Coarse sand	15.15	2.39
	Fine sand	16.65	2.63
	River channel	1.08	0.28
	Mud	1.13	0.18
	TOTAL AREA	38.03	6.00
Torrent Beach Inlet	Salt marsh/herbfield	0.34	0.05
	Coarse sand	0.11	0.02
	TOTAL AREA	0.45	0.07
Frenchman Bay Estuary	Salt marsh/herbfield	0.72	0.11
	Eelgrass	0.16	0.03
	Sand	4.73	0.75
	Coarse sand	1.35	0.21
	TOTAL AREA	6.96	1.1
Sandfly Bay Estuary	Salt marsh/herbfield	0.38	0.06
	Coarse sand	6.30	0.99
	Sand/boulders	0.56	0.09
	River channel	0.38	0.06
	TOTAL AREA	7.62	1.2
Bark Bay Estuary (South)	Coarse sand	0.45	0.07
	TOTAL AREA	0.45	0.07
Bark Bay Estuary	Salt marsh/herbfield	2.9	0.46
	Marram	0.50	0.08
	Coarse sand	3.33	0.52
	Fine sand	2.36	0.37
	River channel	2.25	0.36
	Boulders	0.23	0.04
	TOTAL AREA	11.57	1.83
Mosquito Bay Estuary	Salt marsh	0.38	0.06
	Eelgrass	0.16	0.03
	Coarse sand	1.35	0.21
	TOTAL AREA	1.89	0.29
Onetahuti Estuary	Salt marsh/herbfield	2.14	0.34
	Coarse sand	2.03	0.32
	River channel	2.02	0.32
	TOTAL AREA	6.19	0.98
Shag Harbour Estuary	Pebble/cobbles	0.23	0.04
	Coarse sand/boulders	1.24	0.02
	Eelgrass	0.11	0.02
	TOTAL AREA	1.58	0.25

Estuary	Substrate/vegetation	Hectares	Percentage Area
Awaroa Inlet (East)	Salt marsh	0.34	0.05
	Coarse sand/boulders	1.24	0.02
	Eelgrass	0.11	0.02
	TOTAL AREA	1.58	0.25
Awaroa Inlet	Salt marsh/herbfield	57.78	9.12
	Marram/dunes	13.95	2.2
	Coarse sand/sand	148.61	23.46
	Coarse sand/pebble/cobbles	1.91	0.03
	Coarse sand	17.11	2.7
	Sand	14.63	2.3
	Fine sand	0.56	0.09
	Mud/sand	0.45	0.07
	Pebble/cobble	0.90	0.14
	Sand/boulder	2.03	0.32
	River channel	31.73	5.00
	TOTAL AREA	289.66	45.73
Totaranui Estuary	Salt marsh/herbfield	12.15	1.92
	Coarse sand	4.73	0.75
	Sand	0.45	0.07
	Fine sand	1.46	0.23
	TOTAL AREA	18.79	2.97
Wainui Inlet	Salt marsh/herbfield	44.89	7.09
	Ulva/Gracilaria	2.70	0.43
	Marram	1.13	0.18
	Coarse sand	52.88	8.35
	Sand/coarse sand	87.30	13.78
	Mud	5.40	0.85
	River channel	12.83	2.00
	TOTAL AREA	207.13	32.07
TOTALS FOR ABEL TASMAN	Salt marsh/herbfield	147.02	23.21
	Eelgrass	0.43	0.07
	Ulva/Gracilaria	2.70*	0.43
	Marram	15.58	2.46
	Coarse sand	118.41	18.69
	Coarse sand/sand	261.12	41.22
	Fine sand	21.03	3.32
	Mud	6.98	1.10
	Sand/boulders	4.06	0.64
	Pebble/cobbles	3.04	0.48
	River channels	55.74	8.80
TOTAL ESTUARINE AREA		633.41	100.00

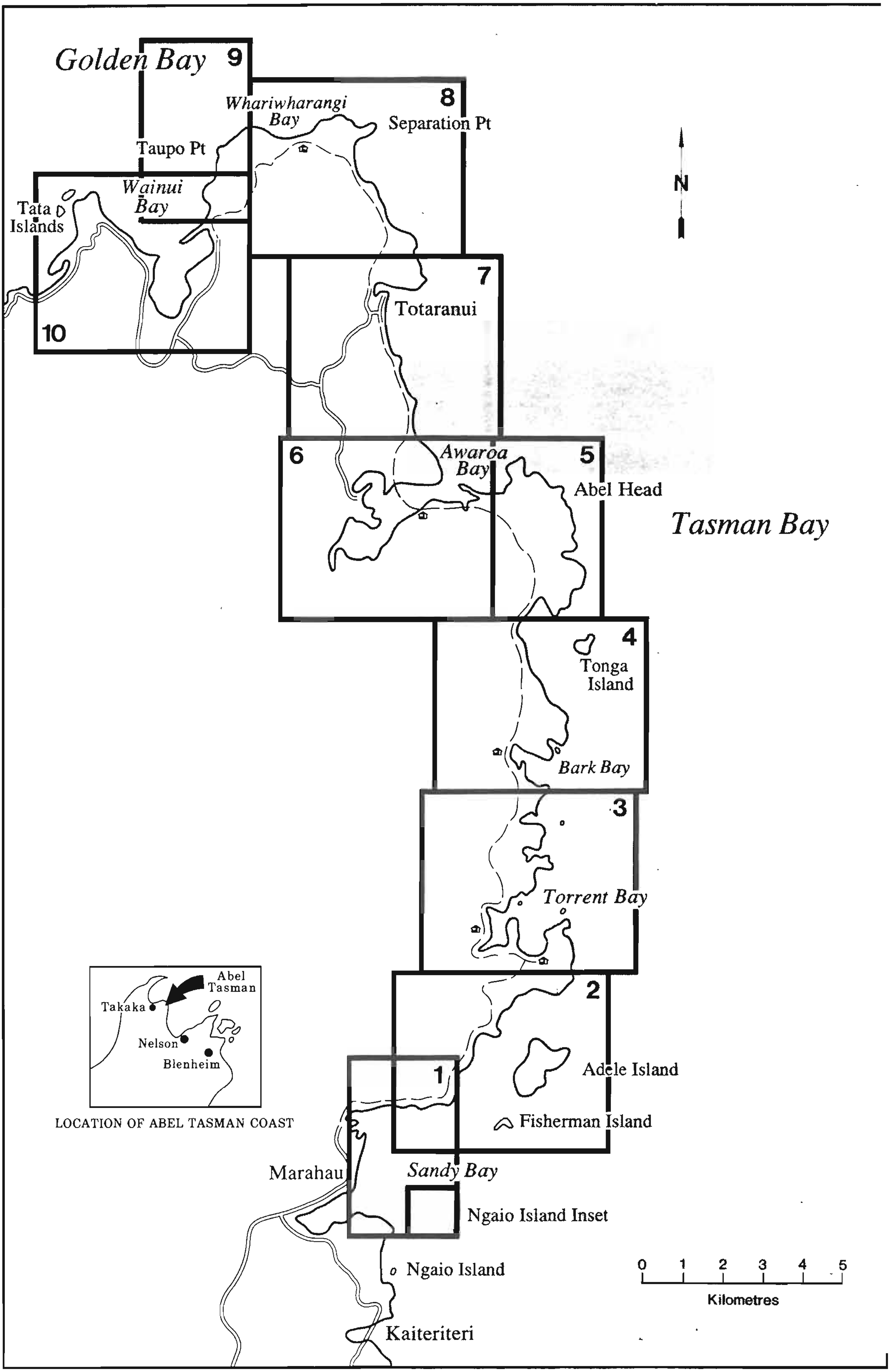


Fig. 3 MAP INDEX

HABITAT TYPES - ABEL TASMAN COASTLINE

INTERTIDAL SUBSTRATES

SOFT SHORES

CS	Coarse Sand
S	Sand
FS	Fine Sand
Mud	Mud

HARD SHORES

R	Rock
B	Boulders
P/C	Pebbles & Cobbles
CS/B	Coarse Sand > 50% Boulders < 50%

SUBTIDAL SUBSTRATES

SOFT SHORES

HARD SHORES

Rf	Reef
Rf/S	Reef & Sand
S/Rf	Sand & Reef
Rf/S	Reef > 50% Sand < 50%

VEGETATION TYPES

COASTAL & ESTUARINE VEGETATION

Z	*Zostera novazelandica*	Se	*Selliera radicans*	Aa	*Ammophila arenaria*
J	*Juncus maritimus*	Su	*Suaeda nova-zealandiae*	Ca	*Carex pumila*
L	*Leptocarpus similis*	Is	*Isolepis cernua*	C	*Carpobrotus edulis*
Sc	*Schoenoplectus pungens*	Jp	*Juncus pallidus*	Pl	*Plantago coronopus*
Gr/Ul	*Gracilaria/Ulva sp*	Mi	*Mimulus repens*	Fe	*Festuca* spp
Sq	*Sarcocornia quinqueflora*	Jpl	*Juncus planifolius*	Ty	*Typha orientalis*
Sm	*Samolus repens*	P	*Plagianthus divaricatus*	M	*Leptospermum* spp
Co	*Cotula coronopifolia*	De	*Desmoschoenus spiralis*	Sx	*Spinifex hirsutus*

TOPOGRAPHY & LINEWORK

Roads

Buildings

Cliffs

Coastline Boundary

Tracks

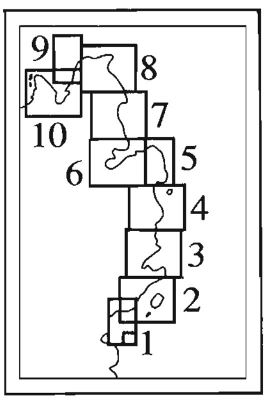
26 Core Samples

T28,29 Transect Lines

S20 Spot Dives

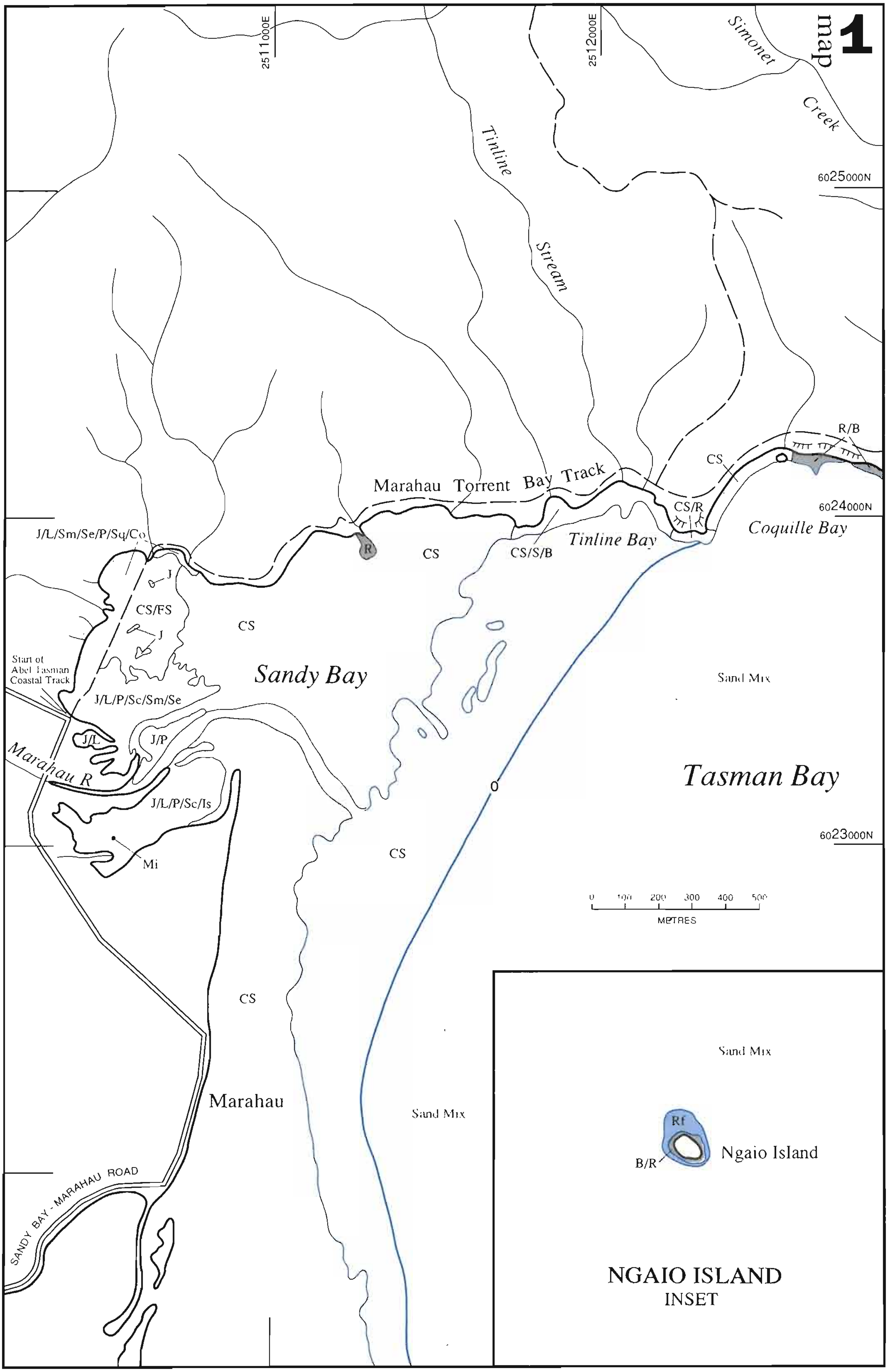
Vegetation & Substrate Boundary

Waterway Boundary

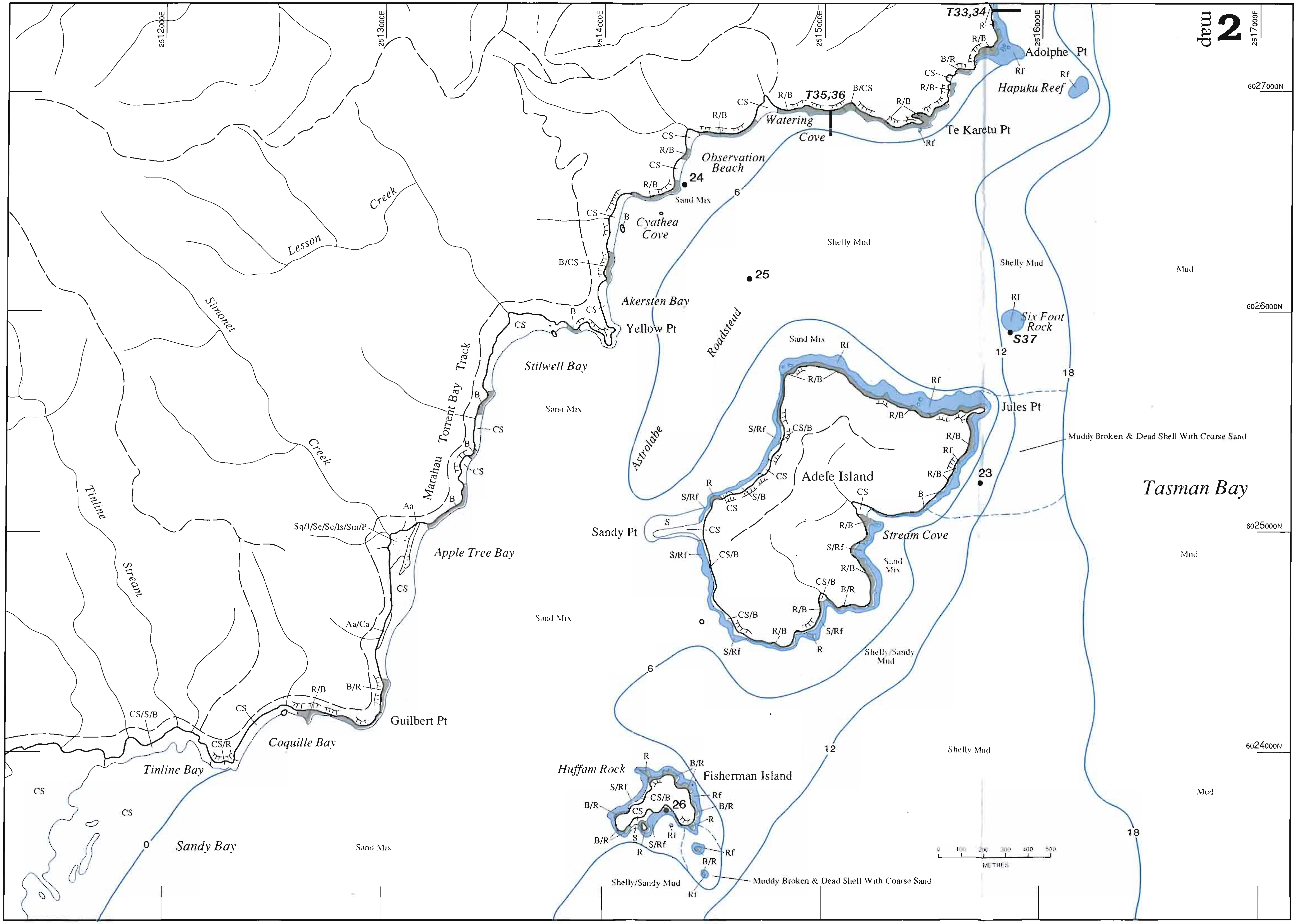


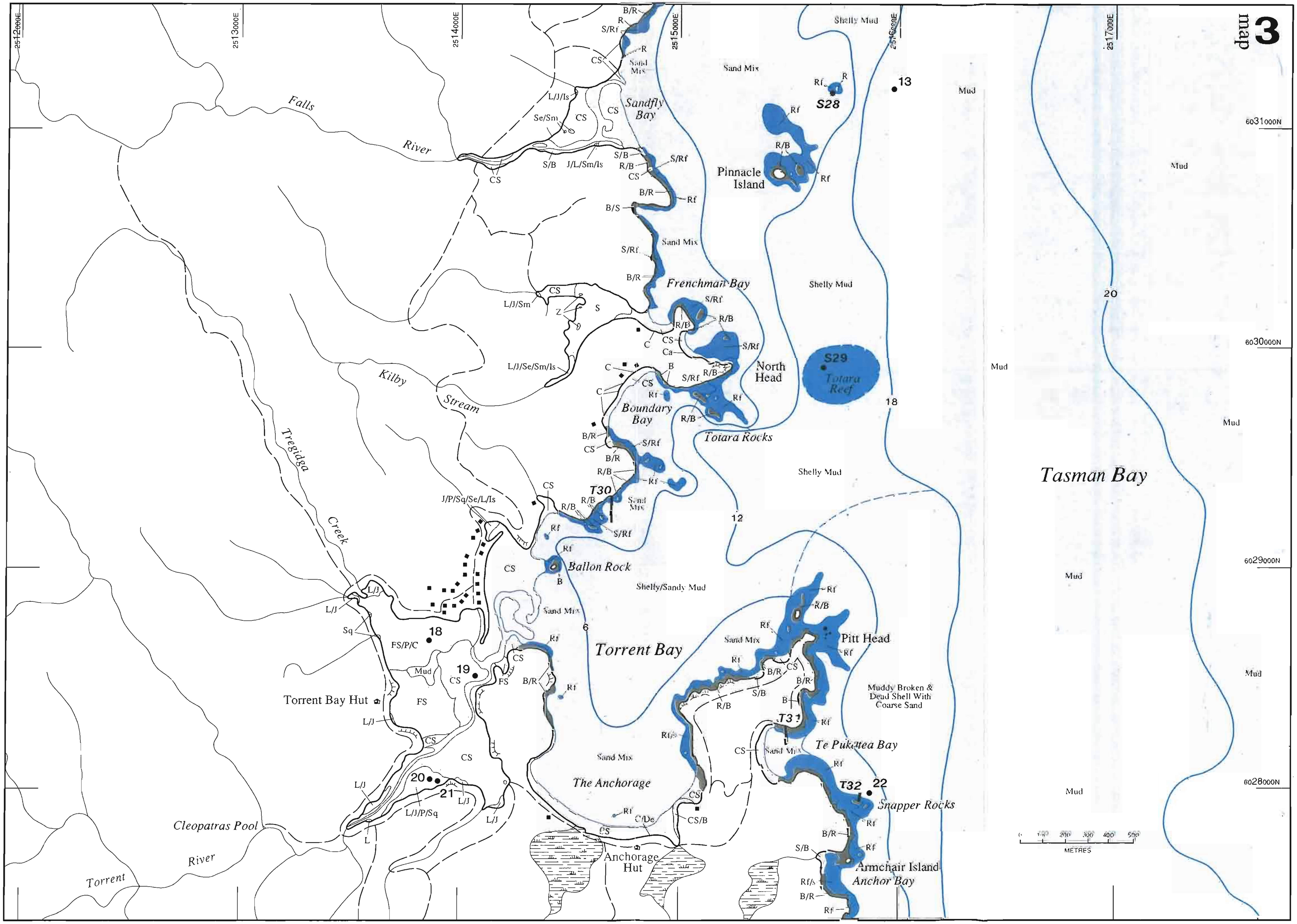
MAP INDEX

The aerial photographs used in the compilation of these maps were flown on 3 March 1988. Sea level was at 0.5 metres above datum. As they were unrectified there may be a small amount of grid to ground position error.



map 1
2511000E
2512000E
Simonet Creek
Tinline Stream
6025000N
6024000N
6023000N
R/B
CS
CS/R
Coquille Bay
Marahau Torrent Bay Track
Tinline Bay
CS/S/B
R
CS
J/L/Sm/Se/P/Sq/Co
J
CS/FS
J
CS
Start of Abel Tasman Coastal Track
Sandy Bay
J/L/P/Sc/Sm/Se
J/L
J/P
Marahau R
J/L/P/Sc/Is
Mi
Sand Mix
Tasman Bay
0
CS
0 100 200 300 400 500
METRES
CS
Marahau
Sand Mix
SANDY BAY - MARAHAU ROAD
Sand Mix
Rf
B/R
Ngaio Island
NGAIO ISLAND
INSET


map 2
T33,34
Adolphe Pt
Hapuku Reef
T35,36
Watering Cove
Te Karetu Pt
Observation Beach
24
Sand Mix
Cyathea Cove
Shelly Mud
25
Akersten Bay
Yellow Pt
Roadstead
Six Foot Rock
S37
Stilwell Bay
Marahau Torrent Bay Track
Lesson Creek
Simonet Creek
Tinline Stream
Astrolabe
Jules Pt
Muddy Broken & Dead Shell With Coarse Sand
Adele Island
23
Tasman Bay
Sandy Pt
Stream Cove
Apple Tree Bay
Shelly/Sandy Mud
Guilbert Pt
Coquille Bay
Tinline Bay
Huffam Rock
Fisherman Island
26
Sandy Bay
Mud
METRES



map 3
Tasman Bay
Torrent Bay
The Anchorage
Anchorage Hut
Torrent Bay Hut
Sandfly Bay
Frenchman Bay
Boundary Bay
Te Pukatea Bay
Anchor Bay
Pinnacle Island
North Head
Pitt Head
Armchair Island
Totara Reef
Totara Rocks
Ballon Rock
Snapper Rocks
Cleopatras Pool
Falls River
Kilby Stream
Tregidga Creek
Torrent River
Shelly Mud
Shelly/Sandy Mud
Sand Mix
Mud
Muddy Broken & Dead Shell With Coarse Sand
S28
S29
T30
T31
T32
13
18
19
20
21
22
6
12
18
20
2512000E
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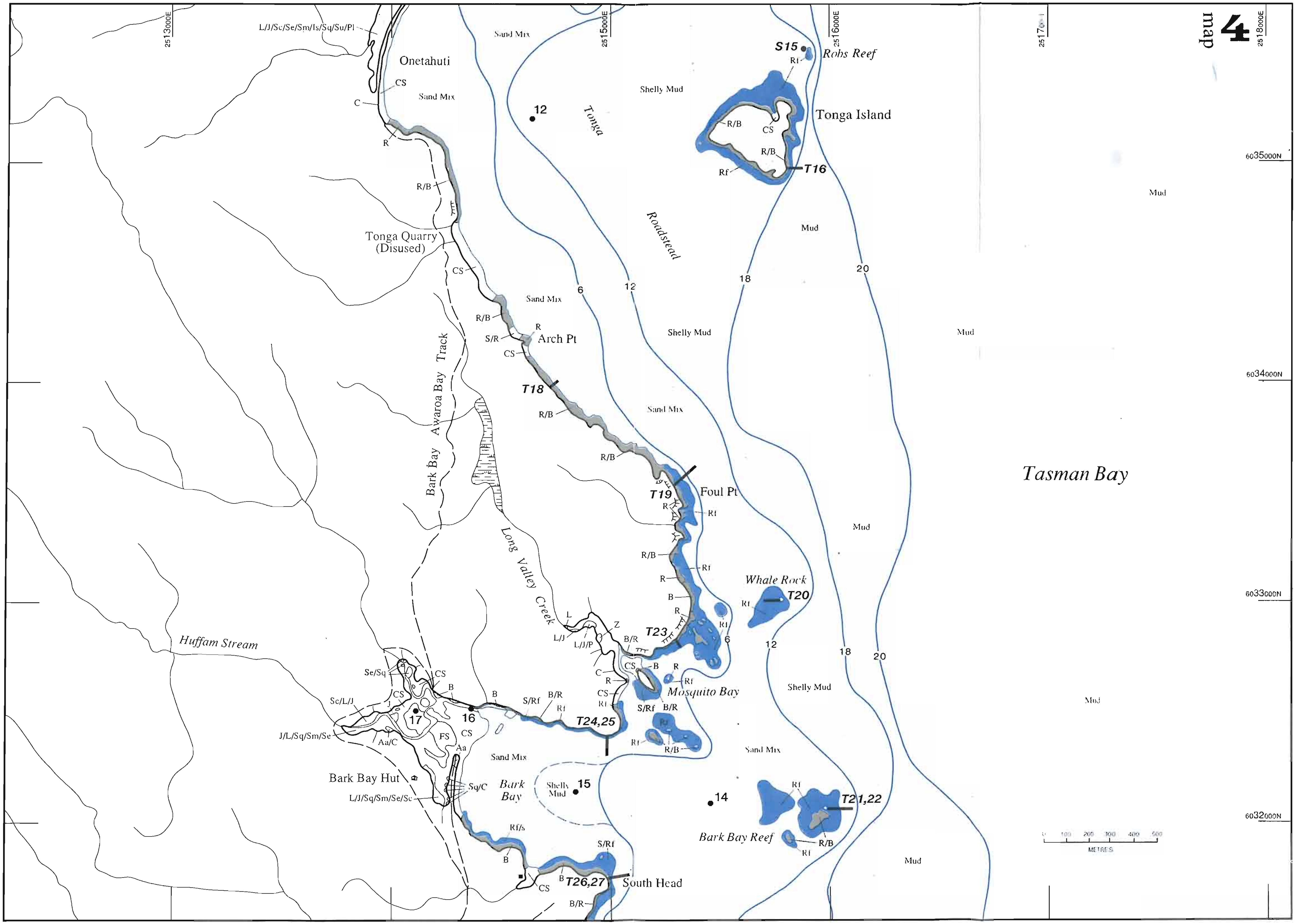
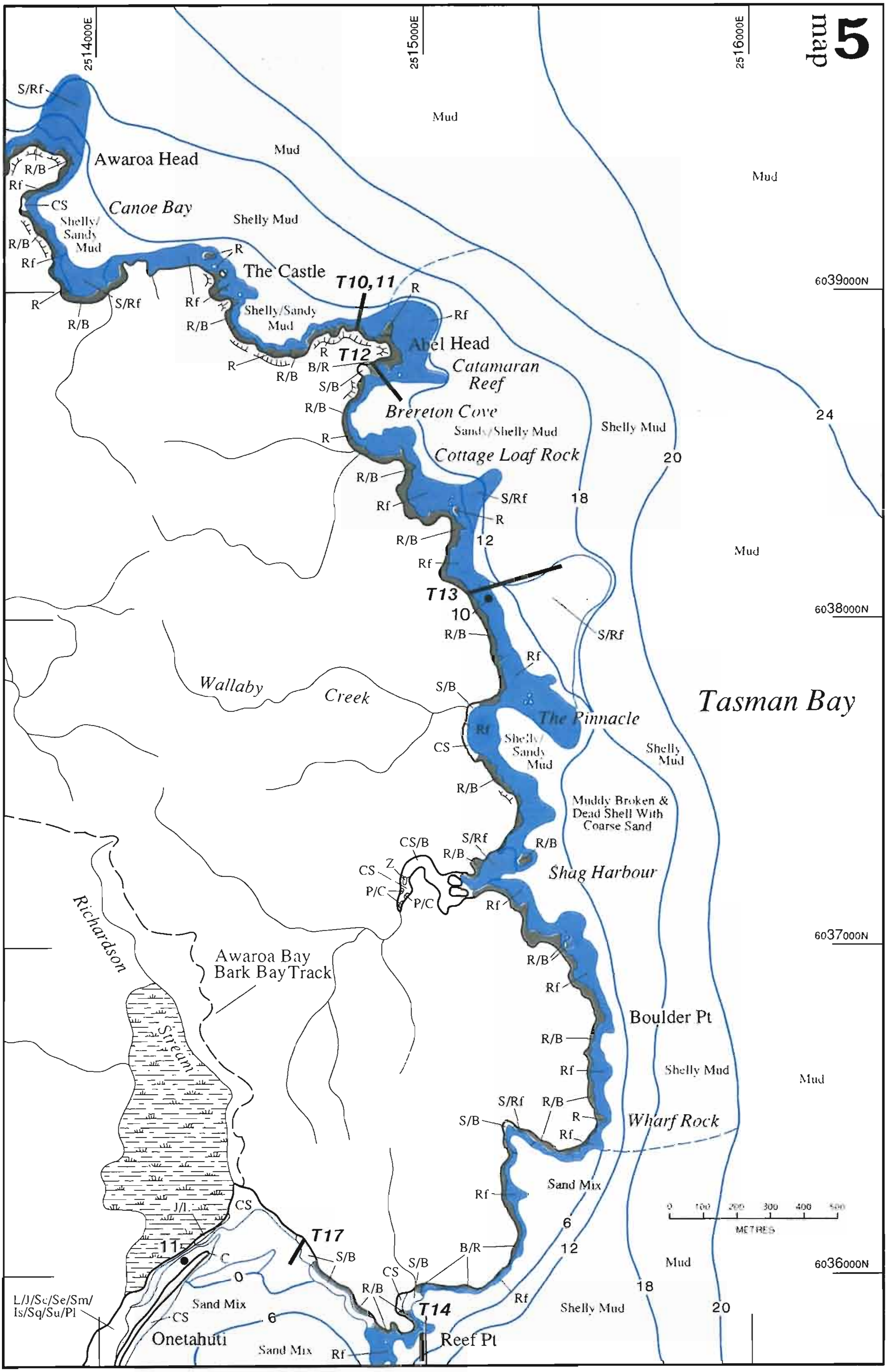
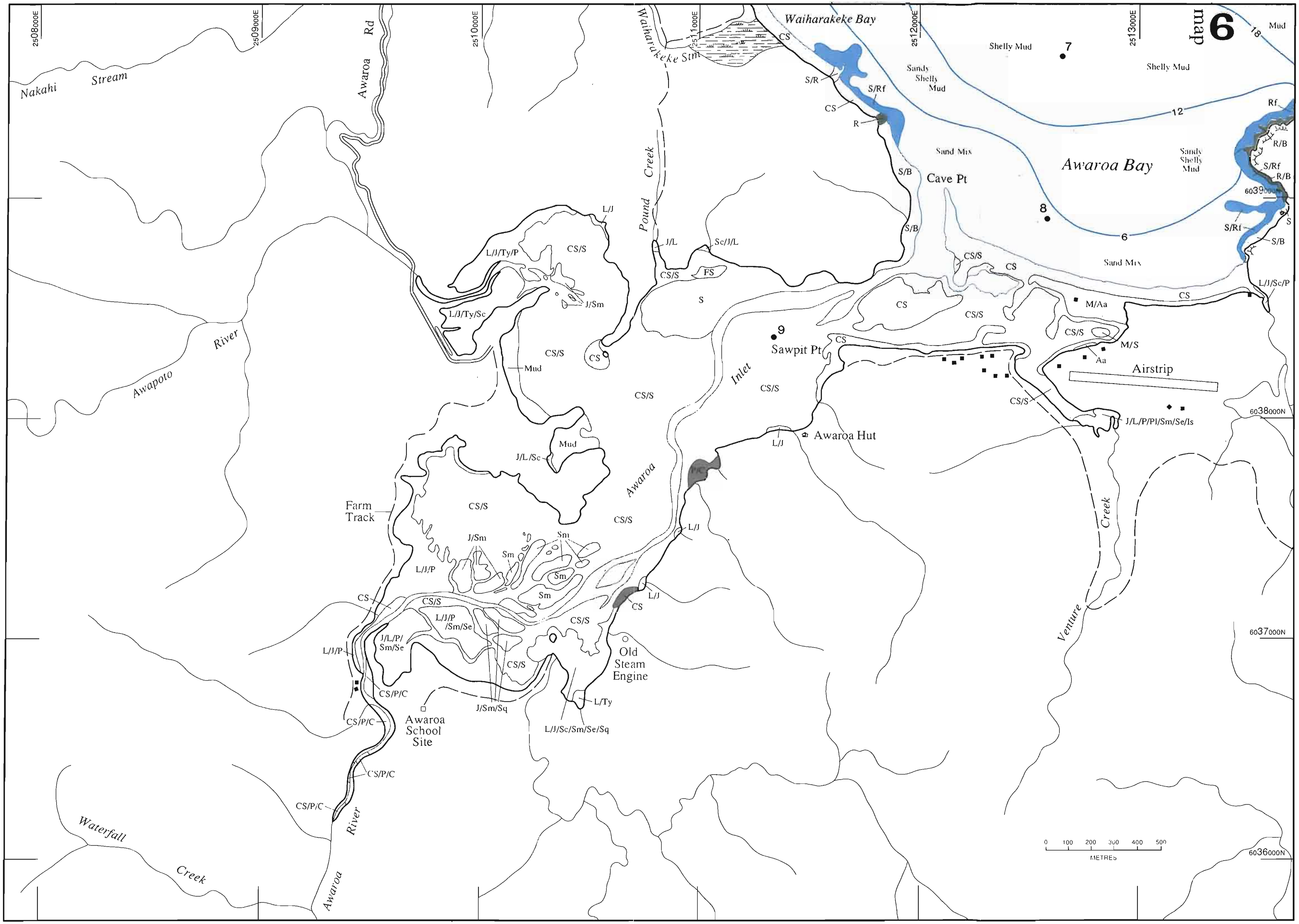
6029000N
6028000N
METRES



map 4
Onetahuti
Tonga Island
Robs Reef
S15
T16
T18
T19
T20
T21,22
T23
T24,25
T26,27
Tonga Roadstead
Tonga Quarry (Disused)
Arch Pt
Foul Pt
Whale Rock
Mosquito Bay
Bark Bay
Bark Bay Reef
Bark Bay Hut
South Head
Tasman Bay
Huffam Stream
Long Valley Creek
Bark Bay Awaroa Bay Track
Sand Mix
Shelly Mud
Mud
L/J/Sc/Se/Sm/Is/Sq/Su/Pl
Se/Sq
Sc/L/J
J/L/Sq/Sm/Se
L/J/Sq/Sm/Se/Sc
Sq/C
Aa/C
FS
R/B
S/R
S/Rf
B/R
Rf/s
L/J/P
2513000E
2515000E
2516000E
2518000E
6035000N
6034000N
6033000N
6032000N
METRES


map 5
2514000E
2515000E
2516000E
6039000N
6038000N
6037000N
6036000N
Awaroa Head
Canoe Bay
Shelly/Sandy Mud
Shelly Mud
Mud
The Castle
T10,11
T12
Abel Head
Catamaran Reef
Brereton Cove
Sandy/Shelly Mud
Cottage Loaf Rock
T13
Wallaby Creek
The Pinnacle
Tasman Bay
Muddy Broken & Dead Shell With Coarse Sand
Shag Harbour
Richardson Stream
Awaroa Bay Bark Bay Track
Boulder Pt
Wharf Rock
Sand Mix
T17
T14
Reef Pt
Onetahuti
L/J/Sc/Se/Sm/Is/Sq/Su/Pl
METRES
24
20
18
12
10
6
0


map 6
2508000E
2509000E
2510000E
2511000E
2512000E
2513000E
6039000N
6038000N
6037000N
6036000N
Waiharakeke Bay
Waiharakeke Stm
Nakahi Stream
Awaroa Rd
Pound Creek
Awapoto River
Awaroa Bay
Cave Pt
Sawpit Pt
Inlet
Awaroa
Awaroa Hut
Airstrip
Venture Creek
Farm Track
Old Steam Engine
Awaroa School Site
Awaroa River
Waterfall Creek
Shelly Mud
Sandy Shelly Mud
Sand Mix
Mud
18
12
8
6
7
8
9
CS
CS/S
S/R
S/Rf
R
S/B
Rf
R/B
S
FS
L/J
J/L
Sc/J/L
L/J/Ty/P
L/J/Ty/Sc
J/Sm
J/L/Sc
M/Aa
M/S
Aa
L/J/Sc/P
J/L/P/Pl/Sm/Se/Is
P/C
L/J/P
Sm
CS/P/C
J/L/P/Sm/Se
L/J/P/Sm/Se
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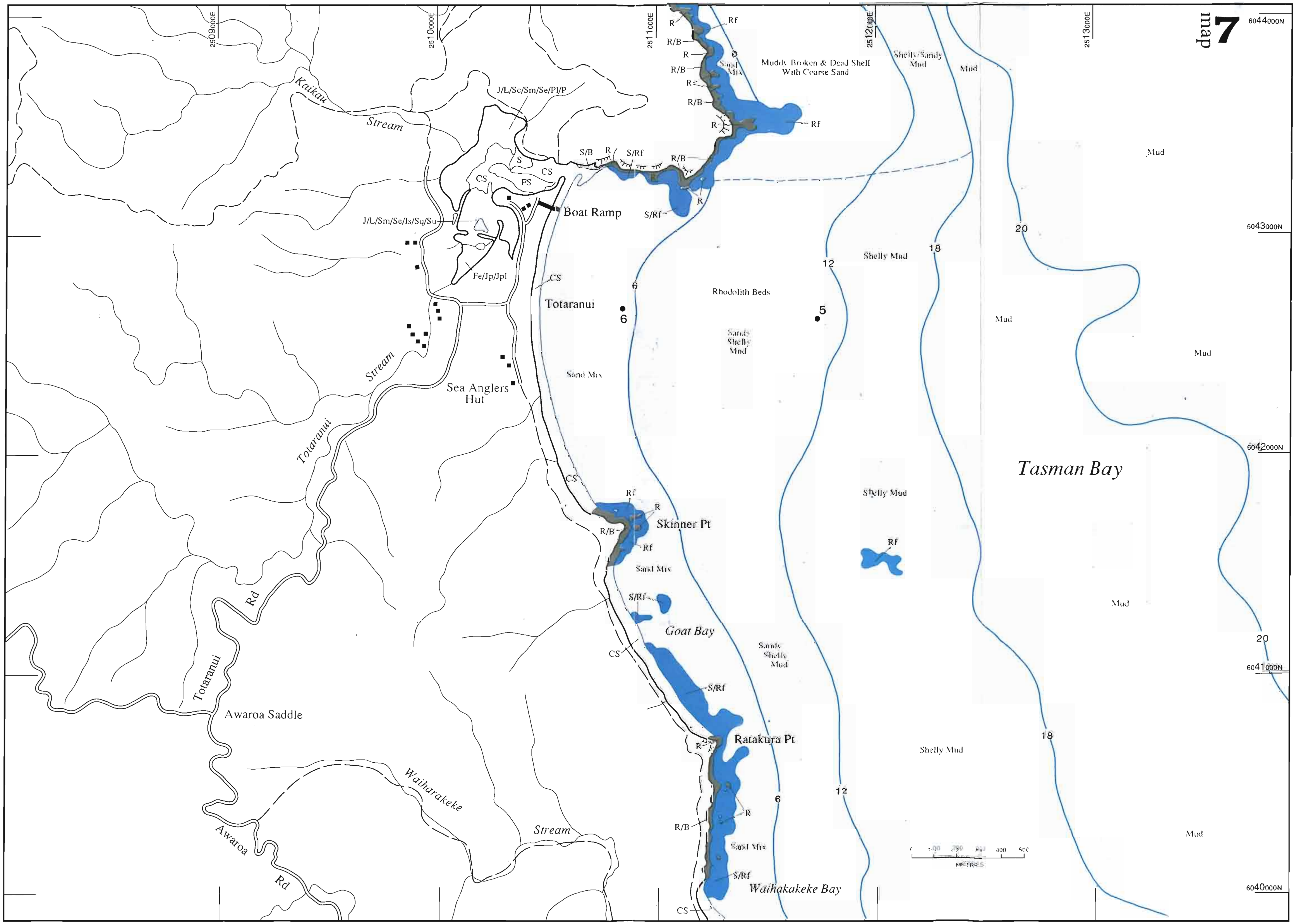
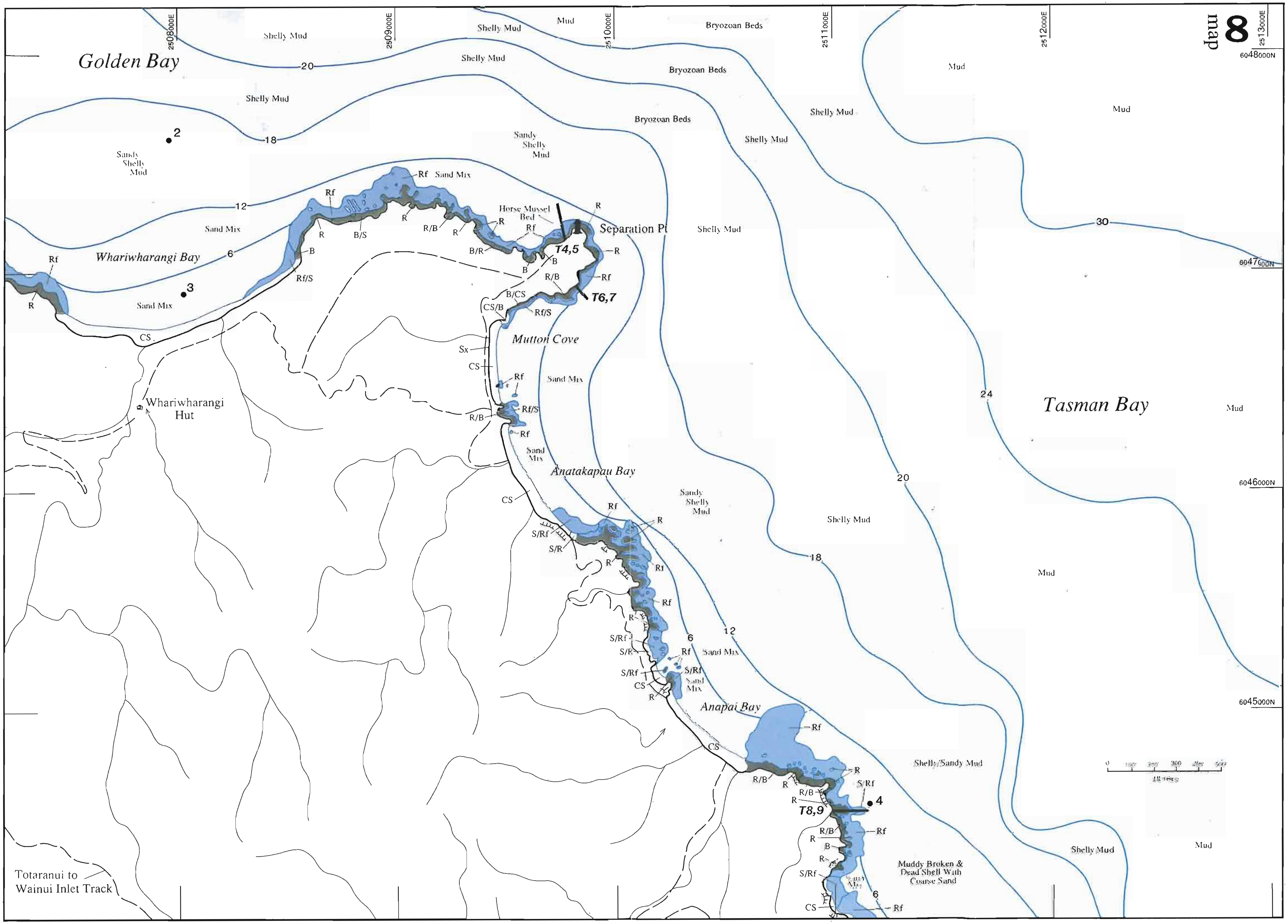
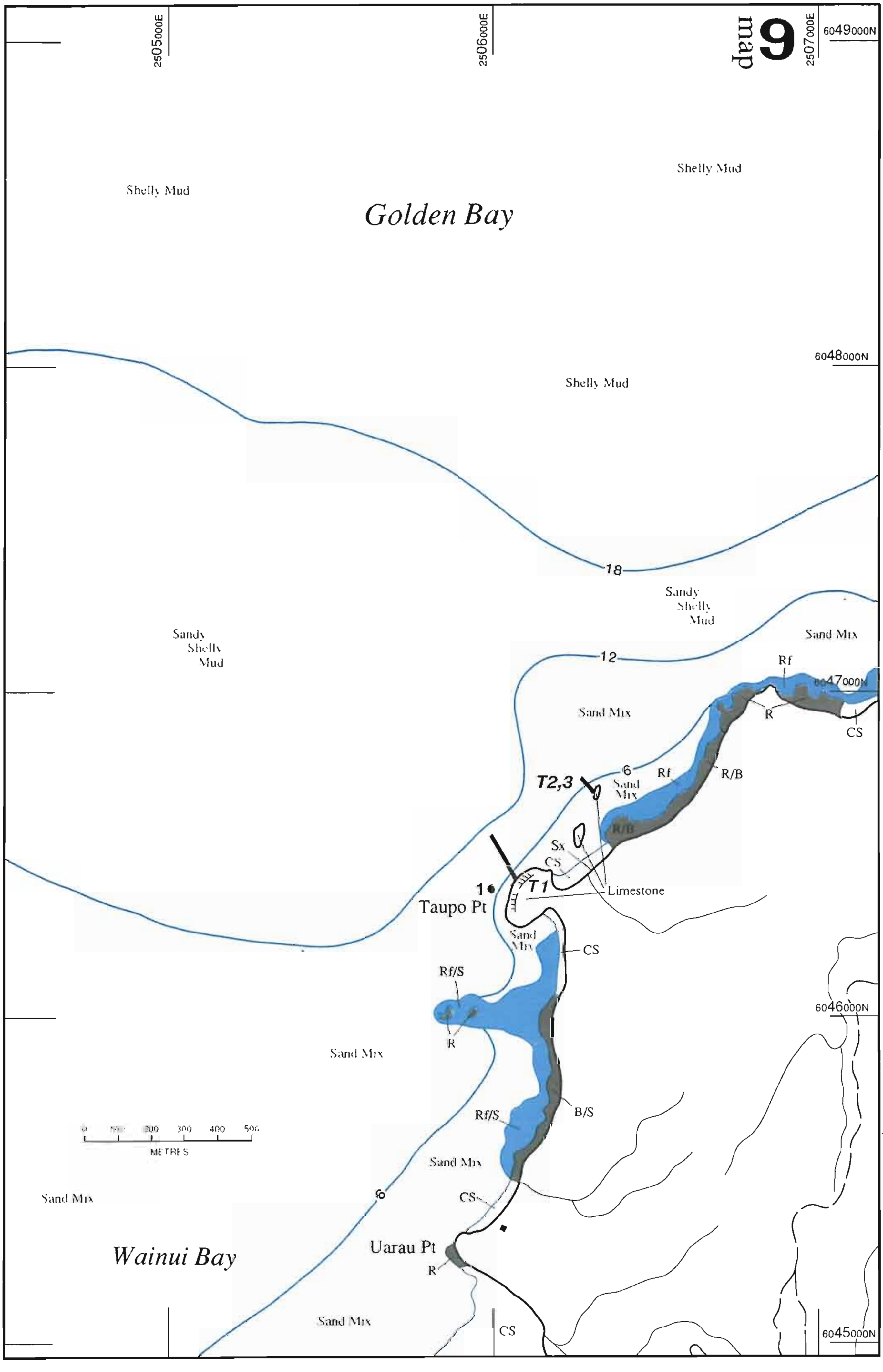
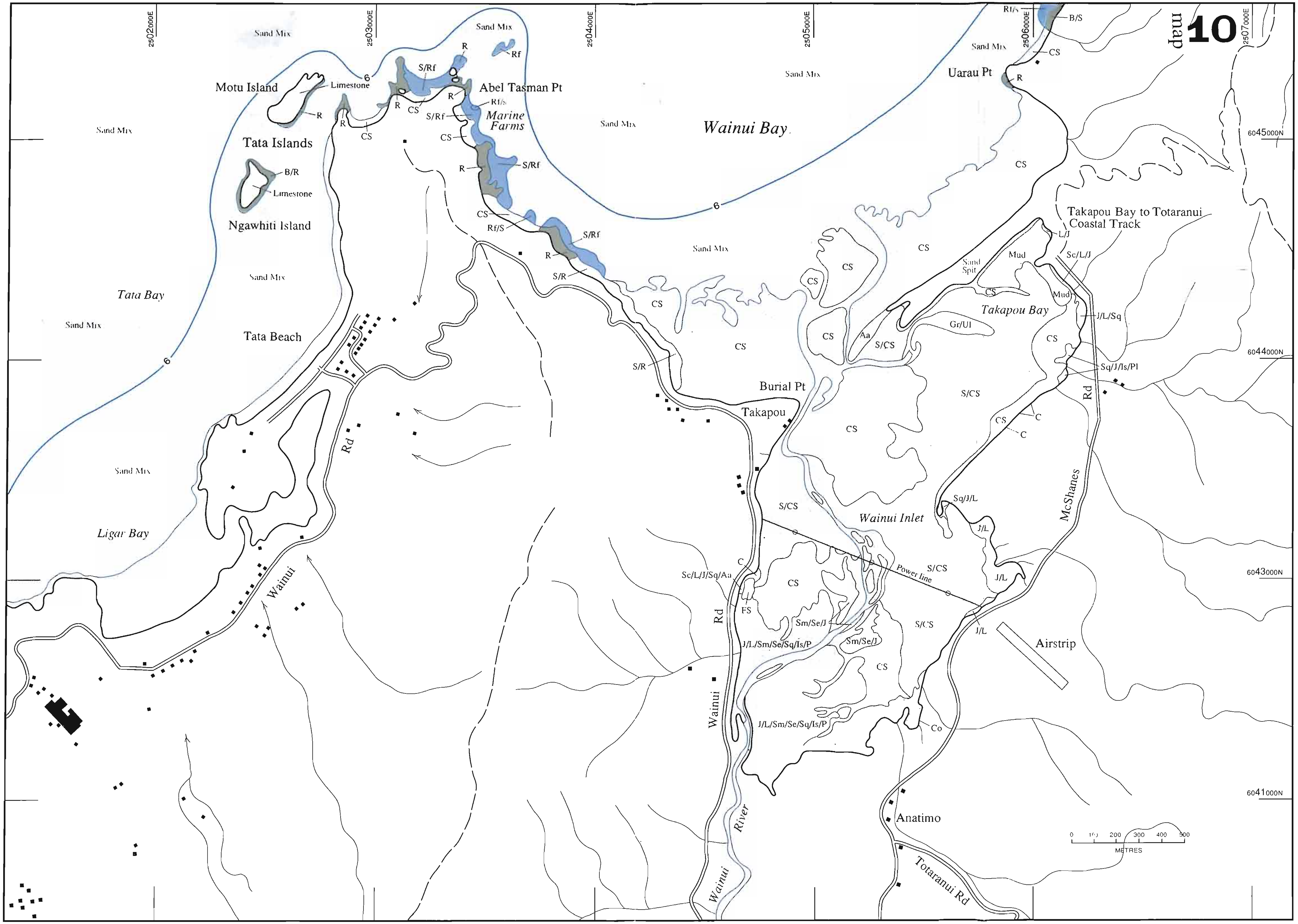
L/Ty
0 100 200 300 400 500
METRES



map 7
Muddy Broken & Dead Shell With Coarse Sand
Shelly/Sandy Mud
Mud
Kaikau Stream
Boat Ramp
Totaranui
Rhodolith Beds
Shelly Mud
Sandy Shelly Mud
Sand Mix
Sea Anglers Hut
Totaranui Rd
Tasman Bay
Skinner Pt
Goat Bay
Awaroa Saddle
Ratakura Pt
Waiharakeke Stream
Awaroa Rd
Waihakakeke Bay
METRES


map 8
Golden Bay
Tasman Bay
Whariwharangi Bay
Separation Pt
Mutton Cove
Anatakapau Bay
Anapai Bay
Whariwharangi Hut
Totaranui to
Wainui Inlet Track
Shelly Mud
Mud
Bryozoan Beds
Sandy Shelly Mud
Sand Mix
Horse Mussel Bed
Shelly/Sandy Mud
Muddy Broken &
Dead Shell With
Coarse Sand
T4,5
T6,7
T8,9
2508000E
2509000E
2510000E
2511000E
2512000E
2513000E
6048000N
6047000N
6046000N
6045000N


map 9
2505000E
2506000E
2507000E
6049000N
6048000N
6047000N
6046000N
6045000N
Golden Bay
Shelly Mud
Shelly Mud
Shelly Mud
18
12
6
Sandy Shelly Mud
Sandy Shelly Mud
Sand Mix
Rf
R
CS
R/B
T2,3
Sand Mix
Sx
CS
Limestone
1
T1
Taupo Pt
CS
Rf/S
R
B/S
Sand Mix
Rf/S
Sand Mix
METRES
Sand Mix
CS
Wainui Bay
Uarau Pt
R
Sand Mix
CS



map 10
2502000E
2503000E
2504000E
2505000E
2506000E
2507000E
6045000N
6044000N
6043000N
6041000N
Motu Island
Limestone
Tata Islands
B/R
Limestone
Ngawhiti Island
Abel Tasman Pt
Marine Farms
Wainui Bay
Uarau Pt
Sand Mix
Tata Bay
Tata Beach
Ligar Bay
Burial Pt
Takapou
Takapou Bay to Totaranui Coastal Track
Takapou Bay
Sand Spit
Mud
Gr/Ul
Wainui Inlet
Power Line
Airstrip
McShanes Rd
Wainui Rd
Wainui River
Anatimo
Totaranui Rd
S/Rf
Rf/S
Rf
R
CS
S/R
S/CS
Aa
B/S
L/J
Sc/L/J
J/L/Sq
Sq/J/Is/Pl
C
Sq/J/L
J/L
Sc/L/J/Sq/Aa
FS
Sm/Se/J
J/L/Sm/Se/Sq/Is/P
Co
0 100 200 300 400 500
METRES

4. PATTERNS IN MARINE COMMUNITIES

4.1 Introduction

Understanding ecological processes affecting populations is not possible until patterns of distribution and abundance of organisms are well documented (Underwood et. al., 1991). There are few studies in the South Island of New Zealand which describe shallow subtidal habitats and associated communities. Particular habitats, however, have been the subject of considerable study and are summarised in Davidson and Moffat (1990) and Davidson (1990). Most studies of shallow subtidal habitats and communities in New Zealand have been generated in the north-eastern coast of the North Island. For example: Leigh (Gordon and Ballantine, 1976; Ayling, 1978; Ayling et. al., 1981), Mimiwhangata (Ballantine at. al., 1973), Paparahi (Grace, 1981), Tuhua (Mayor) Island (Jones and Garrick, 1991), Poor Knights (Schiel, 1984; Battershill, 1986), Hahei (Coffey and Grace, 1990), Mokohinau Islands (Riddle, 1980; Berben and McCrone, 1988), Hauraki Gulf (Grace, 1983). Shallow subtidal habitat and community studies in the South Island exist for the Marlborough Sounds (Duffy et. al., in prep; Chadderton, Davidson and Brown, in prep), and Fiordland (Grange, 1990, Grange, et. al., 1981), and Auckland Islands (Schiel, et. al., in prep).

These and other studies have shown that subtidal marine habitats and their associated biota fall into a sequence of zones, in much the same way as zones are apparent on the rocky shore (Grace, 1983; Morton and Walsby, 1983). Underwater, these zones are determined by a variety of environmental constraints such as light intensity (depth, water clarity), wave exposure, currents, substrate and human modification. In the north of the North Island, five broad habitats typically occur on sheltered to moderately exposed shores. These include a shallow mixed weed zone (*Carpophyllum* dominant), rock flats zone where large algae is absent with abundant populations of kina (*Evechinus chloroticus*), kelp forest with abundant *Ecklonia radiata* or *C. flexuosum*, deep zone with abundant sponges and a very deep zone with abundant sponges and other suspension feeders. Recent research suggests that these patterns may not be prevalent in central of southern New Zealand (Schiel, 1990; Davidson and Chadderton, in prep; Chadderton et.al., in prep).

The present study describes the patterns in marine communities, related habitat and environmental factors along the Abel Tasman coastline and compare these with those recorded from other parts of New Zealand.

4.2 Sampling Methods and Analyses

A variety of quantitative and qualitative scientific sampling techniques were used. Invertebrates from soft shores were sampled using a hand held core sampler. Seven intertidal sites in four estuaries and one intertidal beach were sampled. Intertidal sample sites were limited to the major habitat and substrate types.

Subtidal soft bottom substrates and habitats were also core sampled. A total of 18 sites were sampled at depths between 5 and 22 m. At each site, five random core samples (15 cm diameter and 15 cm deep) were collected, sieved, labelled and the remaining material stored in 70 % isopropyl alcohol. All samples contained a significant proportion of coarse sands and broken shell, therefore, all core samples were passed through a 1.0 mm mesh size.

Rocky intertidal and subtidal environments were investigated using a variety of techniques. At all 13 intertidal and 24 subtidal sites, habitat and community changes were noted. A list of species associated with each zone along the shore and their relative abundance was assessed on a scale of 1 = occasional, 2 = common, 3 = abundant, and 4 = zone forming. Quantitative rocky data collected during this study were published in Davidson and Chadderton (in press).

At all estuarine and coastal sites, time was spent searching for rare or widely distributed invertebrates.

In addition to community investigations, particular organisms were targeted for study. For example, horse mussels *(Atrina zelandica)* densities were determined using either transects or 1 m^2 quadrats depending on their density.

Cockle and Pipi Sampling

Cockles (*Austrovenus stutchburyi)* and pipis (*Paphies australis)* collected from benthic core samples were counted and measured. Measurement dimension for these shellfish are displayed in Appendix 3.

Statistical Analyses

Statistical analyses on all invertebrate data were run on MAC microcomputer using a variety of BASIC computer programmes designed or adopted by J Stark (Cawthron Institute, Nelson). Two types of analyses were used to compare benthic invertebrate species composition for intertidal and subtidal sites along the National Park. Cluster analyses were based on programmes supplied by Professor W Stephenson, University of Queensland, Australia. Data averaged from replicated core samples were transformed using Log_{10} (X + 1) transformation and clustered using the Bray-Curtis Dissimilarity Index of group average clustering strategy (Clifford and Stephenson, 1975). These analyses progressively grouped most similar species composition and abundances based on benthic invertebrate, plant and fish data, and were graphically displayed in a dendrogram (Appendix 4-6). The Bray-Curtis Dissimilarity Index was also used for all data excluding fish information where the Jaccard Index based on presence/absence data was used.

For all cluster groups species which contributed most strongly were determined using a pseudo F-test. The level of significance was set at 0.05 probability. This test, although not fulfilling all the assumptions of a true F-test, allowed characteristic species for each group of sample sites to be determined. This test also determined the relative importance of each species within each group.

4.3 Results and Discussion

4.3.1 Invertebrate Communities

Ecological studies of estuaries, inshore waters and shallow subtidal environments traditionally investigate benthic invertebrate faunas (Knox, 1974; Bolton and Knox, 1977; Knox et.al., 1977; Ayling, 1978; Kilner and Akroyd, 1978; Knox and Bolton, 1978; Knox et. al., 1978; Knox, 1983; Schiel, 1984; Battershill, 1986; Battershill and Bergquist, 1990; Davidson, 1990; Davidson and Moffat, 1990; Knox, 1990). Invertebrate community patterns such as diversity, density, and distribution data, supply valuable information about the coastal environment under investigation. Benthic invertebrate have been used as measures of stress on the system. The abundance of particular species or the absence of others may suggest impact from pollution, sedimentation and poisoning (Ketchum 1969; Odum et. al. 1969; Pearson and Rosenburg, 1978; Stephenson, 1980; Moffat, 1989).

Benthic invertebrates are an important source of food to other invertebrates, fish and birds. They are therefore a crucial part of the coastal food chain along the Abel Tasman National Park. This present study, therefore, places considerable emphasis on the collection and interpretation of invertebrate data.

This chapter is divided into three sections based on the type of environment sampled.

Soft Bottom Communities

A total of 26 intertidal and subtidal soft shores sites were investigated along the Abel Tasman (Table 2, Figure 5). Ninety three invertebrate taxa were recorded from these shores (Table 3). Thirty one species were recorded from intertidal soft shore areas and 71 taxa from subtidal soft shores. Seven invertebrate taxa were recorded from both intertidal and subtidal sites. These taxa included polychaete worms (*Orbina papillosa*, *Armandia maculata*, Spionidae sp., Syllidae sp., Lumbrineridae sp.), a Sipunculida and Isopoda. All but two taxa from intertidal soft bottom species were recorded in estuarine areas. The other taxa were recorded from a beach site (Glyceridae sp., Opheliidae sp.).

Estuarine soft bottom shores were dominated by molluscs (13 species), polychaetes (9 species), crustaceans (6 species), algae (2 species) and one sipunculid, and two species of insect (Table 3). Taxa regularly recorded from estuarine soft shore sites included the pipi (*Paphies australis*), cockle (*Austrovenus stutchburyi*), nereid polychaetes, and mud crab (*Helice crassa*).

Subtidal soft shores were also dominated by molluscs (30 species), polychaetes (19 species), echinoderms (8 species), crustaceans (7 species), one bryozoan, one sipunculid, one nemertine, a brachiopod and *Urechis novaezelandiae* (Table 3). Taxa recorded regularly from subtidal soft shores included the horse mussel (*Atrina zelandica*), bivalves (*Corbula zelandica, Glycymeris laticostata, Nucula nitidula*), scallop (*Pecten novaezelandiae,* polychaete worm (*Spirorbis sp.*), hermit crab species, 11 arm starfish (*Coscinasterias calamaria*), kina (*Evechinus chloroticus*) and cushion starfish (*Patiriella regularis*).

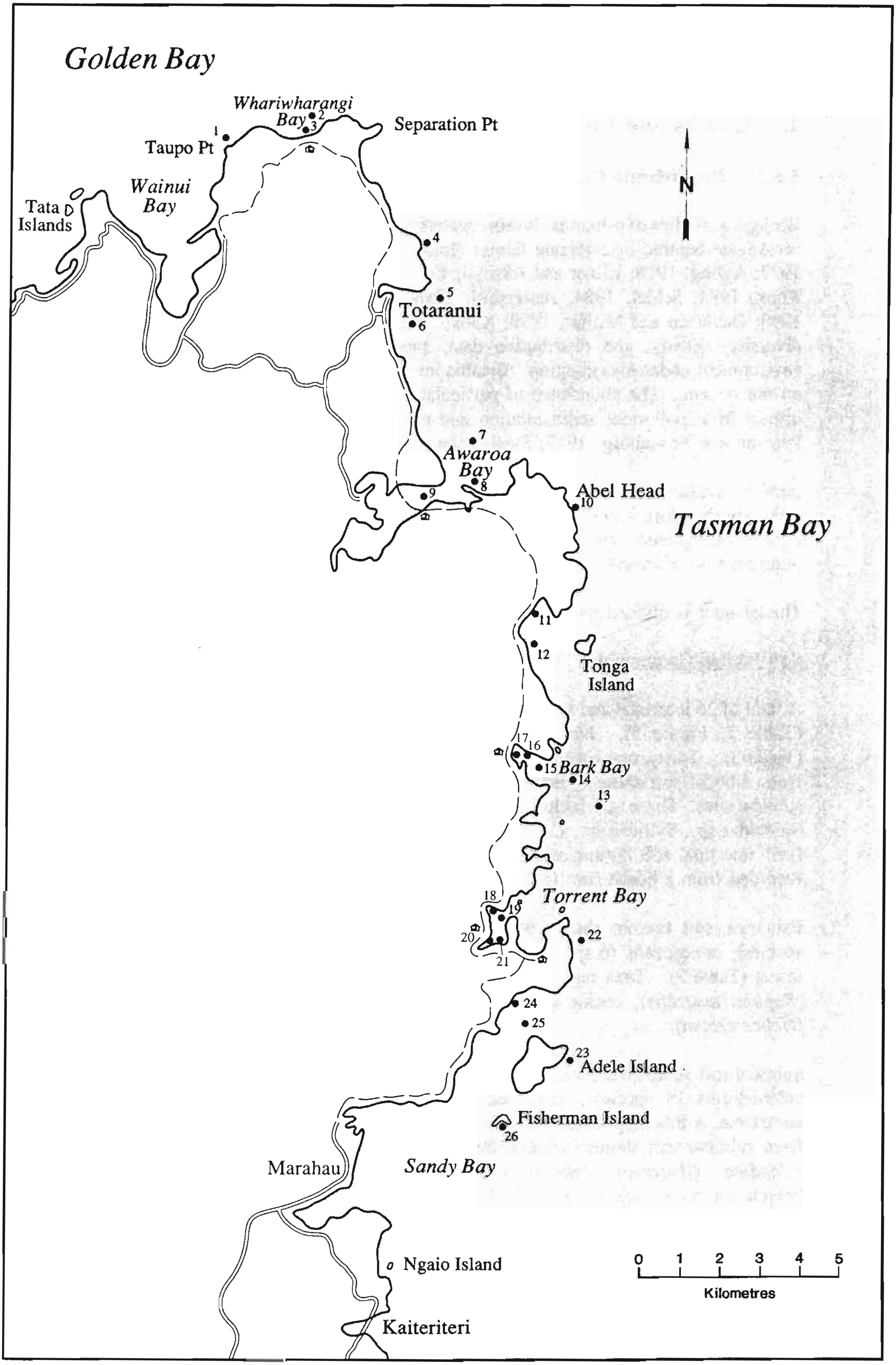


Fig. 5 CORE SAMPLE SITES ALONG THE ABEL TASMAN COASTLINE

TABLE 2: **List of core sample sites along the Abel Tasman coastline.**

Number	Location	Type/Depth	Substrate/Vegetation
1	Taupo Point	Subtidal (11 metres)	Shelly sand
2	Whariwharangi Bay	Subtidal (15 metres)	Shelly mud
3	Whariwharangi Bay	Subtidal (8 metres)	Sand
4	Totaranui (north)	Subtidal (8 metres)	Shelly/muddy coarse sand
5	Totaranui	Subtidal (15 metres)	Rhodolith/shelly mud
6	Totaranui	Subtidal (11 metres)	Shelly sand
7	Awaroa	Subtidal (15 metres)	Shelly mud
8	Awaroa	Subtidal (8 metres)	Sand
9	Awaroa Inlet	Intertidal	Fine sand
10	Cottage Loaf Rock	Subtidal (14 metres)	Shelly coarse sand
11	Onetahuti Estuary	Intertidal	*Schoenoplectus pungens*
12	Onetahuti Quarry	Subtidal (14 metres)	Shelly mud
13	Bark Bay	Subtidal (21 metres)	Mud
14	Bark Bay	Subtidal (13 metres)	Shelly sand
15	Bark Bay	Subtidal (9 metres)	Shelly/sandy mud
16	Bark Bay Estuary Mouth	Subtidal (< 1.0 metres)	Coarse sand
17	Bark Bay Estuary	Intertidal	Fine sand
18	Torrent Bay Estuary	Intertidal	Fine sand
19	Torrent Bay Estuary	Intertidal	Coarse sand
20	Torrent Bay Estuary	Intertidal	*Juncus maritimus*
21	Torrent Bay Estuary	Intertidal	*Leptocarpus similis*
22	Snapper Rocks	Subtidal (16 metres)	Shelly mud/coarse sand
23	Adele Island	Subtidal (15 metres)	Shelly mud
24	Observation Beach	Subtidal (5 metres)	Sand
25	Astrolabe	Subtidal (13 metres)	Shelly mud
26	Fisherman Island	Intertidal	Sand

Invertebrate data collected from intertidal and subtidal soft bottom sample sites were differentiated into three subtidal and four intertidal community assemblages using the Bray-Curtis Dissimilarity Index (Appendix 4). Site groupings information are presented in Table 5. Flora and fauna characteristic of these groups were determined using a pseudo-F-test (Table 5).

Intertidal Soft Shores

1. Sand Beach

   Sand beach shores were characterised by a low number of taxa (three taxa) in relatively low abundances (Table 4) and only polychaete worms (Opheliidae sp., Glyceridae sp.) and another unidentified species were recorded. Burrows in the upper tidal areas of many beaches along this coastline suggest the presence of large numbers of amphipods (sand hoppers).

2. Rushes and Sedge

   Intertidal vegetation was generally restricted to estuarine areas, however, isolated patches of *Leptocarpus similis* were located on the open coast where freshwater and salt spray combine to produce suitable conditions. Vegetation types sampled were the sea rush (*Juncus maritimus*), jointed wire rush (*Leptocarpus similis*) and sedge (*Schoenoplectus pungens*). Other estuarine vegetation types were not sampled, but results from studies in Waimea Inlet and Whanganui Inlet suggest the faunas are similar (Davidson and Moffat, 1990; Davidson, 1990).

   Largest areas of intertidal vegetation were located in Awaroa Inlet, Torrent Bay Estuary, Wainui Inlet, Totaranui Estuary, Bark Bay Estuary and Marahau Estuary. Characteristic species from this habitat include the mud crab (*Helice crassa*), estuarine snail (*Potamopyrgus estuarinus*) and mud-flat snail (*Amphibola crenata*) (Table 5).

   A total of six invertebrate species were recorded from the estuarine vegetation habitat (Table 3). These species were the mud flat snail (*A. crenata*), mud-flat whelk (*Cominella glandiformis*), estuarine snail (*P. estuarinus*), nereid polychaete, mud crab (*Helice crassa*) and insect larvae (Appendix 8).

   A species notable by its absence from this habitat along the Abel Tasman coastline was the gastropod *Ophicardellus costellaris*. The reason for this phenomenon is unknown.

3. Estuarine Coarse Sand

   Estuarine coarse sand flats were located inside the entrance to Awaroa Inlet, Wainui Inlet, Bark Bay Estuary, and Torrent Bay Estuary. Two estuarine coarse sand flats were sampled, one in Torrent Bay Estuary and the other in the entrance channel to Bark Bay Estuary.

   A total of ten invertebrate taxa were recorded from the coarse sand substrate (Table 3). The fauna was dominated by molluscs (6 species), followed by two species of crustacean and two polychaete taxa. Characteristic animals from estuarine coarse sand flats were pipi (*Paphies australis*) and nereid polychaete worms (Table 5). The pipi was recorded in densities as high as 3,531 per m^2.

TABLE 3: Major taxonomic groups from each habitat along the Abel Tasman coastline.

Group Type	Number of Sites	Mean No. of Species	Algae	Crustacea	Mollusca	Polychaeta	Echinodermata	Others	Total
1. Estuarine soft shores (intertidal)	8	7.8 (5.1)	2	6	13	9	0	3	33
- Estuarine vegetation	3	3.7 (0.47)	0	2	3	1	0	0	6
- Estuarine coarse sand	2	6.0 (3.0)	0	2	6	2	0	0	10
- Estuarine fine sand	3	13.0 (4.2)	2	4	10	8	0	1	26
2. Coastal soft shore (intertidal)	1	3.0	0	0	1	2	0	0	3
3. Rocky shores (intertidal)	13	19.6 (3.4)	10	9	25	2	4	3	53
- Limestone	1	27.0	2	5	17	1	1	1	27
- Granite	12	19.3 (3.2)	10	9	23	2	3	4	51
4. Soft shores (subtidal)	17	13.7 (4.7)	0	7	30	19	8	5	69
- Mud	2	11.0 (0)	0	2	6	4	5	0	17
- Coarse substrate dominated	10	15.7 (5.0)	0	5	20	13	6	6	50
- Shallow shores	5	10.8 (2.3)	0	3	7	6	4	4	24
5. Rocky shores (subtidal)	24	31.9 (7.3)	11	4	25	2	10	21	73
- Deep reef	3	35.7 (2.3)	4	4	15	1	5	20	49
- Limestone	2	43.5 (0.5)	8	3	18	3	4	21	57
- Shallow shores	3	28.7 (5.4)	4	4	13	1	8	11	41
- Exposed shores	10	34.0 (3.9)	8	3	21	2	9	20	63
- Sheltered shores	5	22.0 (4.9)	7	2	13	1	9	6	38

TABLE 4: Core sample sites and mean number of invertebrate species associated with each habitat.

Habitat	Number of Sites	Mean Number of Species	SD	Core Sample Site Locations (Table 2)
Sand Beach (intertidal)	1	2	-	26
Mud (subtidal)	2	11	0	7, 13
Coarse Substrates (subtidal)	10	15.6	5.1	1, 2, 4, 5, 10, 12, 14, 22, 23, 25
Shallow subtidal shores	5	10.2	2.0	3, 6, 8, 15, 24
Estuarine Vegetation (intertidal)	3	3.7	0.47	11, 20, 21
Estuarine Coarse Sand (intertidal)	2	6	3.0	16, 19
Estuarine Fine Sand (intertidal)	3	13	4.2	9, 17, 18

TABLE 5: Invertebrates characteristic of soft bottom environments along the Abel Tasman coastline.

Habitat Type	Characteristic Species	Pseudo F-test Significance	Number per Square Metre
Mud (subtidal)	*Echinocardium australe* (Sea mouse)	0.61	22-57
	Amalda australis (Southern olive shell)	4.62	11
Coarse substrates (subtidal)	*Coscinasterias calamaria* (11 arm starfish)	0.27	1-2
	Hermit crab spp.	1.13	1-135
	Spirorbis sp. (polychaete worm)	1.87	67-1669
	Armandia maculata (polychaete worm)	4.0	11-481
Shallow subtidal shores	*Coscinasterias calamaria* (11 arm starfish)	0.27	1-2
	Hermit crab spp.	1.13	11-22
	Armandia maculata (Polychaete worm)	4.0	11-45
Estuarine vegetation (intertidal)	*Potamopyrgus estuarinus*	4.45	90-4957
	Helice crassa (mud crab)	0.27	11-113
	Amphibola crenata (mud snail)	1.07	11-34
Estuarine coarse sand (intertidal)	*Paphies australis* (pipi)	<0.01	2354-3531
	Nereidae spp. (polychaete worm)	0.26	22-170
Estuarine fine sand (intertidal)	*Diloma subrostrata* (top shell)	<0.01	11-34
	Paphies australis (pipi)	<0.01	68-962
	Chione stutchburyi (cockle)	0.04	351-2716
	Halicarcinus whitei (spider crab)	0.06	0-11
	Telina liliana (wedge shell)	0.23	45-249
	Nereidae spp. (polychaete worm)	0.26	22-44

4. Estuarine Fine Sand Flats

Estuarine fine sand flats were located in all of estuaries along the Abel Tasman. Largest fine sand flats were located in Awaroa Inlet, Bark Bay Estuary and Torrent Bay Estuary.

A total of 26 invertebrate species were recorded from fine sand flats along the Abel Tasman coastline (Table 3). An average of 13 species were recorded on fine sand flats, the highest for an estuarine zone in the present survey. The fauna was dominated by molluscs (10 taxa), followed by polychaetes (8 taxa), crustaceans (4 taxa), algae (two taxa) and an anemone.

Characteristic invertebrates of estuarine fine sand flats include the top shell (*Diloma subrostrata*), pipi (*Paphies australis*), cockle (*Austrovenus stutchburyi*), spider crab (*Halicarcinus whitei*), wedge shell (*Telina liliana*) and nereid polychaetes (Table 5). Densities of invertebrates from fine sand flats ranged between 962 - 16,014 individuals per m^2 (Appendix 8). This was the highest recorded for any soft bottom shore in the present study.

Subtidal Soft Shores

1. Shallow Subtidal Soft Shores

Invertebrate communities recorded from shallow subtidal shores were separated into a distinct group by the Bray-Curtis Dissimilarity Index (Appendix 4). This group was generally composed of sites < 10 m depth, which were widely distributed around the Abel Tasman coastline in the inshore areas, especially adjacent to beaches. Dominant substrates were sand, coarse sand, and broken and dead shell. The predominance of these substrates depended on shore aspect and current. Shores exposed to direct wave action were dominated by sand substrates, while sites located on the leeward side of islands or headlands were characterised by a greater broken shell component. Shallow soft bottom shores in current swept areas were dominated by broken shell, dead shell and coarse sand, eg. Taupo Point. Five shallow subtidal sites were sampled along the Abel Tasman coastline. Twenty-four taxa were recorded from this zone, seven mollusc taxa, six polychaete taxa, four echinoderm taxa, three crustacean taxa, a sipunculid, nemertine, and an amphipod. Between 8 and 13 invertebrate taxa were recorded from sand dominated subtidal sites. Densities ranged form 113 to 1,188 individuals per m^2.

Species characteristic of these shores included 11 arm starfish (*Coscinasterias calamaria*), hermit crabs (*Pagurus spinulimanus, Astraleremus* sp.) and polychaete worm (*Armandia australis*) (Table 5). Other species often recorded from sand bottom sites included the cushion star (*Patiriella regularis*), sand dollar (*Arachnoides zelandiae*).

2. Coarse Substrates (shelly sandy mud, sandy shelly mud, shelly mud)

Coarse substrate shores were composed of a variety of materials in varying proportions. This phenomenon appeared to be related to current, depth and shore aspect. Coarse substrate bottoms were generally started at depths between 6 to 10 m and were replaced by mud shores at 20 m depth. Coarse sand faction dominated shallow areas while the broken/dead shell faction dominated deeper areas (see chapter 3.2). Coarse substrate areas are relatively common along the Abel Tasman coastline in inshore areas and around headlands, islands and rocky coasts.

Fifty species of invertebrate were recognised from core samples taken from the coarse substrate shores (Appendix 9). Ten sites were grouped by the Bray-Curtis Dissimilarity Index into this group (Appendix 4). Numbers of individual invertebrates recorded from coarse substrate site varied from 125 to 3,678 per m^2. The 25 species and 3,678 individuals per m^2 recorded from Taupo Point was the highest for any subtidal soft bottom site in the present study (Appendix 9). On average, 16 species were recorded from soft bottom shores (Table 3).

Molluscs dominated this habitat with 20 species, followed by polychaetes (13), echinoderms (6), crustaceans (5), the bryozoan (*Celleporaria agglutinans*), a sipunculid, and the brachiopod (*Waltonia inconspicua*) (Appendix 9).

Animals characteristic of coarse substrate shores were 11 arm starfish (*Coscinasterias calamaria*), hermit crabs, polychaetes (*Spirorbis sp.*, *Armandia maculata*) (Table 5). Other notable species often recorded were the bivalves (*Corbula zelandica, Glycymeris laticostata, Nucula nitidula, Atrina zelandica, Tawera spissa*, cushion star (*Patiriella regularis*) and kina (*Evechinus chloroticus*).

3. Mud
Subtidal mud shores along the Abel Tasman coastline are common below 20 m depth. In offshore areas, mud is glutinous, deep and easily disturbed by divers. Very little current or wave action was observed in these areas. Two mud areas were core samples, offshore Pinnacle Island (21 m) and offshore Awaroa Bay (15 m). Bottom substrate at the Awaroa site had a small component of broken shell, 17 species of invertebrate were recorded from these mud sites along the Abel Tasman (Table 3). Six species of mollusc, five echinoderms, four polychaetes and two Crustacea were recorded from subtidal mud bottoms. Species characteristic of this soft shore type were the sea mouse (*Echinocardium australe*) and the southern olive shell (*Amalda australis*) (Table 5). The densities of invertebrates from mud bottoms were low (170-181 per m^2) (Appendix 9).

Intertidal Rocky Communities

Intertidal rocky shores are located throughout the Abel Tasman coastline. Rocky shores are dominated by bedrock, boulders or combinations of these shore types. The coastline of the Abel Tasman drops relatively quickly, with few intertidal platforms or intertidal expanses.

Granite shores of the Abel Tasman were characterised by a low biomass of algae over most of the shore, giving a barren appearance. Intertidal area was divided into four distinct zones:

1. periwinkle zone;

2. barnacle zone;

3. polychaete zone; and

4. algal zone (Photo 17).

The typical pattern for these zones are displayed in a representative shore profile in figure 7 and 8. A total of 13 intertidal rocky sites were investigated along the Abel Tasman (Table 6, 7, Appendix 10).

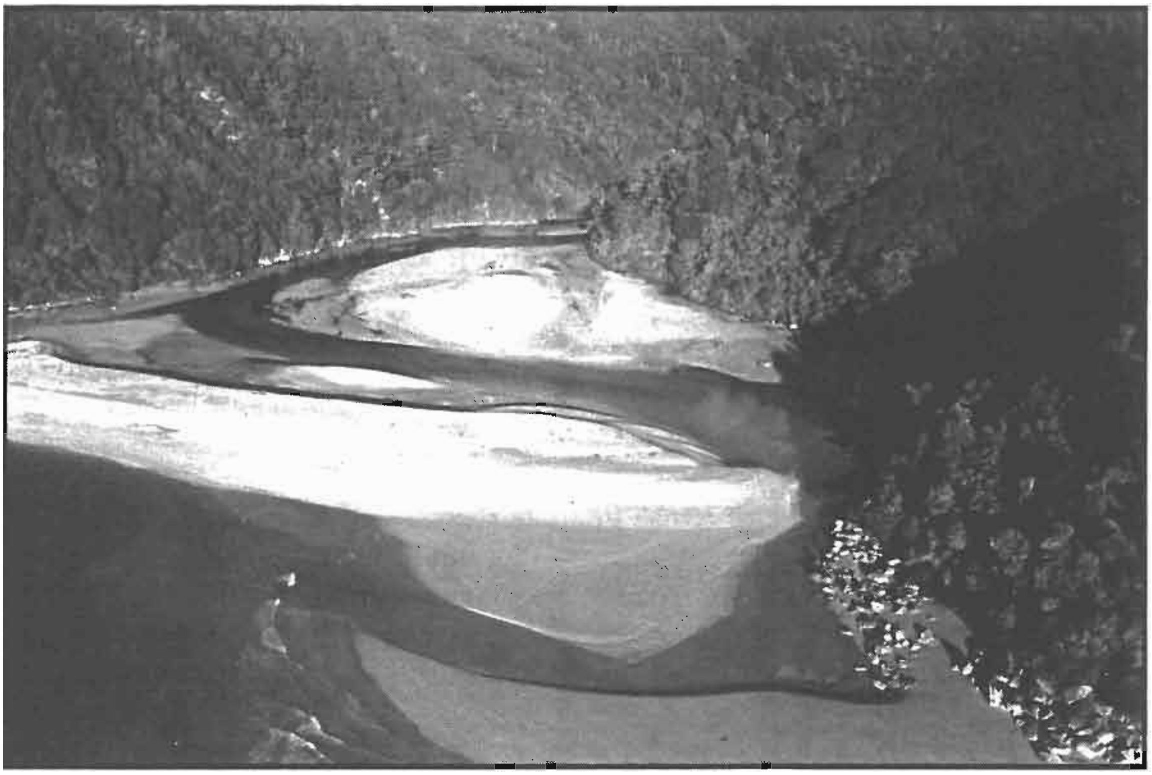


Photo 16. Falls River Estuary and sand-bar.

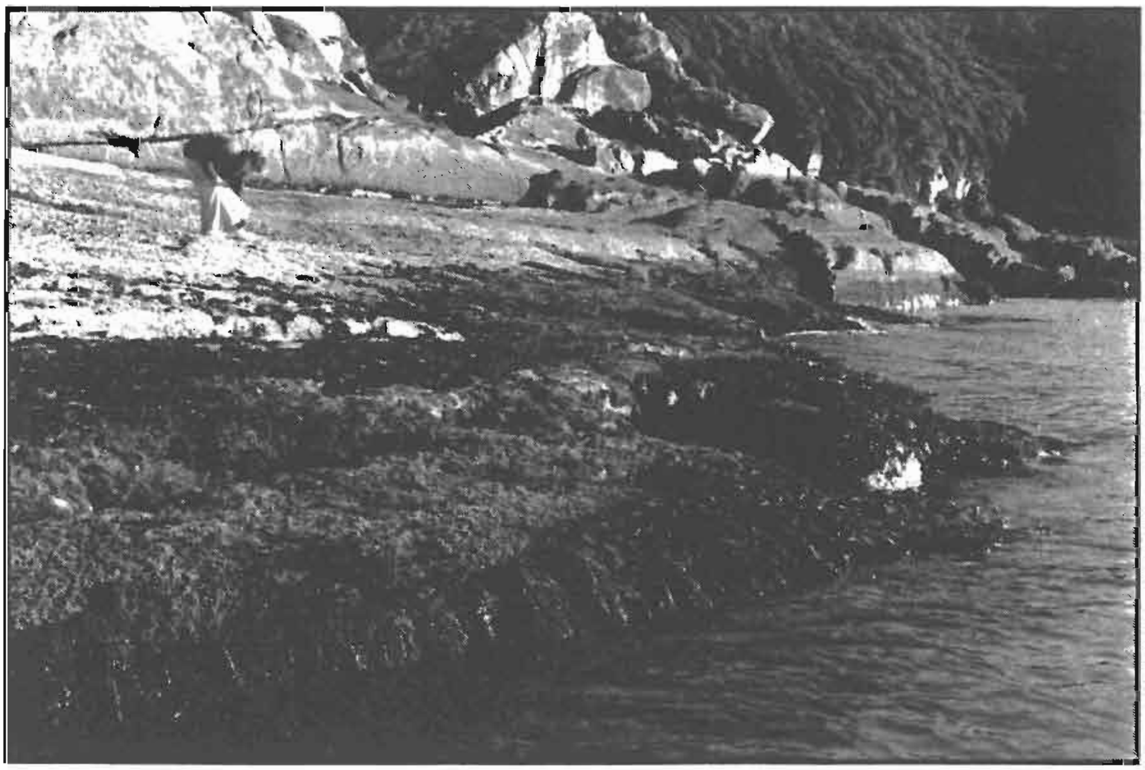


Photo 17. Intertidal granite zonation at an exposed location (Abel Head).

Fifty-three species of invertebrate were recorded from intertidal rocky shores along the Abel Tasman coastline (Appendix 10). These shores were dominated by molluscs (25), followed by algae (10), crustaceans (9), echinoderms (4), polychaetes (2), three species of anemone and a bryozoan (*Watersipora cucullata*). Species recorded regularly from intertidal rocky shores included the ornate limpet (*Cellana ornata*), radiate limpet (*Cellana radians*), chiton (*Chiton pelliserpentis*), Pacific oyster (*Crassostrea gigas*), whelk (*Haustrum haustorium*), purple periwinkle (*Littorina unifasciata*), oyster borer (*Lepsiella scobina*), top shell (*Melagraphia aethiops*), blue mussel (*Mytilus edulis*), white rock shell (*Thias orbita*), cats-eye (*Turbo smaragdus*), little black mussel (*Xenostrobus pulex*), polychaete worm (*Pomatoceros caeruleus*), barnacles (*Chaemosipho columna, Elminius modestus, Epopella plicata*), cushion star (*Patiriella regularis*), reef starfish (*Stichaster australis*) and algae (*Laurencia botyroides*) (Appendix 10).

Analysis of intertidal rocky shore data using the Bray-Curtis Dissimilarity Index revealed little distinction between intertidal communities recorded from granite shores along the Abel Tasman coastline (Appendix 4). However, intertidal limestone sites located at Taupo Point were distinguished from granite invertebrate community structure and composition.

Limestone intertidal shores were recorded from the Tata Islands, Abel Tasman Monument, Taupo Point and two small island stacks adjacent to Taupo Point. Twenty-seven invertebrate species were recorded from the intertidal limestone shore on Taupo Stack Number 2 (Table 3). The fauna was dominated by molluscs (17 species), followed by crustaceans (5 species), algae (2 species), one polychaete, one echinoderm, and one recorded species of bryozoan.

A number of characteristics separated limestone sites from all of the granite sites sampled. These included: 1) presence of a dominant zone of the barnacle *Epopella plicata*, with the subsequent displacement of the barnacles *Chaemosipho columna* and *Elminius modestus;* 2) the encrusting polychaete (*Pomatoceros caeruleus*) did not form a zone, a feature characteristic of all intertidal granite shores; 3) the bryozoan *Watersipora cucullata* and sea lettuce *Ulva sp.* were recorded in higher densities than at granite sites; and 4) at the low tide level, red algal species were recorded at up to 100 % cover on limestone, whereas these species were virtually absent from granite sites.

The limestone areas at Taupo Point were characterised by three zones:

1. periwinkle zone; 2. barnacle zone; & 3. a red algae, brown algae/mussel zone (Fig. 8).

Crevices, cracks, caves, promontories and ridged surfaces were common on limestone shores.

Subtidal Rocky Communities

Subtidal rocky shores are located throughout the Abel Tasman coastline. Like intertidal rocky shores, subtidal areas are characterised by two rock types (limestone, granite). Subtidal rocky shores drop quickly in most areas, terminating in soft bottom substrates before 20 m depth. In many areas, rocky subtidal shore ends at depths < 10 m (eg. Fisherman Island, Astrolabe, Taupo Point, Tata Islands, Onetahuti, Bark Bay, Torrent Bay). Typical shore profile patterns for granite and limestone subtidal shores are displayed in Figure 9.

TABLE 6: List of data collection sites for intertidal and subtidal rocky shores.

Number	Location	Type	Substrate
1	Taupo Point	Subtidal transect	Shelly sand/*
2	Taupo Stack No. 2	Intertidal transect	Limestone
3	Taupo Stack No. 2	Subtidal transect	Shelly sand/*
4	Separation Point (north)	Intertidal transect	Granite
5	Separation Point (north)	Subtidal transect	Shelly mud/+
6	Separation Point (south)	Intertidal transect	Granite boulders
7	Separation Point (south)	Subtidal transect	Sand mix/+
8	Totaranui (north)	Intertidal transect	Granite
9	Totaranui (north)	Subtidal transect	Outcropping rock
10	Abel Head (north)	Intertidal transect	Granite
11	Abel Head (north)	Subtidal transect	Boulders/sand mix
12	Brereton Cove	Subtidal transect	Boulders/shelly sand
13	Cottage Loaf Rock	Subtidal transect	Boulders/outcropping rock
14	Reef Point	Subtidal transect	Boulders/sand mix
15	Rob's Reef	Subtidal spot dive	Outcropping rock
16	Tonga Island	Subtidal transect	Boulders/shelly mud
17	Onetahuti	Intertidal transect	Granite/sand
18	Arch Point	Intertidal transect	Granite
19	Foul Point	Subtidal transect	Granite/sand mix
20	Whale Rock	Subtidal transect	Boulders
21	Bark Bay Reef	Subtidal transect	Boulders
22	Bark Bay Reef	Intertidal transect	Boulders/granite
23	Mosquito Bay (north)	Intertidal transect	Granite Island
24	Bark Bay (north)	Subtidal transect	Boulders/sand
25	Bark Bay (north)	Intertidal transect	Boulders/granite
26	Bark Bay (South Head)	Intertidal transect	Boulders
27	Bark Bay (South Head)	Subtidal transect	Boulders/sand mix
28	Pinnacle Island (east)	Subtidal spot dive	Outcropping rock
29	Totara Reef	Subtidal spot dive	Boulders/rock
30	Boundary Bay (south)	Subtidal transect	Boulders/sand mix
31	Te Pukatea Bay	Subtidal transect	Granite

Table 6 (continued)

Number	Location	Type	Substrate
32	Snapper Rocks (north)	Subtidal transect	Granite
33	Anchor Bay	Intertidal transect	Granite
34	Anchor Bay	Subtidal transect	Granite/boulders
35	Watering Cove (east)	Intertidal transect	Granite/boulders
36	Watering Cove (east)	Subtidal transect	Boulders/sand
37	Six Foot Rock	Subtidal spot dive	Rock

* Limestone
\+ Boulders

TABLE 7: Intertidal and subtidal rocky data collection sites.

Habitat	Number of Sites	Mean Number of Species	SD	Site Locations
Intertidal Granite	12	19.3	3.2	4, 6, 8, 10, 17, 18, 22, 23, 25, 26, 33, 35
Intertidal Limestone	1	24	-	2
Subtidal Deep Reef	3	35.7	2.3	15, 29, 37
Subtidal Limestone	2	43.5	0.5	1, 3
Subtidal Shallow Shores	3	28.7	5.4	7, 20, 27
Subtidal Exposed Shores	10	34	3.9	5, 9, 11, 13, 16, 19, 21, 28, 32, 34
Subtidal Sheltered Shores	5	22	4.9	12, 24, 30, 31, 36

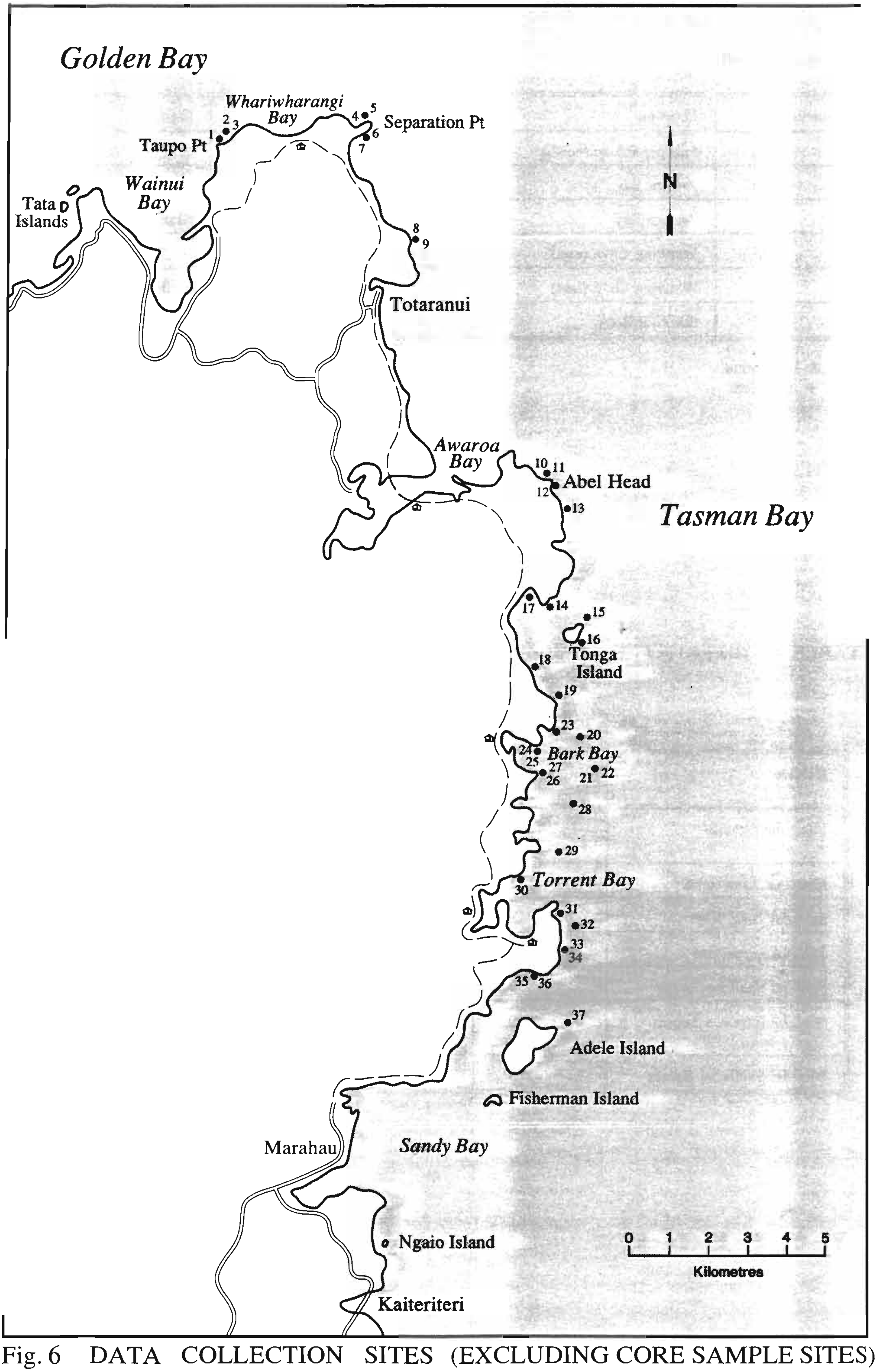


Fig. 6 DATA COLLECTION SITES (EXCLUDING CORE SAMPLE SITES)

A total of 24 subtidal rocky sites were investigated along the Abel Tasman (Table 6, Appendix 14). Seventy-three species of invertebrate were recorded from subtidal rocky shores along the Abel Tasman coastline (Appendix 11). Benthic taxa recorded from all subtidal rocky shore sample sites included: hermit crabs, encrusting polychaete (*Galeolaria hystrix),* 11 arm starfish *(Coscinasterias calamaria)* and kina (*Evechinus chloroticus*). Species recorded from most rocky shores included coralline paint, Cook's turban shell (*Cookia sulcata)*, sea cucumber (*Stichopus mollis*), box anemone (*Culcia rubeola*), cushion starfish (*Patiriella regularis*), cats-eye (*Turbo smaragdus*), window oyster (*Anomia trigonopsis*), radiate limpet (*Cellana radians*) and grey sponge (*Ancorina alata*) (Appendix 11).

Analysis of presence/absence data only grouped sites into five distinct subtidal rocky shore communities (Appendix 6).

1. <u>Deep Reef (Granite)</u>
   Deep reef areas were rocky areas which did not reach the extreme low water level and have most of their mass at depths greater than ten meters. Three deep reef areas were investigated along the Abel Tasman coastline (Six Foot Rock, Totara Reef, Rob's Rock) and 49 benthic taxa recorded (Table 3). The fauna was dominated by molluscs (15 species) and sponges (8 species) (Appendix 11).

   Analyses suggest that deep reef areas differ from other subtidal rocky shores due to the absence of brown algae (*Carpophyllum maschalocarpum*), white rock shell (*Thais orbita*), encrusting bryozoan (*Watersipora cucullata*), reef star (*Stichaster australis*) and encrusting ascidian (*Botryllus schlosseri*). These species were recorded from most other rocky subtidal areas along the Abel Tasman. The presence of particular species were also responsible for the recognition of this habitat. Species recorded from all deep reef sites, but seldom recorded from other rocky shores included a brown algae (*Ecklonia radiata*), barnacle (*Balanus decors*) and the sponge (*Iphon minor*).

2. <u>Limestone</u>
   Limestone rocky shores were located at the Tata Islands, Abel Tasman Monument and at Taupo Point. Two subtidal limestone sites were investigated, one on Taupo Point and the other on the most northerly stack at Taupo Point. These limestone sites were investigated by presence/absence analyses (Appendix 6). Taupo Point sites were characterised by up to 100 % cover of encrusting organisms, and the abundance of the brown macroalgae (*Ecklonia radiata*). Notable species which distinguished the Taupo Point sites included the golf ball sponges (*Tethia aurantium, T ingalis*), nudibranch *(Archidoris wellingtonensis)* and the encrusting bryozoan (*Watersiporia cucullata*). Species recorded only from the limestone sites included: rock borer (*Pholadidea tridens*), and white sponge (*Petrosia sp.*). Algal cover was characterised by a high percentage cover of reds and up to 29 *Ecklonia* plants per m^2 (Davidson and Chadderton, in press). Urchins *Evechinus chloroticus* were significantly larger and more abundant on limestone shores compared with granite. Differences between limestone and granite communities are discussed Davidson and Chadderton (in press).

3. Shallow Rocky Shores (Granite)
   Shallow shores were grouped together by the Jaccard clustering analyses (Appendix 11). Three shallow subtidal rocky shores were characterised by data analyses (Whale Rock, Separation Point (south), Bark Bay (south)). Sites differed from other subtidal sites due to the absence of the finger sponges (*Callyspongia ramosa, C. regularis*), brown algae (*Cystophora torulosa*), mitre shell (*Maoricolpus rosea*), green top shell (*Trochus viridus*), false oyster (*Cheidothaerus albidus*), brachiopod (*Magasella sanguinea*), tiger shells (*Maurea spp.*) and Separation Point coral (*Celleporaria agglutinans*). An average of 28.7 species were recorded from shallow shore sites (Table 3).

4. Exposed Rocky Shores
   Exposed rocky shores were distinguished from other rocky sites by cluster analyses (Appendix 6). These sites were located on north facing shores, islands and headlands around the Abel Tasman coastline. Species that were present on exposed shores and absent from more sheltered sites included: brown algae (*Cystophora torulosa*), green topshell (*Trochus viridus*), nudibranch (*Glossodoris amoena*), tiger shell (*Maurea* spp.), sulphur sponge (*Aplysilla sulfurea*), finger sponge (*Callyspongia ramosa*), false oyster (*Cheidothaerus albidus*), Separation Point coral (*C. agglutinans*), crayfish (*Jasus edwardsii*) and hydroid tree.

   Headlands, promontories, islands and reefs, are relatively common and widespread throughout the Abel Tasman coastline. Many of these areas receive the full force of northerly wave action and are swept by relatively strong tidal currents. Unlike the sheltered embayments of the park, these shores usually drop to 15 to 20 m depth providing the full range of habitat types recorded for rocky shores (Section 3.2).

5. Sheltered shores (Granite)
   Sheltered rocky shores of the Abel Tasman National Park were grouped together by the Jaccard Group average Cluster analyses (Appendix 6). Sheltered shore sites investigated included Brereton Cove, Bark Bay (north), Boundary Bay, Te Pukatea Bay and Watering Cove. They were characterised by a low species diversity (16-28 species) and the dominance of a zone barren of macroalgae. Numerous invertebrate species were conspicuous by their absence. These species included: the finger sponge (*Callyspongia ramosa*), false oyster (*Cheidothaerus albidus*), Separation Point coral (*C. agglutinans*), hydroid tree, sponge (*Strongylacidon* sp.), encrusting bryozoan (*Watersipora cucullata*) and encrusting ascidian (*Botryllus schlosseri*).

INVERTEBRATES OF PARTICULAR INTEREST

CRUSTACEA

Plagusia chabrus (Reef Crab)

Reef crabs live subtidally and in intertidal pools on the rocky coast along the park. It often shares rock crevices and caves with crayfish (*Jasus edwardsii*). This species is confined to the Indo-Pacific from South Africa to Chile, and in New Zealand southwards to Canterbury. *Plagusia* is an opportunistic feeder foraging over rock platforms mainly on limpets, chitons, gastropods, mussels, barnacles, brown algae and coralline turf (McLay, 1988).

Ovalipes catharus (Paddle Crab)

Paddle crabs are widely distributed along the sand beaches of the park, and Tasman and Golden Bays. Their numbers have increased in recent times and this has been attributed to a decline in predatory fish such as snapper and rig. Paddle crabs feed on a variety of prey including bivalves, fish, small crustaceans and polychaetes (Davidson, 1986, 1987). Paddle crabs prefer substrates with a significant sand content into which they are able to burrow. This habitat is present along most of the park in the shallow inshore areas, especially in front of beaches and estuaries. Large numbers of crabs were observed in Bark Bay in the winter months probably coinciding with moulting and pairing up behaviour.

Jasus edwardsii (Crayfish)

Crayfish was recorded along most of the rocky coastline, particularly along the seaward facing shores. Crayfish numbers were very low during most the survey period and no density estimates were therefore attempted. Visual observations suggest that crayfish were relatively uncommon along much of the park with isolated areas where these animals were more common. It is possible that crayfish walk into the park across Tasman Bay. One such migration has been observed in Mutton Cove (Bill Crump, pers. comm.).

Hermit Crab

Two species of hermit crab were recognised from the Abel Tasman (*Pagurus spinulimanus, Astraleremus* sp.). Large numbers of hermit crabs were recorded from shallow sand dominated shores. *P. spinulimanus* is a filter feeder, while *Astraleremus* sp. is a carnivore feeding on a variety of benthic invertebrates. Hermit crabs were recorded from almost all substrates and habitat types and at most depths.

ECHINODERMATA

Evechinus chloroticus (Kina)

Kina or sea urchins were recorded throughout the park on a variety of substrates from rock to broken shell and sand. Kina were not recorded on mobile sand areas. Kina are herbivorous and graze on both microalgae growing on the surface of rock and on macroalgae (Dix, 1970). Many local people believe that kina are responsible for the decline of seaweed along the Abel Tasman coastline.

Studies on Evechinus have suggested that this grazer is a primary determinant of community structure on shallow subtidal rocky reefs (Andrew and Choat, 1985; Andrew, 1988; Schiel, 1988). These investigations suggest that the barren rock zone where kina and other grazers reach high densities is most often encountered between 8 to 10 m depth. Above and below this zone, the shore is dominated by algae, often forming a dense canopy (Choat and Schiel, 1982; Grace, 1983; Schiel, 1988, 1990). Along the Abel Tasman coastline, the barren zone dominates most of the shore with a thin band of macroalgae at low water. However, at some

exposed situations, *Carpophyllum flexuosum* may extend down to depths of 12 m (eg. Foul Point). Reports by locals suggest that the quantity of brown seaweed growing on the rocks has declined. No historical data exists on the cover of seaweed around the park, but

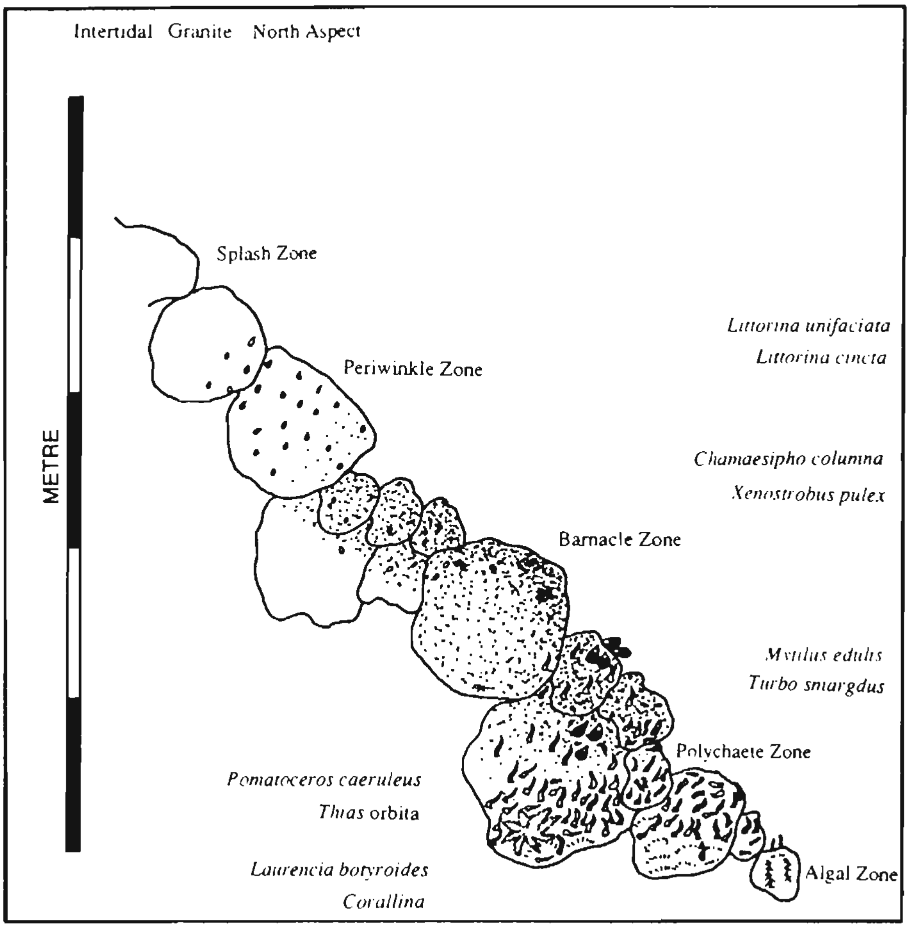


Fig. 7. Representative profile for an intertidal granite shore along the Able Tasman coastline. Species represent those regularly encountered at this shore type.

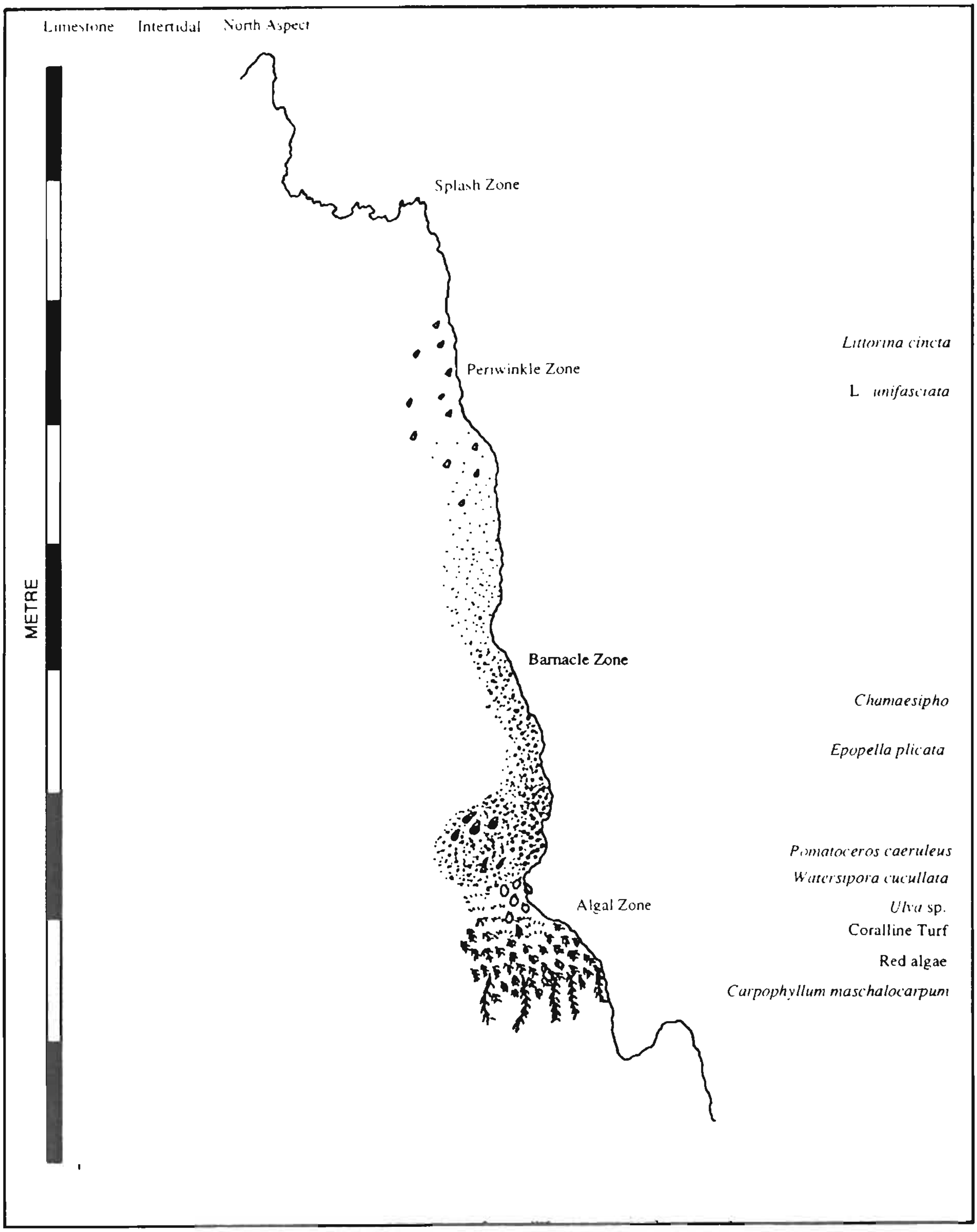


Fig. 8 Representative profile for an intertidal limestone shore along the Abel Tasman coastline. Species represent those regularly encountered at this shore type.

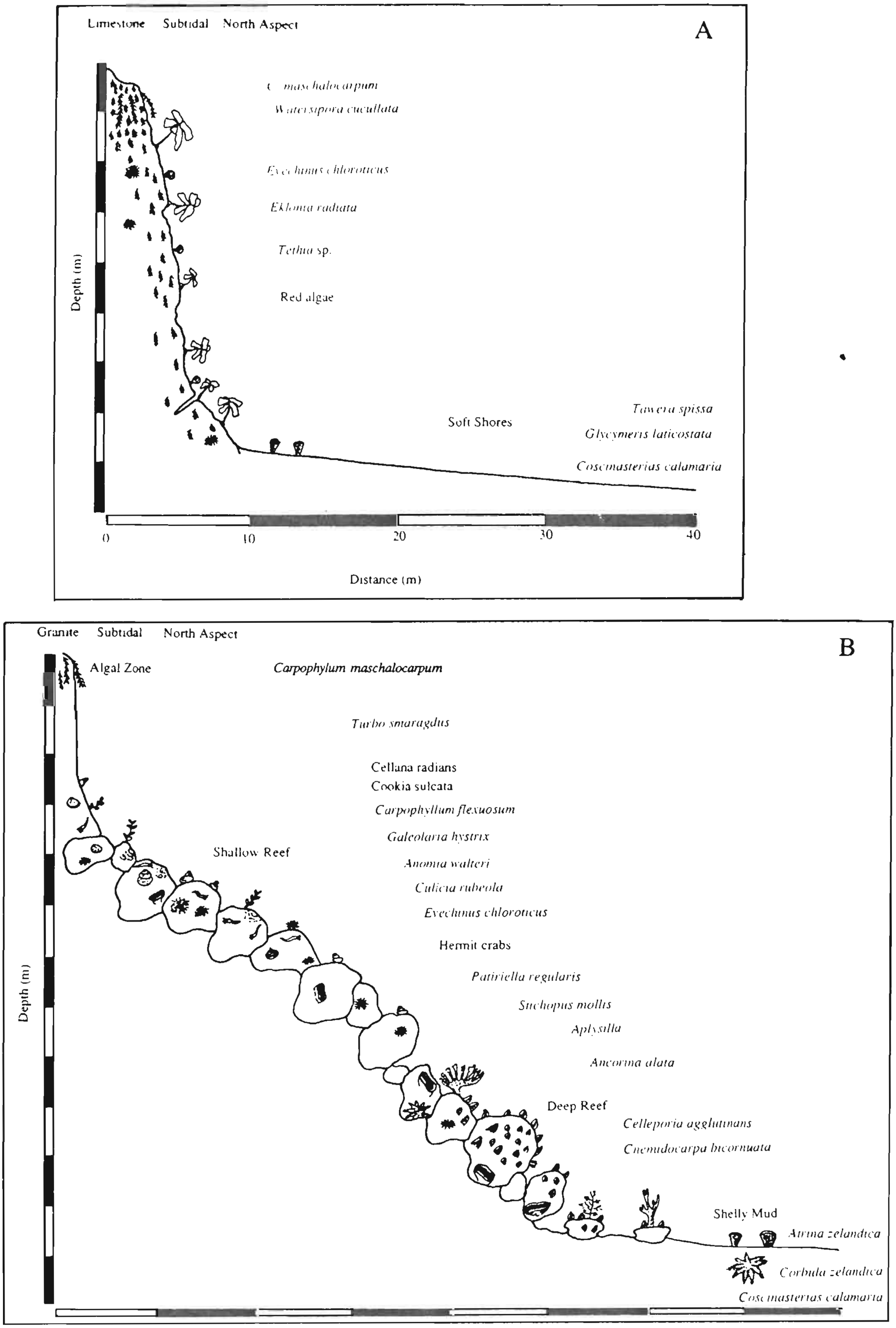


Fig. 9. Representative profiles for (a) subtidal limestone shore (b) subtidal granite shore along the Abel Tasman coastline. Species represent those regularly encountered at this shore type.

examination of historic aerial photographs suggest large brown seaweeds were once more common in particular areas of the shallow subtidal zone (plates 1-5).

At first appearance, this phenomenon could be attributed to a possible increase in kina numbers due to the decline in their natural predators (eg. snapper, blue cod, crayfish). Studies on kina densities from Kaiteriteri and other locations in the South Island, however, suggest that their numbers along the Abel Tasman are in fact lower than at particular sites around Kaikoura Peninsula (Dix, 1970). In addition, the average size of kina along the park is much smaller than other areas in the South Island. Nevertheless, small size, short life span and relatively low density of kina along the park suggests that sea eggs are not thriving and may be limited by environmental factors. In a review of kina in northern New Zealand Andrew (1988) suggested that rock lobsters and predatory fishes were the most likely to have the greatest effect on the abundance of kina. Further, he states that the impact of these predators, whilst measurable, was not sufficiently strong to control the effect of kina on community structure. Initial observations during this study, suggest that urchins probably restrict the distribution of large brown algae along the abel Tasman, but without investigations into the biology of algae and the influence of other herbivores, the real answers to this phenomenon cannot be determined. These issues are further discussed in Davidson and Chadderton (in press).

Scientific studies have suggested that environmental and biological factors may limit colonisation and growth of algae. Factors responsible may include: (a) low light which inhibits gametogenesis (Luning, 1981; Reed and Foster, 1984); (b) sedimentation which may also influence reproduction (Devinny and Volse, 1978); (c) dispersal range of spores (Schiel, 1981); and (d) substrate type (Davidson and Chadderton, in press). Insufficient data is available in the present investigation to determine the reasons for low algal biomass along the park. Further studies on the kina phenomenon along the Abel Tasman coastline are necessary before the situation can be fully understood.

Coscinasterias calamaria (11 Arm Starfish)

The 11 arm starfish is a large benthic predator which was recorded from most substrates and depths along the Abel Tasman. This starfish feeds on a variety of prey including mussels, shellfish and gastropods. *Coscinasterias* is common throughout Tasman Bay, Golden Bay and the Marlborough Sounds.

COELENTERATA

Actinothoe albocincta

This anemone prefers rocky substrate in high current situations. Densities of *Actinothoe* recorded from a shallow passage between Snapper Rocks and the mainland reached up to 6,781 individuals per m^2. These anemones are carnivores, catching prey transported in water currents. Anemones tentacles are covered in minute stinging cells called nematocysts that immobilise their prey. Once the prey is immobilised the food is passed to the mouth.

MOLLUSCA

Atrina zelandica (Horse Mussel)

Horse mussels are the largest bivalve species in New Zealand growing up to 405 mm in length (Powell, 1979). They prefer subtidal, stable soft substrates into which the pointed anterior end is buried and attachment is secured using long byssal threads which are attached to sand and shell particles. Once detached horse mussels appear unable to burrow back into the substrate (Powell, 1979).

Horse mussels were recorded throughout the soft shores of the Abel Tasman coastline usually in very low densities. They were most often encountered in soft substrates near rocky outcrops or reefs where dredging is difficult. A dense bed of horse mussels was recorded north of Separation Point where mussels reached densities up to 10 individuals per m^2 (Table 8). This is the highest density of horse mussels known in the Nelson/Marlborough region (Davidson et. al., 1990; C. Hay, pers. comm.).

Data collected from the only other site along the Abel Tasman (Te Pukatea Bay), where quantifiable numbers of horse mussels were observed are presented in Table 9. Horse mussels from Te Pukatea Bay were recorded in densities of 0.3 mussels per m^2 compared with an average of seven mussels per m^2 at Separation Point.

Cockle (*Austrovenus stutchburyi*)

The cockle is an important member of the estuarine and sand flat community. Stephenson (1980, 1981) recognised cockles as an important component of these areas because they occupied an important niche in most estuarine areas, may be an important indicator of ecological stress and in many areas, support a traditional and recreational fishery. In addition, in recent years cockles have been the focus of commercial activities in Tasman and Golden Bays.

Cockles were collected and measured from three estuaries along the Abel Tasman coastline (Table 10). Cockle size composition from Awaroa Inlet were dominated by large individuals >30 mm in length (Table 10). Although cockle density were the lowest of any sites sampled along the park, the percentage population over 30 mm was the highest recorded for Tasman and Golden Bays (Wilson et. al., 1988; Davidson, 1990; Davidson and Moffat, 1990; Davidson et. al., 1990). In contrast, size data from Bark Bay Estuary and Torrent Bay Estuary showed that cockle population size structure was dominated by small cockles (< 30 mm length). Whanganui Inlet also contained a population dominated by small cockles where < 5 % of cockles reached a size >30 mm length (Davidson, 1990). Results suggest that cockle community size composition from these estuaries were significantly different. The reasons for this feature in particular estuaries in the Nelson/Marlborough region are unclear.

TABLE 8: Horse mussel (*Atrina zelandica*) data for Separation Point.

Quadrat No. (square metres)	Depth (metres)	Number of Mussels	Maximum Width (millimetres)	Mean Size (SD)
1	16.6	10	92, 95, 95, 96, 98, 100, 100, 100, 105, 125	100.6 (8.8)
2	11.8	6	93, 105, 108, 110, 112, 113	106.8 (6.7)
3	12.0	8	98, 98, 100, 103, 112, 112, 120, 123	108.3 (9.3)
4	-	7	96, 103, 105, 106, 107, 112, 118	106.7 (6.4)
5	-	4	100, 100, 110, 120	107.5 (8.3)

TABLE 9: Horse mussel data for Te Pukatea Bay

Transect	Depth Range (metres)	Number	Maximum Width (millimetres)	Mean Size (SD)
1. 48 x 1 m	2.8 - 4.3	13	52, 63, 65, 83, 87, 95, 95, 97, 100, 103, 113, 120, 126	92.2 (21.3)
2. 26 x 1 m	3.3 - 3.8	9	82, 88, 89, 96, 106, 107, 110, 112, 113	100.1 (11.3)

TABLE 10: Density and size of cockles from various locations along the Abel Tasman coastline.

Location	Sample Size	Mean No. per m^2	Mean Size mm (SD)	Percent < 10 mm	Percent 10-30 mm	Percent > 30 mm
Awaroa Inlet	85	1233.6	31.6(6.5)	1.2	16.5	82.4
Bark Bay (Mouth)	9	101.9	17.5 (4.7)	0	100	0
Bark Bay (fine sand)	33	350.8	17.8 (7.4)	18.2	81.8	0
Torrent Bay (fine sand)	91	2716	18.5 (5.6)	7.7	92.3	0

TABLE 11: Density and size of pipi from various locations along the Abel Tasman coastline.

Location	Sample Size	Mean No. per m^2	Mean Size mm (SD)	Percent < 10 mm	Percent 10-30 mm	Percent > 30 mm
Awaroa Inlet	41	962	22.3 (8.2)	4.9	78.0	1.7
Bark Bay (Mouth)	210	3531	22.7 (8.3)	2.9	77.6	19.4
Bark Bay (fine sand)	17	248.9	21.9 (6.1)	5.9	94.1	0
Torrent Bay (coarse sand)	128	2354	19.1 (8.9)	13.3	73.4	13.3

Pipi (*Paphies australis*)

The pipi is the most often encountered member of the tuatua/toheroa group of shellfish. It is found throughout Tasman and Golden Bays and is most often found near or below the low tide mark of estuaries and open beaches. Along the Abel Tasman coastline pipis were often recorded in high densities (Table 11). Dense beds were sampled from Torrent Bay estuary and Bark Bay Estuary. A large pipi bed was also recorded from Awaroa Inlet, but was not sampled.

Coarse sand flats located adjacent or in the mouths of these estuaries were favoured by pipis. Large areas of coarse sands is a feature common in many of the estuaries along the Abel Tasman. Large numbers of wader species, particularly the pied oystercatchers were observed utilizing this large food source.

Scallop (*Pecten novaezelandiae*)

Scallops were recorded along this coastline on sand and coarse substrate shores. No dense scallop beds were recognised in the present investigation, however, historical accounts suggest that dense beds existed throughout this coast. Dredging for scallops along this coastline has probably been largely responsible for the modification of benthic communities (see chapter 5). It is ironic that dredging removes suitable substrates for juvenile scallop settlement. Scallops are filter feeders and prefer areas where good tidal currents bring food. Commercial dredging of scallops has been restricted since 1980 from Bark Bay to Fisherman Island (Fig. 13).

Chromodoris amoena

Chromodoris amoena is the most colourful sea-slug or nudibranch found in the Nelson/Marlborough region. This nudibranch is relatively common in particular areas along the Abel Tasman coastline on subtidal rocky shores. *Chromodoris* was consistently recorded in relatively high numbers from Tonga Island and the adjacent coastline. Nudibranchs are carnivores feeding on colonial benthic organisms such as bryozoans and hydroids.

BRACHIOPODA

Magasella sanguinea and *Waltonia inconspicua*

Brachiopods are a declining group of marine organisms, today enjoying little of their former importance in benthic communities of the continental shelf (Bowen, 1968; Dawson, 1990). New Zealand brachiopods are represented by 35 living species and subspecies out of more than 40,000 fossil species world wide.

Magasella has the widest distribution and is the most common brachiopod in the Nelson/Marlborough region occurring throughout the Marlborough Sounds (Duffy et. al., in prep; Chadderton et. al., in prep.). Along the Abel Tasman coastline, this brachiopod was recorded most often from deep reef areas but rarely in large numbers (> 15 m depth).

Waltonia inconspicua was most often recorded from core samples from coarse substrate areas. Individual *Waltonia* were small and recorded in low densities. Large beds of this species have been recorded from the outer Croisilles Harbour, but no such beds were recorded in the present survey (Davidson and Duffy, 1992).

4.3.2 Fish Communities

Introduction and Methodology

Fish from shallow inshore areas have attracted significant, scientific, recreational, traditional and commercial attention in New Zealand. The coastal zone of the Abel Tasman is no exception, with the most attention coming from commercial and recreational fishing. However, in a recent recreational survey of the Abel Tasman coastline, approximately 60 % of people questioned, rated fishing along this coast as poor or very poor (Clough, in prep.). Unfortunately, little historical data is available on fish populations along the Abel Tasman coastline. However, historical and anecdotal accounts of grouper catches, and the abundance of blue cod and snapper tell of better times past. Commercial catches in the Separation Point and Torrent Bay coral beds were reportedly significant (Vooren, 1975; Saxton, 1980). This chapter outlines preliminary fish information gathered during the present study.

Fish data were collected from 27 sites along the Abel Tasman (Figure 10, Table 12). Collection of these data involved two divers each noting fish species and their relative abundance. Abundance values of: 1 = rare; 5 = occasional; and 20 = common, were assigned to each species at the completion of each dive. Fish data were also collected during invertebrate and shore profile dives. Caves and crevices were also searched for cryptic or secretive species using a torch. Data were analysed using presence/absence values (Dendrogram 1).

Further, records of fish species not recorded from the present survey were derived from historical records and accounts from local fishers.

Results

A preliminary list of 64 fish species recorded for the Abel Tasman coastline are presented in Table 13. Of these species, 30 were used in data analyses as they were often recorded by divers. The remaining 30 species either avoided divers or were never seen during the survey.

Of the 30 species of fish used, only the spotty (*Pseudolabrus celidotus*) was recorded from all sites. The variable triplefin (*Fosterygion varium)* was recorded from all but one site along the Abel Tasman coastline. Variable triplefin usually inhabits water shallower than 10 m depth, explaining the absence from a deeper offshore reef. Other fish recorded from most sites along the Abel Tasman included the goatfish (90 %) (Photo 18), tarakihi (73 %), banded wrasse (77 %) and mottled triplefin (77 %).

Based on presence/absence data, two main groups or area types were differentiated for the Abel Tasman coastline (Dendrogram 1). Group one was characterised by fish communities which preferred exposed situations, while the second group was characterised by a community of fish which inhabited sheltered shores, embayments and coves.

1. Exposed shores along the Abel Tasman National Park coastline included offshore reefs, headlands, northerly facing coasts and islands. The fish community associated with these areas were generally diverse with between eight and twenty-three species. Fish characteristic of exposed sites included butterfly perch (*Caesioperca lepidoptera*), sweep (*Scorpis lineolatus*), scarlet wrasse (*Pseudolabrus miles*), banded wrasse (*Pseudolabrus fucicola*), mottled triplefin (*Forsterygion malcolmi*), yellow-black triplefin (*Forsterygion sp.*) and spectacled triplefin (*Ruanaho whero*). These species were rarely recorded from sheltered sites along the Abel Tasman coastline. Butterfish (*Odax pullus*) and marblefish (*Aplodactylus arctidens*) were also characteristic of exposed coast, even though they were recorded at fewer sites.

2. Sheltered shores were defined as bays, coves and coastline on the leeward side of land masses. Sites investigated included Mutton Cove, Brereton Cove, Te Pukatea Bay, Watering Cove, Bark Bay and Boundary Bay. These areas along the Abel Tasman coastline are sheltered from northerly storms and the prevailing north-east winds. These sites were characterised by the virtual absence of fish species common at exposed sites and generally, fish diversity was low (2 to 10 species). All sheltered shores were shallow and did not exceed 10 m depth. Many of the fish species which prefer deeper waters were therefore also absent (Slender roughy, *Optivus elongatus*; common roughy, *Paratrachthys trailli*; mottled triplefin, *Forsterygion malcolmi*; scarlet wrasse, *Pseudolabrus miles*). The low abundance of algal species may account for the absence of butterfish (*Odax pullus*) from sheltered sites along the Abel Tasman coastline.

Some of the most notable marine fish of the Abel Tasman coastline are:

<u>Tarakihi</u> (*Nemadactylus macropterus*) (Photo 19)

Tarakihi were regularly recorded from data collection sites along the Abel Tasman coastline. Tarakihi were generally very small, often forming schools of juveniles which were regularly observed feeding on an algal layer on bare rock areas.

A fish survey in 1975 recognised the bryozoan 'coral' beds offshore Separation Point as an important juvenile nursery ground, particularly for tarakihi. Recreational reports of tarakihi catches for the Abel Tasman describe a decline in fish numbers and size. Catches of tarakihi up to 9.5 kg or 21 pounds have been recorded by local anglers. Tarakihi remain in nursery grounds until they reach maturity at an age of 4-5 years (25-34 cm length) (Francis, 1988). Females grow bigger and faster than males and the oldest tarakihi may reach 50 years old (Francis, 1988).

<u>Snapper</u> (*Pagrus auratus*)

Snapper were seen on one occasion during dives even though they are often caught along this coast. Adult snapper are known to spawn in Tasman Bay during summer months and the juveniles inhabit shallow inshore waters forming large schools. Snapper eat a great variety of food including kina and are able to take advantage of most coastal habitats.

Recreational catches of snapper along the Abel Tasman coastline have declined significantly and many fishers believe this is due to overfishing by commercial operators. Snapper are particularly vulnerable to pair trawling when they aggregate before group spawning.

Recreational catches of fish up to 15.4 kg or 34 pounds have been reported, but most anglers today have varied success ranging from good catches of schooling 'brim' to reports of snapper being rarely captured.

Blue cod (*Parapercis colias*)

Blue cod were relatively uncommon along the Abel Tasman and were recorded from only 40% of locations investigated. As blue cod are by nature inquisitive and will approach divers, their absence from many locations suggests their numbers are extremely low. Few blue cod observed were adults most being juvenile or two year old fish (ie. less than 25 cm in length). Cod can grow to 60 cm in length and may reach an age of 15 years (Francis, 1988). They will eat almost anything and, as adults, actively defend a home range which they seldom leave.

Historical accounts by recreational anglers suggest blue cod were once common along the park. Catches today reflect the observations made by divers of small size and low density of this fish. The preferred habitat of blue cod is reef areas and sand flat habitats very common throughout the Abel Tasman coastline. As blue cod are not commercially exploited in the area, it is probable that pressure from recreation fishers has restricted the recovery of this species. The Separation Point 'corals' appear to support the best population of blue cod along this coast.

Blue moki (*Latridopsis ciliaris*)

Blue moki were relatively uncommon and generally only small fish were seen. As adults these fish are known to migrate up to 500 km, however, some adults, which can grow up to 90 cm in length, do not join these spawning migrations. Blue moki feed in sandy areas where they suck up crabs, worms and shellfish (Francis, 1988).

Recreational catches of blue moki are most often by net or spearfishing methods. Catches along this coastline have declined to the point where blue moki are seldom caught. During this study, blue moki were most often recorded in areas where netting is difficult.

Red moki (*Cheilodactylus spectabilis*)

Red moki were most often recorded from amongst boulders, caves and in reef areas. The red moki observed were usually less than two years old (< 30 cm length) and were never seen in the present study in numbers greater than one or two per dive. As adults, red moki have home ranges and may grow to a length of 70 cm and an age up to 60 years. This species is very vulnerable to spearfishing and netting and can be quickly fished out of an area.

Spotty, Banded Wrasse, Scarlet Wrasse (*Notolabrus* spp.)

This group of three species were the most common reef fish along the Abel Tasman coastline. Spotty were recorded from all locations along the Abel Tasman and was usually most common in the reef areas of the park. The spotty is endemic, being found nowhere else in the world, but is found throughout New Zealand from North Cape to Stewart Island. Spotties are most common in sheltered waters such as Fiordland, Marlborough Sounds and the Abel Tasman.

TABLE 12: List of fish data collection sites.

Number	Location	Site Description	Depth (m)
1	Taupo Point	Limestone face/soft bottom	0-10
2	Taupo Stack No. 2	Limestone face/soft bottom	0-8
3	Separation Point (north)	Granite rock-boulders/soft bottom	0-12
4	Separation Point (south)	Granite boulders/soft bottom	0-8
5	Mutton Cove	Granite outcrops/soft bottom	0-10
6	Totaranui (north)	Granite outcrops/soft bottom	0-13
7	Awaroa Head (north)	Granite boulders	0-15
8	Catamaran Reef	Granite Rock	5-13
9	Abel Head (north)	Granite rock/soft bottom	0-16
10	Brereton Cove	Granite boulders/soft bottom	0-10
11	Cottage Loaf Rock	Granite boulders/soft bottom	0-17
12	Reef Point	Granite boulders-rock/soft bottom	0-9
13	Rob's Rock	Granite rock/soft bottom	6-15
14	Tonga Island	Granite boulders/soft bottom	0-16
15	Foul Point	Granite rock-boulders/soft bottom	0-14
16	Whale Rock	Granite boulders	0-6
17	Bark Bay Reef	Granite boulders/soft bottom	0-15
18	Bark Bay (north head)	Granite boulders/soft bottom	0-6
19	Bark Bay (south head)	Granite boulders/soft bottom	0-11
20	Pinnacle Island (east)	Granite rock-boulders/soft bottom	0-16
21	Totara Reef	Granite boulders-rock	7-13
22	Boundary Bay (south)	Granite boulders/soft bottom	0-6
23	Te Pukatea Bay	Granite boulders/soft bottom	0-6
24	Snapper Rocks (north)	Granite rock	0-14
25	Anchor Bay	Granite boulders/soft bottom	0-14
26	Watering Cove (east)	Granite boulders/soft bottom	0-7
27	Six Foot Rock	Granite rock	7-16

TABLE 13: Marine fish recorded from the Abel Tasman coastline.

● Hagfish	*Eptatretus cirrhatus*
Mako shark	*Isurus oxyrinchus*
Blue shark	*Prionace glauca*
Bronze whaler	*Carcharhinus brachyurus*
Spiny dogfish	*Squalus acanthias*
● Skate	*Raja* sp.
Electric ray	*Torpedo fiarchildi*
Eagle ray	*Myliobatis tenuicaudatus*
Conger eel	*Conger verreauxi*
Pilchard	*Sardinops neopilchardus*
Sprat	*Clupea antipodum*
Anchovy	*Engraulis australis*
# Red Cod	*Pseudophycis bachus*
# Rock Cod	*Lotella rhacinus*
Piper (Garfish)	*Hyporhamphus ihi*
# Common roughy	*Paratrachthys trailli*
# Slender roughy	*Optivus elongatus*
John Dory	*Zeus faber*
# Seahorse	*Hippocampus abdominalis*
# Sea perch	*Helicolenus percoides*
Red gurnard	*Chelidonichthys kumu*
* Scaly gurnard	*Lepidotrigla brachyoptera*
+ Hapuku	*Polyprion oxygeneios*
# Red-banded perch	*Ellerkeldia huntii*
# Butterfly perch	*Caesioperca lepidoptera*
Trevally	*Pseudocaranx dentex*
Jack mackerel	*Trachurus declivis*
Kingfish	*Seriola grandis*
Kawahai	*Arripis trutta*
Snapper	*Pagrus auratus*
# Goatfish	*Upeneichthys porosus*
# Sweep	*Scorpis lineolatus*

# Marblefish	*Aplodactylus arctidens*
# Tarakihi	*Nemadactylus macropterus*
# Red moki	*Cheilodactylus spectabilis*
● Copper moki	*Latridopsis forsteri*
Magpie moki	*Cheilodactylus nigripes*
# Blue moki	*Latridopsis ciliaris*
# Yellow-eyed mullet	*Aldrichetta forsteri*
# Spotty	*Pseudolabrus celidotus*
# Banded wrasse	*Pseudolabrus fucicola*
# Scarlet wrasse	*Pseudolabrus miles*
# Butterfish	*Odax pullus*
# Blue cod	*Parapercis colias*
# Opalfish	*Hemerocoetes monopterygius*
● Spotted stargazer	*Genyagnus monopterygius*
# Crested blenny	*Parablennius laticlavius*
# Spectacled triplefin	*Ruanoho whero*
# Long-finned triplefin	*Ruanoho decemdigitatus*
Common triplefin	*Fosterygion lapillum*
# Variable triplefin	*Fosterygion varium*
# Mottled triplefin	*Fosterygion malcolmi*
# Blue-eyed triplefin	*Notoclinops segmentatus*
# Yellow-black triplefin	*Fosterygion sp.*
# Oblique swimming triplefin	*Oblilquichtys maryannae*
Blue-dot triplefin	*Notoclinops* sp.
Barracouta	*Thyrsites atun*
Witch	*Arnoglossus scapha*
Yellow-belly flounder	*Rhombosolea leporina*
Sand flounder	*Rhombosolea plebeia*
* Greenback flounder	*Rhombosolea tapirina*
# Lemon sole	*Pelotretis flavilatus*
# Leather jacket	*Parika scaber*
* Porcupine fish	*Allomycterus jaculiferus*

* Vooren 1975
\+ Historic records

\# Species used in data analyses
● K. Goodman, pers. comm.

Scarlet wrasse are also endemic to New Zealand preferring reef areas below 10 m depth along the Abel Tasman. Like all wrasses they eat a variety of invertebrates and have been recorded acting as cleaner fish, picking parasites from the skin and gills of other fishes.

Banded wrasse were recorded from 60% of sites visited along the park and appeared to prefer the more exposed rocky reefs in depths < 10 m with good weed cover.

Triplefins (*Tripterygiidae* spp.)

There are approximately 30 species of triplefins recorded from New Zealand and all but one of these species is endemic to New Zealand (Francis, 1988). They are generally small or very small (< 20 cm length) and are poorly understood in this country with some of the most common species not being recognised until recently.

The most often encountered triplefin along the Abel Tasman was the variable triplefin (*Fosterygion varium*) which was most often recorded in depths less than 10 m on the surface of boulders and rock. Variable triplefins spend their entire lives in one area and are highly territorial. In an experiment at Leigh, fish which were moved up to 700 m from their territories returned to the same spot after 4-6 days (Francis, 1990). Other species recorded in the present survey include the mottled triplefin (*F. malcolmi*), spectacled triplefin (Ruanoho whero), blue-eyed triplefin (*Notoclinops segmentatus*), common triplefin (*F. lapillum*), long-finned triplefin (*Ruanoho decemdigitatus*), blue-dot triplefin (*Notoclinops* sp.), yellow black (*Fosterygion* sp.) and the only schooling triplefin in the world, the oblique swimming trip (*Obilquichtys maryannae*). Much of the biology of these species is unknown and it will be through careful observation that more information will be revealed.

Crested Blenny (*Parablennius laticlavius*)

There are two species of blenny in New Zealand: the crested blenny (*P. laticlavius*) and mimic blenny (*Plagiotremus tapeinsona*). Southernmost records of crested blenny have been Sugar Loaf Rocks, New Plymouth on the West Coast and Pourerere, south of Cape Kidnappers on the East Coast (A. Stewart, pers. comm.). Two observations of crested blenny were documented in the present survey of the Abel Tasman coastline (Taupo Point, Rob's Rock). These are the only records of the Blenniidae family in the South Island. A voucher specimen has been collected for Taupo Point only where this fish appears regularly in vacated rock borer holes.

4.3.3 Bird Communities

Introduction and Methods

The Abel Tasman National Park was rated as of 'high' wildlife value by the Wildlife Service (Walker, 1987) and supports a diverse range of bird species (over 60 species).

The area under consideration in this section is along the coastline and inshore waters of the park, including rocky headlands, stacks, small offshore islands, sandy beaches and tidal estuaries. Even though the park supports much recreational activity, bird life has not always been reliably or well documented.

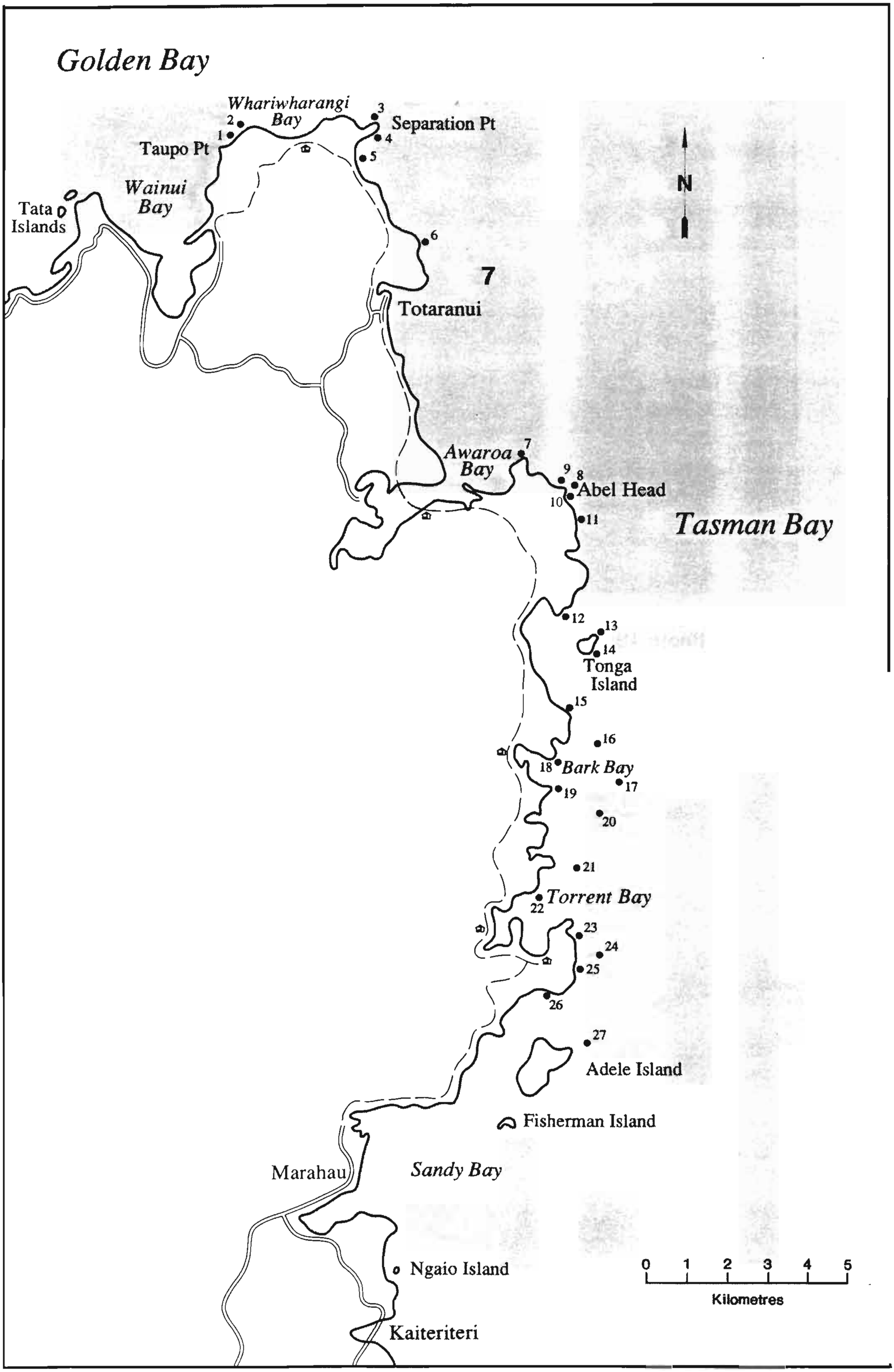


Fig. 10 FISH DATA SITES FOR THE ABEL TASMAN COASTLINE

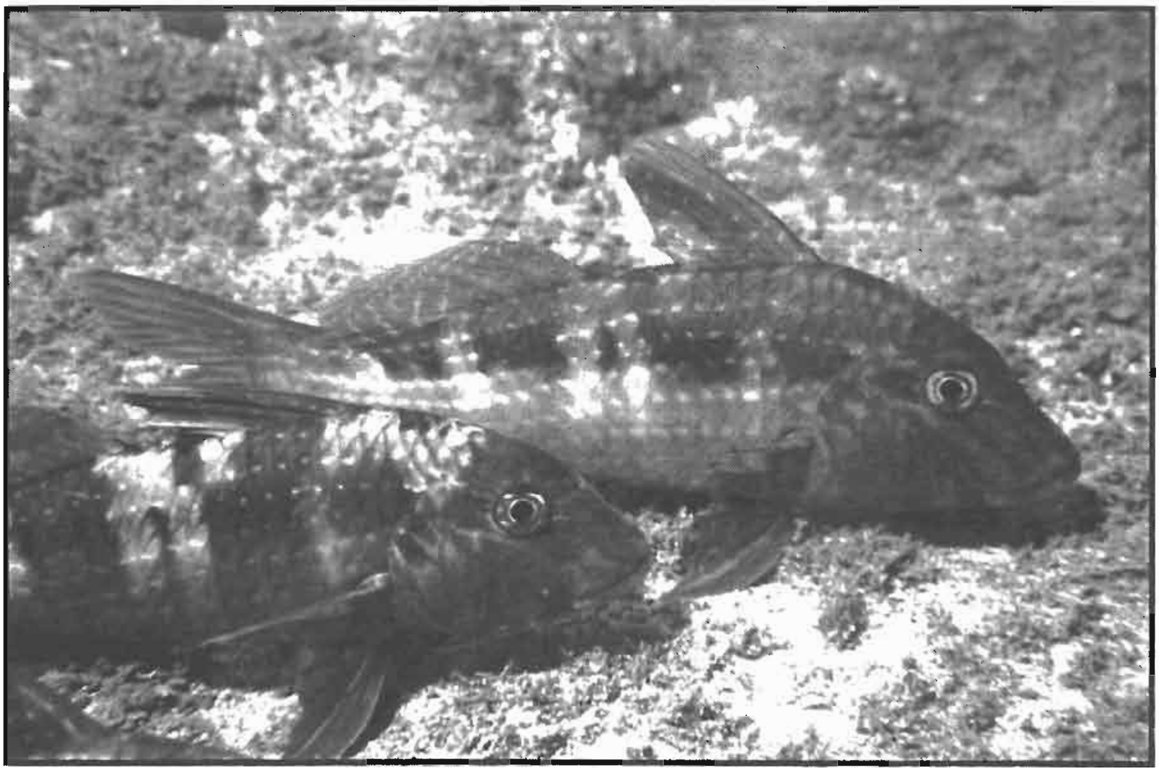
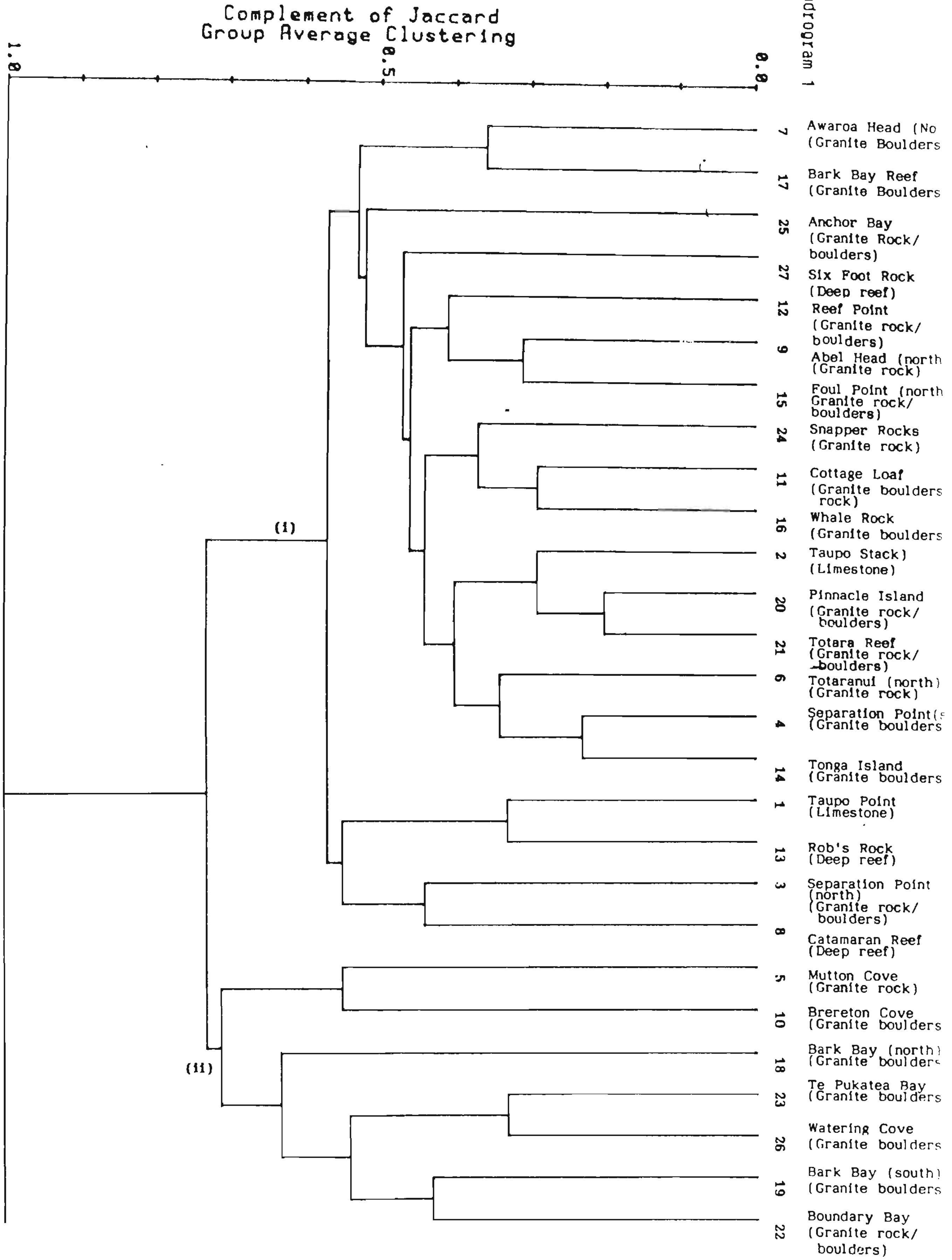


Photo 18. Goatfish or red mullet (*Upeneichthys lineatus*).

Photo 19. Tarakihi (*Nemadactylus macropterus*).

Dendrogram 1



Dendrogram of subtidal sites based on fish presence/absence data. Group reflect differences in fish communities between: (i) exposed sites, headlands, current swept locations; and (ii) sheltered shore situations.

Over 46 species are known from this coastal strip. These are listed in appendix 17 in the order used by Kinsky (1970) as amended in Kinsky (1980). Bird data was obtained from existing information sources and information willingly supplied by the Ornithological Society of New Zealand (OSNZ). This information was augmented by field visits between 19 March 1990 and 11 May 1990. Wader roosts were counted on the highest available tide, footprint and other sign was noted and general bird counts and a species list generated. No birds observed were banded. Autumn is outside the nesting season for most birds, so breeding was not surveyed. Migratory species, both internal and international tend to be still in transit early in the season.

As most of the available records are observations or counts made on a casual basis, this report shows only generalised bird usage and movement within the park's coastal areas.

PATTERNS OF USE

Waders

Daily movements of waders are controlled by the height of tides (ie birds feed on exposed intertidal flats, and at full water move to roost on higher uncovered sites such as shell-banks and sandspits). These roost sites have to have good visibility and a minimum of direct disturbance.

OSNZ conduct twice yearly wader surveys throughout New Zealand and although regular local surveys do not always include the park's estuaries (excepting Wainui Inlet, which is counted along with Golden Bay estuaries), they indicate that sandspits at Awaroa, Bark Bay, Torrent Bay and Marahau (as well as Wainui) are well used as high tide roost sites.

During winter up to 2,000 SIPO and 200 banded dotterel are present on estuaries in the Abel Tasman National Park. This is only a small proportion of the winter waders present in the Nelson region, (ie 17,000 SIPO and 1,800 banded dotterel June 1989 OSNZ census). Awaroa Inlet is not favoured by the migrant waders, perhaps because of the rough quartz sands (J.M. Hawkins, pers. comm.). Only low numbers of godwit are present at Wainui and Marahau (eg. 200 and 100 respectively), (cf 24,700 for Nelson region December 1989 OSNZ census).

Although variable oystercatcher numbers around the Nelson regions's coastline seem to be increasing, presumably including the park's coastline. However, no survey has been carried out to confirm this.

A network of productive and generally unmodified estuaries are important to wader species as, even though regular flocks are found, it is probable that waders move between estuaries within and outside the park. There is also indications that the park's estuaries (along with others) are used as stop-over points for migrating waders.

Marsh Birds

Several marsh bird species of national significance can be found in the estuarine fringe zones within the park (banded rail, marsh crake, fernbird and bittern) (Fig. 11).

Banded rail (precise numbers unknown) were found in all salt marshes except Bark Bay (Elliott, 1983, 1989). Marsh crake have different habitat requirements to banded rail and can exist in salt marsh that are apparently too small for banded rail, eg Bark Bay. The two species can co-exist in larger salt marshes, eg. Marahau. No other records of the secretive marsh crake exist. Unmodified salt marsh reserves are important for the long term presence of banded rail, but the ATNP population itself may be too small to sustain a population (ibid).

Estuaries and wetlands of the Abel Tasman Coastline represents a very important habitat for marsh birds. The distribution of these species outside the park have declined significantly due to loss of habitat and disturbance. The park represents a refuge area where their preferred habitat will remain intact. Recolonisation of areas outside the park may be based on successful reproduction within the Abel Tasman confines.

Fernbirds were recorded in all coastal units with estuarine habitats within the Park (OSNZ Atlas, 1979). Only a few unconfirmed sightings have been reported of the locally rare bittern.

Herons and Shags

The most significant species of heron to occupy the park's coastal habitat is vulnerable rare reef heron. This species in New Zealand has apparently declined in numbers over the past forty years partly due to human changes (M.J. Williams In: Robinson, 1985). The park's coastline is one of the few places in the Nelson region where birds (usually solitary) are frequently encountered and nesting still occurs around the generally isolated and unmodified rocky shore.

Winter numbers of spotted shags in Golden Bay seem to be increasing, as in Tasman Bay, but possible breeding sites around the Golden Bay coastline have not been surveyed and nesting on Ngawhiti Island is unconfirmed. This marine shag eats small fish and prefers rocky headlands and outcrops for communal roosting. It is not known if the Golden Bay birds come from the west or eastern South Island breeding populations.

Gulls, Terns and Skuas

White-fronted terns prey on small fish and are abundant off the park's coast from October to June. Rocky outcrops, cliffs, beaches, sand or shell banks, and wave screens are important as roosting areas close to the birds different daily feeding areas. Similar areas are also chosen for breeding sites although regular breeding cannot be reliably expected from traditional sites such as Awaroa.

On 19 April 1990, ten skuas were observed harrying individuals within a group of our 1000 terns. This is the largest number of skua observed in Tasman Bay at one time and one of the latest local sightings to be recorded before this migrant journeys back to Arctic breeding grounds.

Small numbers of gulls and other terns frequent the park's coastal waters.

AREAS OF IMPORTANCE

Within the park's boundaries lie seven islands and several stacks (Fig.11). These are especially important for several marine birds.

Tata Islands

Ngawhiti and Motu Islands, about 1.5 ha and 2.0 ha in area respectively, were brought into the parks reserved area in 1954. Both islands are inhabited by *Rattus* (Clout and Gaze 1980). Ngawhiti, is used as a roost site for spotted shags but nesting is unconfirmed. Cook Strait blue penguins no longer breed on either Ngawhiti or Motu Islands. One or two pairs of reef heron could still breed on one or both of the islands or an stacks nearby.

Taupo Point Stacks

Two small Island stacks are located adjacent to Taupo Point west of Separation Point. These islands are regularly used by reef herons as a breeding site (P.Fullerton, pers.comm.).

Tonga Island

Tonga Island, c.9 ha in area, is the only island in the park to be recorded as free of introduced mammals (Clout and Gaze, 1980). This island supports large numbers of breeding Cook Strait blue penguins, with burrows present up to the summit. Occupied burrows were found in mid April 1990. Sooty shearwaters breed in small numbers at the western end (ibid). Guano covered rocks indicate a spotted shag roost and reef herons have been observed in the vicinity.

Pinnacle Island

The rock stack off Pinnacle Island is a spotted shag day time roost site. A pair of reef heron were regularly observed in the area and on the island. This suggests that breeding on this small island may occur.

Adele Island

Even though stoats and mice have been trapped on this island and rat presence is suspected (Clout, 1979) Cook Strait blue penguins breed here in significant numbers. Heinekamp (1974) reported burrows were found almost anywhere on the island, however, recent investigation suggested that burrows were restricted to the seaward side of the island and most often in gullies. Spotted shags have a day time roost on Jules Point and the eastern side and reef herons have been recorded on the island. SIPO were noted on the sandspit.

Fisherman Island

Both Adele and Fisherman Islands are within swimming range of the stoat. This island is extensively used by Cook Strait blue penguin for breeding and moulting (Heinekamp, 1974) with burrows found practically anywhere. Occupied burrows were found in mid-April 1990. Guano covered rocks indicate a spotted shag roost site, and two pairs of reef heron were recorded with nests in December 1974 (ibid).

Ngaio Island

Ngaio Island is used as a spotted shag day time roost and reef herons have been observed around its shoreline.

4.4 Comparison With Other Coastal Areas

The Abel Tasman coastline is distinctive in New Zealand due to the nature of the substrate, topography and sediment loading. The coast is dominated by Separation Point granite with two isolated outcrops of limestone. Intertidal and subtidal granite habitats are rare in New Zealand (M. Johnston, pers. comm.). Granite substrate appears to have a significant impact on the flora and fauna inhabiting this coast. The positioning of this coast centrally in Tasman and Golden Bays has resulted in a relatively sheltered shore aspect. High energy wave action occurs infrequently and quickly subsides with no lasting swells. The Abel Tasman coast is also influenced by a significant level of fine sediments transported along the coast by tidal currents from the adjacent rivers. These fine sediments are present in most subtidal habitats as a fine surface layer. This is particularly noticeable on rocky areas below 14 m depth.

Estuaries

The number of invertebrate species recorded from the three largest estuaries along the Abel Tasman coastline are compared with other New Zealand estuaries in Table 14. Combined records taken from Torrent Bay Estuary, Bark Bay Estuary and Awaroa Inlet revealed a relatively low number of invertebrate species compared with other estuaries in the Nelson region. Only the Wairau River Estuary and Vernon Lagoons exhibited a lower diversity of benthic invertebrates (Table 14).

Table 15 compares densities of common benthic invertebrates from estuaries along the Abel Tasman coastline with other estuaries in New Zealand. For the three estuaries investigated along the Abel Tasman, maximum densities of benthic invertebrates were generally low. Abel Tasman values for the cockle (*Austrovenus stutchburyi*), mud flat snail (*Amphibola crenata*), top shell (*Diloma subrostrata*), and nereid polychaetes were lower than other estuaries recorded for the South Island (Table 15). The nutshell (*Nucula hartvigiana*), spire shell (*Zeacumantus lutulentus*), capitellid polychaetes and stalk-eyed crab were not recorded from estuaries along the Abel Tasman. However, maximum densities for pipi (*Paphies australis*) and hairy-handed crab (*Hemigrapsus crenulatus*) were high compared with other New Zealand estuaries studied to date. Values for the hairy-handed crab recorded from Awaroa Inlet were the highest value for any estuary in Table 15.

Studies of estuaries in the Nelson area suggest that estuary size, substrate, salinity and diversity of habitat contribute to the density and diversity of benthic invertebrates (Davidson and Moffat, 1990; Davidson, 1990). With the obvious exceptions of Awaroa (290 ha) and Wainui (207 ha) Inlets , estuaries along the Abel Tasman coastline are small (< 20 ha). Therefore, the range of substrates and habitats represented in estuarine areas of the Abel Tasman are ;lower when compared with large estuaries such as Waimea Inlet (3455 ha) and Whanganui Inlet (2744 ha). Fine substrates such as silts, clays and mud are relatively rare in the Abel Tasman estuarine zones (< 7 ha) (Table 1). Estuaries along the park are generally dominated by coarse substrates such as sand, coarse sand and small pebbles.

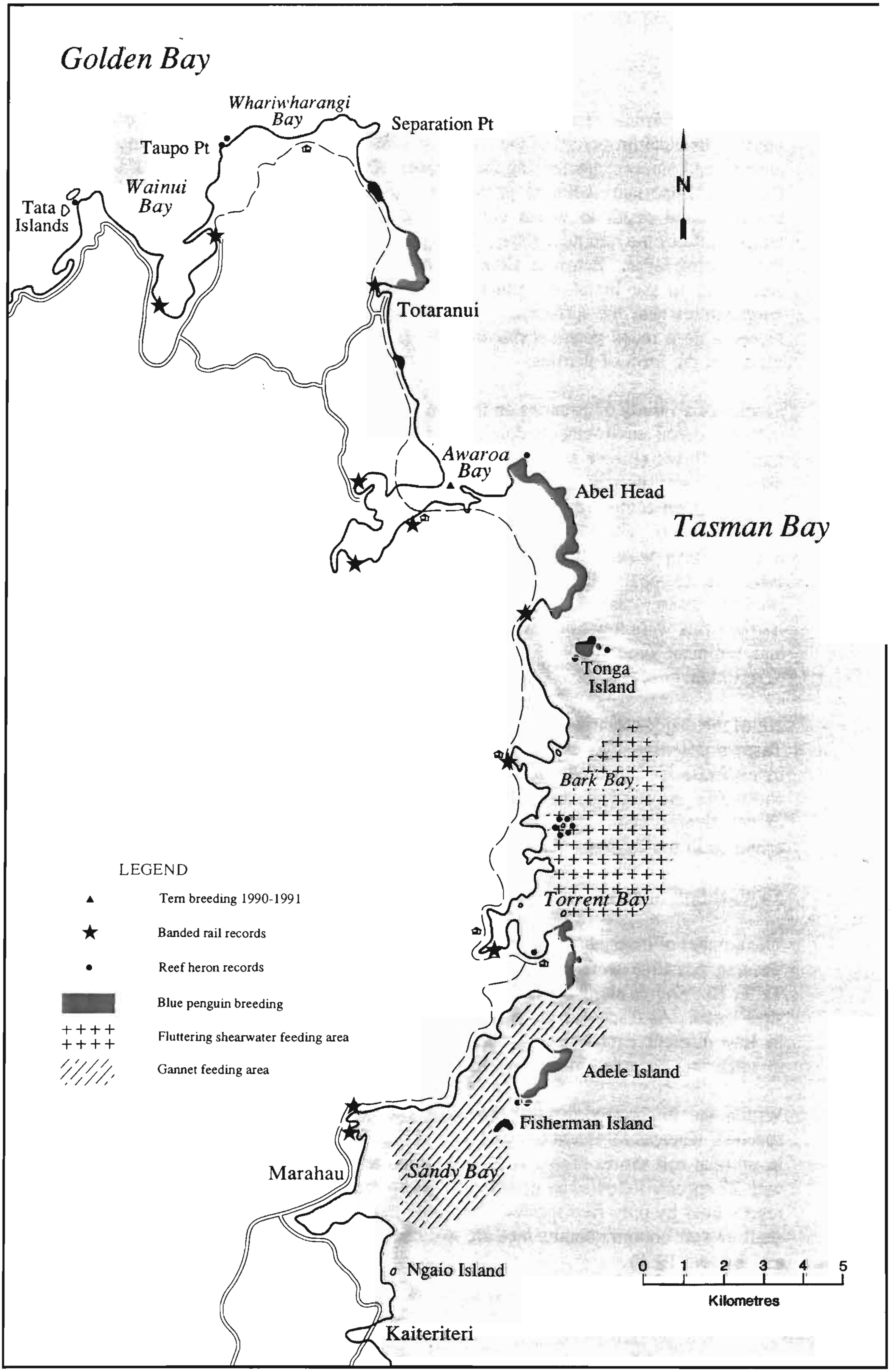


Fig. 11 IMPORTANT AREAS FOR SELECTED BIRD SPECIES

Changes in particle size and the degree of sorting result in important changes in the physicochemical properties of the sediment which are reflected in the diversity and kinds of animals and plants characterising the deposits (Knox, 1986). Furthermore, Knox stated that the most important sediment properties are the interstitial pore space, water content, mobility, and depth to which deposits are disturbed by wave action, the salinity and temperature of the intertidal water, the oxygen content, the organic content and the depth of the reducing layer. Estuaries along the Abel Tasman are dominated by coarse sediments. According to the literature, estuaries with these properties dry out quickly, have high temperatures near the surface and towards high tide, high interstitial salinity, high oxygen levels, a deep redox potential discontinuity (RPD) layer and the low ability to trap organic matter in the form of detritus.

Studies of a variety of estuaries on the east coast of America have revealed that estuaries and inshore coastal environments dominated by sandy to shelly muds had low or non-existent nutrient fluxes (Fisher et. al., 1982). The author further states that in sand dominated estuarine areas, nutrients were not deposited into the sediments. It appeared that bacteria and phytoplankton competed for the small quantities of nutrients available in the water column (Thayer, 1974). These low nutrient estuaries were flushed daily by coastal tides and received a small fresh water input (Fisher et., al., 1982). These studies illustrate the negative influence of coarse sediments, tidal flushing and low freshwater input on primary productivity in estuaries. Fisher (1982) termed estuaries where the nutrient deposition and nutrient flux were low as nutrient-impoverished. Preliminary results using invertebrate data and sediment observations suggest the estuarine areas along the Abel Tasman fit this description.

All of the major estuarine feeding types are represented in the intertidal areas along the Abel Tasman coastline. As expected for estuaries, detritivores (deposit feeders) dominated the invertebrate fauna with 14 taxa. Herbivores, were represented by eight taxa, followed by carnivores and suspension feeders with six species each and one scavenger. The dominance of detritivores in the estuaries of the Abel Tasman is consistent with findings for other estuaries in the Nelson region and throughout the world.

<u>Subtidal Soft Shores</u>

The number of invertebrate species recorded from shallow subtidal soft shores along the Abel Tasman coastline were compared with other shallow soft shores in the South Island in Table 16. Shores along the Abel Tasman have the lowest number of invertebrates of all the sites listed. As discussed in the earlier text, the dominance of coarse substrates may result in low nutrient exchanges. This may be largely responsible for the low diversity of invertebrates recorded in the present study.

Within the Phyla recorded for the Abel Tasman, Crustacea were poorly represented (9 species), whereas Mollusca (30 species) and Echinodermata (8 species) were well represented in subtidal soft shores (Table 16). Suspension feeders dominated the soft bottom sediments with 27 species followed by detritivores (21 species), carnivores (16 species) and herbivores represented by only five species. The high numbers of suspension feeders associated with shallow soft bottom communities are documented for other areas in New Zealand (Morton and Miller, 1968).

Intertidal and Subtidal Rocky Shores

The most notable features of the intertidal and subtidal rocky zone along the Abel Tasman coastline are the tidal range (4.6 m tidal range plus splash zone), low biomass of algae, and the apparent barren nature of the granite shore. The ecology of the Abel Tasman coastline is comparable with the biota associated with sheltered bodies of water such as harbours, sounds and fiords. In these situations, vigorous and frequent wave action does not exist and the large macroalgae species which line the low tide and shallow subtidal areas at exposed locations (eg. *Durvillea, Lessonia, Marginariella, Landsbergia*) are not present. Instead they are replaced along the granite shores of the Abel Tasman by turfing species and an occasional *Carpophyllum* fringe. The most notable feature of the subtidal rocky shore is again the barren nature and lack of macroalgae forests.

Four habitats or zones were recognised for shallow subtidal shores along the Abel Tasman coastline. Studies from the Hauraki Gulf generally recognise five zones (Grace, 1983; Morton and Walsby, 1983). These zones or habitats are compared in the following text.

Shallow Algal Zone (Mixed Weed Zone)

This zone was recorded from both the Abel Tasman and Hauraki Gulf area, but was generally narrower along the Abel Tasman. In many areas in the present investigation, this zone was absent or restricted to occasional plants or groups of plants.

Shallow Reef (Rock Flats)

Shallow reef (present study) or rock flats (Grace, 1983) are common habitats for both areas. These rock areas were located below the shallow algal zone and recognised by their barren appearance due to the lack of large brown algae. At both localities, this zone extends to approximately 10 m depth and is characterised by the dominance of kina (*E. chloroticus*), polychaete (Galeolaria hystrix), green top shell (*Trochus viridis*), cats-eye (*Turbo smaragdus*), chiton (*Eudoxochiton nobilis*) and Cook's turban (*Cookia sulcata*) which graze most encrusting algae, supposedly maintaining the barren nature of the rocks.

Kelp Forest

This zone or habitat is common in the Hauraki Gulf but was only occasionally recorded along the Abel Tasman coastline. In most areas in the Hauraki Gulf the dominant species is *Ecklonia radiata*, but in more sheltered situations the dominant species is *Carpophyllum flexuosum*. Along the Abel Tasman coastline, these species were the dominant kelp forest species, but the distribution of this habitat was restricted to a small number of locations. A relatively patchy *Ecklonia* kelp forest was located at Taupo Point and associated stacks between 1-8 m depth (Davidson and Chadderton, in press). Below this depth, the steep limestone substrate terminated in a soft shore habitat. *Ecklonia* kelp forest habitat was located at Six Foot Rock, a granite shore at depths of 10-15 m. *Ecklonia* was recorded from three other sites along the Abel Tasman, where the plants were sparsely distributed and in a state of poor health. *Carpophyllum flexuosum* kelp forest was recorded a two sites along the Abel Tasman. At Foul Point, *C. flexuosum* forest occurred below the mixed algal habitat and extended to a depth of 10 m. These plants were healthy in appearance and reached lengths up to one meter from their holdfast. *C. flexuosum* forest was also recorded at

Snapper Rocks from below the mixed algae habitat to 8.5 m depth in March, 1990, however, 14 months later this habitat had disappeared and all that remained were the plant stumps. Both Snapper Rocks and Foul Point are located on northerly aspect shores, while Taupo Point is located on the most exposed piece of coast along the Abel Tasman coastline.

Kelp forest along the Abel Tasman is patchy and isolated making identification of a distribution pattern difficult. Several anomalies exist such as the abundance of *Ecklonia* on Taupo Point but not the Tata Islands or the adjacent granite coastline. The presence of the best *Ecklonia* forests at Taupo Point and Six Foot Rock where turbity is consistently the highest for this coastline and the absence of *C. flexuosum* and *Ecklonia* forest over areas where suitable habitat appears to plentiful further complicates these patterns. See Davidson and Chadderton (in press) for further discussion.

<u>Deep Reef</u>

Two deep reef zones were recognised by Grace (1983) for the Harauki Gulf. Along the Abel Tasman coastline rocky substrates seldom reach depths greater than 17 m and, therefore, only one deep reef zone was recognised. The poor light penetration along the Abel Tasman facilitates the start of this deep zone at relatively shallow depths (10 m depth). Here species characteristic of this habitat in the Hauraki Gulf also formed a dominant component of the deep reef habitat along the Abel Tasman coastline (*Ancorina alata, Polymastia granulosa, P. fusca, Calyspongia ramosa, Aaptos,* and *Iophon minor*. As in the Waitemata Harbour (Hauraki Gulf), many areas along the Abel Tasman away from strong currents receive high sediment loads. These deep reef areas were dominated by organisms which tolerate this rain of sediment.

TABLE 14: Number of macroinvertebrate species recorded from estuaries along the Abel Tasman coastline and other estuaries in New Zealand.

	Crustacea	Mollusca	Polychaeta	Others	Total
1. Abel Tasman Estuaries	8	13	10	3	34
2. Whanganui Inlet (North-west Nelson)	45	71	26	20	159
3. Waimea Inlet (Nelson)	27	36	36	12	111
4. Nelson Haven (Nelson)	5	11	17	3	36
5. Parapara Inlet (Nelson)	4	21	24	5	54
6. Moutere Inlet (Motueka)	11	27	16	5	59
7. Wairau River Estuary (Blenheim)	10	3	7	0	20
8. Wairau River Estuary and Lagoons	7	4	7	1	19
9. Brooklands Lagoon (Canterbury)	13	8	10	9	40
10. Avon-Heathcote Estuary (Canterbury)	30	49	27	29	134
11. Okarito Lagoon (Westland)	15	7	3	17	42
12. Ahuriri Estuary (Napier)	6	11	14	2	33
13. Upper Waitemata Harbour (Auckland)	21	31	25	10	87

1. Present study
2. Davidson, 1990
3. Davidson and Moffat, 1990
4. Knox, 1979a
5. Knox et al., 1977a
6. Moffat, 1989
7. Knox, 1983b
8. Knox, 1990
9. Knox and Bolton, 1978
10. Knox and Kilner, 1973
11. Knox et al., 1976
12. Knox, 1979b
13. Knox, 1983a

TABLE 15: **Maximum densities (per square metre) of selected species from estuaries along the Abel Tasman coastline and other New Zealand estuaries.**

	Abel Tasman Estuaries	Whanganui Inlet	Waimea Inlet	Moutere Inlet	Parapara Inlet	Wairau River Estuary	Avon-Heathcote Estuary	Ahuriri Estuary
Bivalves								
Austrovenus stutchburyi	1234	2524	3168	1347	1426	1340	3050	7270
Paphies australis	3531	815	3530+	4494	-	452	2547*	present
Tellina liliana	249	283	815	419	230	-	1337*	730
Nucula hartvigiana	-	1958	1268	226	present	-	-	NA
Gastropods								
Amphibola crenata	40	215	532	68	230	129	977*	580
Diloma subrostrata	40	127	170	79	63	-	1146*	360
Potamopyrgus estuarinus	4957	3656	23450	present	present	10449	884000	2500
Zeacumantus lutulentus	-	260	147	226	150	-	-	740
Zeacumantus subcarinatus	11	962	-	11	-	-	18000*	NA
Polychaetes								
Capitellidae	-	45	4674	691	50	12040	36584*	present
Nereidae	170	555	509	464	230	602	1350*	present
Decapods								
Helice crassa	113	71	328	430	180	516	250*	420
Hemigrapsus crenulatus	747	57	566	260	present	-	255*	present
Macropthalmus hirtipes	-	23	102	215	-	516	250*	present

* Jones, 1983
\+ Subtidal record

TABLE 16: Number of macroinvertebrate species recorded from shallow subtidal soft sediments along the Abel Tasman coastline and other soft sediment communities in New Zealand.

	Crustacea	Mollusca	Polychaeta	Echinodermata	Others	Total
1. Abel Tasman coastline	9	30	19	8	5	71
2. Shakespeare Bay, Marlborough Sounds	38	33	51	7	8	137
3. Pegasus Bay, Canterbury	39	14	36	5	6	100
4. Banks Peninsula, Canterbury (Benthic)	20	10	24	3	1	58
(Epibenthic)	26	8	7	3	4	48

1. Present study
2. Knox and Bolton, 1979
3. Knox, Fenwick and Bolton, 1978
4. Davidson, 1989

5. HUMAN IMPACT

The intertidal and shallow subtidal environments of New Zealand have been significantly adversely affected by human activity. Much of this modification may be irreversible and have left many marine environments damaged or destroyed. There is no doubt that many marine communities have suffered this fate before they were recognised by the scientific community and their importance to the overall inshore marine ecosystem understood. Coastal communities which are particularly sensitive include slow growing benthic organisms such as bryozoan 'coral' beds, brachiopod (lamp shell) beds and horse mussel beds. Coastal areas such as estuaries are vulnerable to nutrient enrichment, infilling, high sedimentation and physical disturbance. There are all too many examples where these sensitive marine environments have been harshly treated. The inshore coastal environment of the Abel Tasman has not been spared from significant levels of human impact.

5.1 Pollution and Nutrient Enrichment

No indication of nutrient enrichment was recognised from invertebrate data from benthic core samples from estuaries and shallow subtidal soft shores around the Abel Tasman coastline. Pollution indicating polychaetes, *Capitella capitata* and *Heteromastides filiformis* were not recorded from any site along the park. Dense beds of macroalgae such as sea lettuce (*Ulva* sp.) and agar weed (*Gracilaria*) were also not recorded.

Potential sources of human derived nutrient enrichment along the Abel Tasman are restricted to those carried in by currents from outside the park, run off from farms at Marahau, Awaroa and Wainui Inlets, leachate from toilets and boat toilets. No subtidal soft sediment samples were taken from Anchorage during the peak tourist season, therefore the impact of boat derived sewerage is unknown. It is suggested that the Department of Conservation and Nelson/Marlborough Regional Council carry out an investigation on the impact of boats on the sheltered waters at Anchorage.

Potentially, the greatest source of pollution along the Abel Tasman coastline is derived from boats travelling along the coast or at anchor. Subtidal clean-ups organised by the Motueka Underwater Club have revealed large quantities of rubbish on the seabed. Clean-up projects of this nature are to be commended. It is the responsibility of boat owners to retain all rubbish on board and it is up to the other boat users and park staff to enforce this practice. Rubbish retrieved by the diving club suggests that commercial fishermen using the safe anchorages along the park also contribute to this problem.

5.2 Fishing

Fishing practices along the Abel Tasman have influenced the marine environment of the Abel Tasman. Most of the terrestrial environment of the park has been retired from farming and is slowly regenerating. The marine environment, however, continues to be modified. Most recreational and commercial fishers recognise changes to the marine ecosystem along the park. This recognition comes from low catch rates and the disappearance of particular species. This phenomenon is also the probable end result of habitat modifications rather than just depletion of fish stocks.

Unfortunately, historical records of the marine environment along the Abel Tasman coastline are virtually non-existent. Much of the historical evidence is derived from early fishermen, the occasional documented record and the remnants of the natural environment which remain today. It appears prior to human modification, the shallow subtidal environment along the park was characterised by large bryozoan coral beds (Saxton, 1980), extensive horse mussel communities, dense scallop beds, populations of crayfish and numerous fish, especially those associated with soft bottom communities (blue cod, gurnard). Reef fish such as hapuku, snapper, blue moki, and red moki were regularly recorded by fishers.

Commercial fishing activities have had a large impact on the fish and benthic communities throughout the Abel Tasman coastline. Dredging, trawling, netting and potting activities were employed to derive a living from the area. Recreational fishing has also had an impact on the ecology of the park. Fish species not targeted by present commercial operations in the area, such as blue cod, blue moki, red moki and gurnard were uncommon in the present survey. Large numbers of recreational anglers visit the park, particularly in the summer months and it appears that fish populations are kept at relatively low levels as a result.

The recreational impacts have been compounded by the widespread usage of set-nets. Ghost nets (drifting or snagged nets) were encountered during this study and these continue to indiscriminately kill fish long after their loss.

6. ESTUARINE EVALUATION

Conservation values for estuaries along the Abel Tasman coastline are compared with four other South Island estuaries in Table 17. The estuaries along the Abel Tasman are evaluated together on the grounds they are similar in size, catchment type, substrate, hydrology, salinity and human influence. Evaluation of estuarine areas of the Abel Tasman, therefore, uses a hypothetical estuary which represents the type locality. Exceptions along this coastline are Awaroa Inlet and Wainui Inlet which are larger in size than most Abel Tasman estuaries and Wainui and Marahau Estuaries which have terrestrial boundaries outside the National Park which are farmed.

The evaluation methodology was developed during an ecological study of Waimea Inlet (Davidson and Moffat, 1990) (Appendix 16). Estuaries used in the present evaluation fit the criteria outlined by the Davidson and Moffat (1990). The ecology of each estuary used in the present evaluation has been fully investigated (Knox and Kilner, 1973; Knox et.al., 1977; Davidson and Moffat, 1990; Davidson, 1990).

On conservation grounds, Whanganui Inlet clearly ranks the highest of the South Island estuaries investigated (Table 17). The estuaries along the Abel Tasman coastline received high scores for representativeness in the region, ecological state of the estuary, pollution status, adjacent terrestrial vegetation, and salt marsh vegetation. The estuaries along the Abel Tasman are considered unique in the Nelson/Marlborough Conservancy (Davidson et. al., 1990). These estuaries have suffered little from human modification. Most receive freshwater which is derived from forest catchments, have adjacent terrestrial vegetation which is in a state of regeneration and most have their original salt marsh vegetation intact. For these reasons estuaries along the Abel Tasman coastline compare favourably with Whanganui Inlet.

Estuaries along the Abel Tasman coastline do not score highly on criteria based on estuary size, diversity of invertebrates, number of water-bird species, number of resident and migrating fish species and maximum density of cockles (Table 17). Results from benthic samples suggest that the low scores for the biotic component of estuaries along the park is largely due to the low productivity nature of the area (section 4.4). Large estuaries such as Waimea Inlet and Whanganui Inlet score well on intertidal flora and fauna criteria (Appendix 16).

Overall, the estuaries of the Abel Tasman National Park have high conservation values (Table 17). Their small size, low freshwater inputs, coarse sediments and quick flushing action means that they are nutrient impoverished and as a consequence have low invertebrate species diversities and densities. As such, they are representative examples of this type of ecosystem. Low production should not belay their importance as estuaries which remain in a very low state of human modification.

TABLE 17: Evaluation of combined estuaries of the Abel Tasman and four other South Island estuaries (see Appendix 16 for criteria).

Criteria	Abel Tasman	Whanganui Inlet	Waimea Inlet	Parapara Inlet	Avon- Heathcote
1. Representativeness in region	80	80	80	27	80
2. State of estuary	60	60	40	40	40
3. Pollution status	60	60	30	45	15
4. State of terrestrial vegetation	45	45	15	30	15
5. State of salt marsh vegetation	60	60	45	45	30
6. Size of intertidal and subtidal areas	16	60	60	24	36
7. Number of invertebrate species	8	40	32	16	32
8. Number of waterbird species	16	24	24	8	32
9. Number of fish species	10	40	40	30	40
10. Maximum cockle density	8	32	40	24	40
11. Number of intertidal vascular plant species	15	10	20	15	20
Total	378	511	426	304	380
Percentage	68%	91%	76%	54%	68%

7. AREAS OF BIOLOGICAL IMPORTANCE

The Abel Tasman coastline represents a unique coastal unit. The beaches and coastal walk are internationally acclaimed by tourists and the granite, estuary, island, water and golden sand landscapes are outstanding. Although the terrestrial and marine ecology of the Abel Tasman has been impacted by human activities, there remain areas with high biological importance. In addition to these areas, there is significant opportunity for ecological improvement through careful management.

This chapter discusses areas along the Abel Tasman coastline with existing ecological value. The areas recognised in this report are displayed in figure 12.

(a) Estuarine Areas

A total of 15 estuaries are recognised along the Abel Tasman coastline. As outlined in section 4.4, the estuaries along this coastline are relatively small ($<$ 20 ha), have low species diversity and density, a significant coarse sand component and are relatively intact with little permanent modification. In New Zealand, few estuaries remain free of human modification. Modifications range from minor impacts such as cattle grazing to large scale impacts such as the infilling and estuary destruction. The Abel Tasman represents an estuary refuge where the encroachment through human activities on the coast is significantly restricted. Here, species like the threatened banded rail have continued to find feeding and breeding habitat.

The estuaries of the Abel Tasman coastline, therefore have high biological value. They are governed by a unique set of biological constraints and are in a relatively low state of modification.

Results from invertebrate analyses, habitat mapping and estuarine evaluation suggest that Awaroa Inlet is of particularly high biological value. This estuary is the largest along this coastline and has a full complement of estuarine habitats, while many of the smaller estuaries along this coast have restricted habitat components.

(b) High Current Areas

High current areas are most often located in subtidal areas where tides and topography combine forming these strong water flow habitats. The most well known areas in the Nelson/Marlborough region are French Pass, Tory Channel entrance, Stephens Passage and Allen Strait. Along the Abel Tasman coast there are sites where tidal currents exist. These current areas are located at headlands where the bottom topography rises due to reef or shoal features. The best examples of this habitat are presented in figure 12. These site include Separation Point, Taupo Point, Totaranui Point, and Fisherman Island. Investigation of these sites often reveal the presence of large numbers of filter feeding organisms such as *Maoricolpus rosea*, *Perna canaliculus*, *Iophon minor*, *Ancorina alata* and hydroid trees. Strong currents also act to sort particle sizes in the immediate area leaving coarse sand and broken shell material. This type of soft shore or habitat often proves ideal for the New Zealand lancelet (*Epigonichthys hectori*), which has a relatively narrow habitat requirement.

(c) *Ecklonia radiata* Areas

Ecklonia radiata is a large brown algae with a wide distribution in New Zealand which extends southward along the east coast to Kaikoura and to Fiordland on the west coast. The distribution of this species in Tasman and Golden Bay is restricted to six known localities with as few as three plants from one location. Taupo Point and associated stacks represent the best population of this large brown algae in Tasman and Golden Bays with densities as high as 29 per m^2. The only other site along the Abel Tasman where greater than 200 plants were observed was Six Foot Rock adjacent to Adele Island (Figure 12). Observations of *Ecklonia* plants over a 14 month period at Rob's Rock adjacent to Tonga Island, showed a decline from 60 plants to as few as nine plants. Areas which support this species are, therefore, considered biologically important.

(d) *Actinothoe albocincta* Area

Actinothoe albocincta is an anemone which inhabits shallow subtidal rocky substrates which are swept by tidal currents. At Snapper Rocks, densities as high as 6,781 individuals per m^2 were recorded. This site is the highest known density of *Actinothoe* known in the Nelson/Marlborough region.

(e) Soft Shore Communities

Various soft shore communities of biological importance were recognised along the Abel Tasman coastline.

The benthos offshore Bark Bay was dominated by a broken shell/dead shell surface layer. The particular substrate composition at this site was not located elsewhere in the Abel Tasman Park during the present survey. This area was dominated by the bivalve *Leptomya retiaria* which was not recorded elsewhere along this coastline.

(f) Algal Community

Sixty species of intertidal and subtidal algae are recorded from the Abel Tasman coastline (Nelson, et.al., 1992). The investigation by Nelson covered Kahurangi Point to Cape Campbell. Five species in this study area were only recorded from sites along the Abel Tasman coastline. A number of other species recorded from the Abel Tasman represent the only sites within Tasman and Golden Bays. As many algae species have limited spore dispersal areas along the Abel Tasman may represent isolated populations. These areas are, therefore, biologically important.

(g) Reef System

Particular reef areas were identified by analyses as having a characteristic community of plants and animals. These deep reef areas are dominated by rock with no intertidal and very little shallow subtidal components (eg. Rob's Rock, Six Foot Rock, Totara Reef).

(h) Horse Mussel (*Atrina zelandica*) Beds

Horse mussel communities were located at Separation Point and Te Pukatea Bay. The mussel bed at Separation Point represents one of the best representative beds in the Nelson/Marlborough region (C. Hay, pers. comm.). These communities have been significantly damaged by dredging activities, therefore, beds which are largely intact are rare and biologically important.

(i) Bryozoan 'Coral' Beds

The bryozoan 'coral' beds offshore Separation Point are protected from commercial dredging and trawling. These bryozoan beds are internationally recognised (IUCN Invertebrate Red Data Book, 1983) as a threatened habitat. The Separation Point coral bed was not the only area where bryozoan colonies had established along the Abel Tasman. Large beds dominated by the bryozoan *Hippomenella vellicata* were destroyed by sledges and chains towed behind fishing boats (Saxton, 1980). Investigations into the state and extent of the Separation Point coral bed was beyond the scope of this study, therefore no information of this nature are presented here.

(j) Rhodolith Beds

Rhodoliths are calcified algae formed into a projection. Rhodolith beds were located in the Totaranui area, but the extent of these formations are unknown. In the Nelson/Marlborough region the distribution of these algae is poorly documented, but the Totaranui bed appears significant. Rhodolith beds have been reported in the Kapiti area (C. Battershill, pers. comm.). Results of a study of rhodolith beds on the inside the Baja Peninsula, Mexico, suggest that the maximum depth is determined by sediment smothering (M. Foster, pers. comm.). The beds along the Totaranui coast may avoid smothering due to strong tidal currents in the area.

(k) Limestone

Limestone substrate is restricted to Taupo Point and two associated island stacks, the Tata Islands and the Abel Tasman Monument. This represents a tidal area of approximately 1-2 hectares or 0.4 % of the Abel Tasman coastline. Results from a subtidal study by Davidson and Chadderton (in press), suggest the ecology of limestone is significantly different from Abel Tasman granites. These small areas are therefore very important along the Abel Tasman coastline.

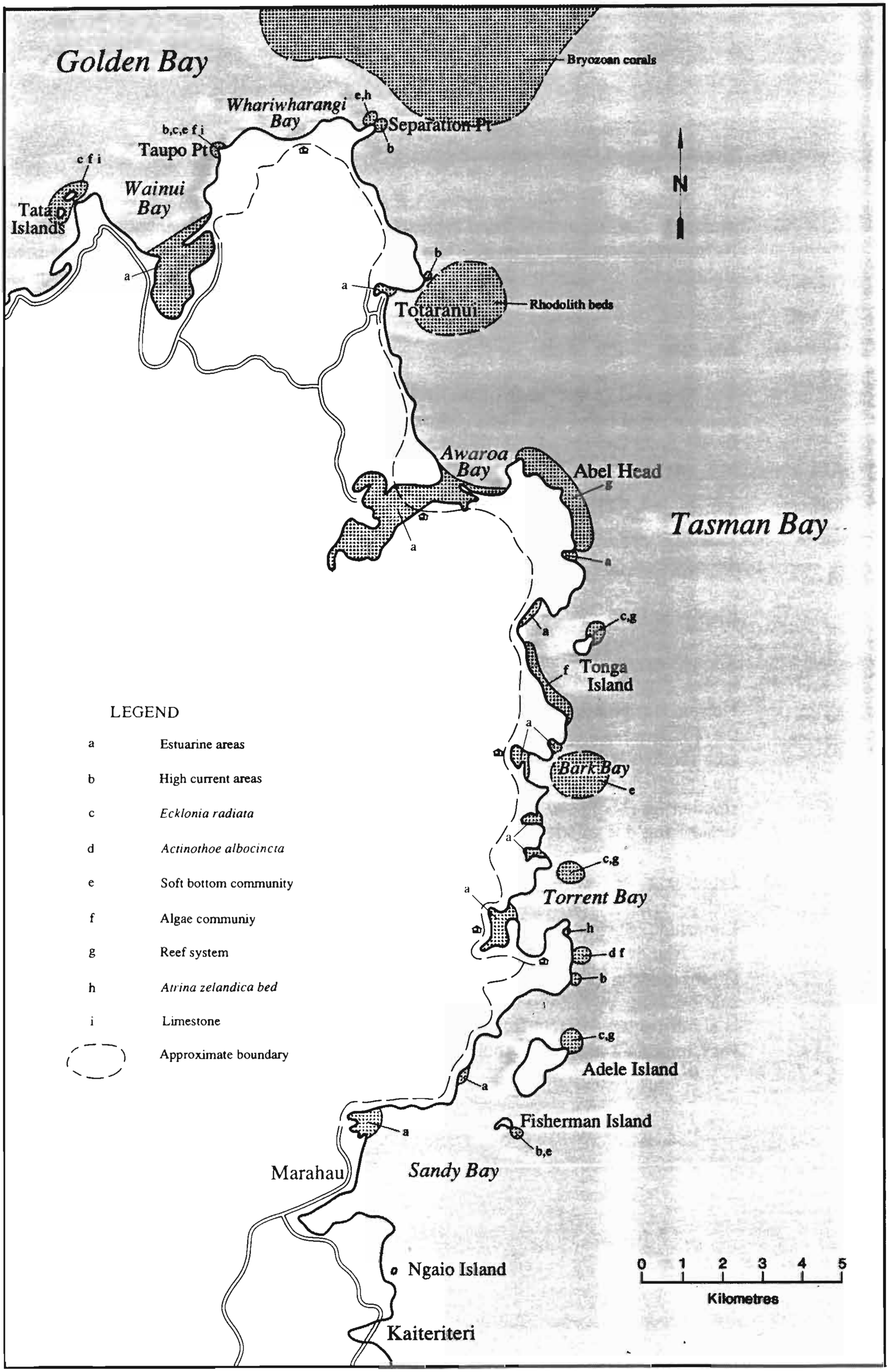


Fig. 12 MARINE AREAS OF BIOLOGICAL IMPORTANCE

8. MANAGEMENT RECOMMENDATIONS

The Abel Tasman coastline is internationally recognised for its seascapes and unique coastal experience. The National Park attracts over 56,000 land-based and up to 50,000 sea-based visitors each year (B. Clough, pers. comm.). These numbers are expected to increase dramatically with predictions of tourists entering the Nelson area doubling over the next five years (Tourism Nelson). This will undoubtedly result in greater numbers visiting the Abel Tasman National Park and consequently greater pressure on the coast environment.

Increased commercial pressure may also occur with diversification in fishing and aquaculture.

This chapter presents management recommendations based on ecological information collected during the present investigation.

8.1 Summary of Ecological Values

Results from the present investigation suggest the coastal environment of the Abel Tasman National Park is relatively homogeneous. There are, however, areas along this coast with international, national or regional importance. These coastal values fit into a unique biological regime which is representative of the only sheltered granite coastline in central New Zealand .

Granite coastlines in New Zealand are limited to Stewart Island, isolated parts of Fiordland, Heaphy River to Kahurangi Point and the Abel Tasman National Park. The physical and environmental constraints are dramatically different between the areas, resulting in very different community assemblages (Davidson and Chadderton, in press).

The granite geology in the Abel Tasman is believed to have an influence on coastal communities. Granite, for example, seldom supports the growth of seaweed species (Davidson and Chadderton, in press). Granite geology contributes to poor catchment fertility and significant coarse sand deposition into the coastal zone. These factors when combined with low freshwater run off, quick flushing of estuarine zones, warm temperatures, and the sheltered nature of the estuaries and coast has lead to a unique set of environmental constraints producing nutrient limited estuarine habitats.

The estuaries along the Abel Tasman coastline represent an important refuge for the nationally vulnerable banded rail which has a significantly reduced distribution primarily caused by loss of habitat. The estuarine zones of the Abel Tasman therefore represent a stable core population under little threat of habitat loss.

Like estuarine areas, the shallow subtidal zone is often characterised by coarse and medium sands. This phenomenon is encountered where wave action and strong tidal currents exist.

Substrate type and strong tidal currents have provided the right environmental conditions for the establishment of large bryozoan communities. Bryozoan 'corals' at Separation Point are internationally recognised and are protected by fisheries legislation.

Similar environmental conditions have lead to the formation of rhodolith beds in the Totaranui area. The size of these beds is unknown, however, they are the only significant beds recorded to date in the Nelson/Marlborough region.

Another vulnerable benthic community recorded along the park are horse mussel beds. The bed located adjacent to Separation Point is probably representative of beds prior to dredging and trawling.

Three small areas of limestone are located in the Abel Tasman National Park. Other than Tarakohe, these are the only tidal limestone areas in Golden Bay, Tasman Bay and the Marlborough Sounds. The marine community associated with limestone areas is notably different from those recorded from the granite coastline along the Abel Tasman (Davidson and Chadderton, in press).

8.2 Existing Protection

The Abel Tasman National Park encompasses an area of 24,500 ha administered by the Department of Conservation. The seaward boundary of islands and rocks in the National Park is 2.41 km seaward of mean high water from Separation Point south to Guilbert Point north of Marahau (Figure 13). Only environs above mean high water (3.6 m above chart datum) are protected by National Park legislation. The mean high water mark boundary is loosely defined in estuaries as the lower level of salt marsh vegetation, and on the rocky coastline as the upper level of the barnacle zone. Under National Park status, all plants and animals are protected and the wilful destruction of plants and animals is expressly forbidden.

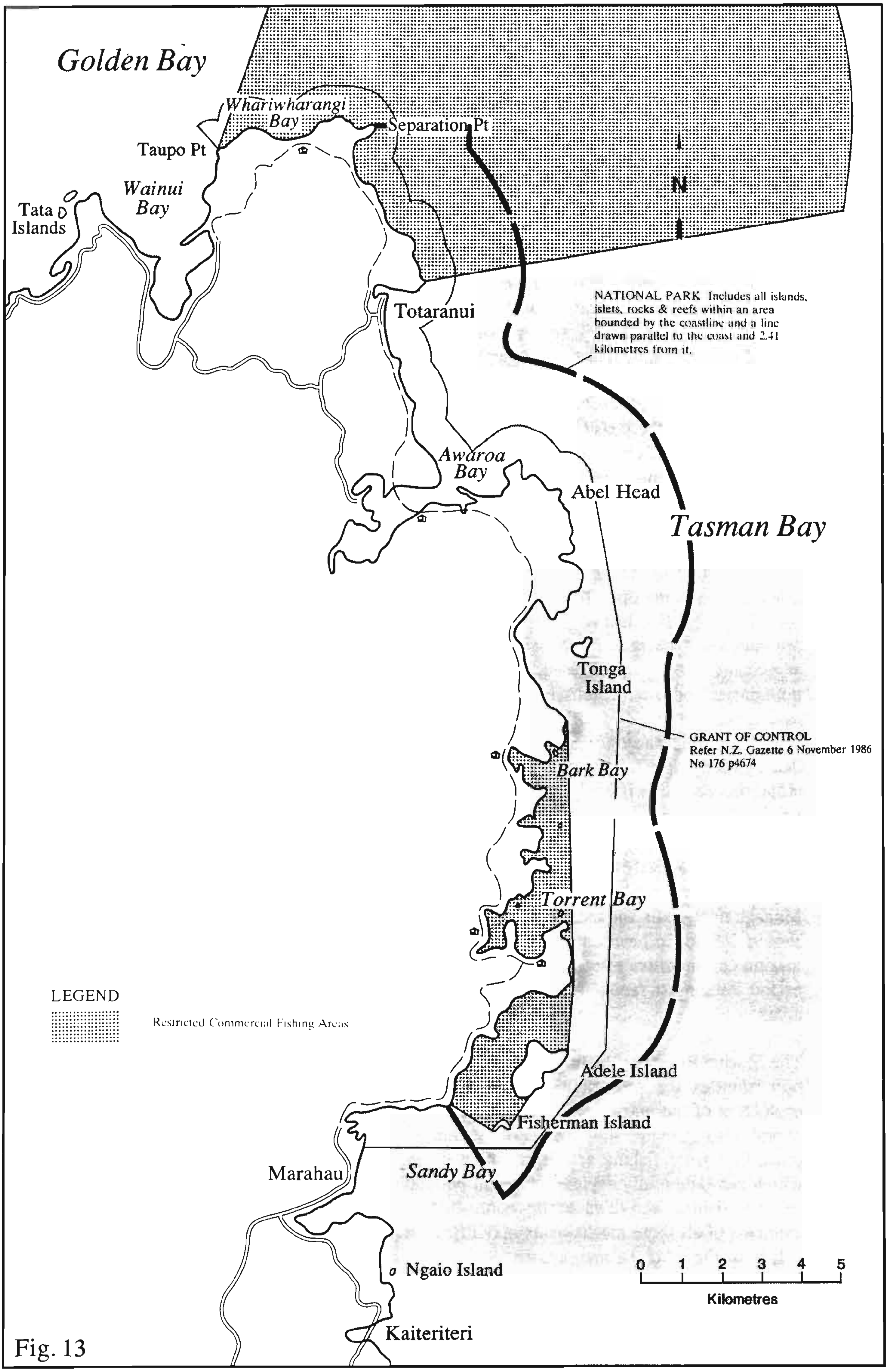
A grant of control areas extends 800 m offshore from Taupo Point south to Fisherman Island and Marahau Estuary (Figure 13). As from 1 July 1992, the Tasman District Council is responsible for administering the bylaws for this area.

Two coastal areas along the Abel Tasman National Park are protected under the Fisheries Act (Fig. 13). The Separation Point zone encompasses an area extending six nautical miles seaward from Taupo Point and Totaranui Point. Restrictions in this area prohibit the commercial use of trawling, dredging and danish seining. Recreational use of trawling and dredging equipment is not restricted within this zone. Oyster and scallop dredging by commercial operators is prohibited on the landward side of a line between Foul Point to Fisherman Island (Figure 13).

8.3 Ecological Damage

The coastal zone adjacent to the Abel Tasman National Park remains free of large scale human development. Large scale impacts such as estuarine infilling, port development, erosion protection, roading, industrialisation, rubbish dumping and sewage disposal are virtually absent. Ecological values of the Abel Tasman National Park coastline have, however, been seriously modified by human activity.

Dredging and trawling have resulted in damage and destruction of large areas of bryozoan corals (Saxton, 1983). These fishing methods have also modified the plant and animal communities which inhabit subtidal soft-bottom areas. The destruction of juvenile fish



SEA BOUNDARIES AND RESTRICTED COMMERCIAL FISHING AREAS habitat and food sources combined with overfishing will have disturbed the ecology along the park. Unfortunately there is little baseline data available which enables comparisons to be made, but catch histories of fishers suggest that some fish species once common are now rarely caught. Observations by local people and historic aerial photographs suggest that seaweed populations have declined over the past two decades. (Plates 1 to 5.)

Ecological degradation may be reversible providing the physical environment remains intact. Although significant damage of large areas of slow growing sessile communities have occurred along the Abel Tasman, most human impacts which cause total loss of habitat are absent. The potential for ecological improvement of the Abel Tasman coastal zone is, therefore, high.

Modification of the coastal ecology of the Abel Tasman National Park has been and still is, largely a factor of extractive practices. By nature of location, this coastline is sheltered and probably never supported the biomass of plants and animals normally associated with exposed coasts such as the outer Marlborough Sounds or Kaikoura coast. Calm weather allows for regular fishing. This combined with a large fishing fleet in the Nelson area, and the influx of visitors in the summer months, has resulted in the depletion (and in at least one case disappearance) of many fish species. Modification of the benthic environment continues along the coastline through commercial and amateur dredging. Hand picking of shellfish on the rocky coastline has depleted stocks of paua and mussels, while populations of crayfish are reduced each season. Pipis in the estuaries are common, but generally small in size suggesting they may also be targeted. Whitebaiting occurs within the National Park boundaries and often results in damage to estuarine vegetation.

Results of this baseline study suggest that the ecology of the Abel Tasman coastline is detrimentally affected by extractive practices. The currently high level of fishing pressure along this coastline is likely to maintain fish shallow subtidal fish stocks at their present low level.

8.4 Management

Management goals for the marine environment adjacent to the Abel Tasman National Park should include protection of the values which remain and to encourage the recovery of marine communities affected by human activities. Management of the marine environment of the Park must recognise the links between terrestrial, estuarine, intertidal and subtidal areas.

The Marine Reserves, National Parks, Resource Management Act and Fisheries Act all offer opportunities for protecting natural values on the coast. Marine reserves afford total protection of the marine environment. Extension of the National Park to the low tide mark would also provide full protection within this zone. Fisheries legislation can provide protection from fishing activities which damage the environment or bulk fishing methods which can potentially deplete local fish populations. The Resource Management Act allows for non-fishing activities to be controlled. A management regime which incorporates elements of all these mechanisms may offer the most positive means of protecting the natural values of the Abel Tasman coastline.

8.5 Marine Reserve or Reserves

Ecological criteria should be recognised in the selection of areas suitable for protection under the Marine Reserves Act (1971) along the Abel Tasman coast. A marine reserve along the park should include where practicable:

1. an estuary, beach, sand bar, island, headland and bay;

2. a full range of intertidal and subtidal substrates;

3. a full range of shore exposure types as determined by statistical analyses;

4. as many biologically important areas as possible (see chapter 7); and

5. representative examples of granite and limestone substrate types (Davidson and Chadderton, in press).

The size of marine reserve areas should be large in order to balance the low productivity nature of this coast (see section 4.4) and probable low recruitment rates of marine species. Populations of marine flora and fauna, particularly edible species, are extremely low, therefore any marine reserve will receive low recruitment from adjacent coastal areas. In addition, the rocky shores of the Abel Tasman are physically isolated by large soft substrate areas of Tasman and Golden Bays. It is unknown whether recruits from rocky areas in North Nelson, outer Marlborough Sounds or West Coast reach this coast in significant numbers. Harvested species within marine reserve areas may therefore be slow to recover along the Park and may rely on recruitment from within the reserve boundary. This factor combined with low energy wave action and low productivity will undoubtedly slow this recovery process. Two relatively large marine reserves are strongly suggested in order to re-establish natural communities along this unique coastline.

Placement of each marine reserve should be based primarily on ecological values. Biologically important areas are widely spread, therefore it would be impossible to include all of these areas without protecting all of the coast in a one large marine reserve. The following is a guideline to the most important of these areas classified on the basis of information presented in this report.

Estuary:

1. Awaroa Inlet: Largest estuary (290 ha); greatest variety of estuarine habitats; largest single salt marsh/herbfield community (58 ha); most productive estuary as indicated by shellfish size classes; largest dune area (14 ha); largest freshwater input; presence of three recorded sites of the nationally important banded rail.

Granite Coast:

1. Tonga Quarry to Foul Point: Greatest diversity of algae recorded for a granite shore with some species not recorded from other areas in park; largest area and greatest depth range of *Carpophyllum flexuosum*.

Limestone Coast:

1. Taupo Point and associated stacks: Representative of a unique community of plants and animals (Davidson and Chadderton, in press); only site in New Zealand south of Taranaki where vouchered specimen of crested blenny has been recorded; rare substrate along park (< 0.35% of intertidal and rocky subtidal area); regular breeding site of vulnerable reef heron; largest area with dense population of *Ecklonia radiata*; greatest diversity of red algae species many of which were not recorded from elsewhere along the coast; highest diversity of fish species recorded for any site.

Subtidal Soft Bottom Community:

1. North-west Separation Point: Recognised for a dense bed of horse mussels (*Atrina zelandica*).

2. Bark Bay: Community type not recorded elsewhere in the park.

3. Totaranui: Community of calcified algae (rhodolith bed) of unknown size and significance.

High Current Habitat:

1. Taupo Point: Habitat utilized by densest population of the lancelet *Epigonichthys hectori*).

2. Totaranui: Habitat dominated by an almost 100% cover of *Maoricolpus rosea*.

3. Snapper Rocks: Rocky passage with an exceptionally high density of anemones.

8.6 Protection of Coastal Areas Outside Marine Reserves

There are numerous biological areas along the Abel Tasman coastline (see chapter 7). Depending on the location of any marine reserve or reserves many of these areas may be omitted from any form of protection. It is therefore important that management of Abel Tasman coastline outside marine reserve areas protect these remaining areas and encourage their recovery.

8.7 Protection and Improvement of the Marine Environment

General Principles

It is recommended that all agencies responsible for the management of the Abel Tasman National Park:

1. recognise the Abel Tasman coastline as ecologically unique with internationally and nationally important values;

2. recognise the importance of managing the coastal zone as one integrated system and not as separate components;

3. recognise that many of the marine ecological values of the park have been severely damaged by human activities, but have the potential for recovery;

4. recognise the importance of subtidal soft-bottom communities which are an important part of the natural food chain;

Specific Management Recommendations

It is recommended that the following principles be adopted by all those using and managing the Abel Tasman National Park coastline and its environments:

1. that the fundamental goal of management be the maintenance and improvement of the natural values of the Abel Tasman coastal environment;

2. that the use of bottom towed fishing methods be prohibited from near-shore areas;

3. that the Department of Conservation work closely with MAFFisheries toward the exclusion of bulk fishing methods such as set nets;

4. that extension of the National Park boundary down the shore to the low tide mark be investigated as a means of protecting intertidal areas adjacent to the park;

5. that the Department of Conservation use the provisions of the National Parks Act and the Marine Reserves Act to protect a representative range of all habitats and communities recognised along the Abel Tasman coastline;

6. that marine farming within the 2.41 km boundary be excluded;

7. that the problems of rubbish dumping and possible pollution associated with large numbers of boats congregating in the sheltered anchorages of the park be recognised and investigated; and

8. the spread of the introduced ice plant (*Carpobrotus edulis*) and cord grass (*Spartina anglica*) be curbed and these species eventually eradicated.

8.8 Monitoring Programme

It is strongly recommended that a baseline monitoring programme be established to investigate the impact of management regimes such as marine reserve or activity restrictions. It is suggested that a BACI (before/after, control/impact) model be used. The selection of site location and sample size as well as other variables should be based on data presented in the present study.

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APPENDIX 1

Birds Recorded from the Abel Tasman Coastline

Yellow Eyed Penguin (*Megadyptes antipodes*) Endemic

The only mainland breeding colonies for yellow eyed penguins are on the coasts of Otago, Southland and Canterbury. Stragglers reach as far north as Cook Strait.

One recent sighting of a solitary bird 200 m offshore from Torrent Bay was recorded on 27 January 1990 (0SNZ).

Cook Strait Blue Penguin (*Eudyptula minor variabilis*) Endemic

This subspecies of blue penguin occurs widely around coastlines of the southern end of the North Island and northern parts of the South Island.

The decline of the Cook Strait blue penguin on the mainland is largely due to introduced predators (Moncrieff, 1967; Dennis, 1985), but large breeding populations occur on Adele, Fisherman and Tonga Islands (Heinekamp 1974; Clout 1979; Clout and Gaze 1980).

On short visits to each island mid April 1990 fresh penguin sign was recorded (footprints, droppings and obvious smell), on beaches, along well formed tracks leading up and inland and at the mouths of burrows. Several burrows were occupied by penguins during the day. Two addled eggs were found on Tonga Island - one at the mouth of a burrow, the other lying loose, measuring 55.3 x 42 mm, and 53.2 x 42.3 mm respectively.

Crosby and Knight (1975) reported penguin trails and nesting sites on both Ngawhiti and Motu Island (Tata Islands) in November 1967, but a subsequent survey by Clout and Gaze (1980) found no active or recently used burrows in December 1980. Visits to Tonga, Adele and Fisherman Islands during November 1990 and January 1991 showed numerous burrows occupied, especially on Tonga and Fisherman Islands (L. Chadderton, pers. comm.).

Penguin activity close to the mainland shore in mid April 1990 was heard at night and footprints were observed on most of the park's beaches, with fresh trails following streams and creeks inland. The Cook Strait blue penguin comes on land to breed, moult and occasionally at other times, (Kinsky, Robinson, Challies, and Jones In: CJR Robinson, 1985). The density of penguin activity on the mainland may be determined by stoat levels throughout the park.

Sooty Shearwater (*Puffinus griseus*) Native

Sooty shearwaters breed in small numbers on many islands off the New Zealand coast, and are concentrated on the islands around Stewart Island. Birds are generally absent from New Zealand waters from mid-May to September.

Scattered sightings of feeding birds have been recorded from Tasman and Golden Bays, and five breeding burrows at the western end of Tonga Island was recorded by Clout (1980), with the capture of one individual. During a short visit to Tonga Island in November 1990, no burrows were observed (P Gaze, pers. comm.). Known breeding colonies exist on many islands in the Marlborough Sounds.

Fluttering Shearwater (*Puffinus gavia*) Endemic

Fluttering shearwaters breed only in New Zealand on well vegetated islands and islets from Cook Strait to the Three Kings Islands. This shearwater generally stays in New Zealand waters over winter.

Large numbers of birds, up to several thousand, feed in Tasman and Golden Bays. Flocks are frequently seen feeding in the park's inshore waters often with other seabirds.

Australasian Gannet (*Sula bassana serrator*) Native
Gannets are most plentiful from Cook Strait northwards with breeding colonies on many offshore islands. After the breeding season, adults disperse in New Zealand waters and juveniles fly to Australia as soon as they are fledged, most returning to their natal site for breeding by the time they are six years old (Robinson, 1985).

A breeding colony established on Farewell Spit in November 1983 and in 1989/90, 70-80 nests and about 600 pairs were recorded (JM Hawkins, pers. comm.).

Adults can be seen feeding in Golden and Tasman Bays throughout the year and are frequently observed off the coast of the park, usually in low numbers. During periods of high winds, large numbers c. 200-300 individuals were observed feeding in the Astrolabe, Sandy Bay area.

Black Shag (*Phalacrocorax carbo*) Native

Little is known of current breeding sites in the Nelson region although winter flocks of 200+ have been recorded on Motueka Sandspit.

Solitary birds or small groups of no more than ten are frequently seen flying and roosting around the park's coastline and estuaries. Black shags were regularly recorded in the Falls River area where the river meets the estuary. Several birds observed in April showed the white side rump patches of breeding plumage. Provided sufficient food and shelter is available, black shags breed at any time of the year (van Tets and Vestjens In: Robinson, 1985).

Pied Shag (*Phalacrocorax varius*) Endemic

Pied shags are present around most of the Nelson coastline but are not common (Walker 1987), with breeding colonies in Nelson Harbour and Waimea Estuary. Birds are seen infrequently along the park's coastline and rarely in numbers > 6 individuals.

Little Black Shag (*Phalacrocorax sulcirostris*) Native

Small numbers of these birds visit the Nelson region, particularly Motueka, Waimea and Nelson estuaries. Sightings have been recorded from Marahau (OSNZ Atlas 1979).

Little Shag (*Phalacrocorax melanoleucos*) Native

Little shags are well distributed around the coastline of the Nelson region, however, current breeding status unknown. Solitary or small groups of < 10 birds are frequently seen feeding and roosting around the park's estuaries and coastline.

Spotted Shag (*Stictocarbo punctatus*) Endemic

A strictly marine species of shag, which is seasonally present in the Nelson region. During winter months 2,500-3,000 birds feed and roost around Golden and Tasman Bays. Major night time roosts exist on Pepin Island-Cable Bay, Haulashore breakwater and Fifeshire Rock in Tasman Bay (JM Hawkins, pers. comm.) and on Ngawhiti Island in Golden Bay (J Jackson, pers. comm.).

Birds on day time roost sites around the park counted in April 1990 showed: Ngaio Island (c.100); Jules Point and the eastern side of Adele Island (c.150); and the rock stack off Pinnacle Island (c.300).

Guano covered rocks observed on Fisherman and Tonga Islands also indicate roost sites, but the coast line north of Abel Head was not surveyed. Some birds remain over summer but no breeding sites within Tasman Bay are known and nesting in Golden Bay (possibly Ngawhiti Island) has not been confirmed.

Spotted shags present on Ngawhiti was not mentioned by Crosby and Knight (1975) in 1967, but Clout and Gaze (1980) recorded c.35 roosting on the seaward cliffs on 8 December 1980 and suggested it was a regular roost site by the volume of guano present. Breeding is dependant on availability of food and local weather conditions, and varies from year to year and colony to colony (G.F.van Tets In: Robinson, 1985).

White Faced Heron (*Ardea novaehollandiae*) Native

Occupies a wide range of habitats throughout New Zealand. After nesting in lone pairs or scattered groups, winter flocks of up to 100 are often formed and there seems to be some movement northward and to coastal areas.

Around the park's coastline, counts of up to 40 birds have been recorded feeding and roosting at Wainui Inlet, Awaroa and Marahau during non-breeding months, with smaller numbers in other estuaries and bays.

Nesting at Awaroa was recorded in earlier years (ATNP Handbook, 1962), but current breeding status is unknown. Juvenile have been observed at Marahau.

White Heron (*Eggretta alba*) Native

In recent years, the New Zealand population has numbered 100-120 birds (Morse and Williams In: CJR Robinson, 1985). A few birds regularly overwinter in the Nelson region, migrating from their only known New Zealand colony at Okarito, West Coast.

Solitary birds have occasionally been recorded from Wainui Inlet, Awaroa and Marahau.

Reef Heron (*Eggretta sacra*) Native

The most solitary of all herons, the reef heron is generally sedentary, with a distinct preference for rocky shores. There has been an apparent decline in numbers throughout New Zealand over the past 30-40 years (MJ Williams In: Robinson, 1985).

In the Nelson region they are sparingly distributed, but individuals were frequently encountered right around the park's coastline, including estuarine areas, reefs and offshore islands. After nesting as lone pairs, families break up several weeks after the young have fledged.

There appears to be less than 20 birds resident within the park's boundaries; compared with 25-29 pairs of nesting birds along 6 miles of coast between Pohara and Separation Point in the summer of 1925 (Guthrie Smith 1936). Nesting has only been recorded from Fisherman Island with two pairs (H. Heinekamp 1974), and at Torrent Bay with one pair (JM Hawkins pers. comm.) and juveniles have been reported from around the coast.

Cattle Egret (*Bubulcus ibis*) Migrant

A number of these birds arrive in the Nelson region from Australia in mid May to spend the winter in small flocks on coastal farmland generally associated with cattle. For example, 23 birds in August 1988 were reported in Golden Bay (OSNZ survey).

An isolated sighting of a single bird was recorded in June 1986 at Wainui Inlet.

Australasian Bittern (*Botaurus stellaris*) Native

In Nelson the Australasian bittern is considered rare. Within the park the presence of bitterns was noted in Walker (1987), but no records are available from the OSNZ Atlas (1979) or Weri Inventory (Wetlands of Ecological and Representative Importance, 1987). In recent years a few unconfirmed sightings have been reported.

Canada Goose (*Branta canadensis*) Introduced

A gamebird mainly confined to the eastern South Island with some birds occasionally moving into Nelson's coastal areas. Less than 100 are resident on coastal farmland at Marahau, (L. Edwards, pers. comm.), associated with domestic geese and other waterfowl on a farm pond. These birds often move out onto the estuary.

Paradise Shelduck (*Tadorna variegata*) Endemic

The paradise shelduck is widespread in river valleys throughout the Nelson region. Movement from breeding sites is generally not extensive.

Within the park, groups of up to 30 have been encountered in the larger estuaries, Wainui Inlet, Marahau and adjacent coastal farmland, and Awaroa. Isolated pairs probably breed near the coast.

Grey Teal (*Anas gibberifrons*) Native

An increase of these birds has been noted in the Nelson region in recent years. A small flock of c.12 was recorded from Awaroa in April (P. Riddett, pers. comm.).

Blue Duck (*Hymenolaimus malacorhynchos*) Endemic

Blue ducks are usually associated with mountainous streams in relatively remote areas. A pair of blue ducks were observed by locals at the mouth of Tinline Stream during May, 1990.

New Zealand Scaup (*Aythya novaeseelandiae*) Endemic

Scaup are found mainly on inland lakes in the Nelson region, where they are uncommon. A few are resident on a farm pond at Marahau, and are occasionally seen in the stream as far down as the Marahau carpark.

Australasian Harrier (*Circus approximans*) Native

In the Nelson region harriers are widely distributed over open country. They are often seen over the park's estuaries, disturbing feeding and roosting flocks of waders.

Californian Quail (*Lophortyx californica*) Introduced

This North American gamebird is widespread throughout open country in Golden and Tasman Bays. Birds are present on some coastal land within the park, but generally make no use of estuarine areas.

Banded Rail (*Rallus philippensis*) Endemic

The distribution of banded rail in the Nelson/Marlborough region is on the decline (Elliot, 1983, 1989). This is due to the reduction and modification of estuarine habitat through human activities such as roading, infilling and scrub clearance.

Banded rail can be found in most of the salt marshes within the park. Although the birds are usually secretive, conspicuous footprint and other sign reveal their presence. A pair of banded rail are regularly seen in Marahau Estuary and two chicks were observed in February 1991 (G Holz, pers. comm.).

Western Weka (*Gallirallus australis*) Endemic

Weka have a localised distribution throughout the Nelson region. They are widespread in Golden Bay and through the Abel Tasman National Park, where birds are frequently seen and heard at hut sites and along the coastal track where they often take advantage of free food hand-outs from trampers. Pairs maintain territories throughout the year. Footprint sign often encountered on beaches shows foraging activity.

Marsh Crake (*Porzana pusilla*) Endemic

Marsh crake are present in scattered localities throughout the Nelson coastal region, but in low numbers. They are secretive and rarely seen. Within the park marsh crake have been recorded from Wainui Inlet and Totaranui (Weri Inventory, 1987); Bark Bay and Marahau (Elliott, 1983, 1989).

Pukeko (*Porphyrio porphyrio*) Native

In the Nelson region, pukeko are widespread and common in swamp, estuarine margins and on wet pasture. Throughout the park, birds are present on coastal wetlands and are particularly numerous at Totaranui.

South Island Pied Oyster Catcher (SIPO) (*Haematopus ostralegus finschi*) Endemic

Generally, SIPO breed only in the South Island. Large winter flocks are present in the Nelson coastal region in winter (17,510 individuals in May 1989 (OSNZ)) and smaller numbers of non-breeders are present over summer (3,347 individuals in December 1989 (OSNZ)).

Numbers build up as birds migrate north in late summer, with numbers dropping to generally stable flocks in winter. It is possible birds take a different route on their southwards journey back to their breeding grounds (JM Hawkins, pers. comm.).

This is the most abundant wader using the park's estuaries in autumn and winter. At Wainui Inlet the twice yearly wader surveys by OSNZ show winter numbers are up to 800 and summer numbers no more than 100.

At Awaroa winter flocks generally number c.700 and a summer flock of 52 were recorded in November 1988. The maximum number recorded was 1200 in June, 1980. Marahau is not always included in the OSNZ surveys but irregular counts show a summer record of c.500 in January 1988 as birds were moving through, but more stable flocks of 200-300 are present for most of the winter.

Lower numbers of SIPO use the smaller estuaries eg. c.50 at Bark Bay,and c.150 at Torrent Bay in April 1990.

Variable Oyster Catcher (VOC) (*Haematopus unicolor*) Endemic

Variable oyster catchers are widespread around the coast and estuaries of the Nelson region in increasing numbers. Generally this species is non-migratory and the local form is predominantly black.

Variables are frequently seen along the park's coastline feeding on rocky shores and in estuaries. Breeding has been reported from a number of sandspit sites (eg. Falls River, Torrent Bay, Bark Bay). Some territories are defended by pairs year round and there is some winter flocking, generally with SIPO.

Spur-Winged Plover (*Vanellus miles*) Native

Spur-winged plovers were first observed in Nelson in 1976. Since self introduction from Australia to Southland in 1932, this bird has spread north. They are now well established with widespread breeding and some flocking (eg. 200 in Appleby, September 1989 (OSNZ)).

Birds in numbers less than six have been recorded using the estuaries of Wainui Inlet, Awaroa, Marahau and adjacent coastal paddocks.

New Zealand Dotterel (*Charadrius obscurus*) Endemic

New Zealand dotterels have been recorded from Wainui Inlet, although these have been only one or two individuals (OSNZ).

This non-migratory species breeds in two very different areas (Stewart Island, and Bay of Plenty northward). Although no known breeding occurs between these two populations, a few birds, up to 11 (OSNZ) are regularly recorded from Farewell Spit, mostly in winter, and one or two birds visit Motueka Sandspit yearly. Breeding plumage has been observed on occasions.

Banded Dotterel (*Charadrius bicinctus*) Endemic

Banded Dotterel are New Zealand's most abundant plover. They are widespread, breeding inland throughout the country and then migrating to the coast, to the north and then to Australia. They are distributed throughout the Nelson region with a small amount of breeding, and winter flocking on many coastal areas. Farewell Spit is regularly used as a traditional wintering ground (1,237 individuals in May 1989 (OSNZ)).

Winter flocks of c.60-70 have been recorded for each of Wainui Inlet, Awaroa and Marahau. Coastal farmland and well cropped pasture is also used for feeding and roosting. Nesting has been recorded from the sandspit and airfield at Awaroa, but current breeding status is not known.

Whimbrel spp. (*Numenius* spp.) Migrant

Asiatic and American whimbrels are regular migrants to the Nelson region, preferring Farewell Spit (18 in December 1989, 5 in May 1989 OSNZ), but also visit other estuaries. OSNZ records for the last five years include two birds at Wainui Inlet on 13 April 1987.

Eastern Bar-Tailed Godwit (*Limosa lapponica baueri*) Migrant

The eastern bar-tailed godwit is the most abundant migratory Arctic wader to visit New Zealand. Nelson estuaries supported 16,400 individuals in December 1986 out of the New Zealand total of 77,300 (OSNZ News No. 45).

At Wainui Inlet the twice yearly wader surveys by OSNZ show summer numbers generally less than 200 and winter numbers less than 40. Few birds visit Awaroa or the smaller estuaries. Marahau is not always included in the OSNZ surveys but counts on an irregular basis show no more than 100 use the estuary in summer with much lower numbers in winter.

After some build up in numbers, at the end of March, birds depart for their Siberian nesting grounds, returning again at the end of September/October.

Knot (*Calidris canutus*) Migrant

The second most common Arctic wader to reach New Zealand but the most common on Farewell Spit; ie 16,000 in December 1989, compared with 15,900 godwit. Recorded from OSNZ Atlas.

Pied Stilt (*Himantopus leucocephalus*) Native

The pied stilt is the most widespread wader in New Zealand. In the Nelson region, after mostly inland breeding, flocking occurs around coastal estuarine habitat and wet pasture.

At Wainui Inlet, winter counts of up to 50 birds, roosting with other waders, have been recorded. Up to 20 birds have been recorded at Awaroa Inlet and c.20-30 at Marahau. A few pairs would be expected to breed on some coastal localities throughout the park.

Skua species Migrants

Pomarine (*Stercorarius pomarinus*) and arctic skuas (*S. parasiticus*) are regular migrants to New Zealand waters, and are regularly recorded from Tasman and Golden Bays between August/September and April.

Ten birds were observed harrying feeding seabirds, mainly terns, out to sea from Bark Bay Reef, on 19 April 1990. Both dark and light phase birds were noted. Southern great skua (*Catharacta lonnbergi*) have also been recorded (OSNZ Atlas).

Southern Black-backed Gull (*Larus dominicanus*) Native

Black-backed gulls are abundant near urban areas within the Nelson region, (1,159 pairs in the main nesting colonies in the Waimea Estuary and the Nelson Boulder Bank in 1989 (JM Hawkins, pers. comm.).

Birds are frequently seen along the park's coastline and estuaries but not in large numbers. Scattered pairs breed along the shore on rock stacks and outcrops. Several juveniles were seen with adults in April, however, most had left the nest by mid-January.

Red-Billed Gull (*Larus novaehollandiae*) Endemic

A common gull around Nelson's coastline with the largest breeding colony on the Nelson Boulder Bank supporting 1,200 pairs in 1989 (JM Hawkins, pers. comm.). Birds are frequently seen around the park's coast, generally in numbers less than 50 individuals. Small nesting colonies may associate with breeding white-fronted terns.

Black-billed Gull (*Larus bulleri*) Endemic

Black-billed gulls breed on river beds and lakes mainly in the South Island, with many birds wintering on the coasts of both the North and South Islands.

Not infrequently seen on Nelson's coasts, and recorded from most of the park's coastal squares in OSNZ Atlas.

Gull-billed Tern (*Gelochelidon nilotica*) Straggler

This tern occasionally visits New Zealand from Australia. Within the park a sighting of five birds was recorded from Marahau in February 1990 (OSNZ).

Caspian Tern (*Hydroprogne caspia*) Native

At the most, 3,500 Caspian Terns live in New Zealand (CN Challies In: CJR Robinson, 1985). They are relatively common around Nelson's coastline with the main breeding colony on Farewell Spit of (c.100 pairs), and c.15 pairs on Bells Island Waimea Estuary in 1989 (JM Hawkins, pers. comm.). Birds disperse from the nesting areas after the breeding season.

Frequently recorded feeding and roosting around the park's coastline and estuaries, but in numbers less than ten individuals.

Black-fronted Tern (*Sterna albostriata*) Endemic

The black-fronted tern is a tern which only breed inland in the South Island and then disperses to coastal areas both north and south. Small groups are regularly seen in the main Nelson estuaries over winter, but few records come from the park. Most recently two were observed roosting with white-fronted terns on Bark Bay Reef in April 1990.

White-fronted Tern (*Sterna striata*) Endemic

White-fronted terns are the most abundant tern in New Zealand and are common around Nelson's coast with widespread breeding and feeding in Tasman and Golden Bays.

They are frequently seen around the park's coastline but seldom between June and October. Terns are notoriously capricious in their breeding affairs and traditional sites are not always used regularly. Nesting has been recorded from Awaroa Sandspit; up to 400 pairs (Walker, 1987), and at Ballon Rock-Torrent Bay with c.30 nests in 1982, (JM Hawkins, pers. comm.). During 1990/91, white-fronted tern were recorded breeding in large numbers in Awaroa sandspit and approximately 30 pairs on Tern Rocks, offshore Mosquito Bay.

Roosting sites during the day are chosen close to feeding areas and in April 1990 included Pitt Head, Torrent Bay Sandspit, Te Puketea Bay, Wallaby Creek, Bark Bay Reef, and Awaroa Sandspit. Many birds were feeding inshore over shoals of kahawai, with an estimate of over 1,000 individuals observed in the Bark Bay Reef area on 19 April 1990.

New Zealand Kingfisher (*Halcyon sancta vagans*) Endemic

In the South Island kingfishers are thinly but widely spread, and in Nelson they can be found well inland, with the bulk of the population moving to low altitude farmland and coasts for the winter months (B.D. Heather In: Robinson, 1985).

Within the park, birds are frequently seen feeding in estuaries mostly on crabs on exposed intertidal areas. An estimated 50 birds were recorded at Awaroa in May 1987 (P. Riddett, pers. comm.).

Welcome Swallow (*Hirundo tahitica neoxena*) Native

Swallows can be seen hunting over the park's mudflats for insects, and some nesting probably occurs. Self introduced from Australia, New Zealand's population of welcome swallows has exploded since the mid 1950s and they are still expanding today. The majority of nests in New Zealand are found attached to man-made features such as bridges, buildings and jetties. Flocking occurs through autumn and winter.

Fernbird (*Bowdleria punctata punctata*) Endemic

Regionally threatened (Bell, 1986), low numbers occur on the fringes of estuaries in Golden and western Tasman Bays (Walker, 1985). Fernbirds were recorded from all coastal squares with estuarine habitats throughout the Park (OSNZ Atlas, 1979).

Other Passerines

Although not dependant on marine systems, several passerine species including finches, sparrows, blackbirds, thrush's and starlings forage on beaches. During winter, flocks of finches take seeds from plants on salt marshes, (eg. 200 goldfinches feeding in Sarcocornia at Marahau in April 1990). Also at Marahau thrushes were seen on mudflats hunting for mud snails, using regular anvils on the shore to break open the shells, and they probably feed in other estuaries throughout the park. Starlings and occasionally blackbirds also feed on mud snails.

Skylarks and pipits were not surveyed and no records are available.

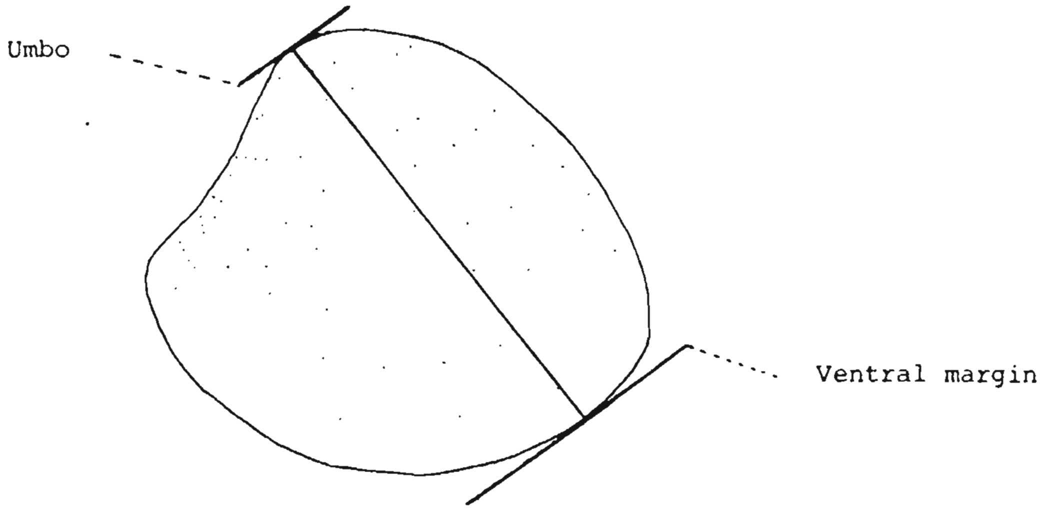
APPENDIX 2: Recorded Archaeological Sites - Abel Tasman National Park

Site Number	Location	Site Description
N25/10	Wainui Bay	Occupation area
N25/11	Wainui Bay	Pit
N25/12	Wainui Bay	Pits/terrace
N25/13	Abel Tasman Point	Pit
N25/14	Abel Tasman Point	Pit
N25/15	Takapou	Midden
N25/43	Takapou	Midden
N25/46	Takapou	Occupation area
N25/47	Wainui Inlet	Occupation area
N25/48	Wainui Bay	Pits
N25/49	Uarau	Pit
N25/50	Taupo Point	Terraces/midden
N25/53	Totaranui	Pits
N25/54	Mutton Cove	Midden/ovens
N25/55	Mutton Cove	Pit
N25/56	Mutton Cove	Terrace
N25/57	Totaranui	Findspot
N25/58	Totaranui	Pit
N25/59	Anapai	Occupation area
N25/60	Totaranui	Pits
N25/61	Totaranui	Occupation area
N25/62	Wharewharangi	Midden
N25/63	Separation Point	Pits
N25/64	Waiharakeke	Occupation area
N25/66	Whariwharangi	Ditch
N25/67	Whariwharangi	Pits/terraces

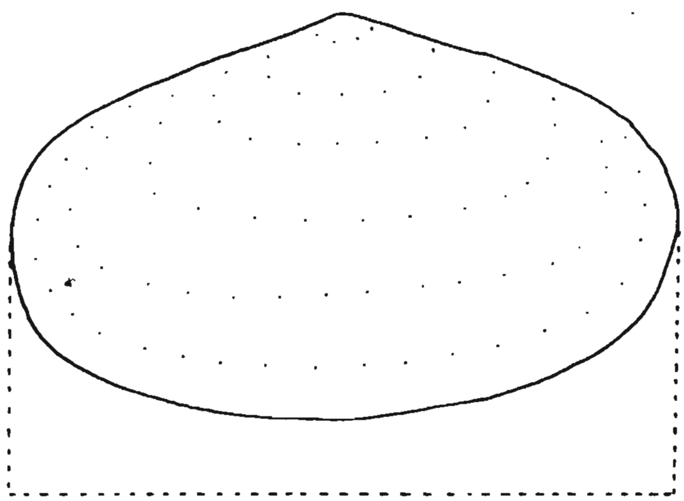
Site Number	Location	Site Description
N26/7	Awaroa	Ovens/midden
N26/8	Awaroa	Findspot
N26/9	Awaroa Head	Pa
N26/10	Awaroa Head	Pits
N26/11	Abel Head	Pa
N26/12	South of Abel Head	Terraces
N26/13	South of Abel Head	Pits/terraces
N26/14	Tonga	Midden/ovens
N26/15	Mosquito Bay	Ovens/findspot
N26/16	Bark Bay	Midden
N26/17	Sandfly Bay	Findspot
N26/18	Awaroa	Midden/work area
N26/19	Frenchman Bay	Findspot
N26/21	Frenchman Bay	Pa
N26/22	Torrent Bay	Findspot/midden
N26/23	Torrent Bay	Village site
N26/24	Pitt Head	Working area
N26/25	Te Pukatea Bay	Midden
N26/26	Torrent Bay	Ovens
N26/27	Observation Beach	Village
N26/28	Te Karetu Point	Pits/terraces
N26/29	Guilbert Point	Village site
N26/30	Tonga	Occupation
N26/31	Sandy Bay	Gardens
N26/32	Sandy Bay	Pits
N26/33	Sandy Bay	Midden/findspot
N26/34	Sandy Bay	Pit
N26/38	Sandy Bay	Midden
N26/45	Sandy Bay	Findspot
N26/46	Sandy Bay	Findspot

Site Number	Location	Site Description
N26/47	Sandy Bay	Ovens/findspot
N26/48	Sandy Bay	Findspot
N26/49	Sandy Bay	Findspot
N26/50	Sandy Bay	Midden/ovens
N26/59	Tinline Bay	Pa/pits/terraces
N26/60	Fisherman Island	Pits
N26/61	Fisherman Island	Midden/ovens
N26/173	Adele Island	Pits
N26/174	Te Karetu Point	Findspot
N26/175	Te Pukatea Bay	Ovens/findspot
N26/176	Te Pukatea Bay	Pits
N26/177	Pitt Head	Ditch/terraces
N26/178	Torrent Bay	Pit
N26/179	Frenchman Bay	Pits/findspot
N26/180	Bark Bay	Pits/terraces
N26/181	Awaroa	Midden
N26/182	Awaroa	Midden
N26/183	Awaroa	Pits
N26/192	Foul Point	Pits/terraces
N26/209	Waiharakeke	Terrace

Appendix 3

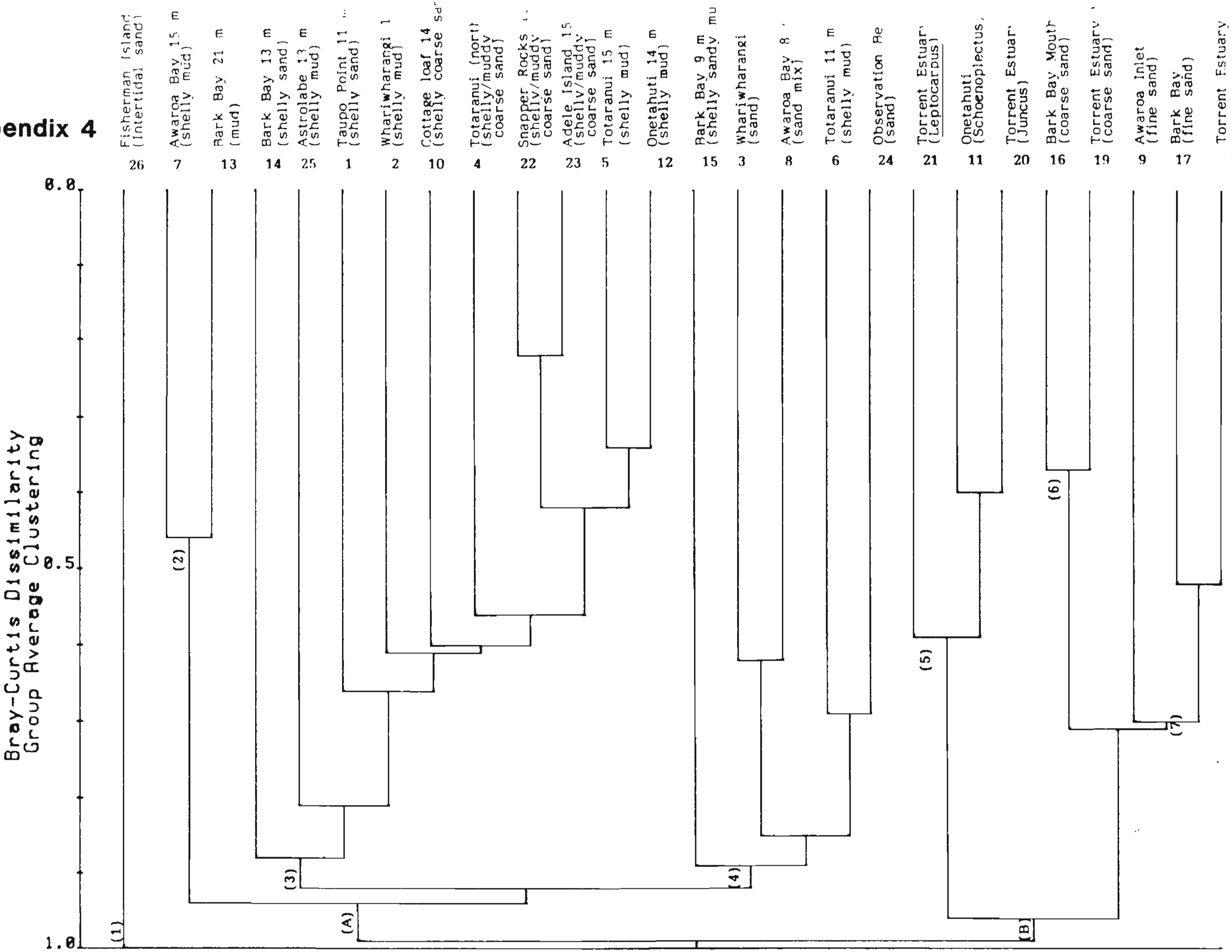


Measurement of cockles *Chione stutchburyi* from the umbo to the furtherest point on the ventral margin.



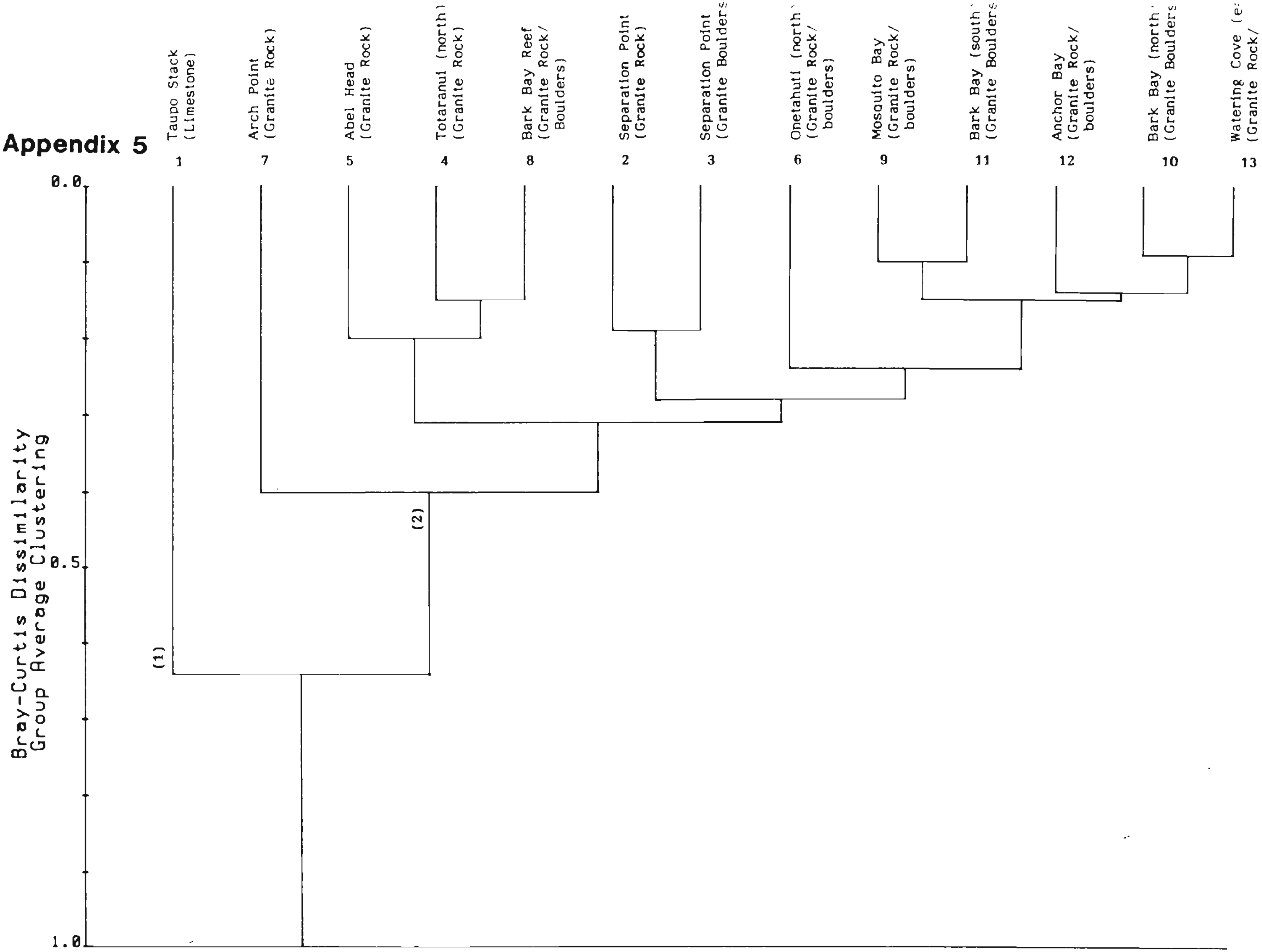
Measurement of pipi (*Paphies australis*).

Appendix 4



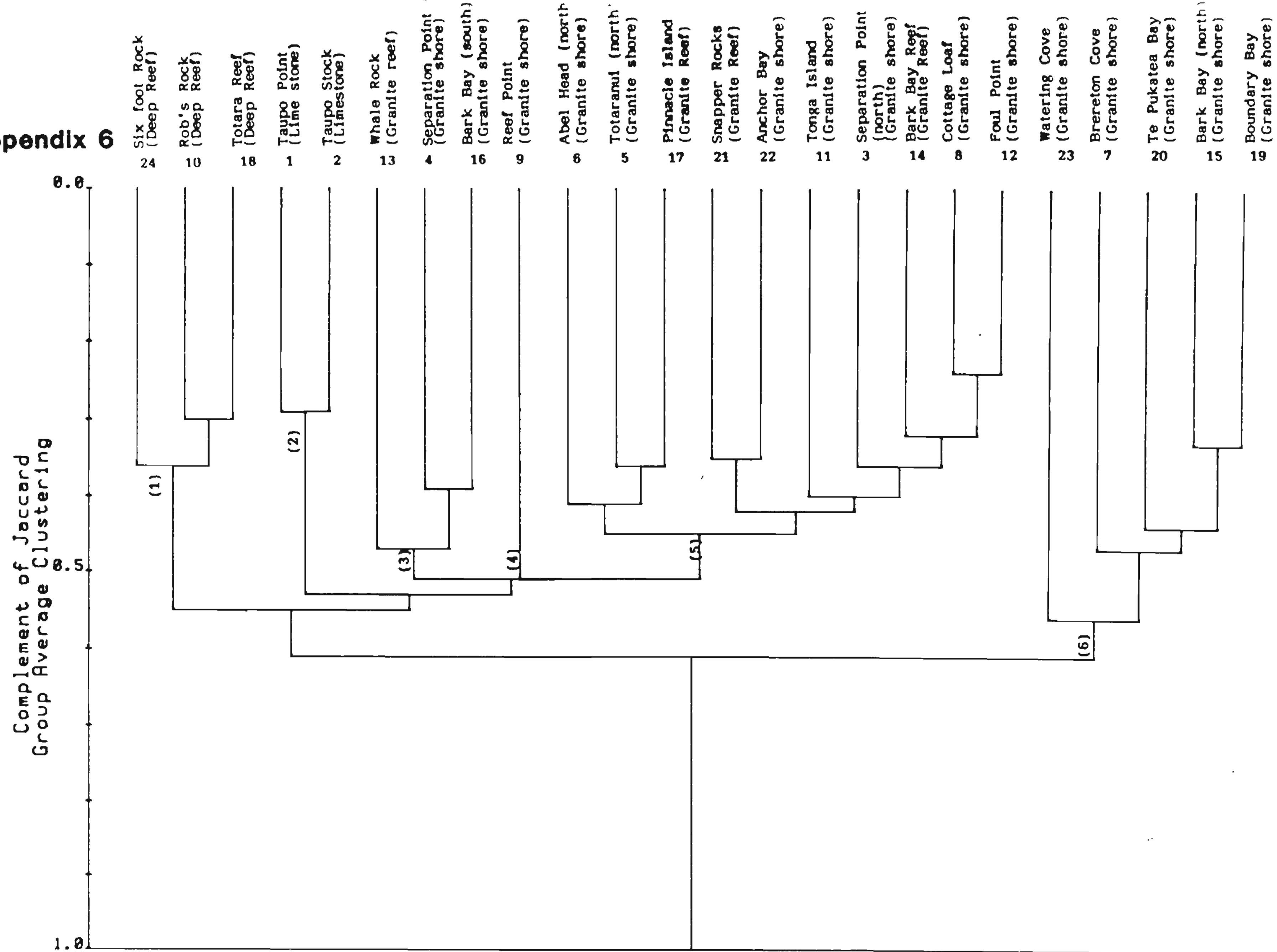
Dendrogram of benthic invertebrate sites based on the mean of five replicate core scamples. Groups reflect differences in invertebrate communities between: (A) subtidal sites; (B) intertidal sites; (1) beach sand intertidal; (2) mud dominated subtidal; (3) coarse sand dominated subtidal; (4) sand dominated subtidal; (5) vegetated intertidal; (6) coarse sand intertidal; and (7) fine sand intertidal.

Appendix 5



Dendrogram of intertidal benthic invertebrate sites based on abundance estimates scaled to an appropriate weight. Groups reflect differences in invertebrate communities beteween: (1) limestone; and (2) granite shores.

Appendix 6



Dendrogram of subtidal benthic invertebrate sites based on presence/absence. Groups reflect differences in invertebrate communities beteween: (1) deep reef; (2) limestone; (3) shallow shore; (4) current shallow shore; (5) exposed shores; (6) sheltered shores.

APPENDIX 7: Species list of benthic invertebrates from the Abel Tasman Coastline.

Veg = Vegetation; P/C = Pebble/Cobbles; M = Mud; S = Fine Sand/Sand;
Sub = Subtidal; Z = *Zostera*; R = Boulders/Rock

C = Carnivore; D = Detritus Feeder; H = Herbivore; Sus = Suspension Feeder;
Scav = Scavenger

Invertebrate	Common Name	Feeding Group	Habitat
Phylum Porifera (Sponges)			
* *Achinoe* sp.		Sus	Sub/R
Ancorina alata		Sus	Sub/R
Aplysilla sulfurea	Sulfur sponge	Sus	Sub/R
Aaptos aaptos		Sus	Sub/R
Callyspongia ramosa	Finger sponge	Sus	Sub/R
Callyspongia regularis		Sus	Sub/R
Callyspongia sp.		Sus	Sub/R
* *Dysidia* sp.		Sus	Sub/R
Iophon minor		Sus	Sub/R
Petrosia sp.	White sponge	Sus	Sub/R
Polymastia agglutinans		Sus	Sub/R
Polymastia fusca		Sus	Sub/R
Stelletta sp.		Sus	Sub/R
Strongylacidon sp.		Sus	Sub/R
Tethya aurantium	Golf ball sponge	Sus	Sub/R
Tethya ingalli	Golf ball sponge	Sus	Sub/R
Phylum Coelenterata (Cnidaria)			
Class Hydrozoa			
Unidentified sp.		C	Sub/R
Pennaria sp.		C	Sub/R
Phylum Platyhelminthes (Flatworms)			
Notoplana sp.			
Class Anthozoa (Sea anemones)			
Actinea tenebrosa	Red waratah	C	R
Actinothoe albocincta		C	Sub/R
Alcyonium aurantiacum	Dead man's finger	C	Sub/R
Anthopleura aureoradiata	Mudflat anemone	C	E
Corynactis haddoni	Jewel anemone	C	Sub/R
Culicia rubeola		C	Sub/R
Isocradactis magna		C	Sub/S
Unidentified sp.		C	Sub/R
Phylum Bryozoa			
Celleporaria agglutinans	Separation Point Coral	Sus	Sub/S
Galeopsis grandipora		Sus	Sub
Galeopsis polypora		Sus	Sub
Hipomenella vellicata		Sus	Sub
Telepora digitata		Sus	Sub

Invertebrate	Common Name	Feeding Group	Habitat
Phylum Nemertina (Proboscis worms)			
Unidentified sp.			
Phylum Brachiopoda			
Magasella sanguinea	Lamp shell	Sus	Sub/R
Waltonia inconspicua	Lamp shell	Sus	Sub
Class Amphineura (Chitons)			
Acanthochiton zelandica	Tufted chiton	H	R
Chiton pelliserpenis	Snakeskin chiton	H	R
Cryptoconchus porosus	Butterfly chiton	H	R
Eudoxochiton nobilis		H	R
Phylum Sipunculida (Acorn worms)			
Unidentified sp.		D	S
Phylum Uchiura			
Urechis novaezelandiae	Sausage worm	D	Sub/S
Phylum Mollusca (Molluscs)			
Class Amphineura chitons			
Acanthochiton zelandica	Tufted chiton	H	P/C
Chiton pellisperpentis	Snakeskin chiton	H	R
Cryptoconchus porosus	Butterfly chiton	H	R
Eudoxochiton nobilis	Noble chiton	H	Sub
Notoplax cuneata		H	S
Rhyssoplax canaliculata		H	Sub
Terenochiton inquinatus		H	Sub
Class Gastropoda (Univalve molluscs)			
Astraea heliotropium	Saw shell	H	Sub/R
Amphibola crenata	Mudflat snail	D	M
Armanda australis	Olice shell	D	Sub
Atalacmea fragilis	Fragile limpet	H	R/Sub
Austrofucus glans	Whelk	C	Sub
Buccinulum vittatum	Lined whelk	C	R
Charonia capax	Trumpet shell	C	Sub/R
Cellana ornata	Ornate limpet	H	R
Cellana radians	Radiate limpet	H	R
Cominella adspersa	Whelk	C	Sub/R
Cominella glandiformis	Mudflat whelk	C	M
Cominella maculosa	Spotted whelk	H	R
Cominella virigata	Whelk	C	R
Cookia sulcata	Cook's turban	H	Sub/R
Diloma nigerrima	Black topshell	H	R
Diloma subrostrata	Mudflat topshell	H	M,S
Diloma zelandica	Topshell	H	M,S
Haliotis australis	Yellow foot paua	H	Sub/R
Haliotis virginea virginea		H	Sub/R
Haliotis iris	Paua	H	R
Haustrum haustorium	Whelk	C	R
Lepsiella scobina	Oyster borer	C	R
Littorina cincta	Brown periwinkle	H	R
Littorina unifasciata	Banded periwinkle	H	R
Maoricolpus roseus	Turret shell	H/Sus	Sub
Mauria tigris	Tiger shell	H	Sub
Mauria sp.	Tiger shell	H	Sub

Invertebrate	Common Name	Feeding Group	Habitat
Melagraphia aethiops	Spotted topshell	H	R
Notoacmea helmsi	Estuarine limpet	H	M
Onchidella nigricans	Shell-less snail	D	R
Penion sulcatus	Whelk	C	Sub
Potamopyrgus estuarinus	Estuarine snail	D	Veg
Risellopsis varia	Topshell	H	R,S
Struthiolaria papulosa	Ostrich foot	C	C
Siphonaria zelandica	Limpet	H	R
Trochus viridus	Green top	H	R/Sub
Zeacumantus subcarinatus	Small spire shell	H	Z/R
Order Nudibranchia (true sea-slugs)			
Archidoris wellingtonensis	Warty sea-slug	C	Sub
Aphelodoris luctosa		C	Sub
Dendrodoris citrina		C	Sub
Glossodoris aureomarginata		C	Sub
Glossodoris amoena		C	Sub
Class Pelecypoda (Bilvalves)			
Anomia trigonopsis	Window oyster	Sus	R/Sub
Atrina zelandica	Horse mussel	Sus	Sub/S
Aulacomya ater maoriana	Ribbed mussel	Sus	R
Austrovenus stutchburyi	Cockle	Sus	S,M
Corbula zelandica			Sub
Chlamys dieffenbachi	Queen scallop	Sus	Sub
Crassostrea gigas	Pacific oyster	Sus	R
Dosinia lambata		Sus	Sub
Dosina zelandica		Sus	Sub
Diplodonta sp.			Sub
Gari lineolata	Pink sunset shell	D	Sub
Glycymeris laticostata	Dog cockle	Sus	Sub
Kelia sp.		Sus	Sub
Leptomya retiaria		D	Sub
Longimactra elongata		Sus	Sub
Modiolarca impacta	Nestling mussel	Sus	Sub/R
Modiolys areolatus		Sus	Sub
Mytilus edulis aoteanus	Blue mussel	Sus	R
Nemocardium pulchellum			Sub
Ostrea lutaria	Dredge oyster	Sus	Sub
Paphies australis	Pipi	Sus	S,Sub
Pecten novaezelandiae	Scallop	Sus	Sub
Perna canaliculus	Green-lipped mussel	Sus	R
Solemya parkinsoni	Razor shell	Sus	M
Soltellina nitida			Sub
Tawera spissa	Morning star	Sus	Sub
Tellina liliana	Wedge shell	D	
Venericardia purpurata			Sub
Xenostrobus pulex	Little black mussel	Sus	R
Class Cephalopoda			
Octopus maorum	Octopus	C	Sub

Phylum Annelida (Segmented worms)
Class Polychaeta (Marine worms)

Invertebrate	Common Name	Feeding Group	Habitat
ERRANTIA			
Family Eunicidae			
Lumbrinereinae sp.		C	Z
Family Glyceridae			
Glycera lamellipodia		C	S
Family Nereidae	Rag worms	C	S
SEDENTARIA			
Family Capitellidae			
Capitella capitata		D	Sub
Family Cirratulidae			
Family Flabelligeridae			
Stylaroides sp.		D	Sub
Family Maldanidae			
Asychis theodori		D	Sub
Family Orbiniidae			
Haploscoloplos cylindrifer		D	S,M
Orbina papillosa		D	S,Sub
Family Opheliidae			
Amandia maculata		D	Sub
Family Serpulidae	Fan worms		
Galeolaria hystrix		Sus	Sub/R
Pomatocercos caeruleus		Sus	R/Sub
Family Sabellidae			
Branchiomma sp.		Sus	Sub/S
Sabellidae sp.		Sus	Sub/S
Family Sigalionidae			
Psammolyce antipoda			Sub
Unidentified sp.			Sub
Family Syllidae			Sub
Family Spionidae			
Spirorbis sp.	Spiral worm	Sus	Sub
Phyllum Anthropoda			
Class Cirripedia (Barnacles)			
Balanus sp.		Sus	Sub
Chamaesipho columna		Sus	Sub
Eliminius modestus	Estuarine barnacle	Sus	R
Epopella plicata		Sus	R
Tetraclita purpurascens		Sus	R
Order Amphipoda (Sand Hoppers)			
Unidentified sp. # 1			Sub
Unidentified sp. # 2			Sub
Unidentified sp. # 3			Sub

Invertebrate	Common Name	Feeding Group	Habitat
Order Isopoda (Sea lice)			
Seriolis sp.			Sub
Order Decepoda			
Astraleremus sp.	Hermit crab	C	Sub/S
Callianassa filholi	Snapping shrimp	Sus	Sub/S
Halicarcinus whitei	Spider crab	C	S,M
Helice crassa	Mud crab	D	M
Hemigrapsus crenulatus	Hairy-handed crab	C	R/S
Hemigrapsus edwardsii	Purple crab	C	R
Heterozius rotundifrons	Pebble crab	H	R
Jasus edwardsii	Crayfish	C	Sub
Leptograpsus variegatus	Shore crab	C.H	R
Ovalipes catharus	Paddle crab	C	Sub
Pagurus spinulimanus	Hermit crab	D/C	Sub
Petrolisthes elongatus	Half crab	Sus	R
Plagusia chabrus	Reef crab	H,C	Sub
Pinnotheres novizelandiae	Pea crab	Parasitic	
Class Insecta			
Dipteran larvae sp. # 1	Larval fly	D	Veg
Philanisus plebejus	Marine caddis larvae	H	Veg
Phylum Echinodermata			
Allostichaster insignis		C	Sub/R
Amphiura aster		D	Sub/S
Arachnoides zelandiae	Sand dollar	D	Sub/S
Astrostole scabra	Seven arm starfish	C	Sub/R
Coscinasterias calamaria	11 arm starfish	C	Sub
Echinocardium astrale	Sea mouse	D	Sub/M
Evechinus chloroticus	Kina	H	Sub
Patiriella regularis	Cushion starfish	C	Sub
Pectinura maculata	Snake starfish	D	Sub
Pentonaster pulchellus	Broach starfish	C	Sub/R
Stegnaster inflatus	Ambush starfish	C	Sub/R
Stichaster australis	Reef starfish	C	Sub/R
Stichopus mollis	Sea cucumber	D	Sub
Phylum Ectoprocta			
Class Gymnolaemata (Bryozoan corals)			
Celleporaria agglutinans	Separation Point coral	Sus	Sub
* *Hippomenella vellicata*		Sus	Sub
Watersipora cucullata		Sus	R/Sub
Phylum Chordata			
Class Ascidiacea (Sea squirts)			
Aplidium adamsi			Sub/R
Aplidium phortax			Sub
Botryllus schlosseri			Sub/R
Cnemidocarpa bicornuata			Sub/R
Didemnum candidum			Sub/R
Sub-phylum Cephalochordata (Lancelet)			
Epigonichthys hectori			Sub/S

* Bradstock

APPENDIX 8: Invertebrate species data recorded from intertidal soft bottom areas along the Abel Tasman coastline. Values represent the mean of five core samples.

* = recorded intertidally only.

Species	Common Name	9	11	16	17	18	19	20	21	26
Sipunculida	Acorn worm				0.2	0.2				
* *Amphibola crenata*	Mud-flat snail		0.6						0.2	
* *Austrovenus stutchburyi*	Cockle	21.8		1.8	6.2	48.0				
* *Cominella glandiformis*	Mud-flat whelk	1.2		0.2					0.2	
Crassostrea gigas	Pacific oyster	0.4								
* *Diloma subrostrata*	Top shell	0.6		0.2	0.2	0.2				
* *Diloma zelandica*	Top shell	7.6								
* *Notoacmea helmsi*	Estuarine limpet	21.0				1.0				
* *Paphies australis*	Pipi	17.0		62.4	4.4	1.2	41.6			
* *Potamopyrgus estuarinus*	Estuarine snail		12.8					87.6	1.6	
* *Risellopsis varia*	Top shell	0.4								
* *Taron dubius*	Whelk			0.2						
Telina liliana	Wedge shell	1.0			4.4	0.8				
* *Xenostrobus pulex*	Little black mussel									
* *Zeacumantus subcarinatus*	Spire shell				0.2					

Appendix 8 continued

Species	Common Name	9	11	16	17	18	19	20	21	26
Armandia maculata	Polychaete worm	1.2								
* Cirratulidae sp.	Polychaete worm	0.2								
Glyceridae sp.	Polychaete worm									0.2
Lumbrineridae sp.	Polychaete worm				0.4					
* Nereidae spp.	Polychaete worm	0.8	0.6	0.4	0.4		3.0			
* Opheliidae sp.	Polychaete worm	1.0								0.2
Orbina papillosa	Polychaete worm					1.4				
Spionidae sp.	Polychaete worm					2.6				
Syllidae sp.	Polychaete worm	0.2								
Unidentified polychaetes		0.4			0.6	4.6				0.8
* Dipteran larvae	Larval fly					0.4			0.2	
Elminius modestus	Estuarine barnacle	149.0		1.8	0.4					
* *Halicarcinus whitei*	Spider crab	0.2			0.2					
* *Helice crassa*	Mud crab		0.8		0.8	0.2		0.2	2.0	
* *Hemigrapsys crenulatus*	Hairy-handed crab	13.2		0.2		0.2				
Isopoda sp # 1	Sea lice						0.4			
* *Philanisus plebejus*	Marine caddis larvae	0.2								
Unidentified amphipoda	Sand hoppers	1.2						0.6		
Total number of species		19	4	9	10	10	3	3	4	3
Total no. per m^2		16014	849	3791	962	3169	2546	4980	226	40

APPENDIX 9: Invertebrate species data recorded from subtidal soft bottom areas along the Abel Tasman coastline. Values represent the mean of five core samples.
*** = recorded visually.**

Species	Common Name	1	2	3	4	5	6	7	8	10	12	13	14	18	22	23	24	25
Bryozoan																		
Celleporaria agglutinans	Bryozoan 'coral'		0.2															
Urechis novaezelandiae	Sausage worm					0.2								0.2				
Sipunculida	Acorn worm					0.4	0.2				0.2		1.2					0.2
Nemertina	Ribbon worm								0.8					0.2				
Mollusca																		
Armandia australis	Olive shell							0.2		0.2		0.2						
Acanthochiton zelandica	Chiton					0.2												
Austrofucus glans	Whelk							0.2										
Atrina zelandica	Horse mussel	0.2	0.2				0.2	0.2						0.2		0.2	0.2	0.2
Cominella adspersa	Whelk																0.2	
Bucinulum vitatum	Whelk																	
Corbula zelandica	Bivalve	0.83	0.3		4.4	0.2	0.6			0.6	0.2		0.4				1.4	
Diplodonta sp.	Bivalve	0.83					0.6											
Dosina zelandica	Bivalve		0.2			0.8									0.2			0.2
Dosinia lambata	Bivalve		0.2															
Gari lineolata	Purple sunset shell	14.3			1								1.6					

ppendix 9 continued

Species	Common Name	1	2	3	4	5	6	7	8	10	12	13	14	18	22	23	24	25
Glycymeris laticostata	Dog cockle	0.2			3.8									0.2		0.6	0.2	
Kelia sp.	Bivalve																0.8	
Leptomya retiara	Bivalve												23.6					
Longimactra elongata	Bivalve	*			0.4													
Maoricolpus roseus	Mitre shell	1.0	5.4			5.6		0.02			2.0					*		
Nemocardium pulchellum	Bivalve											0.2						
Nucula nitidula	Nut shell	2.67			1.0			0.4				0.4					0.2	
Notoplax cuneata	Chiton										0.2							
Octopus maorum	Octopus								*									
Pecten novaezelandiae	Scallop	0.2					*				*			*		*	*	
Penion sp.	Whelk				0.2			*										
Ostrea lutaria	Oyster (dredge)										0.2							*
Solemya parkinsoni	Mussel											0.2		0.2				
Soltellina nitida	Bivalve						0.2											
Tawera spissa	Bivalve	0.33	0.2								0.4		5.4					
Struthiolaria papulosa	Ostrich foot						0.02											
Rhyssoplax canaliculata	Chiton	1.5	0.2			0.4					0.8				0.2			
Terenochiton inquinatus	Chiton	0.17				0.2												
Venericardia purpurata	Bivalve														0.2			

Appendix 9 continued

Species	Common Name	1	2	3	4	5	6	7	8	10	12	13	14	18	22	23	24	25
Polychaeta																		
Agalaophamus sp.							0.4	0.4	0.2								0.8	
Asychis theodori				0.4			17.2											0.2
Armandia maculata		8.5		0.4					0.4					0.2			0.8	
Branchiomma sp.			*		*										*		*	
Capitella capitata			0.2		0.2					1.8			1.4		0.2			
Eunicidae sp.												0.2	0.2					
Flabelligeridae sp.						0.2												
Glyceridae sp.					0.2								0.2			0.2		
Haploscoloplos cylindrifer					4.0					0.4	0.2							
Lumbrineridae sp.							0.2											
Lepidasthenia sp.			0.2								0.2							
Orbina papillosa				0.2	0.2													0.2
Sabellidae sp.		1.7	0.2		1.4			0.6			0.2							0.2
Spionidae sp.							1.0										2.2	
Spirorbis sp.		29.5	1.2		36.0	14.2				5.0	16.6				21.2	22.2		
Syllidae sp.					0.6					0.4								
Sigalionidae sp.												0.2						0.2
Psammolyce antipoda		0.17									0.2			0.8				
Unidentified Polychaetes		1.8	0.4	0.4		1.0	0.2	0.2	0.2	0.2	1.8			0.4	1.2	0.8	1.0	0.4

Appendix 9 continued

Species	Common Name	1	2	3	4	5	6	7	8	10	12	13	14	18	22	23	24	25
Crustacea																		
Amphipoda spp.	Sand hoppers	1.4	0.2	0.2	0.2	0.4			0.6					0.2		0.4	0.4	
Callianassa filholi	Snapping shrimp											*		*		0.2		
Chaemosipho columna	Barnacle																49.6	
Hermit spp.	Crabs	0.17	1.0	*	1.8	4.4	0.4	*		0.6	4.0	*	0.4	0.2	2.4	2.2	0.2	1.2
Isopoda sp. No 1	Fish lice															1.2		
Isopoda sp. No 2	Slender lice	0.5	0.2															
Echinodermata																		
Allostichaster insignis	Starfish	0.17																
Amphiura aster		0.17				1.2	0.2	0.8				0.4						
Arachnoides zelandiae	Sand dollar			*					0.4									
Coscinasterias calamaria	11 arm starfish	*	*		*	*	*			*	*	*	*	*	*	*	*	
Echinocardium australe	Sea mouse							0.4				1.0						
Evechinus chloroticus	Kina	*	*		*	*	*				*	*			*	*		
Patiriella regularis	Cushion-star	*	*	*	*	0.2	*	*	*	*	*				*	*	0.2	*
Stichopus mollis	Sea cucumber		*			*												*
Brachiopoda																		
Waltonia inconspicua						0.6					0.6				0.2	0.4		
Total number of species		25	21	8	19	19	17	13	8	10	19	12	11	13	12	15	17	12
Number of individuals per square metre		3678	736	113	3169	1754	1188	170	170	509	1471	181	1924	124	1415	1528	340	135

APPENDIX 10: Invertebrate and algae data from intertidal rocky shores along the Abel Tasman coastline.

1 = rare, 5 = occasional, 20 = common, 80 = dominant or zone farming

Species	Common Name	2	4	6	8	10	17	18	22	23	25	26	33	35
Mollusca														
Acanthochiton zelandica	Chiton					1	1							
Cellana ornata	Ornate limpet	5	20	20	20				5	1	1	5	1	1
Cellana radians	Radiate limpet	1								1	5	1	1	
Chiton pelliserptertis	Chiton	5	20	20	5	5	5	5	5	5	1	5	5	1
Crassostrea gigas	Pacific Oyster	5	1	-	1	1	5	1	1		5		1	5
Cominella virigata	Whelk	1												
Cominella maculosa	Whelk								1					1
Cryptoconchus porosus	Butterfly chiton	1	1											
Diloma nigerrima	Top shell						5			1				
Diloma subrostrata	Top shell						5			1	1			
Haliotus iris	Paua													1
Haliotus australis	White-foot Paua								1					
Haustrum haustorium	Whelk			5	1		1	1	1	1	1		1	1
Littorina cincta	Brown periwinkle	1					1			1	1		20	
Littorina unifasciata	Purple periwinkle	20	20	20	20	20	20	20	-	20	20	20	20	20
Lepsiella scobina	Oyster borer	5	20	5	20	5	5	5	5	20	1	5	5	1
Melagraphia aethiops	Spotted topshell	1		20			5		5	5	1	5	1	1
Modiolarca impacta	Nestling mussel								1				1	1

Appendix 10 continued

Species	Common Name	2	4	6	8	10	17	18	22	23	25	26	33	35
Mytilus edulis	Blue mussel	5			5	5	1	1	1	1	1		1	1
Notoacmea helmsi	Limpet	1			5		5			1	1		1	1
Onchidella nigricans	Shell-less snail	1	5				1		1				1	
Perna canaliculus	Green-lipped mussel	1	1			1				1				5
Thias orbita	White-rock shell	1	5	5	20	20		5	1		1			1
Turbo smaragdus	Cats eye	1	20	20	1	5	5	1	1	5	20	1	1	1
Xenostrobus pulex	Little black mussel	1		20	20	80	80	80	1	5	20	1	20	20
Polychaetes														
Eulalia microphylla			1				1						1	
Pomatoceros caeruleus		5	80	80	80	80	80	80	80	80	80	80	80	80
Crustaceans														
Chaemosipho columna	Barnacle	20	80	80	80	80	80	80	80	80	80	80	80	80
Elminius modestus														
Epopella plicata	Barnacle	80	20	5	20	20		5	80	5	1	1	5	
Hemigrapsus edwardsii	Purple crab						5							
Ligia novaezelandiae	Isopod						5							
Leptograpsus varigatus	Shore crab									1				
Heterozius rotundifrons	Pebble crab									1				
Petrolisthes elongatus	Half crab	1					1			1			1	
Plagusia chabrus	Reef crab	1				5								

Appendix 10 continued

Species	Common Name	2	4	6	8	10	17	18	22	23	25	26	33	35
Echinoderms														
Coscinasterias calamaria	11 arm starfish	1												
Evechinus chloroticus	Kina		20	1										
Patiriella regularis	Cushion starfish			1			1	5	1	1			5	1
Stichaster australis	Reef starfish				5	20		5	5			1	1	
Coelenterates														
Anthopleura aureoradiata	Mudflat anemone					5	20						1	
Actinea tenebrosa	Red waratah						5							
Isocradactis magna	Sand anemone							1						
Bryozoa														
Watersipora cucullata	Encrusting bryozoan	20	20	5										
Algae														
Codium adherens									5					
Cystophora torulosa			20					5	1	1		1	1	1
Colpomenia sinuosa	Bubble weed		5					5						
Enteromorpha sp.								5		1		1		5
Gracilaria sp.	Agar weed								1					
Hormosira banksii	Neptunes necklace				1			5	1	1			1	1
Laurencia botyroides				1		20		5	5	1		5	5	1

Appendix 10 continued

Species	Common Name	2	4	6	8	10	17	18	22	23	25	26	33	35
Porphyra sp.		5				5								
Splachnidium rugosum			5	5	5									
Ulva sp.	Sea lettuce	20						5						
Total number of species		27	17	16	17	15	20	20	22	24	18	15	24	23

APPENDIX 11: Invertebrate, algae and ascidian data for subtidal rocky shores along the Abel Tasman coastline.
(1 = occasional; 2 = common; 3 = abundant)

Species	Common Name	1	3	5	7	9	11	12	13	14	15	16	19	20	21	24	27	28	29	30	31	32	34	3	37
Algae																									
Asparagopsis armata		5	5	5						1															20
Carpophyllum flexosum		5	1	1	1	20	1		1		5		20	1	1	5		1		5		1			5
Carpophyllum maschalocarpum	Flapjack	5	1	1	5	5		1	1	2		20	5	5	1	5	1	20		5		20	2		
Codium adherens	Rock velvet					5										1		5			5				
Corallina officinalis	Corallina	20	20	20	20	20	20	20	20	20		20													
Coralina officinalis	Paint	5	5	20	20	5	5	5	5	5	5	5		5	20	20	5	5	20	20	20	5	5	5	20
Cystophora torulosa	Zig zag	1	1	5		1	1		1	1			1			1				20	5	1	1		
Eklonia radiata	Paddle weed	20	20								5								1						5
Glossophora kunthii								1	1	1		5													
Hormosira banksii	Neptunes necklace					1		1		1						20				20	5				
Ulva sp.	Sea lettuce		1																						
Crustacea																									
Balanus decors	Barnacle										20			5					1						5
Hermit crab spp.		5	5	5	5	5	5	5	5	20	5	20	5	5	5	20	5	5	5	5	20	5	20	2	5
Jasus edwardsii	Crayfish	1	1	1					1		1	1	1	1	1			1	1			1	1		1
Plagusia chabrus	Reef crab	5	20	1							1	5	1	1		5		5		5		1	1		1
Mollusca																									
Astraea heliotropium	Saw shell								1		1														
Bucinulum vitatum	Whelk	1																							
Cellana radians	Limpet	1		1	20			5	1		5		5	20	5	5	5	5	5	5	20		1	1	
Charonia capax	Trumpet shell		1	1										1											
Cheidothaerus albidus	False oyster		1	5	20	20	1		1	5	5		5		1			5	1			1	20		20
Cookia sulcata	Cooks turban	5	5	1	20	5	5	1	1	1	20	5	1	20	5	20	1	20	5	20	20	5	5		20
Cryptoconchus porosus	Butterfly chiton	5	5		1		1				20			5		5	1	1	5	20				1	5
Eudoxochiton nobilis	Noble chiton				1	1				5	1				1				1				1		
Haliotis australis	Paua																	1		5					
Maoricolpus rosea	Mitr shell		5			5			5	5			5					5		20	20				
Modiolarca impacta	Nestling mussel	5				20					5			20				20	20					1	5
Anomia trigonopsis	Window oyster			5	20	20	1	1	20	5	20	20	1	20	1	20	1	20	20	5	20	5		1	20
Mauria spp.	Tiger shell	5	1	1			1	1	1	1	1	5	1		1	1		1	1						
Mytilus edulis	Blue mussel						1											20							
Perna canaliculus	Green mussel	1	1			5	1				20			5				20	1	20		1			20
Pholadidea tridens	Rock borer	1	20																						

Appendix 11 continued

Species	Common Name	1	3	5	7	9	11	12	13	14	15	16	19	20	21	24	27	28	29	30	31	32	34	3	37
Thias orbita	Rock shell	1	1			20	1	5		20		5		5		1		5		1					
Trochus viridus	Green top		5	5		5			1		5	20	5		1				5				1	1	5
Turbo granosus	Cats eye					1																			
Turbo smaragdus	Cats eye	5	5	5	5	1	1	20	5	5	1	20	1	1	5	20	20	1		20	20	5	20	5	
Sponges																									
Aplysilla sulfurea	Sulfur sponge	5	1	5	5	5	1		1	1	1		5	1	1			5	5			1			1
Ancorina alata	Grey sponge	5	5	5	20		5		1	1		5	1	20	1	5	1	20	20	5		5	5		20
Aptos aptos		1	1		1	1												1							5
Callyspongia ramosa			1			1	1		1		1		1		1			1	1			1	1		5
Callyspongia regularis		1	1			1					1		1					1		1					
Iophon minor				5							1								5						1
Petrosia sp.		5																							
Polymastia spp.		5	1	1								1		1											1
Strongylacidon sp.		5		5	5	1	1			1		1		5	1		1	1	1				1		20
Tethia aurantium/ingalis	Golf ball	20	20			1				1	1	1										1	1		1
Brachiopoda																									
Magasella tenebrosa											20	5						1							
Bryozoans																									
Celleporia agglutinans	Coral			5		1	5		1	5	5		5		1			5	1			1	1		20
Watersipora cucullata		20	20	5		1				1		1		1	1		1	5							
Coelenterates																									
Actinothoe albocincta							5			1	5			20					20			20		5	20
Corynactis haddoni		1	1								1	1	1					5							
Culicia rubeola		5	20	1	20	20	5	5	1	5	20	5	1	20	20		5	20	20	5		20	5	5	20
Hydroid tree		1	1	5	1	5	1		5		1	5	1		1			1	1			1	5		
Pennaria sp. # 1			1		1						1								1						
Isocradactis magna		1																							
Tubularia sp.			1								1														
Unidentified anemone			5																						
Polychaetes																									
Galeolaria hystrix		1	1	5	20	5	5	5	1	20	20	5	1	20	1	20	1	20	20	20	20	1	1	1	5
Serpulid sp. # 1		1				1																			
Serpulid sp # 2			1																						

Appendix 11 continued

Species	Common Name	1	3	5	7	9	11	12	13	14	15	16	19	20	21	24	27	28	29	30	21	32	34	3	37
Echinodermata																									
Allostichaster insignis										1				1		1									
Astrostole scabra	7 arm					1	1	1						1	1			1							
Coscinasterias calamaria	11 arm	1	5	1	5	5	5	1	5	1	5	5	1	5	1	1	1	5	20	1	1	1	1	1	1
Evechinus chloroticus	Kina	20	5	5	20	5	5	20	5	5	20	20	5	20	5	20	5	20	20	20	20	5	5	5	5
Patiriella regularis	Cushion	5	5	5	20	1	1	1	1	1	20	20	1	5	5	20	20	20	1	20	20	5	5	5	
Pectinura maculata	Snake star			1	1						1	5							1						
Pentagonaster pulchellus	Biscuit							1	1																
Stegnaster inflatus	Inflated							5					1												
Stichaster australis	Reef					1	1	5	1	1		20	1	5	1	5	20	20		1	5	5	5		
Stichopus mollis	Cucumber	1	1	1	5	20	1	5		1	20	20	1	1	1	20	1	5	5	20	20	5	1	1	5
Mollusca																									
Nudibranchia (sea slugs)																									
Aphelodoris luctuosa					1									1		1	1		1						1
Archidoris wellingtonensis			5								1	1													
Dendrodoris citrina		1	1																				1		
Glossodoris amoena			1	1		5	5		1	20	20		5		1		1		20						5
Glossodoris aureomarginata		1	1							1		1													
Ascideans																									
Aplidium phortax				1			1		1									1	1						
Botryllus schlosseri		5	5			1				1		1		1	1		1	5				1	5		
Cnemidocarpa bicornuata		5			20	1	1		1	20	5	5	5			20	5		5	20		1			5
Didemnum candidum		5	5	1	5	1			1		1		1	5	1	1		5				1			5
Total number of species		43	44	35	27	39	32	22	32	36	39	33	33	36	32	28	23	43	34	27	17	32	29	1	34

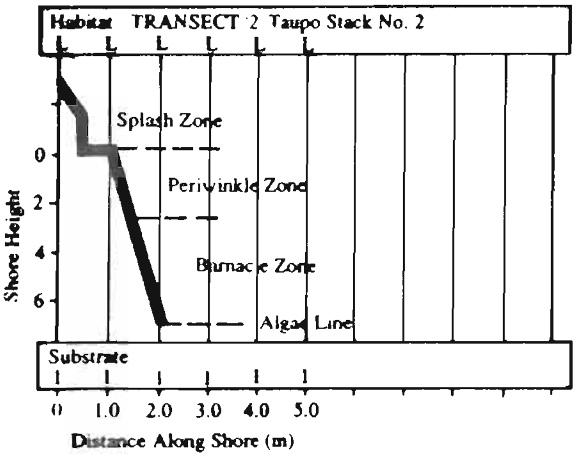
APPENDIX 12: **Fish data recorded from the Abel Tasman coastline. Values represent: 1 = rare; 5 = occasional; 20 = common.**

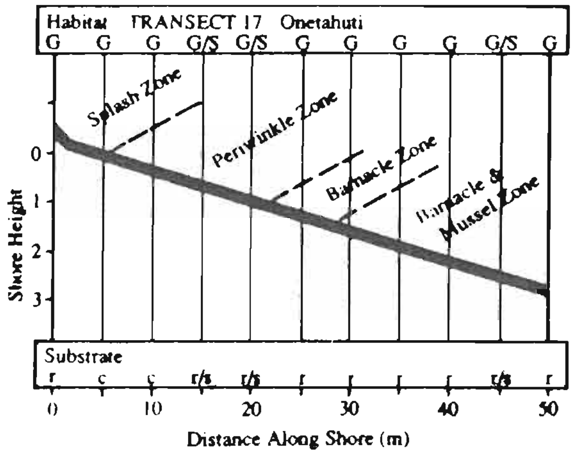
Common Name	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Red cod	*Pseudophycis bachus*					1																						
Rock cod	*Lotella rhacinus*			1		1			1			1					1											1
Common roughy	*Paratrachthys traill*						1																					
Slender roughy	*Optivus elongatus*	1		20			5		1					1														
Sea horse	*Hippocampus abdominalis*	1												1					1									
Sea perch	*Helicolenus percoides*													1														
Red-banded perch	*Ellerkeldia huntii*		1											1														
Butterfly perch	*Caesioperca lepidoptera*	5		1	20		1	1				1		5	5		1	5			20	1			1	1		1
Goatfish	*Upeneichthys porosus*	1	5	5	1	5	1	1	1	5		1	1	1	5	1	1	1	20	1	1	1	5		1		1	1
Sweep	*Scorpis lineolatus*	20	20		1		20		1	1	5	1	1	20	20	5					1	5			1	1		5
Marble fish	*Aplodactylus arctidens*	1	1	1					1			1					1						1		1			
Tarakihi	*Nemadactylus macropterus*	1		5		1	1		1	5	1	1	5	5	20	1	1	1	1		1	1	1		1			
Red moki	*Cheilodactylus spectabilis*								1			1		1		1	1	1		1			1		1			
Blue moki	*Latridopsis ciliaris*	1				1					1			1											1			
Yellow-eyed mullet	*Aldrichetta forsteri*	20				20		20		5								20			5				20			
Spotty	*Pseudolabrus celidotus*	20	20	20	20	20	20	20	5	20	20	20	20	20	20	20	20	20	5	20	20	20	5	5	20	20	5	5
Banded wrasse	*Pseudolabrus fucicola*	1	1		5		5			1		1	1	5	5	1	1	1			1	1			5			5
Scarlet wrasse	*Pseudolabrus miles*	1	1	1	1		5		1	1		1		1	5	1	1				1	1			1			20
Butterfish	*Odax pullus*	1			1		1	5				1				1									1			
Blue Cod	*Parapercis colias*	1		1	1	1	1		1		1			1	5		1											
Opal fish	*Hemerocoetes monopterygius*	1	1																			1						1
Crested Blenny	*Parablennius laticlavius*	1												1														
Spectacled triplefin	Ruanoho whero	1	1	1	1							1		1	5		1		5		1	1				1		
Longfinned triplefin	*Ruanoho decemdigitatus*	1												1														

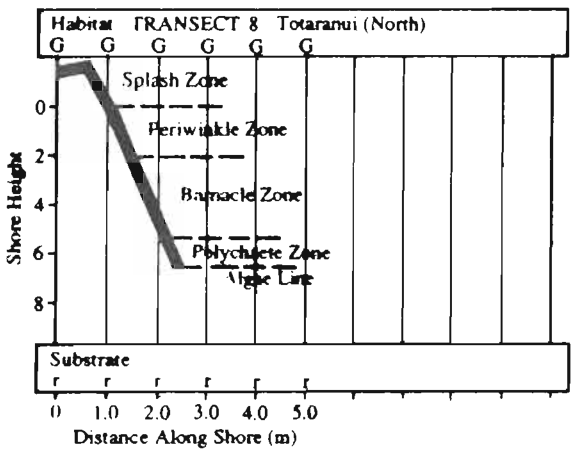
Appendix 12 continued

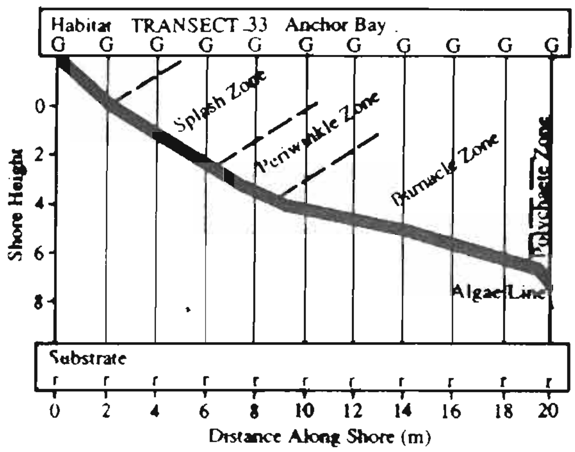
Common Name	Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Variable triplefin	*Fosterygion varium*	20	20	5	5	5	20	20		1	20	5	5	5	5	1	20	5	20	5	5	20	20	20	5	5	5	5
Mottled triplefin	*Fosterygion malcolmi*	5	5	5	1		20	5	1	1		1	1	5	5	1	1	1			5	20			1	1		20
Blue-eyed triplefin	*Notoclinops segmentatus*	1	1									1		1		1				1	1	5				1		
Yellow-black triplefin	*Fosterygion* sp.		1	1			1		1			1	1	20	5				1		1	1						
Oblique swimming triplefin	*Oblilquichthys maryannae*			1										1														
Leather jacket	*Parika scaber*	1				1	1		1	1				1		1		1			1							1
Total Number of Species		22	12	15	11	10	15	8	13	10	6	16	8	23	12	12	13	10	7	5	14	13	6	2	14	8	3	11

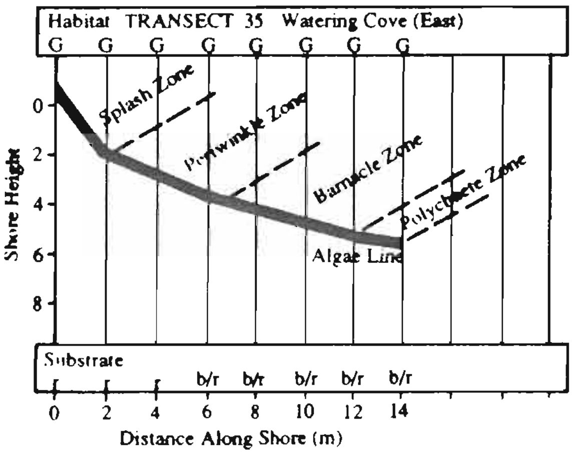
Appendix 13 Intertidal







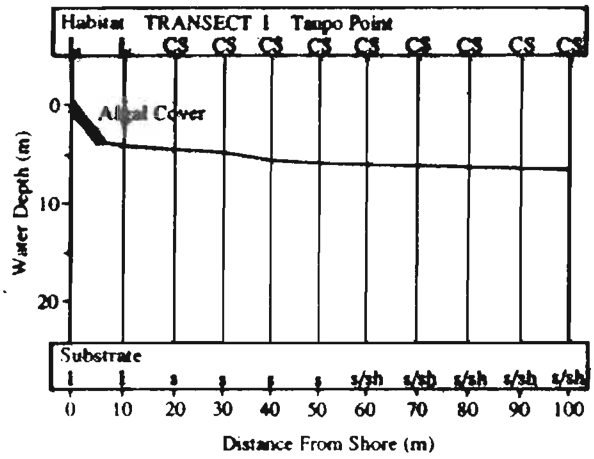


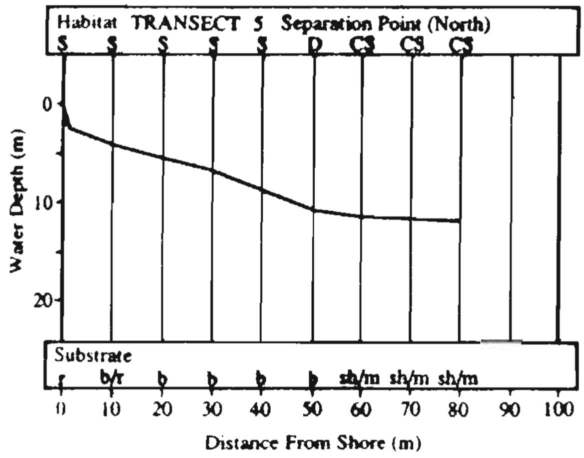


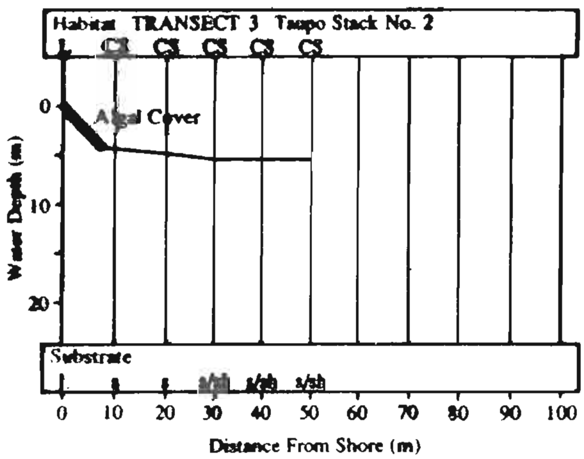
LEGEND

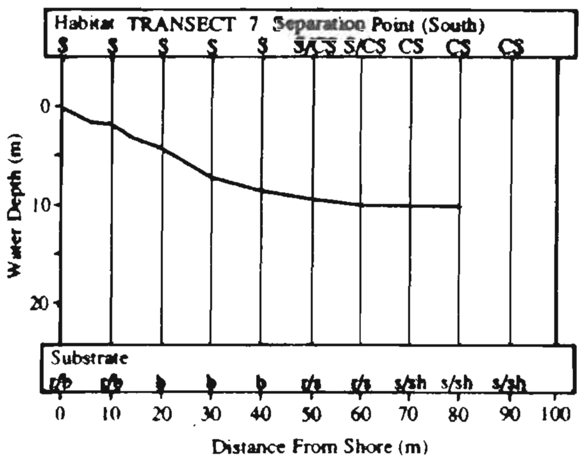
Substrate		Habitat	
r	Rock	G	Granite Shores
b	Boulders	L	Limestone Shores
l	Limestone	P	Periwinkle Zone
c	Cobbles	B	Barnacle Zone
s	Sand	W	Polychaete Zone
		S	Beach Shore
		X	Mussel Zone

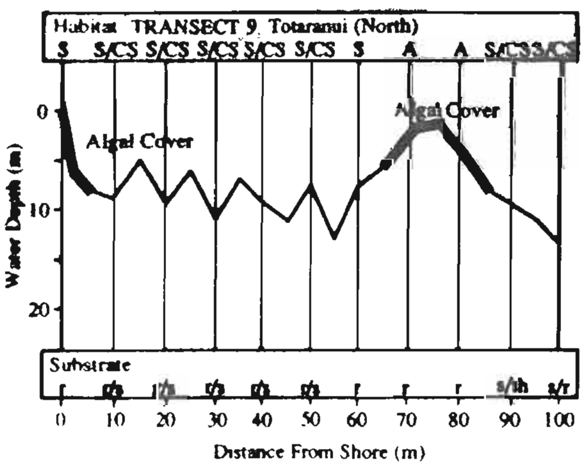
Appendix 14 Subtidal







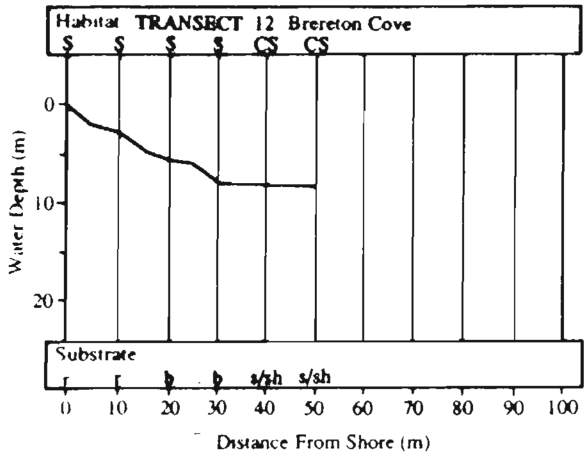


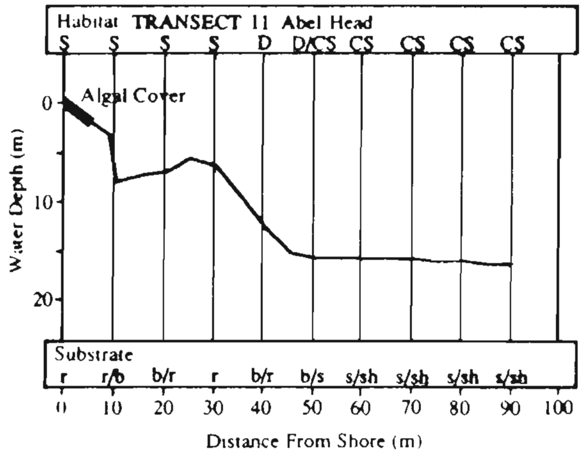


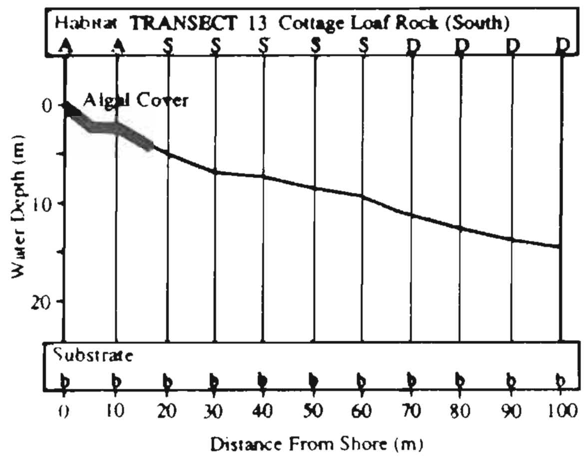
LEGEND

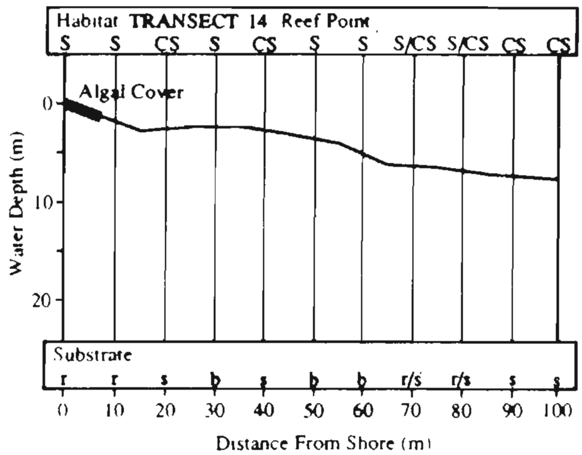
Substrate		Habitat	
b	Boulders (Granite)	L	Limestone
r	Rock (Granite)	S	Shallow Reef
l	Limestone	D	Deep Reef
sh	Broken and Dead Shell	A	Algal Cover
s	Sand Mixtures	CS	Coarse Substrates
m	Mud	SS	Shallow Soft Shores
		M	Mud

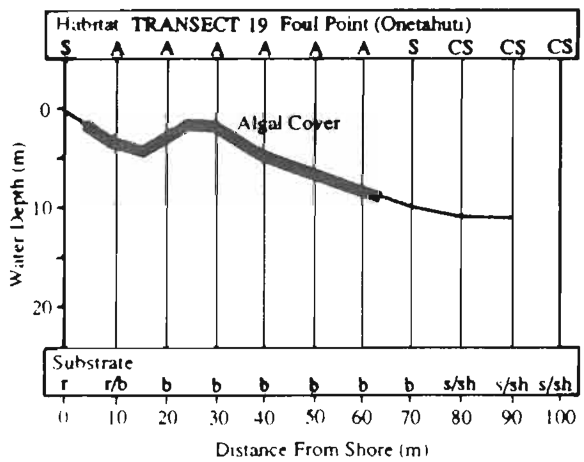
Appendix 14







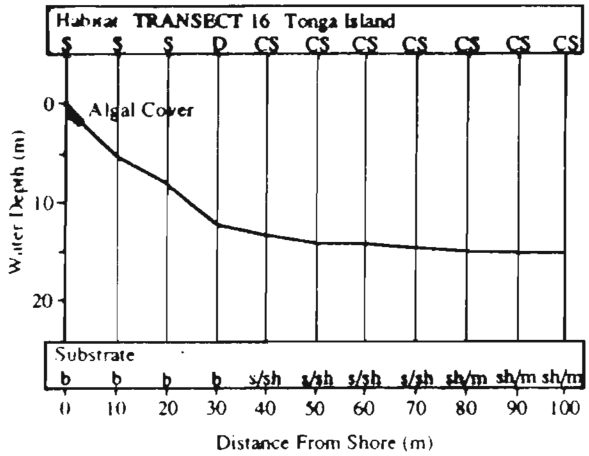


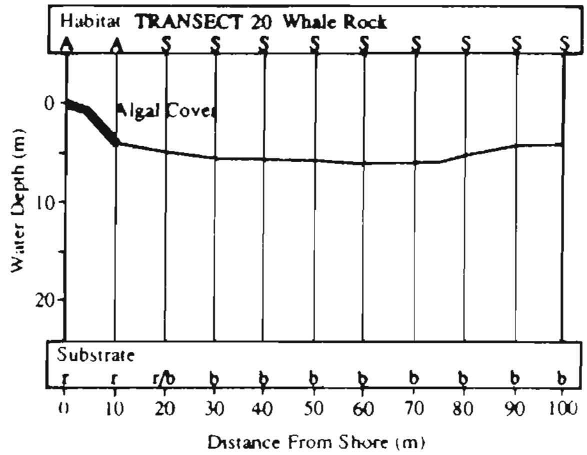


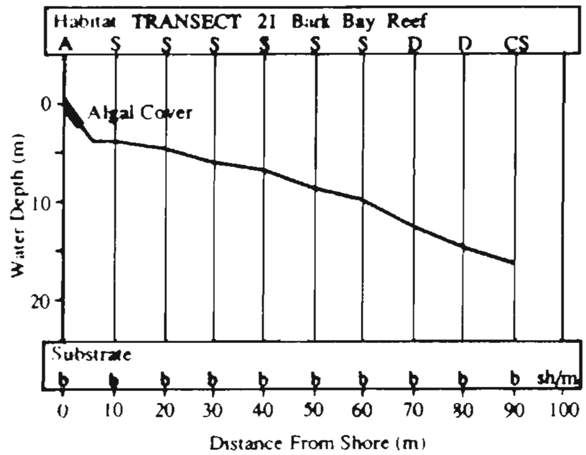
LEGEND

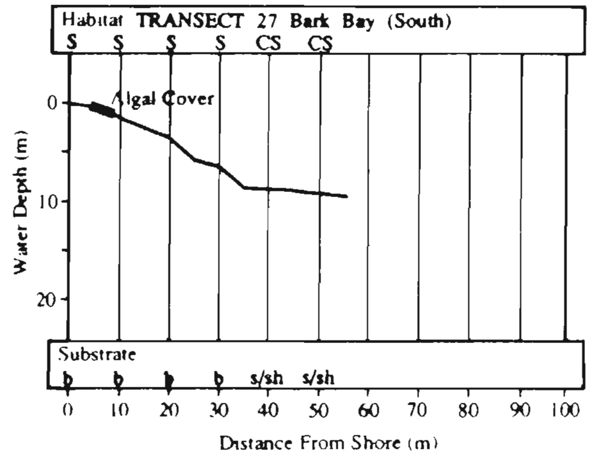
Substrate		Habitat	
b	Boulders (Granite)	L	Limestone
r	Rock (Granite)	S	Shallow Reef
l	Limestone	D	Deep Reef
sh	Broken and Dead Shell	A	Algal Cover
s	Sand Mixtures	CS	Coarse Substrates
m	Mud	SS	Shallow Soft Shores
		M	Mud

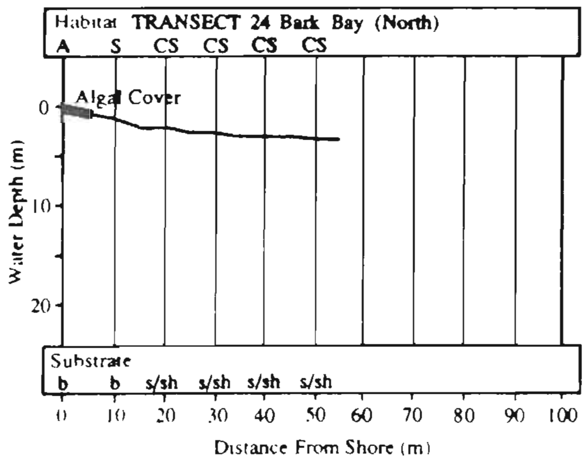
Appendix 14







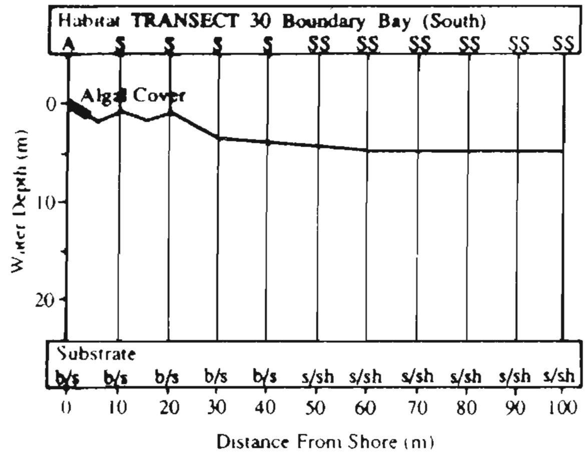


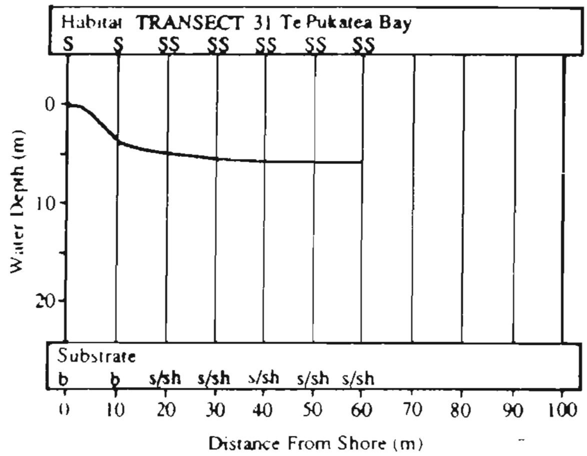


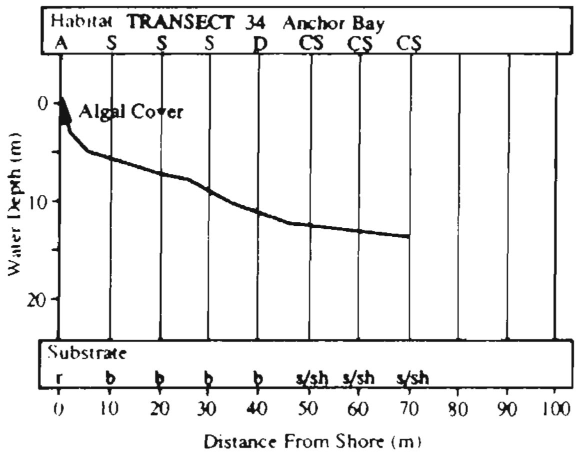
LEGEND

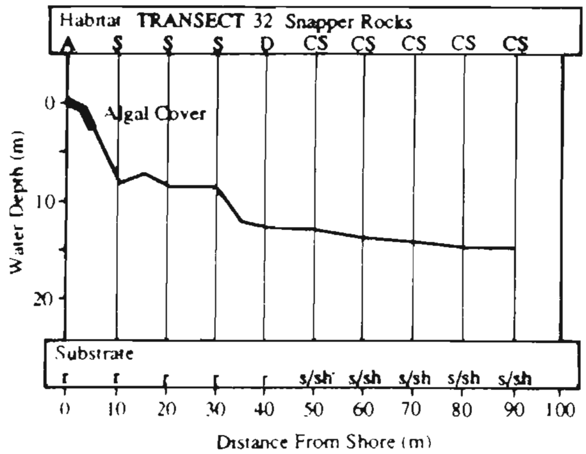
Substrate		Habitat	
b	Boulders (Granite)	L	Limestone
r	Rock (Granite)	S	Shallow Reef
l	Limestone	D	Deep Reef
sh	Broken and Dead Shell	A	Algal Cover
s	Sand Mixtures	CS	Coarse Substrates
m	Mud	SS	Shallow Soft Shores
		M	Mud

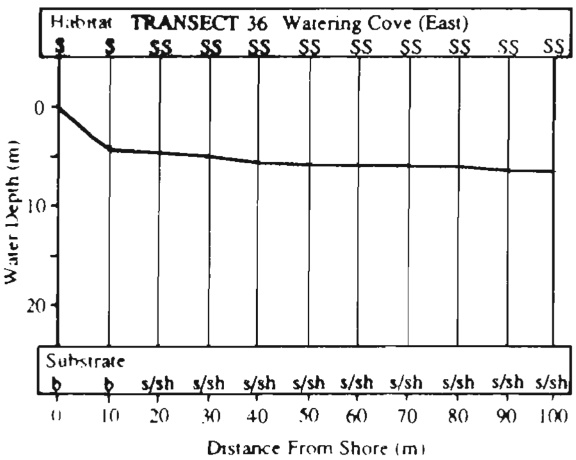
Appendix 14











LEGEND

Substrate		Habitat	
b	Boulders (Granite)	L	Limestone
r	Rock (Granite)	S	Shallow Reef
l	Limestone	D	Deep Reef
sh	Broken and Dead Shell	A	Algal Cover
s	Sand Mixtures	CS	Coarse Substrates
m	Mud	SS	Shallow Soft Shores
		M	Mud

APPENDIX 15: Algae and intertidal vascular plants recorded from the Abel Tasman National Park (Algae recorded from Nelson et, al., 1992).

Chlorophyta
Alvophyceae
Enteromorpha clathrata
Enteromorpha ramulosa
Ulva spathulata
Ulva stenophylla

Cladophoraceae
Chaetomorpha aerea
Cladophora sp.
Cladophoropsis herpestica

Caulerpaceae
Caulerpa geminata

Codiaceae
Codium convolutum
Codium fragile

Chordariaceae
Papenfussiella lutea

Seytothamnaceae
Scytothamnus australis

Splachnidiaceae
Splachnidium rugosum

Scytosiphonaceae
Petalonia fascia

Sporachnaceae
Carpomitra costata

Laminariales
Ecklonia radiata

Fucales
Hormosira banksii
Cystophora retroflexa
Cystophora torulosa
Carpophyllum maschalocarpum
Carpophyllum flexuosum
Sargassum sinclairii

Rhodophyta
Porphyra sp.
Gelidium caulacantheum
Gelidium pusillum
Pterocladia capillacea
Pterocladia lucida

Corallinales
Haliptilon roseum
Corallina officinalis
Jania micrarthrodia
Tenarea carpophylli

Gigartinales
Catenellopsis oligarthra
Caulacanthus ustulatus
Gracilaria chilensis
Plocamium costatum
Plocamium microcladioides
Gigartina chapmanii
Gigartina decipiens

Bonnemaisoniales
Asparagopsis armata

Rhodymeniales
Champia novae-zelandiae

Ceramiales
Ceramium laingii
Ceramium apiculatum
Ceramium discorticatum
Ceranium flaccidum
Ceramium uncinatum
Ptilothamnion rupicolum
Griffithsia traversii
Phycodrys quercifolia
Abroteia orbicularis
Apoglossum sp.
Schizoseris sp.
Hymenena variolosa
Symphyocladia marchantioides
Metamorphe colensoi
Dipterosiphonia heteroclada
Polysiphonia isogona
Polysiphonia rhododactyla
Cladhymenia coronata
Laurencia distichophylla
Laurencia thyrsifera

Appendix 15 continued

Phylum Spermatophyta

Angiospermae (Seed Plants)

Ammophila arenaria	Marram grass
Carpobrotus edulis	Ice plant
Calystegia soldanella	Shore bindweed
Carex pumila	Sand sedge
Cotula coronopifolia	Button weed
Desmoschoenus spiralis	Pingau
Isolepis cernua	
Isolepis nodosa	Knot sedge
Juncus maritimus	Sea rush
Lepidium banksii	Coastal peppercress
Leptocarpus similis	Jointed rush
Mimulus repens	Native musk
Phormium tenax	Swamp flax
Plagianthus divaricatus	Coastal ribbonweed
Plantago coronopus	Bucks'-horn plantain
Samolus repens	Sea primrose
Sarcocornia quinqueflora	Glasswort
Schoenoplectus pungens	Three square
Selliera radicans	Remuremu
Spartina anglica	Cord grass
Spinafex sericeus	Native sandbinder
Suaeda novaezelandiae	Sea bite
Typha orientalis	Raupo
Zostera novazelandica	Eelgrass

APPENDIX 16

Estuarine Evaluation In: Davidson and Moffat (1990)

Schemes for ranking terrestrial habitats (Spect et. al., 1974; Ratcliffe, 1977; Wright, 1977; Imboden, 1978; Park and Walls, 1978; Ogle, 1982; Myers et. al., 1987), wetlands (Morgan, 1982; Angel and Hayes, 1983; Pressey, 1985; Davis, 1987) and lagoons (Barnes, 1989) have been developed in response to a growing need for conservation input into environmental management. These evaluation methods are not directly applicable to estuarine systems, and a system for the evaluation of whole estuaries and parts of estuaries has not been previously developed for use in New Zealand. Two methods for the assessment of estuarine environments are therefore proposed in this section.

The first method evaluates the total estuary, while the second method deals with specific areas within the estuary. The criteria are based on either modified terrestrial criteria or directly on estuarine values. Information of this type, as well as being descriptive, allows estuarine systems to be assessed on conservation grounds. Evaluation is, therefore, an important tool for developing estuarine management guidelines.

Evaluation of an Estuary

The criteria proposed here for estuary evaluation incorporate assessments of habitats, species diversity, productivity and degree of human modification (Table 18). Criteria used are:

1. Representativeness/uniqueness of the estuary, compared with other estuaries in the Conservancy. Representativeness/uniqueness may be classified using flora, fauna, vegetation and/or geological and physical data. In the Nelson Marlborough Conservancy, Waimea Inlet was classified as unique, principally because of the diversity and rarity of the flora and fauna and on the physical structure of the estuary.

2. The state of the estuary. This is an assessment of the degree to which the estuary has been physically modified from its pristine through minor or localised modification to major modification and habitat loss.

3. Pollution status of an estuary. This may range from no pollution through minor effluent discharge in localised areas to nutrient enrichment influencing large areas of estuary.

4. Degree of modification of the terrestrial surrounding the estuary. Intact terrestrial vegetation scores highly, while farmed, industrial or stop-banked estuarine margins rank lowly.

5. State and intactness of salt marsh vegetation.

6. Size of the estuary. Large estuaries are rare in New Zealand: only ten are larger than 2000 ha (McLay, 1976). Approximately 68 % of estuaries in this country are less than 500 ha in size.

7. Total number of invertebrate species in the estuary.

TABLE 18: **Evaluation of an Estuary as One Unit.**

CRITERION 1
Representativeness/uniqueness of estuary compared with other estuaries in the Conservancy:
(a) Unique, only on of its kinds in Conservancy.
(b) One of the few estuaries of its kind in Conservancy.
(c) Typical of many estuaries in Conservancy.

CRITERION 2
State of Estuary:
(a) Pristine condition.
(b) Minor development or modification in localised areas.
(c) Significant areas of estuary modified.
(d) Extensive development of the estuary.

CRITERION 3
Pollution status:
(a) Pristine condition.
(b) Minor pollution in localised areas.
(c) Significant areas of estuary polluted.
(d) Extensive pollution of estuary.

CRITERION 4
State of terrestrial vegetation:
(a) Original terrestrial vegetation intact.
(b) Some areas of original zonation present, or under present regeneration.
(c) Little or no buffering vegetation, <50% of land farmed or developed.
(d) >50% of land adjacent to estuary developed into urban areas, industrial development or farming.

CRITERION 5
State of sale marsh vegetation:
(a) Original salt marsh vegetation around >90% of the estuary.
(b) Siginficant areas of salt marsh vegetation intact.
(c) Small areas of original salt marsh intact.
(d) Remaining salt marsh modified.

CRITERION 6
Size of intertidal and subtidal areas:
(a) >2000 hectares
(b) 1001-1999 hectares
(c) 501-1000 hectares
(d) 100-500 hectares
(e) <100 hectares

(TABLE 18 continued)

CRITERION 7
Number of invertebrate species recorded from estuary:
(a) >125
(b) 101-125
(c) 76-100
(d) 50-75
(e) <50

CRITERION 8
Number of waterbird species recorded from estuary:
(a) >60
(b) 51-60
(c) 41-50
(d) 30-40
(e) <30

CRITERION 9
Number of fish species:
(a) >36
(b) 26-35
(c) 15-25
(d) <15

CRITERION 10
Maximum recorded density of cockles (per m^2):
(a) >3000
(b) 2000-3000
(c) 1000-2000
(d) 500-1000
(e) <500

CRITERION 11
Number of intertidal vascular plant species:
(a) >20
(b) 15-20
(c) 10-14
(d) <10

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8. Number of water bird species present in the estuary for all or part of the year.

9. Number of fish species living, visiting or migrating through the estuary at some stage of their life history.

10. Maximum density of cockles recorded from the estuary.

11. Number of intertidal vascular plant species present. Values above 20 species is considered high, while less than ten species is regarded as low.

This evaluation, therefore, incorporates scientific and subjective assessments and requires that a full biological study be undertaken before all criteria can be accurately answered. Small or limited biological surveys would give lower scores than could be achieved with a large survey and can not therefore be used with any confidence.

Evaluation of Part of an Estuary

The assessment of a part of a single estuary is based on an objective assessment using five criteria (Table 19):

1. Flora, fauna and habitat importance of that part of the estuary. Areas with endangered or breeding species are rated highly; areas with a relatively poor or sparse fauna are rated lowly. Estuarine habitats vital for the survival of estuarine organisms or the estuary itself are also ranked highly.

2. Representativeness/uniqueness of the area within the estuary compared with other areas within the same estuary. The area may be unique, similar to a few areas or similar to numerous areas in the estuary.

3. Representativeness/uniqueness of that part of the estuary compared with other estuaries in the conservancy.

4. The biological and physiological state of the estuary. This is ranked from a pristine condition through isolated development to extensive modification and/or industrial development.

5. State of surrounding terrestrial vegetation, which is ranked from intact original vegetation, to greater than 50 % of the land farmed (Table 19).

Assessment of an estuarine area requires a good knowledge of the estuaries in the region and the part of the estuary in question. A full biological survey is not required.

An important part of the evaluation process is a description of the estuarine area involved. Topics for discussion and description may include:

Habitats:

Description of the habitat types present in the area.

Fauna:

Comment on notable invertebrate, fish or bird communities and not important feeding, breeding, roosting, migrating, juvenile or living sites.

Vegetation:

Comment on any notable species or communities in the area. State quality of vegetation with notes on cultural and historic use.

Human Use:

Note works or structures with notes on location, status (legal) and description of structure.

Comment on types and intensity of recreational use, commercial use and adjoining land use. Note any conflicts in use patterns.

Administration:

Record zoning and land tenure of adjacent land.

Cultural/Historic:

Record any traditional Maori food or material gathering sites. Note historic or archaeological sites (note sensitivity of information).

Threats:

Record threat status of area using modified scale proposed by Saenger and Bucher, 1986.

(i) Immediate threat (requires immediate action, damage to area already occurring).

(ii) Cause for concern (area threatened in the long term).

(iii) None (no potential threat identified, area adequately protected).

Management Options:

An area with low conservation values may have potential for improvement. The area may therefore be awarded a higher score at a later date. Suggestions for the improvement of estuarine areas should be made where appropriate (eg. fencing, replanting, spraying of noxious plants).

Contacts:

Record names and addressed of persons or organisations with interests in the area.

Not all categories may be applicable for an area under investigation. It is at the discretion of the surveyor which categories require description and discussion.

Numerical Score:

A numerical value for the estuary or the part of an estuary was derived using a number ranking system similar to that used by Park and Walls (1978). Each criterion was assigned a possible score, which was derived evenly by the number of ranks within that criterion. The value of each possible score was arbitrarily assigned on the basis of the assumed relative importance of criteria (Table 20).

Criteria for the assessment of areas within an estuary received equal scores, while whole estuary criteria were scaled (80 to 20 points) according to conservation values. Highest scores were awarded for overall estuary values. The total score was calculated by addition of all the criteria scores and represented as a percentage of the total possible score (Table 21).

Although the numerical value is a convenient management tool, it should not be regarded separately from the individual criteria scores which make up the overall value. A low overall score does not necessarily mean there are no valuable area, nor does it mean that the estuary is of no biological value.

TABLE 19: **Evaluation of Part of an Estuary for Conservation Status.**

CRITERION 1

Importance of flora, fauna and habitats:

(a) Area with unique or rare species or area with breeding or roosting sites of important species; area which provides essential resource for particular species, provides nutrients to the estuarine system or provides physical protection for the ecosystem;
(b) Area with a rich or diverse flora and fauna, breeding, feeding or roosting sites for common species.
(c) Area with moderate to sparse flora and fauna.

CRITERION 2

Representativeness/uniqueness of the area within the estuary:

(a) Unique, only area of kind in estuary.
(b) One of the few areas of kind in estuary.
(c) One of many similar areas in the estuary.

CRITERION 3

Representativeness/uniqueness of area compared with other estuarine areas in the Conservancy:

(a) Unique, only area of its kind the Conservancy.
(b) One of the few areas of its kind in Conservancy.
(c) One of many similar areas in the Conservancy.

CRITERION 4

Biological and physiological state of area:

(a) Pristine condition.
(b) Isolated development or modification.
(c) Significant parts of an area modified.
(d) Extensive modification and/or industrial development.

CRITERION 5

State of surrounding terrestrial vegetation:

(a) Original surrounding terrestrial vegetation intact.
(b) Some areas of original vegetation intact, or under regeneration.
(c) Little or no original vegetation, <50% of land farmed or developed.
(d) >50% of land adjacent to the estuary developed for urban, industrial or farming practices.

TABLE 20: **Scores for Conservation Status of an Estuary.**

Each criterion has been assigned a possible score. The value of the score depends on the assessed relative importance of each criterion. The possible score for each criterion is divided by the number of ranks in that criterion to give the difference in scores between adjacent ranks (see table below):

CRITERIA	1	2	3	4	5	6	7	8	9	10	11
Possible Score	80	80	60	60	60	40	40	40	40	40	20
No. of ranks	3	4	4	4	4	5	5	5	4	5	4
Rank (a)	80	80	60	60	60	40	40	40	40	40	11
Rank (b)	54	60	45	45	45	32	32	32	30	32	15
Rank (c)	27	40	30	30	30	24	24	24	20	24	10
Rank (d)	-	20	15	15	15	16	16	16	10	16	5
Rank (e)	-	-	-	-	-	8	8	8	-	8	-

TABLE 21: Scores for Conservation Status of Part of an Estuary.

Each criterion has an assigned value of 60. This value is divided by the number of ranks in each criterion to give the difference in score between adjacent ranks (see table below):

CRITERIA	1	2	3	4	5
Possible score	60	60	60	60	60
No. of ranks	3	3	3	4	4
Rank (a)	60	60	60	60	60
Rank (b)	40	40	40	45	45
Rank (c)	20	20	20	30	30
Rank (d)	-	-	-	15	15

NELSON/MARLBOROUGH CONSERVANCY OCCASIONAL PUBLICATIONS

No.1

Davidson, R.J. and C.R. Moffat, 1990. A report on the ecology of Waimea Inlet, Nelson. 165 pp. NZ $30.00.

No.2

Davidson, R.J., 1990. A report on the ecology of Whanganui Inlet, North-west Nelson. 133 pp. NZ $32.00.

No.3

Bryom, A.E. and R.J. Davidson, 1992. Investigation of behavioural patterns of black swan at Farewell Spit and Whanganui Inlet, North-west Nelson. 20 pp. NZ $10.00.

No.4

Davidson, R.J., 1992. A report on the intertidal and shallow subtidal ecology of the Abel Tasman National Park, Nelson. 161 pp. NZ $30.00.

No. 5

Davidson, R.J. and C.A.J. Duffy, 1992. Preliminary intertidal and subtidal investigation of Croisilles Harbour, Nelson. 36 pp. NZ $12.00.

No.6

Department of Conservation, 1992. Abel Tasman National Park marine reserve discussion paper. Ed: C. Taylor, A.S. Baxter. 43 pp. Free.

In Preparation:

* Duffy, C.A.J. et.al. Preliminary report on the near shore habitats and benthos of the Marlborough Sounds.

* Chadderton, W.L., Davidson, R.J., Brown, D.A., Fullerton, P. and G. Bettjeman. General quantitative investigation of selected subtidal rocky shores in Pelorus Sound, Marlborough.