THE SALTMARSHES AND MANGROVES OF JERVIS BAY

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INTRODUCTION

The coastline of Jervis Bay is geomorphologically diverse and its different landforms support very different vegetation communities. The entrance to the Bay is guarded by impressive cliffs, the tops of which support sclerophyll heathland and woodland (Ingwersen 1973, 1976). Much of the shoreline within Jervis Bay is fringed by sand dunes, extensive stretches of which suffered erosion during the severe storms of 1974. Close to settlements, these damaged dunes have since been rehabilitated (Fleck 1975; Davies 1981). Intertidal wetlands are restricted in their distribution but individual stands are, in comparison with other estuaries on the South Coast, extensive - the total area of mangroves being 1.25 km^2 and that of saltmarsh 2.33 km^2 (West *et al.* 1985).

A general introduction to the vegetation of the Jervis Bay region was provided by Ingwersen (1973). The vegetation of the Commonwealth Territory was described in detail by Ingwersen (1976) and a checklist of the vascular flora was compiled by Ward and Ingwersen (1978).

Ingwersen (1973, 1976) gave only a brief introduction to the mangrove communities and did not discuss saltmarsh, although the freshwater swamps and *Casuarina glauca* woodlands, which are an important component of the regional landscape, were described briefly.

Hutchings (1973) discussed the mangrove communities around Jervis Bay, concentrating on those in Currambene Creek, and also provided a brief outline of the saltmarsh vegetation occurring behind the mangroves. Boston (1981) reported the persistence in the upper part of Currambene Creek of a small patch of the introduced saltmarsh grass *Spartina townsendii (S. anglica)* which was first planted in 1932. *Spartina* is an aggressive colonist in Tasmania and Victoria (Boston 1981) but shows no such tendency in New South Wales.

Saltmarsh in Wowly Gully. Low vegetation dominated by *Wilsonia backhousei* , large tussocks of *Gahnia filum* .

SALTMARSH AND MANGROVE VEGETATION OF JERVIS BAY

Hutchings (1973) identified three mangrove stands within the Bay; on Moona Moona Creek just south of Huskisson, along Currambene Creek which flows into the Bay at Huskisson, and on Carama Inlet which flows into the north eastern corner of the Bay.

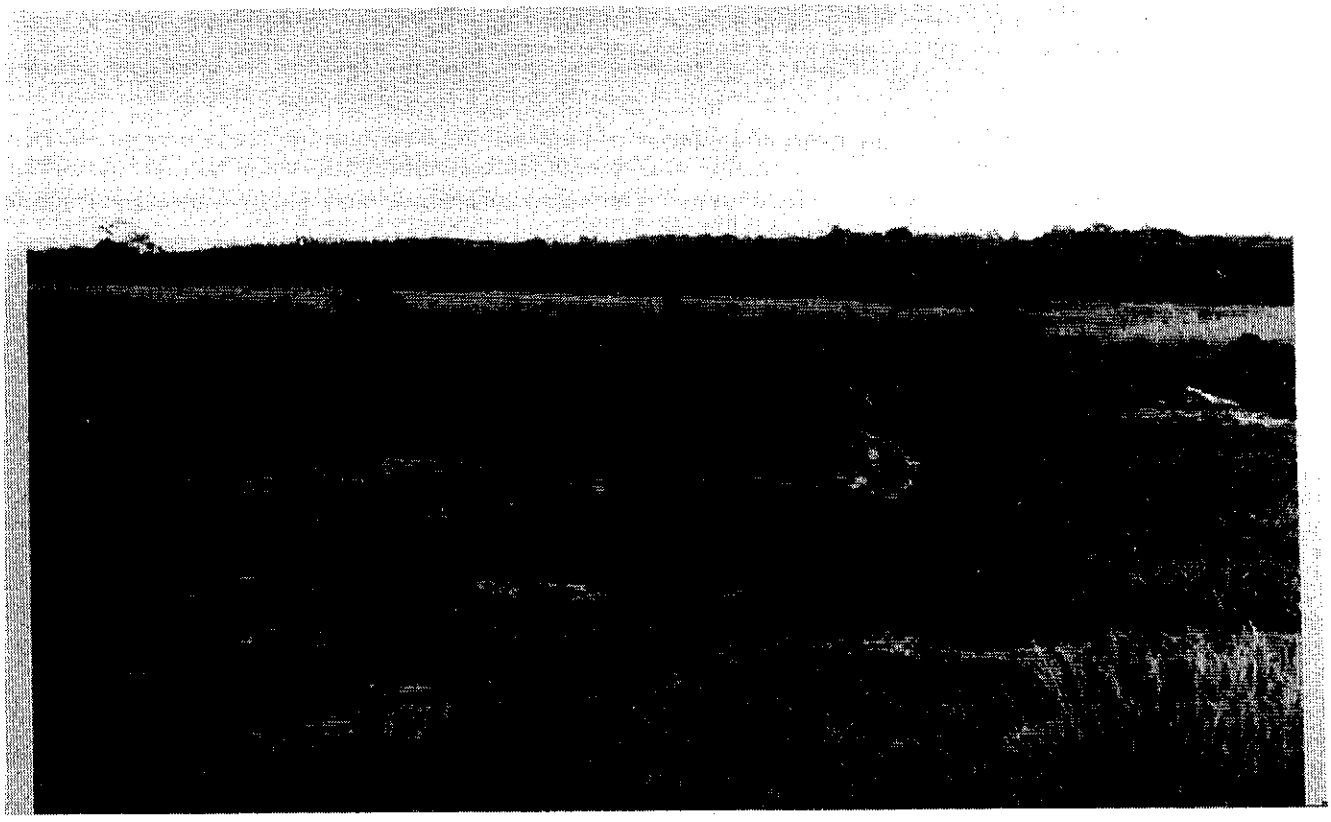
Saltmarsh is associated with mangroves at these localities but also occurs independently of mangroves at other locations. The largest area of saltmarsh not associated with mangrove is in Wowly Gully,which enters the Bay near the settlement of Callala Bay. Very small patches of saltmarsh (consisting of *Sporobolus virginicus* and *Sarcocornia quinqueflora*) are found at the mouths of some of the other small creeks flowing into the Bay. (For further details of saltmarsh and mangrove distribution see West (1987)). In addition, vegetation similar to that of saltmarsh occurs on very exposed areas on the seacliffs fronting the ocean. The major saltmarsh species on seacliffs are the grasses *Sporobolus virginicus* and *Zoysia macrantha* ; a large stand dominated by these two species occurs on Bowen Island (Ingwersen 1976).

Scattered pockets of saltmarsh vegetation and isolated mangrove trees are found on rock platforms at various localities around the Bay.

The dominant mangrove species is *Avicennia marina*, with much smaller amounts of *Aegiceras corniculatum* also being present. Along Currambene Creek the distribution pattern of *Aegiceras* differs from that normally found elsewhere on the New South Wales coast. On the south bank of the Creek, *Aegiceras* occupies a position above a zone of *Avicennia* , the common pattern along the coast; however, on the northern bank *Aegiceras* and *Avicennia* are intermingled (Hutchings 1973). The *Avicennia* tree canopy averages 6-8 m in height; while not notable for their height, the boles of some trees along Currambene Creek have substantial girths (circumference breast height exceeding 2 m).

Saltmarshes of Wowly Gully

As portrayed on the Nowra 1: 25000 topographical map, Wowly Gully consists of a series of interconnected pools with no opening to the sea and fringed by sandflats and swamp. This situation may prevail for some of the time but frequently the Gully is open directly to Jervis Bay, at which times it becomes a tidal channel.



Saltmarsh fringing Carama Inlet. Extensive stand of *Sarcocornia quinqueflora* . The tall shrub in the middle distance is *Sclerostegia arbuscula* .

In the lower reaches of the Gully, there is a well developed fringing saltmarsh; there is no mangrove community although a few scattered shrubs of *Avicennia* occur. About 1.5 km upstream from the mouth, the Gully crosses a broad sandflat. At this point it is traversed by a power transmission line; the easement along the line allows access to 4-wheel drive vehicles and trail bikes so that the sandflat is criss-crossed with vehicle tracks. This sandflat seems to be of relatively recent origin, as at several places there are stumps of *Casuarina* (presumably *C. glauca*).

In January 1985, the Gully was open to the sea and the channel was filled with a dense stand of *Ruppia megacarpa.* Close to the mouth, a few small patches of *Zostera capricorni* and *Halophila ovalis* occurred. The density of *Ruppia* stands often fluctuates considerably from year to year, and that in Wowly Gully appears to be no exception - very little *Ruppia* was recorded during the 1983-84 summer.

The lower saltmarsh is a mosaic of two communities, one dominated by *Wilsonia backhousei* (Convolvulaceae), the other by the succulent *Sarcocornia quinqueflora. Sarcocornia* communities are widespread on southern Australian coasts (Bridgewater 1982; Kirkpatrick and Glasby 1981).

The individual stands of the *Wilsonia* community form patches up to several hundred square metres in area. Vegetation cover is between 60-70% and, apart from *Wilsonia,* there are only small quantities of *Sarcocornia* and *Triglochin striata. W. backhousei* is widespread on saltmarshes in southern Australia (Bridgewater, Rosser and de Corona 1981), but is rare in New South Wales. Small populations occur in the Sydney region (Homebush Bay, Saltpan Creek and Mill Creek - Wilson 1984), and a large stand has recently been discovered at Wamberal Lagoon (Benson 1986). On the South Coast *W. backhousei* is found at a few, widely separated, sites. Bridgewater (1982) provides a description of saltmarsh communities in southern Australia but gives no example of one dominated by *W. backhousei.* However, he does report an increase in the abundance of *W. backhousei* in a number of communities under waterlogged conditions. Kirkpatrick and Glasby (1981) recognize a community dominated by *W. backhousei* in Tasmania but do not provide full floristic details so that it is not possible to judge whether the community is identical to that in Wowly Gully. However, Kirkpatrick and Glasby provide vegetation maps of the sites they investigated and from these it is clear that *W. backhousei* is local in its occurrence and covers only limited areas at those sites in which it is found. On the basis of current knowledge, therefore, these stands in Wowly Gully must be regarded as unusual.

The mid-marsh zone is discontinuous but is occupied by a community with *Sporobolus virginicus* and *Samolus repens* as the main species; similar stands are widespread along the New South Wales coast. The upper marsh is again a mosaic of communities, the major ones, dominated by *Juncus kraussii* and *Baumea juncea,* being widespread in New South Wales. However, there are also stands dominated by the tall, tussocky sedge *Gahnia filum.* These stands appear to represent a community described by Bridgewater (1982) as the Gahnio-Juncetum kraussii and reported by him from Victoria and eastern Tasmania.

In New South Wales, *G. filum* reaches its northern limit along the Georges River (Wilson 1984) where the populations are so small that the individual plants can be readily counted. *G. filum* is locally abundant in the upper zone at a number of marshes south of Jervis Bay.

A feature of the upper marsh communities is the local abundance of the creeping *Selliera radicans.* Around Sydney *S. radicans* is abundant in poorly drained saline depressions on sandstone cliffs but is rare in intertidal saltmarshes. Bridgewater (1982) records *S. radicans* forms a number of saltmarsh communities in southern Australia.

The terrestrial vegetation above the Wowly Gully saltmarsh is predominantly a *Eucalyptus-Banksia* woodland with some stands of *Casuarina glauca.* The interface between saltmarsh and the woodland is heterogenous with a mosaic of linear stands dominated by species such as *Melaleuca ericifolia, Leptospermum* ssp., *Goodenia ovata, Pteridium esculentum, Gahnia* ssp. (other than *G. filum*) and in a few places *Phragmites australis.* it is possible that this zone is influenced by freshwater seepage from the surrounding sand dunes - certainly with the exception of *Melaleuca ericifolia* (and to a lesser extent *Phragmites*) the assemblage of species in the zone is not notably salt tolerant.

Although the dominant vegetation on the sand mass between Wowly Gully and Carama Inlet is woodland (locally approaching forest in stature) there are also areas of wet heath and scrub and sedge swamps. The total flora is rich and the area would repay further study.

Carama Inlet

Carama Inlet is fringed with mangroves behind which are areas of saltmarsh, particularly extensively developed on the southern bank. These saltmarshes merge through transition zones of *Casuarina glauca* woodland and *Melaleuca* ssp. scrub into the terrestrial woodlands on the sand dunes.

A feature of the mangroves is the presence of free-living forms of the brown alga *Hormosira banksii.* This seaweed is widespread on rocky shores but well developed communities of the free-living form are rare in New South Wales; they were first recorded from Weeny Bay (Towra Point) (King 1981a,b) and are now known from a few South Coast localities.

The most striking feature of the saltmarsh is the presence of the tall shrubby chenopod *Sclerostegia arbuscula*; with twisted gnarled trunks densely encrusted with lichens these plants convey an impression of great age but this may be illusory.

S. arbuscula is widespread in southern Australia (Wilson 1980; Bridgewater 1982) and is known from a number of sites in New South Wales. Of these, Carama Inlet is the most northerly and supports what is probably the largest population.

Most of the *Sclerostegia* occurs in an open shrubland with a range of widespread saltmarsh species. This community is related to the Samolo-Sclerostegietum described by Bridgewater (1982) from Victoria and Tasmania, differing from it in the abundance of *Sporobolus virginicus*. (*Sporobolus*, which is the major grass in New South Wales saltmarshes, is replaced further south by *Distichlis distichophylla*.)

In slight depressions in the marsh, the density of *Sclerostegia* increases and the only associated species is *Sarcocornia quinqueflora*. These stands appear identical to those described by Bridgewater (1982) as the Sclerostegietum arbusculae sarcocornietosum. Bridgewater records this community only from South Australia, at about the same latitude as Jervis Bay.

Bridgewater (1982) and Kirkpatrick and Glasby (1981) suggest that cattle grazing may cause a reduction in cover of *Sclerostegia* on saltmarshes. The saltmarsh on the south side of Carama Inlet shows signs of cattle grazing although the grazing pressure is clearly neither high nor continuous. Nevertheless, given the rarity of *S. arbuscula* in New South Wales and the apparent absence of any juvenile plants, the population should be monitored and attempts made to protect the species from grazing.

The upper saltmarsh has, in places, been heavily burnt in recent years, reducing tussocks of *Juncus kraussii* and *Gahnia filum* to charcoal stumps. Little is known about the effects of fire on saltmarsh vegetation but it is unlikely that most saltmarsh communities would withstand frequent burning.

In addition to *Sclerostegia*, the major community dominants over much of the marsh area are *Sarcocornia quinqueflora, Sporobolus virginicus* and *Juncus kraussii*. There are also large areas dominated by *Gahnia filum* and small patches of *Wilsonia backhousei*. *Selliera radicans* is abundant in the upper marsh, while *Samolus repens* is very common in the *Sporobolus* grassland and is locally dominant. In poorly drained areas *Triglochin striata* becomes very common.

A further species of interest, present only as scattered plants, is *Limonium australe*. Although widespread in southern Australia and also occurring in Queensland, *L. australe* is restricted to the South Coast in New South Wales, with a northern limit on the Minnamurra River.

Currambene Creek and Moona Moona Creek

The saltmarshes of Currambene Creek and Moona Moona Creek have not been investigated in as much detail as those in Wowly Gully and Carama Inlet. The major communities are those dominated by *Sarcocornia quinqueflora, Sporobolus virginicus* and *Juncus kraussii* (see photographs in Hutchings 1973); *Gahnia filum* is also widespread (West 1987). Some of the saltmarshes along Currambene Creek are extensive (West *et al.* 1985) but are difficult of access.

On both creeks there are well developed *Casuarina glauca* swamp forests (covering extensive areas on Currambene Creek), with a saltmarsh understorey near the main creeks merging into a brackish, or even freshwater, community along the inland margin.

Robinson (pers. comm.) has recorded *Wilsonia backhousei, Gahnia filum* and *Stipa stipoides* from saltmarsh in the Moona Moona Creek system. *Stipa stipoides* (also referred to as *S. teretifolia*) is characteristic of the upper marsh fringe on the South Coast of New South Wales and also occurs on clifftops (Ingwersen, 1976). It is probable that it occurs in other saltmarshes in the Jervis Bay region but was not recorded at the time of the survey because of the effects of fire on the upper marsh zone. Jervis Bay appears to represent the northernmost occurrence of *Stipa* on saltmarsh in N.S.W.

PHYTOGEOGRAPHIC SIGNIFICANCE OF THE JERVIS BAY INTERTIDAL WETLANDS

The Jervis Bay wetlands contain a number of species which are either rare or absent further north (*Wilsonia, Gahnia, Sclerostegia, Stipa* and *Limonium*) (see Wilson 1984, Yassini 1985).

Limonium is recorded as locally abundant from a number of saltmarshes further south in New South Wales; *Gahnia* is characteristic of the upper marsh fringe on the South Coast. Although a few scattered plants have been found further north, Jervis Bay represents its northern limit as a common species. *Wilsonia* has been recorded from a number of localities on the South Coast but the population in Wowly Gully is particularly large. *Sclerostegia arbuscula* is a large and obvious shrub. While scattered plants may occur elsewhere on the South Coast, it seems probable that the known occurrences represent the only large populations in New South Wales.

Jervis Bay represents the northern limit of occurrence of a number of saltmarsh community types widespread in southern Australia (Bridgewater 1982; Kirkpatrick and Glasby 1981). The reason for this remains obscure. At the present time, there does not appear to be any major disjunction in either climatic or other habitat conditions between Jervis Bay and sites further north. The saltmarshes discussed by Bridgewater (1982) are

characterised by mediterranean climatic regimes with marked seasonality in rainfall. Such conditions do not apply to the New South Wales coast and the climatic data presented by Ingwersen (1976) do not suggest that the climate around Jervis Bay displays any features that could be regarded as unusual for the New South Wales south coast.

The saltmarsh flora of New South Wales is characterised by a small number of species with wide geographical distributions, with very few species which could be described as rare. The occurrence in the one area of a whole suite of geographically restricted saltmarsh species is therefore unusual and suggests that the Jervis Bay saltmarshes should be regarded as sites of high biogeographic interest.

The wetlands of the Jervis Bay area are still poorly studied. No serious studies have been undertaken on the *Casuarina glauca* communities; the preliminary results from Towra Point reported by Clarke (1983) suggest that these communities may be important in nutrient cycling within estuarine wetlands, as they contain a high proportion of the total nitrogen in the system. Little is known either of the various freshwater swamp systems of the region.

Saltmarsh, mangroves and *Casuarina glauca* forests are habitats poorly represented in existing conservation reserves in New South Wales (Hitchcock 1985). The Jervis Bay wetlands provide extensive examples of these habitats in a relatively undisturbed condition. Securing the long term protection of these sites should be given high priority.

MANGROVE FAUNA

Hutchings (1973) briefly listed the common members of the invertebrate fauna occurring in the mangroves of Jervis Bay. Since then, a considerable amount of information on the fauna of Australian mangroves has appeared (see reviews by Hutchings and Recher 1982 and Hutchings and Saenger 1987). The fauna of Jervis Bay mangroves is typical of that of temperate regions, with all the species also occurring in nearby mudflats or seagrass beds. Species restricted to mangroves are most abundant at low latitudes and none occurs south of northern New South Wales (Hutchings and Recher 1982)

Knowledge of the fauna of Jervis Bay mangroves has not substantially increased since 1973, although a number of species listed in Hutchings (1973) have been the subject of taxonomic studies. The gastropod recorded as *Melaraphe scabra*, common on mangrove leaves and trunks, is now understood to consist of a complex of species which have been transferred to the genus *Littoraria* (Reid 1986). The polychaete previously listed as *Notomastus* sp. has been described as a new species, *N. estuarius* (Hutchings and Murray 1984).

Studies on mangrove fauna at other localities in New South Wales allow the fauna in Jervis Bay to be compared with that from other temperate sites. Extensive faunal studies have been carried out at Towra Point (Australian Littoral Society 1978) and Careel Bay, Pittwater (Hutchings and Murray 1984). The diversity of the fauna at Jervis Bay is lower than that at either Towra Point or Careel Bay, although in all three areas the mangroves probably experience similar fully marine salinity regimes. The reasons for the lower diversity are unclear but may be related to the size of the mangrove stands or to latitude. Hutchings and Recher (1982) showed that the diversity of mangrove fauna increases with decreasing latitude, but it also seems likely that, up to a certain area, faunal diversity is related to the size of mangrove stands.

In contrast, the faunal diversity of Jervis Bay mangroves is higher than that found at Merimbula or Pambula in southern New South Wales, at the southernmost distribution limit of *Aegiceras corniculatum*. The mangrove stands in this area are small and stunted and subjected to varying salinities (Day and Hutchings 1984). A total of 24 species of molluscs, crustaceans and polychaetes have been recorded from the mangroves at Pambula and Merimbula.

FAUNA OF THE SEAGRASS BEDS AT JERVIS BAY

Recently, the macro-invertebrate benthic fauna of the seagrass beds in Jervis Bay has been investigated in some detail by Collett *et al.* (1984). Quantitative collections were made in the *Posidonia australis* meadows at Murrays Beach. This site yielded 96 species (which may be a conservative figure) with an average density of 2491 individuals per m^2. This diversity was relatively high compared with the other nine *Posidonia* sites examined along the New South Wales coast, which were sampled in a similar way. The fauna of Jervis Bay was that of a marine-dominated site and was most similar to that found at Towra Point, Shoal Bay and Broughton Island, a pattern which is in contrast to that shown by the mangrove fauna. The seagrass fauna of Jervis Bay was dominated by three species, the capitellid polychaete, *Heteromastus filiformis*, and two crustaceans, *Ampelisciphotis* sp. and *Halicarcinus ovatus*. The ten most common species represented 68.9% of the total number of individuals recorded. Fifteen species were exclusive to Jervis Bay and did not occur at any of the other nine sites sampled.

The main finding of this extensive survey along the New South Wales coast was that there was no characteristic *Posidonia* seagrass bed fauna. Salinity appeared to be the principal determinant of the faunal composition, rather than latitude.

Even within the same estuary the faunas of seagrass beds are not necessarily similar if they are subjected to differing salinity regimes. However, it could be predicted that the other *Posidonia* beds in Jervis Bay would have a similar fauna to that at Murrays Beach, as they are all subjected to similar salinity regimes. Collett *et al.* (1984) also showed that every site investigated had a large number of endemics. This probably reflects the way in which the

fauna of seagrass beds is recruited from pelagic larvae. The fauna of a particular seagrass bed is not constant over time, but represents the results of chance recruitment of larvae. Many of the polychaete species in seagrass beds can also live in nearby unvegetated muddy areas (Hutchings 1982).

The importance of temperate seagrass beds and mangroves to commercially important species of fish has recently been documented for Botany Bay by Middleton *et al.* (1984), but much more work still remains to be seen on the diet of this fish fauna whilst it is in the mangroves and seagrass beds. We also need information on the rates of turnover and life history studies of the resident invertebrate fauna of both mangroves and seagrass beds.

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