LITTORAL AND SUB-LITTORAL HABITATS OF JERVIS BAY

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INTRODUCTION

Jervis Bay is a large deep open embayment with a shoreline consisting predominantly of long sandy beaches and intervening rocky outcrops. Although at least ten creeks enter the Bay, only six are of any significance. The total catchment is very small (400 km^2) when compared to the large water area (102 km^2). Fluvial sediments are confined to the upper portions of creeks, while marine sands dominate in the majority of habitats including the creek entrances, beaches and subtidal areas.

Littoral and sub-littoral plant communities are found on the rim of shallow sandy beaches and rocky foreshores, as well as in the shallow estuarine environment of the creeks. This paper deals with these plant communities, which are important as fish nursery and feeding areas. The principal plant communities to be considered here are the shallow rocky reef algae, seagrasses, mangroves and saltmarshes.

There are several reviews of the vegetation of Jervis Bay. Of particular relevance are those dealing with marine plants (Larkum 1973), the mangrove environment (Hutchings 1973) and the saltmarshes and mangroves (Adam and Hutchings 1987). An important generalization from both the available literature and from the present study is that Jervis Bay appears to be in the transition zone between the warm temperature (or Peronian) and the cold temperate (or Maugean) biogeographic zones. For example, in terms of algae, seagrasses and saltmarshes, Jervis Bay contains an array of species more akin to those of southern Australia than to the eastern coastline, and is located at the northern geographical limit for many of these species.

Also relevant to the study of these plant communities is a recent report published by the N.S.W. Department of Environment and Planning (D.E.P.) entitled "Coastal Wetlands of New South Wales" (Anon 1985). This report and accompanying legislation (State Environmental Planning Policy No. 14 - Coastal Wetlands) are designed to protect remaining N.S.W. coastal wetlands. Maps 30-31 of the report identify a number of wetlands within the Jervis Bay catchment.

This paper summarizes existing information concerning the littoral and sub-littoral plant communities and presents new data on these communities. The information is presented in two sections. Firstly, community types are described in terms of their species composition and, secondly, habitat types are discussed in terms of their relative size and importance. This paper does not deal with communities in deeper areas of the Bay. A brief description of such communities is given by Leadbitter (1987).

METHODS

A base map was prepared using 1: 25,000 Central Mapping Authority (C.M.A.) maps (Nowra, Crookhaven, Huskisson, Currarong and Sussex Inlet). Aerial photographs (NSW Coastal Wetlands Misc. 1309, 1981) were then used to transfer the boundaries of habitats dominated by rocky reef algae, seagrasses, mangroves and saltmarshes.

Extensive ground truthing was carried out. Observations were made on foot, by boat and by SCUBA diving to obtain site specific information concerning the vegetation type. Where possible, species lists were produced.

Areas of waterbodies and lengths of shorelines were measured from the 1: 25,000 C.M.A. maps. Areas of algae, seagrasses, mangroves and saltmarshes were measured from the prepared 1: 25,000 vegetation maps. These estimates were made using millimetre grid paper.

COMMUNITY TYPES

The distribution of the major rocky reef algae, seagrass, mangrove and saltmarsh communities in Jervis Bay has been mapped at a scale of 1: 25,000 and a reduced version of this map is shown in Fig. 1. Mapping at this scale presents difficulties in determining boundaries accurately, e.g. an area of 1000 m^2 of seagrasses would not be represented. It does, however, provide an adequate basis for the interpretation of the relative importance of the various sites throughout the Bay (in terms of size and community structure).

Table 1. presents the overall estimates of the areas of macrophyte communities in Jervis Bay. The previous mapping of the State's seagrasses, mangroves and saltmarshes by the Fisheries Research Institute (West *et al.* 1985) has been used to place Jervis Bay in a regional and state context.

Table 1. Area estimates of selected macrophyte communities important as fish habitats.

COMMUNITY TYPE	JERVIS BAY AREA (ha)	% OF ILLAWARRA REGION	% OF NSW
rocky reef algae	356	unknown	unknown
seagrass	906	32	9
mangrove	125	22	<1
saltmarsh	233	51	4

Algal communities

Jervis Bay contains many intertidal and subtidal rocky reef areas that support diverse algal communities. This study considered only the macroscopic algae, generally attached to rocks by means of a holdfast. Larkum (1973) suggests that the communities here are particularly noteworthy, due to the representation of plants normally found to the north, or to the south.

The rocky reef algae of Jervis Bay were difficult to map from aerial photography, due to the depths to which they occur, however, it was estimated that there are approximately 356 ha of this habitat type within the Bay's headlands (Fig. 1). There are no embayments on the N.S.W. coastline useful for comparison with this figure because Jervis Bay offers a unique blend of rocky headlands, deep clear marine waters and protection from the open ocean swell. It is thus an ideal environment for the development of large and diverse algal communities.

Because there is a high diversity of algae in Jervis Bay, with over 100 intertidal and 85 subtidal species having been recorded at Plantation Point (see Fig. 1; May and Larkum 1981; May 1981), this study did not attempt to present an exhaustive description of algal communities. Instead, dominant species in most areas were recorded (see below). In general, *Hormosira banksii* dominates the intertidal areas throughout the Bay, both on rocks and amongst the mangrove pneumatophores (cf. King 1981). On shallow subtidal rock platforms the large brown algae *Ecklonia radiata, Sargassum flavicans, Phyllospora comosa* and *Cystophora moniliformis* are dominant species. Red encrusting algae are also common in both the intertidal and subtidal areas.

The effects of physical disturbances (canopy clearances) on *Ecklonia radiata* communities (flora and fauna) in Jervis Bay is being investigated by Kennelly and Underwood (pers. comm.). Areas of *Ecklonia* were cleared at Plantation Point and H.M.A.S. Creswell to study recolonisation of the bared areas.

Many other types of algal communities occur in Jervis Bay. May *et al.* (1978) found approximately 57 species of algae attached to seagrasses. Shallow turf algae communities (e.g. *Sargassum* sp. and *Codium* sp.) are often found in the wave zone (see May and Larkum 1981), and the sciaphilous or deepwater red algal communities (e.g. *Kallymenia rosea, Sporochnaus radiciformis, Gracillaria* spp. and *Ceramium* sp.) attached to shells and shell fragments occur at several locations throughout Jervis Bay, particularly along the southern shoreline (Larkum 1973).

During this preliminary study we did not investigate the deepwater rocky reefs which occur primarily around the headlands of Jervis Bay. The boulders and caves of these areas are covered with a vast array of sponges, tube worms, bryozoans and ascidians. Although algal development is somewhat restricted in these areas due to light limitation, large kelp beds have been reported to depths of over 30 metres (D. Pollard, pers. comm.).

Seagrass communities

Jervis Bay ranks fifth of the 133 estuaries in New South Wales in terms of total seagrass area, containing 906 ha of seagrass beds (Fig. 1). The Bay's seagrass beds are of particular importance for two reasons - first, they contain examples of all seagrass species found in New South Wales, and second, they contain the largest area of one of those species (*Posidonia australis*) in New South Wales.

In addition to the *Posidonia australis* beds (often called strapweed), the other species of seagrass found in Jervis Bay are *Zostera capricorni, Zostera muelleri, Heterozostera tasmanica* (all commonly called eelgrass), *Halophila ovalis* and *Halophila decipiens* (both commonly called paddleweed). *Ruppia megacarpa*, a brackish water macrophyte closely allied to the seagrasses, is also found in some isolated patches of water, e.g. in Wowly Gully (Fig. 2.1).

Posidonia, the largest of the Australian seagrasses, is found in only 20 of the 133 estuaries in New South Wales. It appears to occur only on sandy substrata in marine waters, and is therefore restricted to open embayments and a few well-flushed estuaries (West *et al.* 1985). In Jervis Bay, *Posidonia* is found below the low tide level to a depth of about ten metres offshore from sandy beaches and rocky headlands, but not within the creeks. These are probably the deepest *Posidonia* beds in New South Wales, although the species occurs to greater depths in other

states. There are about 687 ha of *Posidonia* in Jervis Bay, representing the largest area of this species in the State. The *Posidonia* bed in Hare Bay is the largest continuous bed in New South Wales.

The *Zostera* and *Halophila* species are more widespread in New South Wales, with *Zostera capricorni, Halophila ovalis* and *Halophila decipiens* being common throughout most of Australia. They occur on most sediment types and in most estuary types. These species occur throughout Jervis Bay and in the creeks feeding the Bay. Within the Bay proper, *Zostera capricorni* is generally dominant in the intertidal zone (above the level of the lowest tides). It is a faster growing species than *Posidonia* (Larkum and West 1982) and therefore can also withstand a more mobile (higher wave energy) environment. This species is also the most widespread within Currambene, Moona Moona, Bid Bid and Carama Creeks, where it grows both inter-tidally and sub-tidally (to about 2 metres).

Zostera muelleri and *Heterozostera tasmanica* are both uncommon in New South Wales, and have a patchy distribution in Jervis Bay. Until recently Jervis Bay was considered the northern geographical limit in New South Wales for both of these species, however, *Heterozostera tasmanica* has recently been collected from Port Stephens, where a small bed is located in similar conditions to the Jervis Bay beds. Both species are more common in Victoria and Tasmania.

Mangrove communities

Jervis Bay contains only two species of mangrove, the grey mangrove (*Avicennia marina*) and the river mangrove (*Aegiceras corniculatum*). There are approximately 125 ha of mangrove forests in the Bay, giving Jervis Bay a rank of sixteenth amongst the 133 estuaries in the State. The small area of mangroves relative to the size of Jervis Bay is not unexpected as there are few suitable sites. Mangroves generally require protection from wind and waves and reach their greatest development on muddy sediments and in brackish environments. In Jervis Bay, mangroves are generally restricted to the creeks (Fig. 1) with *Avicennia* dominating in most areas. Individual mangroves are relatively small, with the exception of large dense stands of tall trees in Currambene Ck. and Carama Inlet.

Since mangroves are generally found on soft sediments, the stunted *Avicennia* occasionally found on rock platforms such as at Green Point are an unusual occurrence.

Saltmarsh communities

Saltmarshes are areas of low-lying lands covered by the highest tides and which often contain a variety of habitats, such as salt and freshwater pools, saltflats, and vegetated areas. The vegetation can consist of an array of up to forty species of salt-tolerant plants. Jervis Bay contains approximately 233 ha of saltmarshes, which places it seventh in area for New South Wales. The saltmarshes occur in the creek environments, generally situated behind the mangroves. The largest areas are in Carama Inlet and Currambene Ck. (Fig. 1).

Adam and Hutchings (1987) noted that saltmarshes in Jervis Bay are of particular importance due to the occurrence of "a number of species that are either rare or absent further north (*Wilsonia, Gahnia, Sclerostegia, Stipa* and *Limonium*)" and that "the reason for this (distribution) remains obscure". These species are, however, more common on saltmarshes of Southern Australia (Bridgewater 1982) and occur at a number of localities on the South Coast of N.S.W.

The uncommon saltmarsh species seem to be restricted to the northern saltmarshes around Carama Inlet, Wowly Gully and Bid Bid Ck. (see below). Currambene and Moona Moona Creeks contain saltmarsh species more common to New South Wales, such as *Sporobolus virginicus, Juncus kraussii, Sarcocornia quinqueflora, Selleria radicans, Samolus repens* and *Suaeda australis*, although *Gahnia filum* is also widespread in the saltmarshes of these two creeks.

HABITAT TYPES

Rocky reef habitats

Rocky foreshores make up approximately 14 kilometres (29%) of the Jervis Bay shoreline (Fig. 1). Table 2 lists the major rocky reefs in Jervis Bay, their approximate areas and their dominant algal and/or seagrass species. The close proximity of seagrass and reef communities is quite unusual for New South Wales, and is a result of the comparatively low wave energies within the Bay.

The major reefs are around Huskisson (Moona Moona Point, Tapalla Point and Huskisson Reef), at Callala Point and at Plantation Point. As outlined previously the intertidal and subtidal flora of the rock platform at Plantation Point have been well studied (May 1981, May and Larkum 1981). These studies were conducted in response to the construction of a sewerage outfall at Plantation Point in 1975. May (1981) considered that naturally occurring variations in flora were greater than those induced by the sewerage outfall, except in the immediate vicinity of the outfall. An interesting study could be carried out now to investigate longer term changes in the flora because the sewerage treatment works have been in operation for 10 years, and local townships have expanded.

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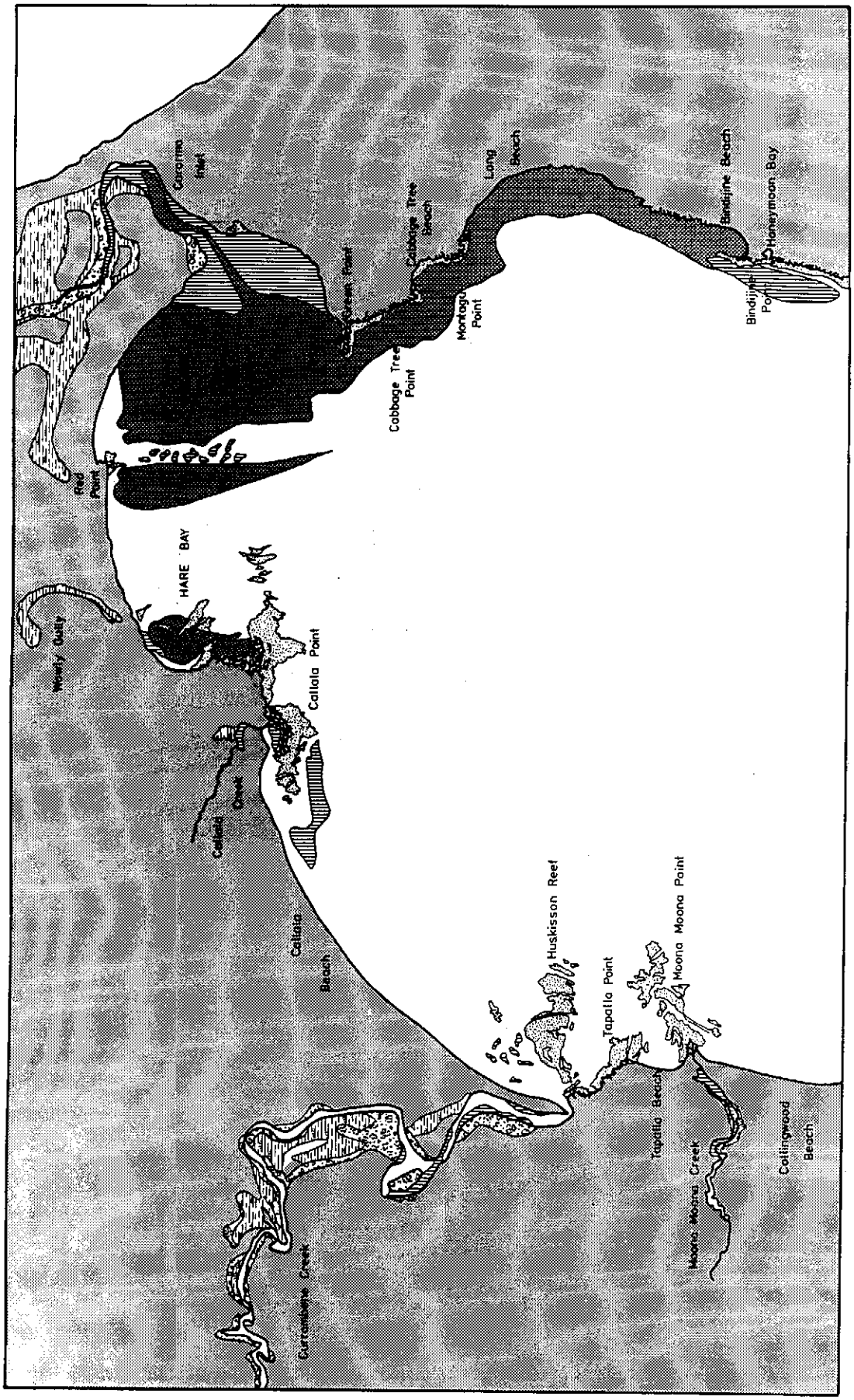
Rocky Reef	Approx. Area (ha)	% of reef habitat in Jervis Bay	Dominant Macrophytes
Longnose Point	7	<2	Ecklonia, Sargassum, Corallina, Dictyopteris, encrusting red, Amphiroa.
Groper Coast	27	7	Cystophora, Dictyopteris, Corallina, Amphiroa, Ecklonia, Sargassum, Caulerpa.
Bindijine Point	3	<1	Hormosira, Ecklonia, Posidonia, encrusting red, Cystophora, Padina.
Montagu Point	9	3	Ecklonia, Cystophora, Dictyopteris, Corallina, Posidonia and Zostera.
Cabbage Tree Point	7	<2	Giffordia, Sargassum, Phyllospora, Cystophora, Ecklonia, Amphiroa.
Green Island	6	<2	Hormosira, Ecklonia, Sargassum, Dictyopteris.
Red Point	2	<1	n.d.*
Callala Point	77	22	Hormosira, Sargassum, Ecklonia, Dictyopteris, Cystophora, Posidonia, Padina.
Huskisson Reef	39	11	Hormosira, Dictyopteris, Caulerpa, Cystophora, Padina, Phyllospora, Halophila, Zostera.
Tapalla Point	13	4	Phyllospora, Macrocystis, Ecklonia, Cystophora, Dictyopteris, Padina, Carpoglossum, Laurencia.
Moona Moona Point	32	9	n.d.*
Plantation Point	69	19	Ecklonia, Dictyopteris, Hormosira, Cystophora, Macrocystis, Padina, Notheia, Laurencia, Corallina, Amphiroa, Zostera, Posidonia.
Blenheim Point	6	<2	Dictyopteris, Cystophora, Ecklonia, Corallina, Macrocystis, Amphiroa.
Chinamans Point	8	2	Ecklonia, Dictyopteris, Sargassum, Padina, encrusting red.
Hyams Point	15	4	Ecklonia, Dictyopteris, Phyllospora, Macrocystis, Padina, Corallina.
Captains Point	8	2	n.d.*
Bristol Point	10	3	Corallina, Dictyopteris, Ecklonia, Amphiroa, Padina, Cystophora, Zostera, & Halophila.
Scottish Rocks	4	1	Hormosira, Padina, Ecklonia, Cystophora, Laurencia, Posidonia, Zostera, Halophila.
Murrays Point	4	1	Hormosira, Corallina, Ecklonia, Padina, Cystophora, Dictyopteris, Posidonia, Zostera, Halophila.
Bowen Island (west)	10	3	Padina, Macrocystis, Dictyopteris, encrusting red, Posidonia.

* n.d. - no data

Table 2. Area estimates of rocky reef habitats in Jervis Bay and their dominant macrophyte communities.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Montagu Point
Cabbage Tree Point
Red Point
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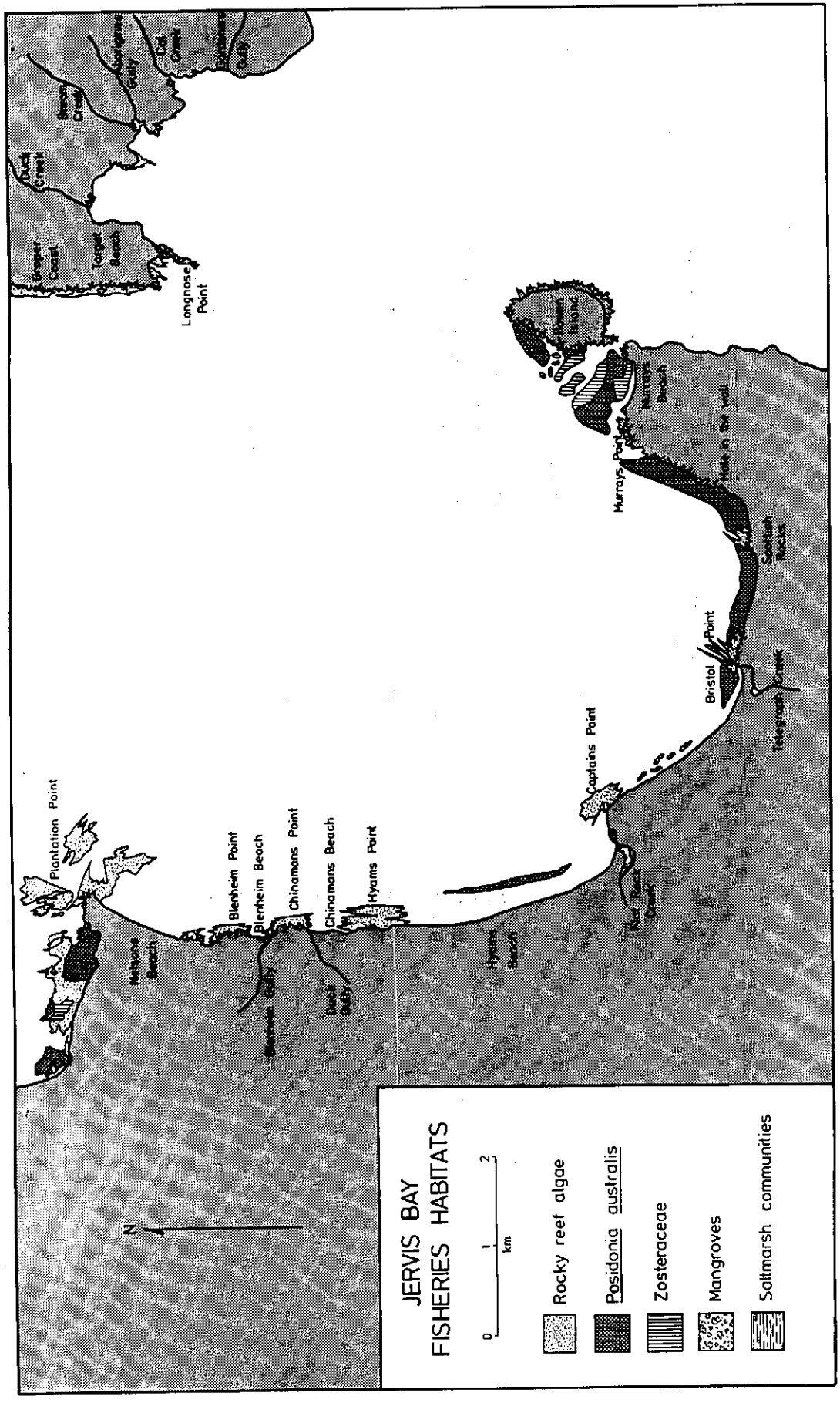
Windy Dusty
Callala Point
Callala Creek
Callala Beach
Huskisson Reef
Tapatla Point
Moona Moona Point
Tapatla Beach
Collingwood Beach
Moona Moona Creek
Currambene Creek


JERVIS BAY
FISHERIES HABITATS
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Rocky reef algae
Posidonia australis
Zosteraceae
Mangroves
Saltmarsh communities
Plantation Point
Blenheim Point
Blenheim Beach
Chinamans Point
Chinamans Beach
Hyams Point
Hyams Beach
Captains Point
Bristol Point
Scotch Rocks
Murrays Beach
Longnose Point
Target Rock
Duck Creek
Telegraph Creek

Beach	Length (km)	% of Beach Habitat in Jervis Bay	Dominant Macrophytes
Target Beach	0.64	<2	–
Bindijine Beach	0.53	<2	*Posidonia*, *Zostera*, *Halophila*.
Long Beach	2.76	8	*Posidonia*.
Cabbage Tree Beach	0.50	<2	*Posidonia*.
Hare Bay (Chinamans)	8.61	25	*Posidonia*, *Zostera*, *Heterozostera*.
Callala Beach	6.09	18	*Zostera*, *Heterozostera*.
Tapalla Beach	0.66	<2	–
Collingwood Beach	4.29	13	*Posidonia*, *Zostera*, *Heterozostera*.
Nelsons Beach	1.48	4	–
Blenheim Beach	0.27	<1	–
Chinamans Beach	0.64	<2	–
Hyams Beach	5.85	17	*Posidonia*.
Captains/Bristol	2.46	8	*Posidonia*, *Zostera*.
Bristol/Scottish	0.88	<3	*Posidonia*.
Scottish/Hole-in-Wall	0.63	<2	*Posidonia*, *Zostera*.
Murrays Beach	0.58	<2	*Posidonia*, *Zostera*, *Heterozostera*.

Table 3. Estimated lengths of sandy beach habitats in Jervis Bay and their dominant macrophyte communities.

Creek	Water Area (ha)	% of creek habitat in Jervis Bay	Dominant Macrophytes
Gardeners Creek	-	<1	-
Cat Creek	-	<1	-
Aborigines Gully	-	<1	-
Bream Creek	-	<1	-
Duck Creek	2	<2	-
Cararma Inlet	33	21	*Posidonia*, *Zostera*, *Avicennia*, *Aegiceras*, *Juncus*, *Sarcocornia*, *Sporobolus*, *Scelerostegia*, *Ghania*.
Wowly Gulley	2	<2	*Ruppia*, *Juncus*, *Wilsonia*.
Callala Creek	3	<2	*Avicennia*, *Zostera*, *Juncus*, *Sarcocornia*, *Limonium*, *Sporobolus*.
Currambene Creek	107	70	*Avicennia*, *Zostera*, *Juncus*, *Phragmites*, *Sarcocornia*, *Ghania*, *Sporobolus*.
Moona Moona Creek	9	6	*Avicennia*, *Zostera*, *Juncus*, *Sarcocornia*, *Aegiceras*.
Blenheim Gulley	-	<1	-
Duck Gulley	-	<1	-
Flat Rock Creek	-	<1	*Avicennia*.
Telegraph Creek	-	<1	-

Table 4. Estimates of the area of creek habitat in Jervis Bay and their dominant macrophyte communities.

The reef at Green Point represents less than two percent of the reef habitat in Jervis Bay (Table 2), and in this preliminary survey we found similar algal communities at this site to others in the Bay. As variation between seasons and years is significant (May 1981, May and Larkum 1981), a more detailed study involving several years of algal collections would be required to confirm this latter observation.

Sandy beach habitats

Jervis Bay is renowned for its white sandy beaches (Fig. 1), which make up approximately 34.5 kilometres of its foreshores. Table 3 lists the major beaches in Jervis Bay, their size, the dominant species of algae and seagrasses found in adjacent waters. Growth of large areas of seagrasses in waters adjacent to the sandy beaches depends upon the degree of protection and depth of water.

By far the largest area of seagrass is in the waters between Green Point and Red Point (Fig. 1). It consists of *Posidonia australis, Zostera capricorni, Zostera muelleri, Heterozostera tasmanica* and *Halophila ovalis*. Another large area of seagrass occurs at Murrays Head, where the mobile sands result in a complex assortment of seagrass communities. Small patches of *Zostera capricorni* and *Heterozostera tasmanica* are also found in the waters off Hyams, Collingwood and Callala Beaches.

Creek habitats

There are no large freshwater flows into Jervis Bay. The brackish water environment consists of about twelve small creeks and gullys, and the areas of only ten of these are large enough to be estimated from the 1: 25,000 C.M.A. maps. Table 2.4 lists these creeks and gullys, their sizes and dominant plant communities.

By far the largest of these waterbodies is Currambene Creek. The creek is navigable by small boats for approximately 17 km. *Phragmites australis* dominates the upper portion of the creek, occurring with *Juncus kraussii* on the edge of the banks. The mangrove shrub, *Aegiceras corniculatum*, is found up to about the 15 km point, and from about 10 km to the entrance of the creek, the grey mangrove (*Avicennia marina*) dominates the upper tidal zone. *Zostera* is also found in small patches beside the banks. The saltmarshes here are dominated by *Juncus kraussii, Gahnia filum* and *Sporobolus virginicus* , with other common species being *Sarcocornia quinqueflora, Suaeda australis, Samolus repens* and *Triglochin striata*. The largest stands of seagrasses, mangroves and saltmarshes are found near Wollamia. Although the D.E.P. coastal wetland study (Anon 1985) has identified seven wetlands for protection along Currambene Ck. (Map 30, Wetlands 327-333), it failed to include these large mangrove and saltmarsh areas near Wollamia.

Moona Moona Ck. is considerably shallower and smaller in area than Currambene Ck. (Table 2.4 and Fig. 2.1). However, it contains similar plant communities. *Zostera capricorni* seagrass beds cover the sandy shoals near the entrance, while the banks are lined with the mangroves *Avicennia marina* and *Aegiceras corniculatum*. Behind the mangrove zone, *Juncus kraussii* dominates the saltmarsh.

Carama Inlet, which empties into Hare Bay, is the second largest of the creek waterbodies. It is very different from Currambene Ck. in that its catchment is small and there is likely to be very little freshwater runoff. The inlet contains what appears to be a disproportionately large area of saltmarsh, considering the small catchment and small entrance to Jervis Bay. At the end of the Inlet, which is only about 4 kilometres long, there is a large saltmarsh area through which a number of small tidal channels radiate. This site contains a number of uncommon saltmarsh species such as *Scelerostegia arbuscula, Gahnia filum, Wilsonia backhousei* and *Limonium australe* interspersed with large areas of *Sarcocornia quinqueflora, Sporobolus virginicus* and *Juncus kraussii*. The stands of *Scelerostegia arbuscula* at this site are probably the largest in New South Wales, and Adam and Hutchings (1987) consider that protective measures are necessary to conserve the species, particularly against grazing. A plan of management should ultimately be prepared for this portion of land. Although this wetland is included in the D.E.P.'s coastal wetland study (Anon 1985, Map 30, Wetland 366), there are also significant areas not included, such as the mangroves and saltmarshes behind the Hare Bay beach (Fig.1). The latter areas are of particular interest as they are fed by two or three small creeks, only a few feet in width, and contain some of the largest mangroves in Jervis Bay. These trees are perhaps several hundred years old. The site is situated in front of what appears to be a relic beach shoreline.

To the west of Carama Inlet is Wowly Gully (see Table 4). This gully, described by Adam and Hutchings (1987) as "a series of interconnected pools of water", has and intermittently open entrance. The upper reaches of the gully contain a large saltmarsh area of *Wilsonia backhousei*, largely degraded by trail bike tracks. It is probably the largest area of this species in New South Wales.

Callala Ck. is the last of the sizable bodies of tidal water (Table 4) and contains a small stand of very large *Avicennia marina* trees, patches of the seagrass *Zostera capricorni* and similar saltmarsh communities to Carama Inlet (e.g. *Limonium australe*). The upper saltmarsh areas have not been included on Fig.1.

CONCLUSIONS

Jervis Bay contains large areas of algae, seagrass and saltmarsh communities, but a relatively small area of mangroves. The algae, seagrass and saltmarsh communities, although dominated by species common in other parts of N.S.W. are characterized by the inclusion of a few species more widespread in southern Australia.

Carama Inlet and Hare Bay have particular significance in New South Wales in terms of their saltmarsh and seagrass habitats. Carama Inlet contains the largest area of *Scelerostegia arbuscula* in N.S.W. and a number of other relatively uncommon saltmarsh species. Hare Bay contains the largest area of seagrass in Jervis Bay, and the largest area of *Posidonia australis* in N.S.W.

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