Vegetation of the Coastal Lowlands of Tweed Shire, Northern New South Wales: Plant Communities, Species and Conservation

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Plant communities of the coastal lowlands of Tweed Shire, on the far north coast of New South Wales, are described. The communities are grouped into three broad categories: floodplain wetlands which are not further subdivided; estuarine wetlands in four communities; and floodplain forest and the vegetation of dunal areas with 16 sampled communities and brief descriptions of alluvial forest, foredune formations and additional emergent wetland communities. The occurrences of 505 plant taxa in relation to the sampled communities are listed.

Natural vegetation in the study area occupied about 3,300 ha at the time of mapping in 1985. This represents a decline of over 87% from its original extent. The formal reserves in the study area fail to represent much of its natural diversity. The coverage and level of protection provided by less secure conservation measures should be extended.

Increased efforts at conservation planning are needed, particularly because of the biogeographic significance of the area, the significance of some habitats for the mobile fauna of a region much larger than the Shire, the many rare, threatened or otherwise significant species, and the inevitable limitations of available data as a basis for ensuring the adequate protection of the area's species.

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INTRODUCTION

The coastal wetlands and associated vegetation types of Tweed Shire were surveyed in 1985 as part of a series of consultancy studies funded by the National Parks and Wildlife Service. The studies were intended to provide information on the wetlands of areas which were not well known and were under pressure from development. The survey of coastal Tweed Shire was preceded by surveys of the Hunter, Clarence and Macleay floodplains (Pressey, 1981a, 1989a,b).

Information from the surveys was intended to be used in determining conservation priorities and for responding to proposals for developments which could adversely affect wetlands. In the case of the Tweed survey, attention was not restricted to the wetlands of the floodplain, which is very limited in extent compared to those of the other rivers included in the series, but directed also to estuarine and dunal wetlands. These other wetland types were poorly known and under significant threat from agricultural expansion and clearing for housing and tourist developments. Because the dunal wetlands occur in a matrix of heathland and forest, the Tweed survey was further extended to the remaining naturally vegetated areas of the dunal formations.

Several studies of wetlands and other coastal vegetation types in Tweed Shire preceded the survey reported here but these were either limited in geographical scope or lacked the detail required for decisions on the conservation priorities of particular areas. Hannah (1968) mapped and provided general descriptions of landforms, vegetation, land systems and land use of the coastal strip. Goodrick (1970) mapped and broadly

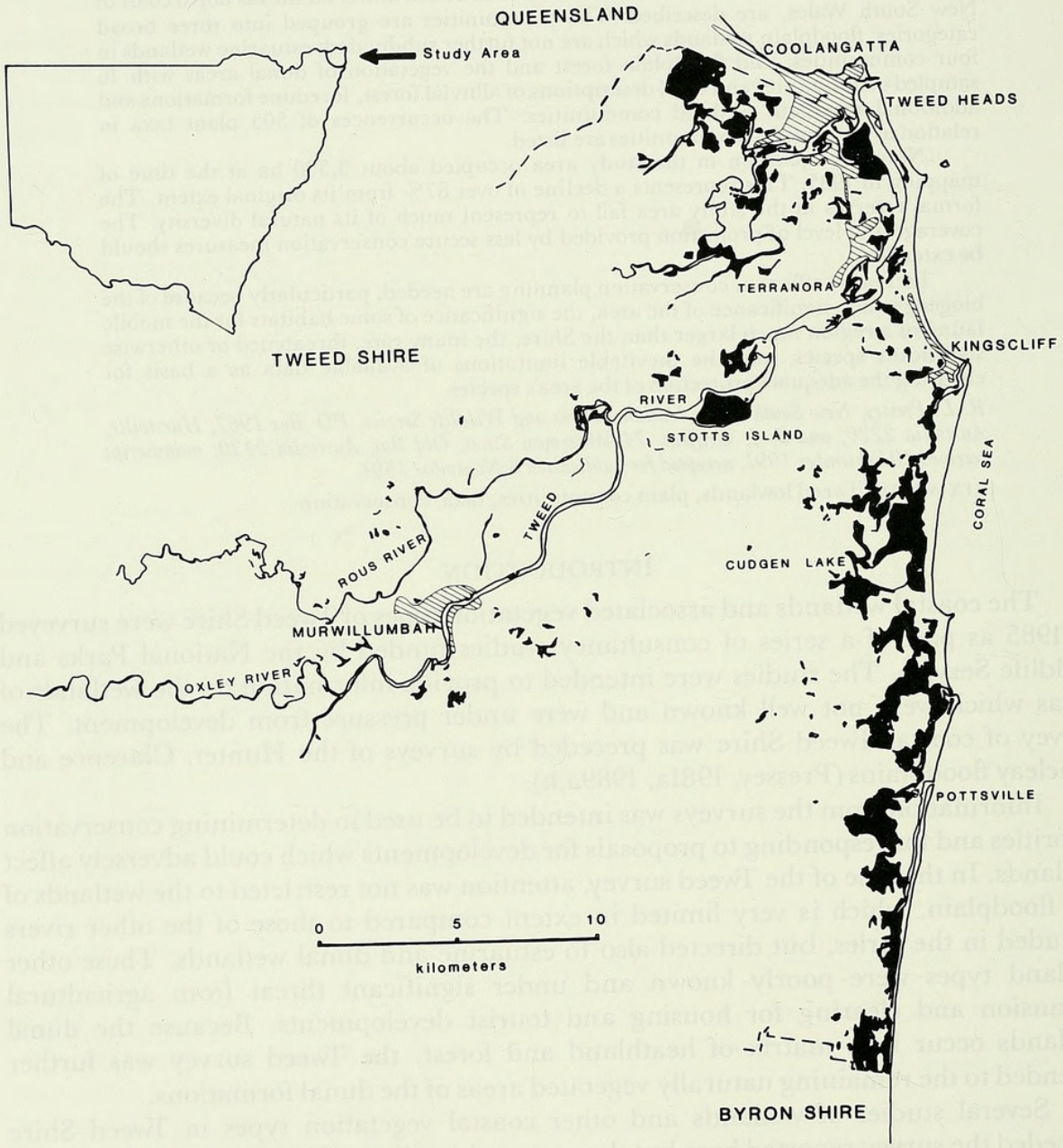

Fig. 1. The study area. Black areas show the remaining extent of wetlands and other communities on the coastal lowlands.

classified the major wetlands of the Tweed region along with those of the remainder of the state's coast. Some of the Tweed wetlands were covered generally by Bell and Edwards (1980) in their inventory of the state's coastal lagoons and their catchments.

The Planning and Environment Commission (1978) undertook a broad-scale study of the Shire's coastal plant communities. The draft plan of management for Stotts Island Nature Reserve (National Parks and Wildlife Service, 1979), a remnant of the original floodplain forest, contains a compilation of information on flora and discussed management issues. Investigation reports by the National Parks and Wildlife Service (Meehan, 1981; Hunter, 1982) provided detailed information on parts of the coastal lowlands and Gilmore (1983) compiled information on significant vegetation in the area in a submission to the Tweed Shire Local Environmental Study.

More recently, West *et al.* (1985) mapped and classified the estuarine wetlands of the state and listed species of mangroves and seagrass for each estuary. In the same year, the Coastal Council of New South Wales (1985) delineated wetlands, without descriptions, for the purposes of development controls under State Environmental Planning Policy No. 14. The other biophysical literature on the coastal parts of Tweed Shire listed by Pressey (1981b) deals with the geomorphology, soils and avifauna of limited areas.

Several detailed surveys of the vegetation of parts of coastal Tweed Shire followed or were concurrent with the study reported here and make a significant contribution to the knowledge of the plant communities and floristics of the region. Gilmore *et al.* (1985) produced a comprehensive report on the hydrology, vegetation, fauna and conservation needs of wetland and associated habitats in the Pottsville area. Detailed surveys of vegetation and vertebrate fauna have also been completed by Murray (1987a) for a small wetland on the Fingal Peninsula, near Tweed Heads, Murray (1987b) for an area adjoining the Cobaki Broadwater and Murray (1989) for land north of Cudgen Lake.

This paper summarizes the inventory and description sections of the 1985 survey of coastal Tweed Shire which was designed to be both comprehensive and detailed in its coverage of wetlands and associated dunal environments, to provide new information on floristics and vegetation formations and to compile information already gathered. Information on sampling sites, detailed maps and the results of conservation evaluation are given in the original survey report (Pressey and Griffith, 1987). Some of the information from the four concurrent or later studies mentioned above has also been summarized in this paper.

Study Area

The study area includes the northernmost part of the New South Wales coastline, about 650 km north of Sydney (Fig. 1). Tweed Shire has the Queensland border to the north and Byron Shire to the south. The areas surveyed and described all lie below the 10 m contour and are mainly on the dunal formations of the immediate coastal strip, although they also include the floodplains and estuaries of the Tweed River and minor streams.

Agricultural and urban development of the Tweed Valley began in about 1865 with the settlement of the first farms, although cedar-getting preceded farming by about 20 years (Soros-Longworth and McKenzie Pty. Ltd., 1981). The Tweed floodplain has been almost entirely cleared for sugar cane cultivation and pastoral use, as have the minor floodplains of the Cobaki and Terranora Broadwaters and those of the small coastal streams such as Cudgen and Cudgera Creeks. More recently, urban expansion has been significant and rapid (Soros-Longworth and McKenzie Pty. Ltd., 1981) due to the tourist potential of the region and annual population increases of 4-5% in the period 1976-1986 (Tweed Shire Council, 1987).

This rapid growth has been sustained. In June 1990, Tweed Shire had the highest

estimated population and the highest population growth rate for the previous five years (4.3%) of any local government area on the north coast (Department of Planning, 1990). The estimated 1991 population in the northern coastal strip of Tweed Shire was about 33,500, some 58% of the Shire's total, and the increase in population in this area from 1986 to 1991 was 40% (Tweed Shire Council, 1991). Population increase and associated developments therefore represent a serious threat to the remaining natural habitats on the Tweed coastal lowlands. Planning for population growth in the region to minimize or avoid further impacts on the coastal habitats is a major challenge for the State Government and Tweed Shire Council.

Methods

The floodplain wetlands of the study area were treated as a floristic complex, but the vegetation of the estuarine and dunal areas was subdivided into communites. Assuming one 'does not insist upon quantitative uniformity of the dominants, which rarely occurs' (Beadle and Costin, 1952), then most of the communities recognized in the present study could be considered associations after Beadle (1981): 'the association is defined as a community in which the dominant stratum exhibits uniform floristic composition, the community exhibiting uniform structure'.

Wetlands and other communities were initially mapped on aerial photographs from two series: Murwillumbah 1:41,000 black and white (March 1979) and NSW Coastal Wetlands 1:25,000 colour (July 1981). Floodplain wetlands were simply delineated without any attempt at classification. Estuarine wetlands were mapped as either mangrove or saltmarsh. Although distinct plant communities were identified in saltmarsh areas during field work, these could not be reliably distinguished on aerial photographs because of lack of photo signature and small, irregular size. Remnant patches of floodplain forest and most of the plant communities identified in the dunal areas were mapped together as either a forest complex or an emergent wetland complex. Detailed photo-interpretation would have allowed mapping of separate communities in these areas but constraints on the time for the study did not allow the field work necessary to accurately locate boundaries.

Most of the field work for the estuarine and dunal areas was completed during May 1985 when 55 sites were systematically sampled and described. Sampling sites were generally 400 sq. m, although 100 sq. m quadrats were used for floristically simple communities such as sedgeland. The information collected for each site included a list of species observed, an assessment of species abundance, structural information (after Walker and Hopkins, 1984), physiographic details, inferred relationships to other communities, and notes on any forms of disturbance. The precise locations of these sampling sites and another 84 descriptive sites were recorded to assist mapping for this and subsequent studies. Additional sampling of plants and truthing of aerial photograph interpretation in the estuarine and dunal areas was carried out in October 1985.

Floodplain wetlands were each visited once in October 1985 and plant species and other information recorded after the procedure outlined by Pressey (1989a). Altered boundaries of wetlands and other communities due to clearing since the dates of aerial photographs were noted during field work and the preliminary mapping of estuarine wetlands was checked against that of West *et al.* (1985). Mapping information was transferred from aerial photographs to 1:25,000 topo-cadastral maps using a zoom transfer scope and then copied onto transparent overlays of the base maps.

Results and Detailed Discussion

Plant Community Definitions in Relation to Other Studies

The classification of vegetation into the communities listed is based on the previous

experience of one of the authors (SJG). It is intuitively derived and based on dominants, but has been consistently used over much of the north coast of New South Wales for mapping at 1:12,500 and 1:25,000 (Griffith, 1991).

Most of the communities identified in this study have also been recognized by others in south-eastern Queensland. Other intensive studies of small parts of Tweed Shire have produced similar but finer-scale classifications. The intensive survey of low-lying coastal vegetation near Pottsville by Gilmore *et al.* (1985) covered an area of about 370 ha and recognized 22 associations and other units at 1:4000, some of which were confined to bedrock with others ecotonal or resulting from disturbance. Similarly, Murray (1987a) has produced a very detailed vegetation map of a small wetland and its surrounds near Fingal Head, identifying 11 vegetation types over an area of about 20 ha, five of which are estuarine wetland associations. Murray (1987b) identified ten non-estuarine units near the Cobaki Broadwater, three of which were on bedrock, and Murray (1989) mapped 12 units over about 700 ha to the north of Cudgen Lake. Despite the more detailed subdivisions of the vegetation in these studies and the recognition of units not covered by sampled sites for the present study, these other classifications are generally comparable to the one used here.

Floodplain Wetlands

The coastal floodplain wetlands of Tweed Shire were defined as those on alluvium below the 10 m contour and not associated with dune formations or significantly influenced by tidal action. They are basins which occasionally or regularly hold water and which occur on the lower floodplain of the Tweed River upstream of Stotts Island and along the tributaries of the Cobaki and Terranora Broadwaters. Stands of trees in these areas without wetland plants in the understorey were included in a separate category of vegetation (floodplain forest and vegetation of dunal areas, see below) as were forested areas with or without wetland plants in the understorey in areas fringing the estuaries and on the minor alluvial flats of the coastal strip.

The survey covered 48 floodplain wetlands with a total area of 144 ha (Table 1), a much smaller number and area than on any of the large floodplains of the Hunter, Clarence or Macleay. Most of the wetlands are smaller than 5 ha and the largest is only about 19 ha. Two of the wetlands with a combined area of 7 ha were identified on Stotts Island from aerial photographs but not visited on the ground.

Eighty-five plant taxa were recorded during the survey (Appendix 1) to which a herbarium record was added of *Eleocharis dulcis*, collected from a drainage channel near Murwillumbah. Of the total of 86 taxa, one is a liverwort, five are ferns, 61 are monocots and 29 are dicots. Families with the most taxa were Cyperaceae (29 taxa), Poaceae (8) and Polygonaceae (8). The most extensive taxa were *Cyperus lucidus* (17.7% of total area), *Persicaria hydropiper* (15.9%) and *Melaleuca quinquenervia* (10.1%). *Cyperus lucidus*, extensive stands of which were characteristic of the Tweed floodplain wetlands, was not recorded at all during surveys of the Hunter, Macleay and Clarence floodplains, even though it occurs in most of the botanical regions in New South Wales (Jacobs and Pickard, 1981). Other species found in the Tweed floodplain wetlands but not in surveys of other floodplains to the south were *Acacia maidenii*, *Gahnia clarkei*, *Lophostemon suaveolens*, *Ludwigia octovalvis*, *Persicaria dichotoma* and *Rhynchospora corymbosa*.

Apart from occasional floodwaters from the river, eleven of the wetlands receive only local runoff from the surrounding alluvial flats. Of the other 35 which have catchments on nearby land above the 10 m contour, only five are fed by catchments larger than 100 ha.

Forty-two wetlands are grazed and 20 wetlands with a total area of 63 ha have been directly affected by drainage. It is possible that the wetlands which have not been

directly drained have also been altered hydrologically by changed patterns of flooding and drainage following flood mitigation works. Other alterations include impoundment, excavation and filling for urban development. The pre-European extent and nature of the floodplain wetlands is difficult to assess but it is likely that some of the original wetlands have been completely destroyed due to structural flood mitigation works. Much of the sugar cane land which now takes up virtually the whole floodplain downstream of Murwillumbah is reclaimed wetland subjected to drainage by local drainage unions and with reduced flooding frequency due to construction of levees (Soros-Longworth and McKenzie Pty. Ltd., 1981). The extensive destruction of shallow wetlands on the main floodplain is also suggested by their present confinement to narrow tributary valleys of the bedrock margins. The remaining wetlands on the broad alluvial flats are deep channels which could not be completely drained or converted to agriculture.

TABLE 1

Original and 1985 extent of vegetation associations or complexes in coastal Tweed Shire (Bracketed figures indicate percentage decline)

Association/Complex	1985 (ha)	Original (ha)
FLOODPLAIN		
Floodplain wetlands	144	
Floodplain forest	194	
Floodplain total	338	11,460 (97%)
ESTUARINE WETLANDS		
Mangroves	371	
Saltmarsh	55	
DUNAL AREAS		
Forest complex	2298	
Shrubland	10	
Dry heath	56	
Wet heath	46	
Emergent complex	131	
Estuarine and dunal total	2967	14,990 (80%)
OVERALL TOTAL	3305	26,450 (87.5%)

The floodplain wetlands of Tweed Shire are poorly represented in reserves, with only 7 ha of wetland within Stotts Island Nature Reserve. The two within the nature reserve are unusual in having their natural context of surrounding vegetation types, a very rare situation in coastal New South Wales. Poor representation in reserves is typical of other floodplain wetlands on the north coast (Pressey, 1981a, 1989a,b).

Other protection measures are available for wetlands, although of limited value in some cases. Under State Environmental Planning Policy 14 (SEPP 14), clearing, filling, drainage and construction of levees in wetlands delineated on planning maps are now designated developments. They require development applications and environmental impact statements and can only proceed after the consent of local government and the concurrence of the Department of Planning. However, SEPP 14 is only a potential protection measure for the wetlands on the Tweed floodplain, many of which are outside the limits of the Policy's mapping, with the remainder not identified under the Policy, despite their apparent distinctiveness in a state context.

Estuarine Wetlands

For the purposes of this survey, estuarine wetlands were defined only as saltmarsh and mangroves. West *et al.* (1985) have also mapped areas of seagrass in the estuaries of Tweed Shire and elsewhere in the state. The intertidal mudflats and sandflats of the state's estuaries have apparently not been included in any surveys.

Most of the mangrove area in the Shire occurs in the estuary of the Tweed River (Table 2) with relatively small areas in Cudgen Lake and Creek, Cudgera Creek and Mooball Creek. The Tweed estuary is the only estuary in the Shire which contains all five species known to occur in New South Wales: *Aegiceras corniculatum*, *Avicennia marina*, *Bruguiera gymnorrhiza*, *Excoecaria agallocha* and *Rhizophora stylosa*. Only one other estuary in the state, that of the Brunswick River, is known to have all these species together (West *et al.*, 1984) although they each extend well southward. Mangroves in the Shire are in places associated with *Hibiscus tiliaceus* which occurs at the upper limit of tidal influence. Hunter (1982) also reported that *Dendrobium monophyllum* is a common epiphyte on *Bruguiera* on Caddys Island in the Terranora Inlet. In addition, there is an unconfirmed report of *Ceriops tagal* from Cudgera Creek (Shine *et al.*, 1973). This species is not otherwise known from the state and was not found during surveys by West *et al.* (1984).

Saltmarsh is considerably more restricted in extent in Tweed Shire than mangroves and distributed differently between estuaries (Table 2). About half the total area of saltmarsh in the Shire occurs in each of the Tweed and Cudgen estuaries if the stands of *Schoenoplectus litoralis* mapped by West *et al.* (1985) in Cudgen Lake are not considered as typical saltmarsh vegetation. The extensive (about 35 ha) area of *S. litoralis* is significant, however, at least in the context of Tweed Shire, and could be one of the biggest occurrences in the state (Adam, 1991, pers. comm.).

TABLE 2

Extent of estuarine wetlands in Tweed Shire (ha). Data from West et al. *(1985)*

System	Mangrove	Saltmarsh #	Seagrass
Tweed River *	309	21	33
Cudgen Lake	9	56(31)	–
Cudgera Creek	14	2	2
Mooball Creek	5	–	1
Total Area	337	79(44)	36

bracketed figures represent areas after subtracting 35 ha of *Schoenoplectus litoralis* mapped by West *et al.* (1985) as saltmarsh in Cudgen Lake.

* includes the Cobaki and Terranora Broadwaters.

Estimates for this study of total areas of mangrove and saltmarsh in Tweed Shire differ from those of West *et al.* (1985). Our estimates of mangrove and saltmarsh extent are 371 ha and 55 ha respectively (Table 1) as opposed to 337 ha and 44 ha respectively (excluding *Schoenoplectus litoralis* in Cudgen Lake) in Table 2. The disparities are presumably due to differences in interpretation of aerial photographs, production of final maps and estimation of areas.

The saltmarsh vegetation seen during field work was divided into three communities on the basis of dominant species and structure, all on interbedded estuarine sediments:

S1. *Sporobolus virginicus* – *Sarcocornia quinqueflora* dwarf to mid-high closed tussock grassland/chenopod shrubland. Inundated by spring high tides; grades sharply, or occasionally diffusely, into mangrove vegetation downslope; grades diffusely into S2 or S3 upslope where seldom inundated by high tides.

S2. *Juncus kraussii* tall to very tall closed rushland. Grades sharply or diffusely into S1 downslope with more inundation from spring high tides; grades sharply or diffusely into S3 or *Casuarina glauca* (with or without *Melaleuca quinquenervia*) swamp forest higher above the level of tidal influence.

S3. *Baumea juncea* tall to very tall closed sedgeland. Grades sharply or diffusely into S1 or S2 where occasionally subject to tidal inundation; often grades diffusely into swamp forest further upslope.

The communities recognized here are very similar to those derived from more detailed studies of estuarine wetlands in Tweed Shire. After a survey of a small wetland on the Fingal Peninsula, Murray (1987a) was able to map two mangrove units, *Avicennia* and *Excoecaria*, although his saltmarsh associations were virtually identical. In the Cobaki area, Murray (1987b) recognized an *Avicennia* unit, a *Casuarina* — *Excoecaria* unit and a saltmarsh association equivalent to S1. The units defined in the present study translate readily into the communities described by Adam *et al.* (1988) and are similar or equivalent to those recognized in south-eastern Queensland. S1 was described from Moreton Island (Durrington, 1977) and a *Sporobolus virginicus* saltmarsh was listed by McDonald and Elsol (1984). S2 is known from Moreton Island (Durrington, 1977) and from the Sunshine Coast (Batianoff and Elsol, 1989) and was listed by McDonald and Elsol (1984). S3 also occurs in south-eastern Queensland (McDonald, 1991, pers. comm.).

Twenty-two species were recorded in these three communities (Appendix 1). Most of these are native, non-woody plants typical of saltmarshes elsewhere. *Avicennia marina*, *Melaleuca quinquenervia* and *Bruguiera gymnorrhiza* were recorded as scattered emergents. Two species, *Aster subulatus* and *Baccharis halimifolia*, are introduced.

The only estuarine reserve in Tweed Shire, Ukerebagh Nature Reserve, contains 15% of the Shire's mangroves and 33% of its saltmarsh. Elsewhere on the far north coast, limited areas of saltmarsh occur in Broadwater, Bundjalung and Yuraygir National Parks (Griffith, 1983,1984, 1985). In a state context, the *Sporobolus virginicus* — *Sarcocornia quinqueflora* and *Juncus kraussii* communities are inadequately represented in reserves (Benson, 1989) and the reservation of *Baumea juncea* sedgeland is fair. All three saltmarsh communities are covered by SEPP 14.

The estuarine wetlands of the Shire have been subject to a variety of disturbances. Structural flood mitigation works in the Tweed Valley have included floodgates on tidal creeks (Soros-Longworth and McKenzie Pty. Ltd., 1981) which can seriously affect estuarine wetlands (Pressey and Middleton, 1982; Middleton *et al.*, 1985). Clearing and filling for canal estates and other developments are often directly adjacent to mangroves and have in some places extended into estuarine wetlands. Some reductions in the extent of mangroves since the 1981 aerial photography were evident in several areas during field work in 1985. The mangrove islands in the Tweed estuary and some other mangroves fringing the mainland remain relatively undisturbed, although there have been proposals for potentially damaging developments in these areas. Mapping of estuarine wetlands in the Tweed estuary over the period 1947 to 1986 shows a reduction of 20 ha (6%) in the extent of mangroves, a more substantial proportional reduction of saltmarsh from 70 to 21 ha (70%) and a reduction in the extent of seagrass of 72% (Walford, 1991, pers. comm.).

Grazing has affected some saltmarsh areas. One of the introduced plants, *Baccharis halimifolia*, which was recorded at one site is a potential invader of other areas. Another potential impact on estuarine wetlands comes from the control of biting midges which breed in intertidal areas. Watson and Watson (1984) believed that control measures were necessary in the Tweed area and that larviciding was probably the best approach. These views are still held strongly by scientists and urban planners (e.g. Allaway and Reye,

1990; Kettle, 1990). The effects of larvicide on non-target organisms are poorly understood, although limited experiments suggest they could be significant (West, 1990) and the impacts are not necessarily restricted to intertidal organisms. Species of rare and threatened butterflies inhabiting mangroves could be affected as well (Sands, 1991 pers. comm.). Control of insects in Queensland saltmarshes is also attempted by runnelling (construction of shallow drainage channels); however, the effects of this on other organisms are not well known (Adam, 1991, pers. comm.).

Floodplain Forest and Vegetation of Dunal Areas

This broad category of vegetation refers to low-lying coastal vegetation in four main physiographic positions, although there is considerable overlap of plant communities between these:

- the dune formations along the coastal strip and inland to the north and west of the Cobaki Broadwater;
- the small coastal floodplains associated with dune formations south of Kingscliff, occurring between bedrock spurs and derived from both marine and fluvial material (Roy, 1975);
- the alluvial and marine deposits surrounding mangroves and saltmarsh of the lower Tweed River such as those around Banora Point and Tweed Heads South;
- remnant areas of floodplain forest without wetland understorey near the floodplain wetlands.

Sixteen plant communities occurring in these areas were identified. The ten forest communities and the three emergent wetland communities were mapped as forest and emergent complexes, respectively. In the following descriptions, information on geology and geomorphology has been taken from Roy (1982).

F1. Littoral rainforest (low to tall simple notophyll-microphyll forest). Floristic composition variable but falls within the *Cupaniopsis anacardioides* and *Syzygium luehmannii — Acmena hemilampra* suballiances of Floyd (1990). Occupies sheltered aspects of Holocene outer barrier dunes where the soils are siliceous sands. Grades into *Banksia integrifolia* var. *integrifolia* forest where exposure to prevailing winds increases; often grades into *Melaleuca quinquenervia* (with or without *Archontophoenix cunninghamiana*) swamp forest downslope as soils become waterlogged. Both suballiances extend into south-eastern Queensland (Floyd, McDonald, 1991, pers. comm.). Conservation: the *C. anacardioides* suballiance is very well reserved over its range but the *S. luehmannii — A. hemilampra* suballiance is inadequately reserved over the southern part of its range in the Bellinger, Nambucca and Macleay Valleys (Floyd, 1990); extensive areas of both suballiances have been destroyed by mineral sand mining; in Tweed Shire, a limited area of each suballiance occurs in Ukerebagh Nature Reserve; remaining areas outside reserves are protected by State Environmental Planning Policy 26 which defines types of developments affecting designated areas of littoral rainforest and surrounding buffer zones for which the consent of local councils and the concurrence of the Director (private proponents) or Minister (Crown proponents) for Planning is required; despite this protection, many areas of the *Cupaniopsis* suballiance are excessively disturbed (Adam, 1991, pers. comm.).

F2. *Lophostemon confertus* tall to very tall closed forest (grading into mallee forest where multi-stemmed due to past fire), usually with an understorey of subtropical rainforest shrubs and small trees. Occurs on Pleistocene barrier sands of marine-aeolian origin but also extends onto sheltered bedrock slopes. Grades diffusely into *Melaleuca quinquenervia* or *Casuarina glauca* swamp forest downslope as soil waterlogging increases. Reported for sand soils in south-eastern Queensland by

Durrington (1977) and McDonald and Elsol (1984). Conservation: inadequately conserved on bedrock soils (Benson, 1989) and those derived from sand; limited areas occur on sand soils in Bundjalung and Broadwater National Parks (Griffith, 1983, 1985).

F3. *Eucalyptus pilularis* very tall open forest. Occurs on freely draining Pleistocene barrier sands of marine-aeolian origin. Grades into *Melaleuca quinquenervia* swamp forest downslope where soil waterlogging occurs. Reported in south-eastern Queensland by Durrington (1977) and McDonald and Elsol (1984). Conservation: a widespread community on the north coast in which the species *Eucalyptus gummifera*, *E. planchoniana* and *Angophora costata* can be present as associates of *E. pilularis*; well represented in reserves including Bundjalung, Yuraygir, Crowdy Head and Myall Lakes National Parks (Griffith, 1983; 1984, Myerscough and Carolin, 1986).

F4. *Callitris columellaris* tall open to closed forest. Occurs on Pleistocene barrier sands of marine-aeolian origin. Grades into *Melaleuca quinquenervia* swamp forest downslope as soil waterlogging increases; *Eucalyptus signata* is an associate in places. Reported for south-eastern Queensland by Batianoff and Elsol (1989) and Durrington (1977). Conservation: very limited areas are reserved over its range on the New South Wales north coast in Broadwater, Bundjalung and Yuraygir National Parks (Griffith, 1983, 1984, 1985); Benson (1989) considers the association to be vulnerable in a state context.

F5. *Eucalyptus tereticornis-E. intermedia-Lophostemon suaveolens* tall to very tall open forest. Typically occurs on Pleistocene backbarrier deposits of estuarine origin. Grades into *Melaleuca quinquenervia* (with or without *Casuarina glauca*) swamp forest downslope as soil waterlogging increases. Reported from south-eastern Queensland by Batianoff and Elsol (1989) while McDonald and Elsol (1984) describe similar, related communities. Conservation: apart from some 200 ha in Yuraygir National Park (Griffith, 1984), only small areas are in reserves on the north coast of the state; examples are occurrences in Ukerebagh Nature Reserve, within Tweed Shire, and in Limeburners Creek Nature Reserve in the Hastings Valley.

F6. *Eucalyptus signata* mid-high to tall open forest and woodland (grading into open mallee forest and woodland on less favourable sites). On poorly drained Pleistocene barrier sands of marine-aeolian origin. Grades into *Eucalyptus robusta* forest or wet heath downslope as soil waterlogging increases. Reported for south-eastern Queensland by Durrington (1977) and McDonald and Elsol (1984). Conservation: overall, adequately reserved in north-eastern New South Wales (Benson, 1989) but, north of the Clarence River, represented on Pleistocene sands only as tiny patches (<2 ha) in Broadwater and Bundjalung National Parks (Griffith, 1983, 1985).

F7. *Eucalyptus robusta* mid-high to very tall open forest (grading into mallee forest and woodland on less favourable sites). Occurs in low-lying, open depressions on Pleistocene backbarrier deposits of estuarine origin. Grades diffusely into *Melaleuca quinquenervia* swamp forest and borders wet heath at some locations. Reported for south-eastern Queensland by Durrington (1977) and McDonald and Elsol (1984). Conservation: considered by Benson (1989) to be adequately reserved state-wide; however, only limited areas are reserved on the far north coast in, for example, Broadwater and Bundjalung National Parks (Griffith, 1983, 1985); *E. robusta* is very poorly reserved in the southern part of its range (Adam, 1991, pers. comm.).

F8. *Melaleuca quinquenervia* tall to very tall open to closed forest (grading into woodland on less favourable sites). Occurs in low-lying open depressions, commonly on

Pleistocene backbarrier deposits of estuarine origin. Grades diffusely into *Eucalyptus robusta* and *Casuarina glauca* swamp forests; commonly borders areas of sedgeland or open water. Reported for south-eastern Queensland by Batianoff and Elsol (1989), Durrington (1977) and McDonald and Elsol (1984). Conservation: adequately reserved state-wide (Benson, 1989) but only as a small proportion of its original extent which has been largely cleared; poorly reserved in Tweed Shire with only very small areas in Stotts Island and Ukerabagh Nature Reserves; extensive in other north coast reserves including Bundjalung, Yuraygir, Crowdy Bay and Myall Lakes National Parks (Griffith, 1983, 1984; Myerscough and Carolin, 1986); most unreserved stands are protected under SEPP 14.

F9. *Archontophoenix cunninghamiana-Melaleuca quinquenervia* very tall feather palm swamp forest. Occurs in areas of impeded drainage at the base of bedrock spurs on colluvial material. Grades into *Melaleuca quinquenervia* swamp forest on sandier soils; formerly graded into moist eucalypt forest and subtropical rainforest upslope on bedrock soils before clearing of these areas. Conservation: the community falls within Floyd's (1990) *Archontophoenix-Livistona* subtropical rainforest suballiance which extends into southern Queensland (Floyd, 1991, pers. comm.) and in which *M. quinquenervia* is a common associate; Floyd (1990) rates the statewide conservation status of this suballiance as good and records that the largest single remaining stand in the state (77 ha) is in Stotts Island Nature Reserve in Tweed Shire.

F10. *Casuarina glauca* tall to very tall open to closed forest. Occurs on Holocene intertidal sediments where soils are saline or sub-saline. Grades into saltmarsh communities downslope towards high tide level and into *Melaleuca quinquenervia* and *Eucalyptus robusta* swamp forests under less saline conditions. Reported for south-eastern Queensland by Batianoff and Elsol (1989) and McDonald and Elsol (1984). Conservation: inadequately reserved state-wide (Benson, 1989); only minor areas reserved in Tweed Shire in Ukerebagh and Stotts Island Nature Reserves; limited areas reserved elsewhere on the north coast, for example in Bundjalung, Yuraygir and Crowdy Bay National Parks (Griffith, 1983, 1984); many unreserved stands are protected under SEPP 14.

Sh. *Banksia aemula* very tall (dry) shrubland to open shrubland. Occurs on Pleistocene barrier sands of marine-aeolian origin, typically on well-drained sand podzol soils. Reduced in stature to a heathland formation (community H1) on aspects exposed to prevailing onshore winds; grades into wet heathland (community H2) where soils become waterlogged. Reported for south-eastern Queensland by Batianoff and Elsol (1989), Durrington (1977) and McDonald and Elsol (1984). Conservation: unreserved in Tweed Shire but well reserved elsewhere on the north coast in, for example, Broadwater, Bundjalung, Yuraygir and Crowdy Bay National Parks (Griffith, 1983, 1984, 1985).

H1. *Banksia aemula* mid-high to tall closed (dry) heathland. Occurs on sand podzol soils derived from Pleistocene barrier sands of marine-aeolian origin. Increases in height to form a shrubland formation (community Sh) where less exposed to prevailing onshore winds; grades into wet heathland (community H2) downslope as soil waterlogging increases. Reported for south-eastern Queensland by Batianoff and Elsol (1989), Durrington (1977) and McDonald and Elsol (1984). Conservation: as for *B. aemula* shrubland.

H2. *Banksia oblongifolia-Leptospermum liversidgei-Lepyrodia interrupta-Sprengelia sprengelioides-Xanthorrhoea fulva* mid-high to tall closed (wet) heathland. Occurs in low-lying open depressions on humus podzol soils derived from Pleistocene barrier sands of marine-aeolian origin. A floristically variable community in which the

species by which it is named are characteristic but not always present together. Grades into *Banksia aemula* heathland or *Eucalyptus signata* forest/mallee forest upslope as soil drainage improves; also grades into *Eucalyptus robusta* swamp forest; replaced by sedgeland where soil waterlogging increases. Equivalent, equally variable communities have been recognized for south-eastern Queensland by Batianoff and Elsol (1989) and Durrington (1977). Conservation: as for *B. aemula* shrubland and heathland.

E1. *Baumea rubiginosa* tall closed sedgeland. Occurs in low-lying open depressions on acid peat soils derived from Pleistocene backbarrier deposits of estuarine origin. Grades into *Melaleuca quinquenervia* swamp forest upslope as drainage improves; also grades into *Triglochin procera* forbland. Conservation: unreserved in Tweed Shire but well reserved elsewhere on the north coast in, for example, Bundjalung, Yuraygir and Crowdy Bay National Parks (Griffith 1983, 1984); many near-coastal occurrences would be protected under SEPP 14 although some could occur inland of the limit of SEPP 14 mapping (Adam, 1991, pers. comm.).

E2. *Eleocharis equisetina* tall closed sedgeland. Occurs in open depressions on Holocene tidal delta sand of estuarine origin. Adjacent land has been converted to pasture but formerly probably dominated by *Casuarina glauca* swamp forest. Conservation: only known to be reserved in Hat Head National Park (Pressey, 1989b); very extensive on the floodplains of the north coast (Pressey, 1989a,b) and, although not well conserved there, unlikely to be further affected by flood mitigation or other developments.

E3. *Triglochin procera* tall forbland to tall open forbland. Occurs in open depressions on acid peat soils derived from Pleistocene backbarrier deposits of estuarine origin. Grades into *Melaleuca quinquenervia* swamp forest upslope as drainage improves; also grades into *Baumea rubiginosa* sedgeland. Conservation: a very small area occurs in Yuraygir National Park (Griffith, 1984); present over very small areas on the floodplains of the north coast (Pressey, 1989a,b).

Some vegetation types occur in coastal Tweed Shire which were not sampled during field work. One of these is a significant area of alluvial forest in Stotts Island Nature Reserve. Stotts Island supports the only substantial remnant of lowland floodplain subtropical rainforest in the state and gives an indication of the vegetation which once covered the Tweed floodplain — stands of rainforest on the higher, better-drained soils grading down into *Melaleuca quinquenervia* forest with rainforest understorey, then palm glades and finally treeless swamps (National Parks and Wildlife Service, 1979). Floyd (1990) has identified three suballiances of subtropical rainforest on Stotts Island, one of which, the *Toona-Flindersia* spp. suballiance, is one of two remaining stands of any significance in New South Wales.

Foredune vegetation was not sampled for the present study and includes the following communities, often in a complex mosaic:

- *Spinifex sericeus* low to mid-high tussock grassland of variable crown cover; also reported for south-eastern Queensland by Batianoff and Elsol (1989), Durrington (1977) and McDonald and Elsol (1984).
- *Acacia longifolia* var. *sophorae* low to tall closed shrubland; reported for south-eastern Queensland by W. McDonald (1991, pers. comm.) but reaches northern limit at Coolum;
- *Banksia integrifolia* var. *integrifolia* mid-high to tall open to closed forest (grading into shrubland on more exposed positions); *Eucalyptus intermedia* and *Lophostemon confertus* are occasional associates; reported for south-eastern Queensland by Batianoff and Elsol (1989) and Durrington (1977) and as a *B. integrifolia* — *Melaleuca quinquenervia* map unit by McDonald and Elsol (1984).

The vegetation of a small area of coastal dune on the Fingal Peninsula has also been mapped and described by Murray (1987a). Much of the foredune vegetation in Tweed Shire is regrowth following sand mining and contains non-indigenous taxa such as *Acacia saligna*, *Chrysanthemoides monilifera* ssp. *rotundata* (bitou bush) and *Leptospermum laevigatum*. Extensive stands of *Casuarina equisetifolia* var. *incana* have also been established. Tweed Shire is within the geographic range of this plant but the extent to which it occurred naturally before sand mining is uncertain. Nevertheless, it has been used to characterize a community in south-eastern Queensland (Batianoff and Elsol, 1989; Durrington, 1977; McDonald and Elsol, 1984). Statewide, foredune communities are considered to be adequately conserved (Benson, 1989) but, on the north coast, all are subject to ongoing displacement by bitou bush.

The emergent wetland complex of the dunal areas also includes stands of three unsampled vegetation types to the north of Cudgen Lake:

- *Lepironia articulata* tall closed sedgeland in low-lying open depressions on acid peat soils derived from backbarrier deposits of estuarine origin; reported for south-eastern Queensland by Batianoff and Elsol (1989) and Durrington (1977); unreserved in Tweed Shire although reasonably well represented in reserves elsewhere on the north coast, for example Bundjalung, Yuraygir, Crowdy Bay and Myall Lakes National Parks (Griffith, 1983, 1984; Myerscough and Carolin, 1986); many occurrences outside existing reserves are protected by SEPP 14 although there are some notable exceptions (Adam, 1991, pers. comm.); this association has been sampled in Tweed Shire by Murray (1989);
- *Phragmites australis* rushland;
- *Typha orientalis* rushland.

The *Phragmites* and *Typha* communities have been combined and described for the Cobaki Broadwater area by Murray (1987a), where they were mixed with *Cyperus lucidus*, and for dunal wetlands north of Cudgen Lake by Murray (1989). Benson (1989) lists both communities as adequately conserved and not threatened in coastal New South Wales but only very small areas appear to be in reserves on the north coast.

Another, somewhat variable, sedgeland community is characterized by species such as *Baumea teretifolia*, *Chorizandra sphaerocephala*, *Leptocarpus tenax*, *Restio pallens* and *Schoenus brevifolius*. It is widespread on the north coast in open depressions inundated to a lesser degree than those supporting, for example, *Lepironia articulata* or *Baumea rubiginosa* (E1). The community is equivalent to Goodrick's (1970) 'coastal bog' and, although not observed during this study of the Tweed, is likely to be present as dunal remnants. Indeed, Gilmore *et al.* (1985) reported four of the characteristic species to be conspicuous elements of some sedgelands in the Pottsville area. The community is not known to be reserved in Tweed Shire but is well conserved elsewhere on the north coast in, for example, Bundjalung, Yuraygir and Crowdy Bay National Parks and Booti Booti State Recreation Area (de Castro Lopo, 1980; Griffith, 1983, 1984). Sedgelands of comparable composition have been reported for south-eastern Queensland by Batianoff and Elsol (1989).

Estimates were made of the extent of each of the mapped communities or complexes in the floodplain forest and dunal areas at the time of the field survey in October 1985 (Table 1). The total extent of the forest complex was 2492 ha, shrubland 10 ha, dry heath 56 ha, wet heath 46 ha and the emergent complex 131 ha with an overall total area of natural or near-natural plant associations of 2735 ha remaining at that time. Within the forest complex, the forest remnants on the Tweed floodplain covered only 194 ha — 135 ha in Stotts Island Nature Reserve and 59 ha of small remnants elsewhere on the floodplain. About 92% of the remaining extent of the forest complex in

the Shire was therefore adjacent to the estuaries and on the dunal and minor floodplain formations of the narrow coastal strip.

Four hundred and twenty-three plant taxa were recorded from sampling sites within the sixteen communities listed above (Appendix 1). A further 25 taxa were recorded incidentally at other sites. Of the total 448 taxa recorded for the floodplain forest and vegetation of dunal areas, inadequate specimens allowed eight to be identified only to generic level and five to be tentatively identified. The remaining taxa were identified at least to species level. One of the recorded plants is a moss, one a clubmoss, one a selaginella, 21 are ferns, two are conifers, 110 monocotyledons and 312 dicotyledons. Families represented by the most taxa are Fabaceae (40 taxa: Caesalpinioideae 3, Fabiodeae 27, Mimosoideae 10), Poaceae (38 taxa), Myrtaceae (36), Cyperaceae (28), Asteraceae (19), Epacridaceae (16), Rutaceae (12), Euphorbiaceae (11), Lauraceae (11), Proteaceae (10) and Sapindaceae (10).

More sampling would certainly enlarge this list of taxa. The list of bryophytes, in particular, would be considerably enlarged if the less conspicuous forms were collected and recorded. Other recent surveys in Tweed Shire have provided additional locations for the taxa listed and added species to those in Appendix 1. A list of 115 plant species has been compiled for Stotts Island Nature Reserve with indices of abundance in each of several vegetation types (National Parks and Wildlife Service, 1979). Investigation reports by Meehan (1981) and Hunter (1982) listed species for particular localities in and around the Tweed estuary.

Gilmore's (1983) submission to the Tweed Shire Local Environmental Study contains the localities of significant sites for flora and fauna including the names of plants of particular interest. The very detailed survey by Gilmore *et al.* (1985) lists about 340 taxa for an area near Pottsville, many of which were not recorded in the survey reported in this paper. The inclusion of bedrock sites by Gilmore *et al.* (1985) would be an important reason for the many records additional to the present study. Murray (1987a) recorded about 160 taxa from the Wommin Lagoon area on the Fingal Peninsula, Murray (1987b) recorded about 300 taxa near the Cobaki Broadwater, including bedrock areas, and Murray (1989) listed 260 taxa for an area north of Cudgen Lake.

Of the 41 plant species in the study area considered to have particular significance for conservation (Appendix 2), 20 are listed by Briggs and Leigh (1988) as rare or threatened in a national context. Eleven species are significant because of very few records in the state, localities in Tweed Shire near their distributional limits or disjunct occurrences. Another ten are generally rare or uncommon in New South Wales. Thirty-one of the species in Appendix 2 occur on the coastal lowlands surveyed for this study and the other ten occur on adjacent bedrock areas which must be considered in co-ordinated conservation planning for these areas. Of the 20 species listed by Briggs and Leigh (1988), one is considered to be adequately reserved, six to be inadequately reserved while the adequacy of reservation of eleven is not known. The remaining two are listed as unknown from reserves, although another source (Floyd, 1990) indicates that one of these is reserved. The extent of reservation of many of the other species in Appendix 2 is also inadequate or unknown.

Floodplain forest and the vegetation of the dunal areas is highly fragmented and greatly reduced from its original extent due to clearing for agriculture and other activities. Recent clearing for canal estates and other housing developments is widespread and has significantly reduced the extent of some associations since the 1981 aerial photography. A large area of *Eucalyptus signata*, wet heath and other vegetation was cleared in 1985 on the western side of the Cobaki Broadwater. Extensive recent clearing has also affected natural vegetation on Cobaki Creek, *Melaleuca quinquenervia* near Banora Point and *Lophostemon suaveolens* south of Pottsville. Smaller, recent intrusions

into stands of vegetation from existing developments are common in the coastal parts of the Shire. Clearing for cane growing in the catchments of the coastal creeks has been accompanied by drainage which has caused settlement of the peaty soils and lowering of ground levels (Soros-Longworth and McKenzie, 1981).

Previous sand mining has greatly modified the vegetation of the immediate coastal strip. Sand dunes adjacent to Cudgen Creek underwent at least three episodes of mining before the mid-seventies (Roy, 1975). Clearing prior to sand mining has removed very extensive areas of littoral rainforest in sheltered areas behind the frontal dune. Littoral rainforest originally occurred in a nearly continuous strip south of the Queensland border to at least the Richmond River (Floyd, 1990). Sand mining has significantly modified the soil profile of areas near Pottsville (Gilmore *et al.*, 1985). Extractive industries also operate inland from the coast. Several sites in old dune deposits were being worked in 1985 near the Cobaki Broadwater and around Coolangatta Airport where vegetation was being cleared.

In many cases, the areas of remaining vegetation have been altered by various activities. Disturbance seen at or near sampling sites includes logging, burning, grazing, drainage, ringbarking and harvesting of paperbark. Gilmore *et al.* (1985) observed a local lowering of the watertable near Pottsville due to canal construction. Clearing in the catchment of Cudgen Lake is probably increasing the rate of sedimentation in this body of water (Roy, 1975). Other wetlands with catchments on the coastal bedrock slopes could also be affected.

The remaining vegetation also contains a large number of introduced species. Forty-three exotic species were recorded during the survey for the present study, 32 exotics were recorded by Gilmore *et al.* (1985), 46 by Murray (1987a), 46 by Murray (1987b) and 31 by Murray (1989). Some of these are particularly troublesome. Groundsel bush, *Baccharis halimifolia*, is a declared noxious weed and occurs in the dunal areas near Pottsville along with lantana, *Lantana camara*, bitou bush, *Chrysanthemoides monilifera*, and other species capable of invading natural vegetation (Gilmore *et al.*, 1985). Bitou bush occurs commonly in the coastal dunes disturbed by sand mining and, in the long-term, could displace littoral rainforest.

General Discussion

Extent, Decline and Conservation Status

The survey reported here has mapped and described plant communities which occupy a total area of some 3305 ha — 144 ha of floodplain wetlands, 426 ha of mangrove and saltmarsh, and 2735 ha of floodplain forest and vegetation on the dunal formations. The original extent of these communities, as estimated from the total land area below the 10 m contour in the region surveyed, was 26,450 ha. Up until 1985, the plant communities described in this paper had therefore been reduced in extent by over 87%, 97% on the Tweed River floodplain and 80% around the estuaries and along the immediate coastal strip (Table 1).

The extent of clearing would now be somewhat greater. By far the greatest reduction has been in the extent of plant communities grouped here as floodplain forest and vegetation of the dunal areas. Within this broad category, most of the forest of the Tweed floodplain has been cleared. Widespread clearing has also affected the vegetation communities of coastal south-eastern Queensland with which the communities of Tweed Shire have much in common floristically (McDonald and Elsol, 1984).

The plant communities of the low-lying coastal parts of Tweed Shire have not only been greatly reduced in extent but the remaining areas have been fragmented and altered from their original condition by a variety of factors. To these past impacts is

added the ongoing pressure for development of the coastal strip where most of the natural vegetation of the survey area remains. Moreover, this small, altered and steadily disappearing resource of native vegetation on the coastal lowlands of Tweed Shire is poorly represented in formal conservation reserves.

Stotts Island Nature Reserve contains the only significant remnant (135 ha) of alluvial forest left in Tweed Shire and 7 ha of floodplain wetland, 5% of the total remaining. The other reserve in the Shire, Ukerebagh Nature Reserve, has a total area of 120 ha and contains about 57 ha of mangroves, 18 ha of saltmarsh and 34 ha of forest complex, including examples of F2 (*Lophostemon confertus*) and F10 (*Casuarina glauca*) and a small patch of littoral rainforest. Overall, the 270 ha in these two reserves represents only 8% of the remaining vegetation on the coastal lowlands of the Shire and 1% of the original vegetation of the same area.

These reserves are far from representative of the plant communities in coastal Tweed Shire. Only alluvial forest, mangroves and saltmarsh are well represented in terms of percentage area. All the sampled forest and emergent wetland communities are either under-represented or completely unrepresented. This situation could be substantially improved by the dedication of two proposed reserves in Tweed Shire, one on the Fingal Peninsula and one in the Cudgen-Mooball area.

Other planning measures in coastal Tweed Shire afford less secure protection than formal reserves but have been effective in slowing the destruction and alteration of native habitats. SEPP 14 covers large areas of wetland, although it has missed some important wetlands. SEPP 26 protects significant areas of littoral rainforest. Mapping of protected lands under the New South Wales Soil Conservation Act, 1938 mainly covers areas with slopes greater than 18 degrees but does identify some parts of the lowlands as environmentally sensitive, including a large area to the north of the Cobaki Broadwater and the coastal dunes of the Fingal Peninsula. There is additional coverage by environmental protection zonings under the Tweed Shire Local Environmental Plan, although these miss floodplain wetlands and some significant patches of vegetation in the dunal areas. Aside from area coverage, these measures provide incomplete protection and have the potential to be removed. There is a clear case for expanding the network of protected areas in the Shire with formal reserves and the more widespread and stringent application of other protection measures.

The location of the new protected areas must be selected and their representativeness judged with criteria additional to the occurrence of plant communities. Four other considerations are important: the general biogeographic significance of the area, the importance of the low-lying coastal vegetation of Tweed Shire to the fauna of a much wider geographical area, the occurrence of rare or threatened plants and animals, and the more general problem of conserving species with limited information on their localities and requirements. These issues are discussed in turn below.

Biogeographical Significance of Tweed Shire

Biogeographically, Tweed Shire lies within a region which Burbidge (1960) called the MacPherson-Macleay Overlap, extending from the MacPherson Range in southern Queensland to the Macleay River in northern New South Wales, in which many of the plant genera of her tropical and temperate zones intermingle. Burbidge also identified many genera endemic to the Overlap.

More recently, the MacPherson-Macleay Overlap has been shown to be a region where several rainforest floristic alliances are interspersed (Webb *et al.*, 1984) and where there is a zone of overlap between megatherm and mesotherm environments with relatively high growth indices, indicating a region where plants with relatively distinct growth response curves to temperature co-occur (Nix, 1982). The biogeographic

importance of the MacPherson-Macleay Overlap has also been reinforced by McDonald and Elsol (1984) with their comprehensive analysis of plant species' distributions in coastal regions between Gladstone and Newcastle. They showed that many species reach their northern or southern limits of distribution in this broad region and in the smaller region of south-eastern Queensland and north-eastern New South Wales in which Tweed Shire lies. In another distributional analysis, Turner (1981) estimated that about 25% of the 370 species of rainforest trees and shrubs which extend southward into New South Wales reach their southern distributional limits within one degree of latitude of the border. Many of these have their southern limits in Tweed Shire (Gilmore *et al.*, 1985). The present study and that of Gilmore *et al.* (1985) showed that several non-rainforest plant species also have their southern limits in Tweed Shire or on the far north coast.

Tweed Shire also lies in a region with a diversity of terrestrial vertebrates much higher than most of the Australian land mass (Pianka and Schall, 1981) and where animal, as well as plant, species approach their southern or northern limits of distribution. Among the vertebrate fauna of Tweed and neighbouring Byron Shire are five mammal, 12 bird and one reptile species approaching their southern breeding or distributional limits, four bird, two reptile and two frog species approaching their northern distributional limits and two frogs with a restricted distribution in north-eastern New South Wales and south-eastern Queensland (Gilmore *et al.*, 1985; Milledge, 1986, 1988).

These considerations also apply to invertebrates. Several species of rare and threatened butterflies are near their southern limits in Tweed Shire (Sands, 1979, 1991, pers. comm.; Common and Waterhouse, 1981; Samson, 1989). The mangrove butterfly, *Acrodipsas illidgei*, is very rare and endangered in New South Wales with a range only from Bribie Island south to Brunswick Heads and is confined to old stands of *Avicennia marina*. *Hypochrisops apelles* is endangered, has its southern limit at the Richmond River and is also confined to mangroves. Both species would be at risk in areas which are treated chemically for midges or mosquitoes. *Pseudodipsas cephanes* occurs only in coastal lowland rainforest as far south as Iluka but is rare and becoming rarer and *Hypochrisops digglesii* is now known from only one locality in the state, in dry eucalypt forest fringing rainforest at Broken Head. The New South Wales form of *H. digglesii* is quite distinct morphologically from Queensland specimens.

The biogeographic position of Tweed Shire therefore contributes to the area's conservation significance in three ways: species at or near the ends of their geographic ranges warrant protection because of the likelihood of genetic distinctiveness and the possibility of further adaptation and extension into new habitats; the few known localities of species near the southern limits of their distributions present the only opportunities for retaining these elements of natural diversity in New South Wales; and some species have limited total ranges in and around Tweed Shire.

Wide Faunal Significance of the Tweed Shire Coastal Lowlands

Another reason for the biological significance of Tweed Shire in a broad context is that the coastal lowlands of north-eastern New South Wales and south-eastern Queensland serve as an overwintering area for bats and birds which migrate latitudinally and altitudinally (Porter, 1982; Gilmore *et al.*, 1985; Milledge, 1986; Eby, 1990). This is attributable to two factors. First, the far north coast of New South Wales has higher growth indices for primary production in all seasons than the remainder of south-eastern Australia, a difference which is particularly pronounced in winter when there is a great reduction of plant growth and associated insect activity throughout the south-east (Nix, 1976). Birds and bats are sufficiently mobile to move to the region, and to

other regions further north, when resources become limiting elsewhere. Second, extensive stands of winter-flowering trees and shrubs in the region provide a source of nectar and associated insect food for birds and bats. Of the most common trees and shrubs on the Tweed coastal lowlands, *Eucalyptus tereticornis*, *E. robusta*, *Melaleuca quinquenervia*, *Banksia aemula*, *B. integrifolia* and *B. oblongifolia* are known to flower during winter (Clifford and Specht, 1979; Clemson, 1985; Gilmore *et al.*, 1985; Milledge, 1986), as are other species recorded in the study area. Coastal heaths on the far north coast are a very valuable over-wintering resource for the apiary industry (Stace, 1988), indicating their importance for native fauna as well.

The coastal lowlands of Tweed Shire therefore play an important role in maintaining faunal populations over a much larger area. Destruction of this vegetation has wide implications which will become more serious while clearing continues for rural and urban development. Gilmore *et al.* (1985) have also suggested that further reduction of this vegetation could create a gap in the sequence of nectar availability provided by the full suite of plant species, with adverse consequences for the dependent fauna.

The estuarine wetlands of Tweed Shire also have a wider significance for fauna. Research over the last decade has established the importance of estuarine wetlands in New South Wales as feeding and nursery areas for fish, including commercial species and many others which spend their adult stages offshore (Pollard, 1976, 1984).

Rare and Threatened Species

In addition to the biogeographic considerations above, the Shire contains plant species which are listed by Briggs and Leigh (1988) as rare or threatened nationally. Of the 111 rainforest plant species, subspecies or varieties in New South Wales which are rare or threatened nationally, all but ten occur in the north coast subdivision (region 56 of Briggs and Leigh, 1988) and 21% of these are endemic to the region (Floyd, 1990).

The broader region also has a relatively high number of mammals and birds which are rare or threatened in a national context (Woinarski and Braithwaite, 1990). Other species are at risk in a state context. For example, two species of butterflies occurring on the Tweed coast warrant particular attention: *Hypochrisops epicurus*, which is confined to mangroves, and *Ogyris amaryllis*, which is associated with mangroves, *Casuarina glauca*, and certain mistletoes. The first is at risk in New South Wales and the second was locally common but is becoming scarce (Sands, 1991, pers. comm.).

By their nature, these species are difficult to find in a biological survey, even for a single development on one portion of land. They tend to be sparsely distributed locally as well as regionally and some are cryptic or only occasionally present. Continued new findings indicate that unrecorded occurrences of many of the species listed are likely in coastal Tweed Shire. This fact, and the inadequate or uncertain protection of many of these species in reserves, calls for great caution in approving additional developments in the Shire. It also emphasizes the need for detailed surveys and impact assessments to strongly influence the feasibility and design of developments.

Problems of Conserving Species

More species can be at risk in a rapidly developing region than just the ones which have been formally listed as rare or threatened. In such a region, the species not contained in formal reserves or other protected areas in the near future have an uncertain fate. The problem for species conservation is to gather enough information to ensure that a population of each is protected. In reality, a complete data base on all the species in a region is never available. Some will go unrecorded and none will be fully understood in terms of all its occurrences, variations in density or habitat requirements.

For these reasons, conservation planning relies heavily on subdivisions of regions into land classes of some sort, commonly on the basis of vegetation types. These provide the only way of seeing natural variation across the whole region, rather than through the tiny, and often unclear, windows provided by sampling sites. Even in well sampled regions, samples of the biota make up only a fraction of one percent of the landscape (Margules and Stein, 1989).

Although vegetation types or any other land classes are a necessary basis for conservation planning they are not sufficient. Land classes function as surrogates for detailed information on species and as a basis for spatial extension of data collected at some sites. However, no matter how meaningful the land classification used to judge the adequacy of and need for reserves in a region, land classes are always heterogeneous units. Representation of all land classes in a reserve system does not therefore guarantee the protection of all the region's species. Recognition of this limitation underlies the dual approach to reserve selection by the United States Nature Conservancy: a 'coarse filter' approach based on land classes and a 'fine filter' approach based on the species still in need of protection (Noss, 1987).

Intuitively, the species most likely to be missed or under-represented by land class reservation are the ones with the smallest and most patchy distributions. Other species which are threatened because of sensitivity to changes wrought by European settlement also warrant particular attention in a conservation strategy. Close attention to rare and threatened species in planning the land use of a region is therefore a logical complement to the protection of samples of each land class, a 'fine filter' approach to increase the likelihood of all species being protected.

Although logical, this complementary approach to conservation planning has an important limitation. It assumes that the only species which will slip through the 'coarse filter' and need special attention are the ones on an *a priori* list of rare or threatened plants and animals. The number of species missed by land class reservation can be large (Pressey and Bedward, 1991) and little work has been done on the characteristics of species most likely to require 'fine filter' strategies. There is thus no way to guarantee complete representation of species in a region's reserves unless sites where each species is known to occur and persist in the required numbers are included in the reserve network. Not only is this information seldom available for any significant number of species in a region but the reserve area required to achieve such a coverage would generally be prohibitively large.

Another limitation of plant communities as a basis for conservation planning is that they are incomplete reflections of faunal habitat (Pressey and Bedward, 1992). *A priori* vegetation types or other land classes are not necessarily the best descriptors of faunal habitat. In addition, plant communities do not necessarily delineate or highlight areas of critical resources such as drought refuges and overwintering areas and some animal species require combinations of vegetation types, often poorly defined, to satisfy all their needs. Without specific information on the habitat requirements of each species, some areas of particular importance to fauna might be overlooked in a conservation strategy. For example, some parts of estuarine wetlands and other areas fringing intertidal mudflats of the lower Tweed River are important as high tide roosts for wading birds. Martindale (1987) identified ten such roosts in the Tweed estuary and stressed that destruction or disturbance of these areas will adversely affect the ability of the wading birds to exploit food resources. Hunter (1982) recorded that Womgin Island in the Terranora Broadwater supported a camp of about 1200-1500 black fruit bats (*Pteropus alecto*), although the bats are known to move from one island to another periodically. Such information is impossible to glean from a classification of the landscape and stresses the importance of autecological data. The problems of temporal variation in

species occurrence and habitat suitability add an extra layer of complexity to the problem.

All these examples demonstrate the difficulty of conserving species in a relatively well-studied region because of the inevitably limited information on distributions, densities and requirements of plants and animals. Species and their particular needs can be overlooked, even by a comprehensive conservation strategy which delineates large areas for environmental protection. The limitations of available information and planning call for extreme caution in making decisions which permanently alienate natural habitat in a region such as the Tweed.

The Future

The remaining natural vegetation on the coastal lowlands of Tweed Shire is diverse in terms of communities, plant species and animal habitat and contains many species which are rare, threatened or geographically significant. The area of the plant communities mapped in 1985 represented only about 12% of the original vegetation of the coastal lowlands. Perhaps less than 10% now remains. Formal reserves in the study area total 270 ha, about one percent of the original area, and fail to represent much of the natural diversity described and mapped, although additional natural diversity is protected by less secure means.

Decisions on land use planning by local and state government have had and will continue to have serious ecological implications, not only for the biota of the Shire but also in a much wider context. The coastal parts of Tweed Shire are nationally significant biogeographically and because of the rare and threatened species present. The fauna of a large section of south-eastern Australia relies on the study area and the surrounding region as an over-wintering resource. Finally, as in any region, there are many limitations on adequately protecting species which call for a highly conservative approach to planning.

These facts put a weighty responsibility on the relevant planning authorities. They indicate the urgent need for more extensive and stringent application of existing measures for protection and challenge the justification for any further clearing of the study area. A sound basis for adequate planning and management of the remaining habitats requires four things:

- a comprehensive compilation of the data available on natural environments and species, regularly updated as new information becomes available;
- further surveys of the area, designed to fill the geographical gaps in the existing data base and to provide information on the requirements of selected species;
- immediate controls on further clearing and degradation of the remaining naturally vegetated parts of the lowlands with the onus resting on proponents of developments to demonstrate no significant impacts on the natural features of the area;
- delineation of a comprehensive network of protected areas, considering the needs for formal reservation and complementary zonings, which is regularly updated as conservation goals, data and information on the condition and extent of natural areas are refined.

The conservation of habitats and species in New South Wales, as elsewhere, is an understaffed and underfunded enterprise, reflecting the relatively low priority placed on conservation by the electorate and, therefore, by politicians. Environmental planning in coastal Tweed Shire and in many other regions is therefore beset, not only by lack of political commitment, but by lack of information. The way to adequately protect the area's natural diversity is only dimly perceived at present. A clear view and a real chance

to conserve that diversity need more from planning authorities than has been given so far.

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APPENDIX 1

*Plant species list for the study area. Plant community codes — FL: floodplain wetland complex; S: saltmarsh complex (three communities); F: forest complex (ten communities); Sh: shrubland; H1: dry heath; H2: wet heath; E: emergent wetland complex of the dunal areas (three communities). Other symbols — * indicates introduced species; ?* indicates possibly introduced; ? and *? indicate tentative identification; (Hb) indicates herbarium record; (D) indicates recorded in dunal areas but not during systematic sampling. Unless otherwise indicated, authorities for plant names are those in Harden (1990) or, for families not included in this publication, in Jacobs and Pickard (1981) as amended by Jacobs and Lapinpuro (1986)*

Taxa	Plant Community Codes
	FL S1 S2 S3 M F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 Sh H1 H2 E1 E2 E3
MOSSES	
SPAGNACEAE	
Sphagnum sp.	H2
LIVERWORTS	
RICCIACEAE	
Ricciocarpus natans (L.) Corda	FL
CLUBMOSSES	
LYCOPODIACEAE	
Lycopodium cernuum (D)	
SELAGINELLAS	
SELAGINELLACEAE	
Selaginella uliginosa	H2
FERNS	
ASPLENIACEAE	
Asplenium australasicum	F1 F4
AZOLLACEAE	
Azolla filiculoides var. *rubra*	FL E2
A. pinnata	FL
BLECHNACEAE	
Blechnum cartilagineum	F2 F8 F9
B. indicum	FL F2 F3 F7 F8 F9 E1

Taxa	Plant Community Codes																		
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
CYATHEACEAE																					
Cyathea cooperi														F9							
DENNSTAEDTIACEAE																					
Histiopteris incisa												F7	F8								
Hypolepis muelleri	FL					F1	F2					F7	F8	F9							
Pteridium esculentum						F1	F2	F3	F4	F5	F6	F7	F8			Sh	H1				
DICKSONIACEAE																					
Calochlaena dubia							F2			F5											
GLEICHENIACEAE																					
Gleichenia dicarpa													F8								
LINDSAEACEAE																					
Lindsaea fraseri (D)																					
L. linearis (D)																					
OSMUNDACEAE																					
Todea barbara						F1															
POLYPODIACEAE																					
Platycerium bifurcatum						F1	F2		F4				F8								
Pyrrosia rupestris									F4												
PTERIDACEAE																					
Acrostichum speciosum			S2																		
Pteris vittata							F2														
SCHIZAEACEAE																					
Lygodium microphyllum						F1	F2						F8	F9	F10						
SINOPTERIDACEAE																					
Pellaea falcata						F1															
P. paradoxa						F1															
THELYPTERIDACEAE																					
Christella dentata														F9							
Cyclosorus interruptus	FL												F8	F9	F10						
CONIFERS																					
ARAUCARIACEAE																					
Araucaria cunninghamii						F1								F9							
CUPRESSACEAE																					
Callitris columellaris									F4												
ANGIOSPERMS — MONOCOTYLEDONS																					
AGAVACEAE																					
Cordyline congesta (Sweet) Steudel						F1	F2			F5		F7	F8	F9							
AMARYLLIDACEAE																					
Crinum pedunculatum													F8	F9	F10						
ARACEAE																					
Alocasia macrorrhizos														F9							
* *Colocasia esculenta*	FL																				
Pothos longipes														F9							
ARECACEAE																					
Archontophoenix cunninghamiana						F1	F2						F8	F9							
Linospadix monostachya							F2														
Livistona australis						F1							F8								
COMMELINACEAE																					
Commelina cyanea	FL					F1	F2		F4	F5			F8		F10						
CYPERACEAE																					
Baumea articulata	FL												F8		F10						
B. juncea				S3											F10						
B. muelleri																		H2			
B. rubiginosa	FL												F8						E1		E3

Taxa	Plant Community Codes																			
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
Bolboschoenus caldwellii	FL																				
B. fluviatilis	FL																				
Bulbostylis barbata																	H1				
Carex appressa	FL													F9							
C. fascicularis	FL																				
C. gaudichaudiana	FL																				
C. neurochlamys	FL																				
C. sp.													F8								
Caustis recurvata											F6					Sh	H1				
Chorizandra cymbaria													F8								
Cladium procerum (D)																					
?* *Cyperus brevifolius*	FL																				
C. elatus L.															F10						
C. enervis							F2		F4	F5											
* *C. eragrostis*	FL																				
C. exaltatus	FL																				
C. haspan	FL												F8								
C. lucidus	FL												F8							E2	
C. pilosus	FL																				
?* *C. polystachyos*	FL														F10						
C. sanguinolentus	FL																				
C. sphaeroideus															F10						
C. sp.						F1	F2		F4	F5			F8	F9	F10						
(Hb) *Eleocharis dulcis*	FL																				
E. equisetina	FL																			E2	
?* *E. minuta*	FL																				
E. sphacelata	FL																				
Fimbristylis ferruginea		S1		S3											F10						
Gahnia clarkei	FL						F2			F5		F7									
G. sieberana																		H2	E1		
G. sp.										F5		F7	F8								
Isolepis inundata	FL												F8								
* *I. prolifera*	FL																				
Lepidosperma laterale R. Br.								F3													
Lepironia articulata	FL												F8								
Rhynchospora corymbosa	FL																				
?* *Schoenoplectus litoralis* (D)	FL																				
S. mucronatus	FL																				
S. validus	FL																				
Schoenus brevifolius				S3									F8					H2	E1		
S. ericetorum																	H1				
S. nitens	FL																				
DIOSCOREACEAE																					
Dioscorea transversa						F1	F2														
FLAGELLARIACEAE																					
Flagellaria indica						F1	F2							F9	F10						
HYDROCHARITACEAE																					
Ottelia ovalifolia	FL																			E2	
IRIDACEAE																					
Patersonia sericea																Sh	H1				
JUNCACEAE																					
Juncus kraussii		S1	S2	S3																	
J. polyanthemus	FL																				
J. polyanthemus x *usitatus*	FL																				
J. prismatocarpus	FL																				
J. usitatus	FL																				

Taxa	Plant Community Codes																		
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
JUNCAGINACEAE																					
Triglochin procera																					E3
T. striata	FL	S1													F10						
LEMNACEAE																					
Lemna minor	FL																				
Spirodela oligorrhiza	FL																				
S. sp.																				E2	
LILIACEAE																					
* *Asparagus densiflorus*						F1															
Dianella caerulea						F1	F2	F3	F4	F5		F7	F8		F10						
D. revoluta										F5	F6										
* *Gloriosa superba*						F1															
Tricoryne elatior (D)																					
ORCHIDACEAE																					
Acianthus fornicatus											F6										
Cryptostylis sp.							F2	F3													
Cymbidium suave							F2			F5		F7									
Pterostylis sp.							F2						F8								
PANDANACEAE																					
Pandanus pedunculatus						F1															
PHILESIACEAE																					
Eustrephus latifolius							F2			F5		F7	F8								
Geitonoplesium cymosum						F1	F2		F4	F5		F7	F8	F9	F10						
PHILYDRACEAE																					
Philydrum lanuginosum	FL												F8								
POACEAE																					
Agrostis avenacea var. *avenacea*	FL																				
* *Andropogon virginicus*										F5		F7	F8								
Aristida warburgii (D)																					
* *Axonopus affinis*						F1				F5		F7			F10						
* *Chloris gayana* (D)																					
Cymbopogon refractus										F5											
Cynodon dactylon										F5											
Digitaria parviflora							F2			F5											
? *D.* sp.	FL																				
Diplachne fusca															F10						
Entolasia marginata												F7	F8		F10						
E. stricta							F2	F3				F7	F8					H2			
Eragrostis interrupta (D)																					
Eriochloa procera															F10						
Hemarthria uncinata				S3									F8								
Imperata cylindrica var. *major*						F1	F2	F3		F5	F6	F7	F8								
Isachne globosa (D)																					
Ischaemum australe				S3									F8		F10						
Leersia hexandra	FL												F8	F9							
* *Melinis minutiflorus*										F5											
Microlaena stipoides var. *stipoides*								F3													
Oplismenus aemulus						F1	F2							F9							
O. imbecillis						F1	F2						F8								
O. sp.												F7		F9							
Ottochloa gracillima						F1									F10						
Panicum obseptum	FL																				
P. simile							F2				F6						H1				
Paspalidium distans																	H1				
P. ? *gausum*										F5											

Taxa	Plant Community Codes																		
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
* *Paspalum conjugatum*														F9	F10						
P. distichum	FL																			E2	
P. orbiculare										F5			F8								
* *P. urvillei*															F10						
P. vaginatum	FL														F10						
Phragmites australis	FL												F8	F9	F10						
* *Rhynchelytrum repens*										F5											
Sacciolepis indica										F5			F8		F10						
* *Setaria sphacelata*	FL																				
* *Sporobolus africanus*										F5											
S. virginicus		S1	S2	S3																	
Stenotaphrum secundatum						F1															
Themeda australis										F5	F6						H1				
Zoysia macrantha (D)																					
POTAMOGETONACEAE																					
Potamogeton javanicus	FL																				
RESTIONACEAE																					
Hypolaena fastigiata																	H1				
Leptocarpus tenax																		H2			
Lepyrodia interrupta																Sh		H2			
L. muelleri																			E1		
Restio pallens													F8					H2	E1		
R. tetraphyllus ssp. *meiostachyus*											F6	F7						H2			
SMILACACEAE																					
Ripogonum album							F2			F5				F9							
Smilax australis						F1	F2		F4	F5		F7	F8	F9	F10						
S. glycipylla						F1	F2	F3		F5	F6	F7		F9							
SPARGANIACEAE																					
Sparganium antipodum	FL																				
TYPHACEAE																					
Typha orientalis (D)	FL																				
XANTHORRHOEACEAE																					
Lomandra elongata																Sh					
L. longifolia						F1	F2	F3	F4	F5	F6	F7	F8								
Xanthorrhoea fulva (A. Lee) Bedford																		H2			
X. johnsonii																Sh	H1				
X. macronema								F3			F6										
ZINGIBERACEAE																					
Alpinia caerulea						F1	F2			F5		F7		F9							
ANGIOSPERMS — DICOTYLEDONS																					
AIZOACEAE																					
Carpobrotus glaucescens (D)																					
Macarthuria neocambrica (D)																					
Sesuvium portulacastrum		S1																			
AMARANTHACEAE																					
Alternanthera denticulata	FL													F9	F10						
Deeringia amaranthoides						F1															
ANACARDIACEAE																					
Euroschinus falcata var. *falcata*						F1				F5											
ANNONACEAE																					
Ancana stenopetala						F1															
Polyalthia nitidissima						F1	F2														

Taxa	Plant Community Codes																		
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
APIACEAE																					
Apium prostratum ssp. *prostratum*				S3											F10						
Hydrocotyle acutiloba (F. Muell.) N. A. Wakef.						F1															
* *H. bonariensis*	FL																				
H. verticillata															F10						
Platysace ericoides											F6						H1				
Trachymene sp.												F7									
APOCYNACEAE																					
Alyxia ruscifolia						F1															
Melodinus australis														F9							
Parsonsia straminea var. *straminea*				S3		F1	F2			F5			F8	F9	F10						
ARALIACEAE																					
Astrotricha latifolia								F3			F6	F7									
Polyscias elegans						F1			F4	F5											
* *Schefflera actinophylla* (Endl.) Harms						F1	F2			F5		F7									
ARISTOLOCHIACEAE																					
Aristolochia praevenosa						F1															
ASCLEPIADACEAE																					
Cynanchum carnosum			S2	S3											F10						
Hoya australis						F1															
Marsdenia fraseri (D) *M. rostrata*													F8								
Tylophora crebriflora						F1															
ASTERACEAE																					
* *Ageratina adenophora*													F8	F9							
* *A. riparia*	FL													F9							
* *Ageratum houstonianum*	FL																				
* *Ambrosia tenuifolia*										F5											
* *Aster subulatus*				S3									F8		F10						
* *Baccharis halimifolia*				S3						F5			F8	F9	F10					E2	
?* *Bidens pilosa*										F5											
* *Chrysanthemoides monilifera* ssp. *rotundata*						F1				F5											
* *Conyza bonariensis*								F3		F5											
* *C. parva*								F3		F5											
* *Coreopsis lanceolata* (D)																					
* *Crassocephalum crepidioides*														F9	F10						
Eclipta platyglossa															F10						
E. prostrata														F9	F10					E2	
Enydra fluctuans													F8		F10						
Helichrysum apiculatum																	H1				
* *Hypochoeris radicata*						F1															
Senecio lautus ssp. *lanceolatus*										F5											
Sigesbeckia orientalis							F2			F5											
Vernonia cinerea							F2	F3		F5			F8								
AVICENNIACEAE																					
Avicennia marina var. *australasica*		S1	S2		M																
BAUERACEAE																					
Bauera capitata																		H2			
BIGNONIACEAE																					
Pandorea jasminoides						F1															
P. pandorana ssp. *pandorana*						F1						F7									

Taxa	Plant Community Codes																			
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
BRASSICACEAE																					
Cardamine paucijuga	FL																				
?* *Rorippa* sp.	FL																				
CARYOPHYLLACEAE																					
Drymaria cordata ssp. *diandra*	FL																				
CASUARINACEAE																					
Allocasuarina littoralis										F5						Sh					
Casuarina equisetifolia (D)																					
C. glauca	FL		S2	S3		F1	F2						F8		F10					E2	
CELASTRACEAE																					
Cassine australis (Vent.)																					
Kuntze var. *australis*						F1															
Denhamia celastroides																					
(F. Muell.)						F1	F2							F9							
Loeseneriella barbata						F1															
CHENOPODIACEAE																					
Einadia nutans ssp. *linifolia*												F7									
Sarcocornia quinqueflora		S1																			
Suaeda australis		S1													F10						
CONVOLULACEAE																					
Convolvulus erubescens										F5											
Dichondra repens													F8								
* *Ipomoea cairica*						F1	F2			F5			F8	F9	F10					E2	
CUCURBITACEAE																					
Diplocyclos palmatus						F1															
DILLENIACEAE																					
Adrastaea salicifolia																		H2			
Hibbertia aspera (D)																					
H. dentata													F8								
H. fasciculata																Sh	H1				
H. linearis											F6										
H. scandens						F1	F2	F3		F5			F8	F9							
DROSERACEAE																					
Drosera auriculata																		H2			
D. spathulata																		H2			
EBENACEAE																					
Diospyros fasciculosa						F1															
D. pentamera						F1															
ELAEOCARPACEAE																					
Elaeocarpus grandis						F1															
E. obovatus						F1	F2					F7									
E. reticulatus						F1	F2	F3		F5	F6	F7	F8								
EPACRIDACEAE																					
Brachyloma daphnoides																	H1				
B. scortechinii											F6										
Epacris microphylla																		H2			
E. obtusifolia																		H2			
E. pulchella																Sh	H1	H2			
Leucopogon deformis																	H1				
L. ericoides											F6						H1				
L. lanceolatus var. *gracilis*						F1				F5	F6	F7									
L. leptospermoides									F4		F6	F7				Sh	H1	H2			
L. margarodes								F3	F4	F5	F6	F7									
L. virgatus																	H1				
Monotoca elliptica						F1			F4	F5	F6					Sh					
M. scoparia											F6					Sh	H1				
Sprengelia sprengelioides																		H2			

Taxa	Plant Community Codes																		
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
Styphelia viridis											F6					Sh					
Trochocarpa laurina						F1	F2			F5				F9							
EUPHORBIACEAE																					
Actephila lindleyi						F1															
Breynia oblongifolia						F1	F2		F4	F5		F7	F8	F9							
Drypetes australasica						F1	F2			F5				F9							
Excoecaria agallocha					M										F10						
Glochidion ferdinandi						F1	F2	F3		F5		F7	F8	F9							
G. sumatranum						F1	F2	F3		F5		F7	F8	F9	F10						
Macaranga tanarius						F1	F2			F5		F7		F9							
Mallotus discolor						F1															
Omalanthus populifolius						F1	F2					F7		F9							
Pseudanthus orientalis																					
Ricinocarpos pinifolius																	H1				
EUPOMATIACEAE																					
Eupomatia laurina						F1	F2														
FABACEAE																					
Sub-Family																					
CAESALPINIOIDEAE																					
Caesalpinia scortechinii							F2														
* *Cassia coluteoides*						F1	F2														
* *C. floribunda*						F1							F8								
Sub-Family FABOIDEAE																					
Aotus ericoides											F6	F7				Sh	H1	H2			
A. lanigera																		H2			
Bossiaea ensata																	H1				
B. heterophylla																Sh					
Chorizema parviflorum (D)																					
?* *Crotalaria incana*										F5											
Daviesia arborea									F4												
D. umbellulata (D)																					
Desmodium nemorosum													F8								
D. rhytidophyllum						F1				F5											
* *D. uncinatum* (Jacq.) DC.														F9							
D. varians									F4												
Dillwynia floribunda var. *floribunda*																		H2			
D. retorta											F6					Sh					
Glycine clandestina										F5											
Gompholobium virgatum											F6					Sh	H1				
Hovea acutifolia							F2	F3	F4	F5		F7									
Indigofera australis										F5											
Jacksonia scoparia																	H1				
Kennedia rubicunda						F1	F2	F3	F4	F5	F6	F7									
Kunstleria blackii														F9							
* *Macroptilium atropurpureum* (D)																					
Millettia megasperma														F9							
Mucuna gigantea						F1															
Oxylobium robustum								F3	F4			F7									
Phyllota phylicoides																		H2			
Pultenaea villosa								F3													
Sub-Family																					
MIMOSOIDEAE																					
Acacia aulacocarpa									F4	F5	F6										
A. baueri ssp. *baueri*																	H1				
A. longifolia var. *sophorae*						F1							F8				H1				

Taxa	Plant Community Codes																		
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
A. longissima								F3													
A. maidenii	FL																				
A. melanoxylon						F1	F2					F7	F8								
A. obtusifolia											F6	F7									
A. saligna (D)																					
A. suaveolens											F6					Sh	H1				
A. ulicifolia									F4		F6	F7				Sh	H1				
Archidendron hendersonii (F. Muell.)						F1	F2														
GOODENIACEAE																					
Dampiera stricta																	H1				
HALORAGACEAE																					
Gonocarpus micranthus ssp. *ramosissimus*																		H2			
G. tetragynus								F3													
* *Myriophyllum aquaticum*	FL																				
LAURACEAE																					
Cassytha glabella																Sh	H1	H2			
C. pubescens											F6	F7				Sh	H1	H2			
* *Cinnamomum camphora*						F1	F2			F5		F7	F8	F9							
Cryptocarya foetida						F1	F2														
C. microneura						F1	F2						F8	F9							
C. triplinervis						F1	F2			F5				F9							
Endiandra discolor						F1	F2			F5			F8	F9							
E. globosa														F9							
E. sieberi							F2	F3		F5		F7									
Litsea australis						F1	F2							F9							
Neolitsea dealbata													F8	F9							
LENTIBULARIACEAE																					
Utricularia australis																				E2	
U. lateriflora																		H2			
LOBELIACEAE																					
Lobelia alata															F10						
L. trigonocaulis						F1															
Pratia purpurascens										F5			F8								
LORANTHACEAE																					
Dendrophthoe vitellina													F8								
MALVACEAE																					
Hibiscus diversifolius						F1							F8		F10						
H. splendens													F8								
H. tiliaceus					M										F10						
MELASTOMATACEAE																					
Melastoma affine						F1		F3		F5			F8								
MELIACEAE																					
Dysoxylum rufum						F1															
Synoum glandulosum							F2							F9							
MENISPERMACEAE																					
Hypserpa decumbens						F1															
Stephania japonica						F1	F2			F5		F7	F8	F9							
MENYANTHACEAE																					
Villarsia exaltata													F8		F10						
MONIMIACEAE																					
Wilkiea heugeliana														F9							
MORACEAE																					
Ficus coronata						F1							F8	F9							
F. fraseri						F1															
F. obliqua						F1															

Taxa	Plant Community Codes																			
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
F. rubiginosa						F1			F4												
F. superba var. *henneana*														F9							
F. virens														F9							
F. watkinsiana						F1															
Maclura cochinchinensis						F1	F2			F5			F8	F9	F10						
Malaisia scandens						F1	F2														
MYRSINACEAE																					
Aegiceras corniculatum					M																
Embelia australiana														F9							
Rapanea howittiana														F9	F10						
R. subsessilis						F1															
R. variabilis						F1				F5											
MYRTACEAE																					
Acmena hemilampra						F1															
A. smithii						F1	F2	F3		F5		F7	F8	F9	F10						
Archirhodomyrtus beckleri														F9							
Austromyrtus dulcis						F1	F2	F3	F4	F5	F6	F7				Sh					
Baeckea linearis																Sh	H1				
B. stenophylla									F4									H2			
Callistemon pachyphyllus													F8					H2	E1		E3
C. salignus	FL					F1	F2	F3		F5		F7	F8	F9	F10						
Eucalyptus grandis							F2							F9							
E. gummifera								F3			F6										
E. intermedia							F2		F4	F5		F7				Sh					
E. pilularis								F3													
E. propinqua													F8								
E. robusta	FL										F6	F7	F8					H2			
E. signata									F4		F6										
E. tereticornis										F5											
Homoranthus virgatus											F6					Sh	H1				
Leptospermum attenuatum											F6										
L. flavescens								F3			F6	F7				Sh					
L. juniperinum													F8								
L. laevigatum																	H1				
L. liversidgei																		H2	E1		
L. semibaccatum																	H1				
L. whitei								F3			F6	F7				Sh		H2			
Lophostemon confertus							F2	F3		F5	F6	F7	F8			Sh					
L. suaveolens	FL						F2	F3		F5			F8								
Melaleuca linariifolia	FL												F8								
M. quinquenervia	FL			S3		F1	F2	F3		F5		F7	F8	F9	F10			H2	E1		E3
M. thymifolia																		H2			
Pilidiostigma glabrum							F2														
Rhodomyrtus psidioides						F1															
Syzygium coolminianum							F2			F5											
S. francisii														F9							
S. luehmannii						F1	F2														
S. oleosum (F. Muell.) B. Hyland						F1	F2			F5			F8								
Tristaniopsis laurina						F1															
NYCTAGINACEAE																					
* *Bougainvillaea spectabilis* Willd.										F5											
NYMPHAEACEAE																					
* *Nymphaea capensis*	FL																				
OCHNACEAE																					
* *Ochna serrulata*						F1	F2						F8	F9							

Taxa	Plant Community Codes																		
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
OLACACEAE																					
Olax retusa																		H2			
OLEACEAE																					
Jasminum volubile						F1															
* *Ligustrum sinense*							F2						F8								
Notelaea longifolia						F1	F2			F5											
ONAGRACEAE																					
Ludwigia octovalvis (D)	FL																				
L. peploides ssp. *montevidensis*	FL																			E2	
* *L. peruviana*															F10						
PASSIFLORACEAE																					
* *Passiflora edulis*						F1	F2					F7									
P. herbertiana										F5											
* *P. suberosa*												F7									
* *P. subpeltata*						F1	F2			F5			F8	F9							
PITTOSPORACEAE																					
Pittosporum revolutum						F1	F2		F4	F5		F7			F10						
POLYGALACEAE																					
Comesperma defoliatum																		H2			
POLYGONACEAE																					
Persicaria attenuata	FL																			E2	
P. decipiens	FL																			E2	
P. dichotoma	FL																				
P. hydropiper	FL														F10					E2	
P. orientalis	FL																				
P. strigosa													F8	F9						E2	
P. strigosa/praetermissa	FL																				
P. subsessilis	FL																				
* *Rumex crispus*	FL																				
PRIMULACEAE																					
Samolus repens		S1																			
PROTEACEAE																					
Banksia aemula											F6					Sh	H1				
B. integrifolia						F1	F2		F4	F5											
B. oblongifolia																	H1	H2			
B. robur								F3					F8					H2			
Conospermum taxifolium																	H1				
Lomatia silaifolia (D)																					
Persoonia attenuata						F1															
P. cornifolia						F1		F3	F4	F5						Sh					
P. virgata											F6					Sh		H2			
Strangea linearis																Sh	H1				
RANUNCULACEAE																					
Clematis glycinoides						F1															
Ranunculus inundatus	FL													F9	F10					E2	
R. plebius	FL																				
RHAMNACEAE																					
Alphitonia excelsa						F1	F2			F5		F7	F8								
RHIZOPHORACEAE																					
Bruguiera gymnorrhiza			S2		M																
Rhizophora stylosa					M																
ROSACEAE																					
Rubus hillii														F9							
R. parvifolius						F1				F5											
R. rosifolius														F9							

Taxa	Plant Community Codes																		
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
RUBIACEAE																					
Canthium odoratum						F1															
Coelospermum paniculatum						F1	F2														
Hodgkinsonia ovatiflora						F1															
Morinda jasminoides						F1	F2														
Pomax umbellata								F3	F4	F5	F6		F8								
Psychotria loniceroides						F1	F2														
RUTACEAE																					
Acronychia imperforata						F1	F2		F4	F5		F7									
A. littoralis T. Hartley & J. Williams						F1			F4												
A. wilcoxiana						F1	F2														
Boronia falcifolia																		H2			
B. parviflora													F8								
B. rosmarinifolia											F6										
Euodia elleryana						F1	F2						F8								
Flindersia bennettiana						F1	F2														
F. schottiana						F1															
Halfordia kendack						F1	F2														
Zieria laevigata											F6					Sh	H1				
Z. smithii							F2					F7	F8								
SANTALACEAE																					
Exocarpos latifolius						F1	F2														
Lepotomeria acida											F6							H2			
SAPINDACEAE																					
Alectryon coriaceus						F1															
Arytera divaricata						F1															
Cupaniopsis anacardioides						F1	F2			F5			F8		F10						
Dodonaea triquetra									F4	F5	F6		F8			Sh					
Guioa semiglauca						F1	F2						F8	F9							
Harpullia hillii						F1															
Jagera pseudorhus						F1	F2						F8	F9							
Lepiderema pulchella Radlk. (D)																					
Mischocarpus pyriformis						F1	F2		F4	F5				F9							
Sarcopteryx stipitata													F8								
SAPOTACEAE																					
Planchonella chartacea						F1	F2							F9							
P. laurifolia						F1															
SCROPHULARIACEAE																					
Bacopa monnieri	FL														F10						
SIMAROUBACEAE																					
Ailanthus triphysa						F1															
SOLANACEAE																					
Duboisia myoporoides						F1						F7									
* *Solanum mauritianum*							F2					F7	F8	F9	F10						
* *S. nigrum*														F9	F10						
* *S. seaforthianum*						F1															
STERCULIACEAE																					
Commersonia bartramia						F1	F2														
Sterculia quadrifida						F1															
SYMPLOCACEAE																					
Symplocos stawellii						F1	F2							F9							
THYMELAEACEAE																					
Pimelia linifolia											F6						H1	H2			
Wikstroemia indica										F5											

Taxa	Plant Community Codes																		
	FL	S1	S2	S3	M	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Sh	H1	H2	E1	E2	E3
TREMANDRACEAE																					
Tetratheca thymifolia																	H1				
ULMACEAE																					
Aphananthe philippinensis														F9							
Celtis paniculata						F1															
Trema aspera						F1	F2														
URTICACEAE																					
Dendrocnide moroides						F1															
D. photinophylla						F1															
VERBENACEAE																					
Clerodendrum floribundum						F1	F2			F5											
Gmelina leichhardtii						F1															
* *Lantana camara*						F1	F2		F4	F5		F7	F8	F9	F10						
VIOLACEAE																					
Viola hederacea						F1	F2			F5		F7	F8		F10						
VITACEAE																					
Cayratia clematidea							F2														
C. eurynema B. L. Burtt						F1															
Cissus antarctica						F1								F9							
C. hypoglauca						F1	F2			F5			F8								
C. sterculiifolia						F1	F2														
WINTERACEAE																					
Tasmannia insipida							F2														

APPENDIX 2

Plant species of particular conservation significance. Numbers of sites refer to sampling sites for this study; locality information also includes some areas of bedrock on Round Mountain and adjacent to extensive wetlands south of Pottsville and south of the Cobaki Broadwater because of the need to consider these jointly with low-lying lands in conservation planning; authorities given only for species not in Appendix 1 or not covered by sources for Appendix 1

Species (Family)	Status, Distribution, Comments
Acacia bakeri (Fabaceae).	Listed by Briggs and Leigh (1988) as 3VC-: range over 100 km, vulnerable, reserved but adequacy of reservation unknown. Southern limit of distribution is Brunswick Heads (Floyd, 1989). Recorded by Murray (1987b) from a bedrock spur near wetlands south of the Cobaki Broadwater and from other specific sites in Tweed Shire.
Acacia baueri ssp. ***baueri*** (Fabaceae).	This plant is very rare on the north coast of New South Wales (Griffith, 1983, 1984, 1985; Pressey and Griffith, 1987) and has been described as rare and in danger of extinction over its range in the extreme south-east of Queensland (Stanley and Ross, 1983). The National Herbarium of New South Wales has north coast collections from Port Stephens, (1 plant in 1912), Myall Lakes (1 in 1987), Nabiac (subject to past and present sand mining), Crowdy Bay and South West Rocks. Recorded in disturbed dry heathland north of Kingscliff.
Acronychia littoralis (Rutaceae).	Rare (Williams *et al.*, 1984). Listed by Briggs and Leigh (1988) and Leigh and Briggs (1992) as 3ECi: range over 100 km, endangered, inadequately reserved. Communities: F1 (one site); a few trees on roadside close to sampling site in F4 — possibly present in the community as it occurs in similar habitat in Bundjalung National Park.
Amorphospermum antilogum (Sapotaceae).	Range extends from the Tweed River to the Olive River in northern Queensland (Floyd, 1989) over which it has a number of disjunct occurrences (Hunter, 1991, pers. comm.). Occurs in lowland subtropical rainforest on stony slopes (Floyd, 1989). Known from four records in the Tweed including a gully to the south of Round Mountain (Floyd, 1989; Hunter, 1991, pers. comm.).
Angiopteris evecta (Angiopteridaceae).	Listed by Leigh and Briggs (1988) as 3RC-: range over 100 km, rare, reserved but adequacy of reservation unknown. Confined to the Tweed Valley and listed as very rare in New South Wales by Harden (1990) but extends into eastern Queensland and the Carnarvon Range (Andrews, 1990). The only specimen known for the state occurs on the edge of the floodplain of a tributary of Cudgera Creek (Hunter, 1991, pers. comm.).
Archidendron hendersonii (Fabaceae).	An uncommon species reduced in abundance because of clearing and sand mining; southern limit of distribution is the Richmond River. Communities: F1 (one site); F2 (two sites). Occurs in Ukerebagh Nature Reserve. Also recorded by Gilmore *et al.* (1985) on bedrock and floodplain south of Pottsville, by Murray (1987a) from littoral rainforest near Wommin Lagoon on the Fingal Peninsula, by Murray (1987b) from the margin of *Melaleuca quinquenervia* forest near the Cobaki Broadwater and by Hunter (1991, pers. comm.) from the northern edge of the Tweed River next to McAuleys Road. Records for Tweed Shire listed by Floyd (1989) are from Stotts Island Nature Reserve, Wooyung, Terranora, Tweed Heads, Mooball State Forest and Murwillumbah.
Archidendron muellerianum (Maiden and R. Barker) Nielsen (Fabaceae).	Listed by Briggs and Leigh (1988) as 3RCa: range over 100 km, rare, adequately reserved. Limited distribution from Tallebudgera Creek in far south-eastern Queensland to the Richmond River. Recorded by Murray (1987b) from *Melaleuca quinquenervia* forest south of the Cobaki Broadwater. Other records for Tweed Shire are listed by Floyd (1989).
Baumea nuda (Cyperaceae).	Collection from sedgeland near Pottsville in 1985 was the third record for the state (Gilmore *et al.*, 1985).
Banksia robur (Proteaceae).	Of regional significance because of disjunct distribution in coastal New South Wales. Considered by George (1981) to occur in two principal areas: one from Kempsey to Wollongong in New South Wales and another from Coolangatta to Shoalwater Bay in Queensland. Records in Tweed Shire

Species (Family)	Status, Distribution, Comments
	are therefore extensions of the previously known northern population. Absent from Broadwater National Park in the Richmond River region and from Bundjalung and Yuraygir National Parks in the Clarence River region although present southwards from Hat Head National Park in the Macleay River region. Communities: F3 (one site); F8 (one site and reported by Hunter, 1982, from elsewhere in this association); H2 (one site). Also reported from the Cudgen Lake area by Murray (1989) and from forested land near Pottsville (Gilmore *et al.*, 1985) which is probably the southern limit of the north coast disjunction.
Boronia rosmarinifolia (Rutaceae).	Apparently rare over its range on the north coast of New South Wales and only known to be reserved at one location in the Sandon area of Yuraygir National Park (Griffith, 1984); confined to the north coast of New South Wales but extends into Queensland where it is reported to be locally common in coastal heathland (Stanley and Ross, 1983); status requires investigation. Communities: F6 (one site).
Bosistoa transversa (Rutaceae).	Listed by Briggs and Leigh (1988) as 3VC-: range greater than 100 km, vulnerable, reserved but adequacy of reservation unknown. Distribution from Mullumbimby to Maryborough in Queensland (Floyd, 1989). Recorded for Stotts Island Nature Reserve by Briggs and Leigh (1988). Other Tweed records listed by Floyd (1989).
Caesalpinia scortechinii (Fabaceae).	Occurs in subtropical and dry rainforest north of Lismore and extends into Queensland (Williams and Harden, 1988); uncommon in New South Wales (Williams, 1985, pers. comm.). Communities: F2 (one site).
Cassia marksiana (Fabaceae).	Listed by Briggs and Leigh (1988) as 3VCi: range over 100 km, vulnerable, inadequately reserved. Known from very few specimens and over a very restricted range from Crabbes Creek to Currumbin. Hunter (1991, pers. comm.) reports it as occurring only as scattered populations or single specimens in New South Wales and generally on alluvial flats and adjacent bedrock margins. Found on the lower edge of a bedrock spur to the south of the Cobaki Broadwater by Murray (1987b) and listed by Floyd (1989, 1990) from several localities including Stotts Island Nature Reserve.
Cayratia acris (Vitaceae).	Considered to be uncommon in New South Wales (Williams, 1985, pers. comm.; Floyd, 1990). Reported from Round Mountain (Hunter, 1985, pers. comm.; Floyd, 1990).
Cordyline congesta (Agavaceae).	Listed by Briggs and Leigh (1988) as 2RC-: range less than 100 km, rare, reserved but adequacy of reservation unknown. Occurs in extreme south-eastern Queensland and in north-eastern New South Wales (Pedley, 1986, and see Williams *et al.*, 1984 who listed it as *Cordyline* sp. aff. *stricta*). In New South Wales, extends south to Ballina and is generally confined to near-coastal areas where it can be locally common (Hunter, 1991, pers. comm.). Communities: F1 (one site); F2 (three sites); F5 (one site); F7 (one site); F8 (one site); F9 (two sites). Occurs in Ukerebagh Nature Reserve.
Cryptocarya foetida (Lauraceae).	Listed by Briggs and Leigh (1988) as 3VCi: range greater than 100 km, vulnerable, inadequately reserved; occurs in littoral rainforest from Ballina to Fraser Island. Very few fertile specimens known and recent records from higher altitude rainforest on basalt (Hunter, 1991, pers. comm.). Communities: F1 (two sites); F2 (one site). Two good populations with fruiting specimens occur at Fingal Head and on the northern side of Terranora Lake at the foot of a bedrock slope (Hunter, 1991, pers. comm.). Also recorded by Murray (1987b) from the margin of a bedrock spur to the south of the Cobaki Broadwater. Floyd (1989) and Hunter (1991, pers. comm.) have listed additional records for the Tweed region.
Cupaniopsis newmanii S. Reyn. (Sapindaceae).	Limited range from Mullumbimby to Mount Tambourine (Williams *et al.*, 1984; Floyd, 1989). Recorded by Gilmore *et al.* (1985) on bedrock near Pottsville. Additional Tweed records listed by Floyd (1989).
Cyperus haspan ssp. ***juncoides*** (Lam.) Kuk. (Cyperaceae).	Collection from dune near Pottsville in 1985 was the third record for the state (Gilmore *et al.*, 1985).

Species (Family)	Status, Distribution, Comments
Dendrocnide moroides (Urticaceae).	Extremely rare in New South Wales but more common in Queensland (Williams *et al.*, 1984). Known present locations of the species are all in the Tweed region (Hunter, 1991, pers. comm.). Communities: F1 (one site — Camp Wollumbin). Other records include Round Mountain near Cudgen Lake (Gilmore, 1983; Hunter, 1991, pers. comm.; Floyd, 1990), Murwillumbah (Floyd, 1989) and Reserve Creek, near Round Mountain (Floyd, 1990; Hunter, 1991, pers. comm.).
Desmodium acanthocladum (Fabaceae).	Listed by Briggs and Leigh (1988) as 2V: range less than 100 km, vulnerable, not known to be reserved (although Floyd, 1990, lists it as reserved). A shrub occurring only on the north coast of New South Wales, between the Clarence and Tweed Rivers, where it has been recorded from the margins of subtropical and dry rainforests (Williams *et al.*, 1984). Only two records for the Tweed, from the Eungella Dip area on the Oxley River and Wollumbin Wildlife Refuge (Hunter, 1991, pers. comm.).
Diospyros mabacea (Ebenaceae).	Listed by Briggs and Leigh (1988) and Leigh and Briggs (1992) as 2ECi: range less than 100 km, endangered, inadequately reserved. Restricted to the Tweed River Valley (Williams *et al.*, 1984; Floyd, 1989) and recorded for Stotts Island Nature Reserve (Floyd, 1989).
Diploglottis campbellii (Sapindaceae).	Listed by Briggs and Leigh (1988) and Leigh and Briggs (1992) as 2E: range less than 100 km, endangered, not known to be reserved. Occurs in riverine rainforest from Tintenbar, on the Richmond River, to upper Tallebudgera Creek in south-eastern Queensland (Floyd, 1989). The best remaining population in the Tweed is on the floodplain of the Oxley River at Eungella Dip (Hunter, 1991, pers. comm.). Other Tweed records listed by Floyd (1989).
Eleocharis dulcis (Cyperaceae).	A herbarium record of this species, from a drain near Murwillumbah, represents its known southern limit, although it is widespread in northern Australia (K. Wilson, Nat. Herb. NSW, 1985, pers. comm.). The species could be present in wetlands on the floodplain or in the dunal areas.
Endiandra globosa (Lauraceae).	Listed by Briggs and Leigh (1988) as 2RC-: range less than 100 km, rare, reserved but adequacy of reservation not known; restricted to lowlands between Mullumbimby and the Gold Coast hinterland (Floyd, 1990). Locally common on metasediments and alluvials in the Tweed-Brunswick region (Hunter, 1991, pers. comm.). Communities: F9 (seen near one site). Also reported on Round Mountain near Cudgen Lake (Gilmore, 1983; Floyd, 1990; Hunter, 1991, pers. comm.), from bedrock and swamp margin south of Pottsville (Gilmore *et al.*, 1985), from the footslopes of a ridge to the south of the Cobaki Broadwater (Murray, 1987b) and from Tanglewood, west of Bogangar, and floodplain margins east of Mooball by Hunter (1991, pers. comm.). Floyd (1989) lists other Tweed records.
Endiandra hayesii (Lauraceae).	Listed by Briggs and Leigh (1988) as 3VC-: range greater than 100 km, vulnerable, reserved but adequacy of reservation unknown. Ranges from the Richmond River to Burleigh Heads in Queensland (Floyd, 1989). Reported from bedrock areas adjacent to coastal wetlands south of Pottsville (Gilmore *et al.*, 1985). Additional Tweed records listed by Floyd (1989).
Geodorum densiflorum (Orchidaceae).	In New South Wales, confined to the coastal region north from the Macleay River (Metcalfe in Beadle, 1987); considered to be uncommon in the state (B. Wallace, Nat. Herb. NSW, 1986, pers. comm.), although apparently common in Queensland. Recorded from bedrock ridges 2 km south of Norries Head, Bogangar (Griffith, 1986).
Hypserpa decumbens (Menispermaceae).	Very rare in New South Wales, known only from Brunswick Heads and Cudgen Lake (Williams, 1991, pers. comm.) and one site in community F1 at Mooball Creek. Extends into south-eastern Queensland.
Lepiderema pulchella (Sapindaceae).	A rare plant occurring from the Brunswick River to Tallebudgera Creek in southern Queensland (Williams *et al.*, 1984; Floyd, 1989). Listed by Briggs and Leigh (1988) as 2RC-: range less than 100 km, rare, reserved but adequacy of reservation unknown. One shrub seen in a highly disturbed area at the end of Mahers Lane, Terranora (D24). Hunter (1991, pers. comm.) reports the species scattered throughout the foothills immediately

Species (Family)	Status, Distribution, Comments
	south of Terranora Road and McAuleys Road and on the north side of Terranora Lake. Not reserved in this area but recorded from Stotts Island Nature Reserve (Floyd, 1989, who lists other Tweed records).
Lindsaea fraseri (Lindsaeaceae).	Locally common in an area of swamp forest-dry sclerophyll forest ecotone 2 km south of Norries Head, Bogangar (Griffith, 1986). This is one of four records for the state, the others coming from the same general locality (Nat. Herb. NSW, 1986, pers. comm.). Extends into southern Queensland.
Macadamia tetraphylla (Proteaceae).	Listed by Briggs and Leigh (1988) as 2VC-: range less than 100 km, vulnerable, reserved but adequacy of reservation not known. According to Floyd (1989), confined chiefly to the Tweed and Richmond Rivers in New South Wales, extending into the Numinbah Valley and Coomera River in south-eastern Queensland and occurring in subtropical rainforest near the coast. Although more common at higher altitudes, found occasionally on toeslopes adjoining the coastal plain, for example east of Mooball on the Pottsville Road (Hunter, 1991, pers. comm.). Floyd (1989) lists other Tweed records.
Maundia triglochinoides (Juncaginaceae).	Limited range between far south-eastern Queensland and about Wyong in New South Wales; status poorly known but thought to be rare (Pressey, 1989a,b). Collected in wetland habitat near Pottsville by Gilmore *et al.* (1985).
Ochrosia moorei (Apocynaceae).	Listed by Leigh and Briggs (1988) as 2RC-: range less than 100 km, rare, reserved but adequacy of reservation unknown. Occurs in riverine and lowland subtropical rainforest from the Richmond River to Springbrook and Currumbin Creek in south-eastern Queensland (Floyd, 1989) who lists Tweed records. One specimen occurs in a small remnant of floodplain rainforest on Cudgera Creek, about 5 km south-west of Pottsville (Hunter, 1991, pers. comm.).
Planchonella laurifolia (Sapotaceae).	Tweed records are close to the southern limit of distribution at the Brunswick River. Habitat is littoral and dry rainforest (Floyd, 1990) and is mostly now cleared (Hunter, 1991, pers. comm.). Communities: F1 (one site). Also recorded from swamp forest and palm forest along gullies to the south of Round Mountain (Gilmore, 1983) and on Round Mountain (Hunter, 1985, pers. comm.). Most records listed by Floyd (1990) are from the Tweed, including several from the area covered by the present study.
Polyalthia nitidissima (Annonaceae).	Rare in New South Wales; recorded from Iluka, Cudgen Lake and Terranora (Floyd, 1989). Occurs in Ukerebagh Nature Reserve. Communities: F1 (one site); F2 (one site).
Potamogeton javanicus (Potamogetonaceae).	Known only from the central and north coast botanical subdivisions of the state (Sainty and Jacobs, 1981) and recorded very rarely over this range although it is widespread in northern Australia and overseas (Aston, 1973). Recorded in one floodplain wetland.
Rhodamnia maideniana (Myrtaceae).	Listed by Briggs and Leigh (1988) as 2RC-: range less than 100 km, rare, population reserved but adequacy of reservation unknown; occurs in occasional populations from Tallebudgera Creek in far south-eastern Queensland to the Richmond River (Williams *et al.*, 1984), more commonly above the coastal lowlands (Hunter, 1991, pers. comm.). Recorded on Round Mountain (Hunter, 1985, pers. comm.) and from the margin of a bedrock spur to the south of the Cobaki Broadwater (Murray, 1987b).
Sterculia quadrifida (Sterculiaceae).	Uncommon to rare (Williams *et al.*, 1984; Floyd, 1990). Occurs as far south as Coraki in New South Wales (Floyd 1989). Communities: F1 (one site). Floyd (1989) records it from Stotts Island Nature Reserve, Round Mountain and other sites in the Tweed region. Also recorded from Ukerabagh Nature Reserve (Hunter, 1991, pers. comm.).
Strangea linearis (Proteaceae).	Confined to the sandmasses of the far north coast of New South Wales and south-eastern Queensland. Formerly considered to be rare or threatened nationally (Leigh *et al.*, 1981) but not listed by Briggs and Leigh (1988). Nevertheless, only reserved at one place in the state, in Tyagarah Nature Reserve south of Brunswick Heads (Hunter, 1991, pers. comm.). Communities: Sh (one site); H1 (one site); also recorded by Murray (1989) in dry heath and tall shrubland near Cudgen Lake.

Species (Family)	Status, Distribution, Comments
Syzygium moorei (Myrtaceae).	Listed by Briggs and Leigh (1988) as 2VCi: range less than 100 km, vulnerable, population inadequately reserved. Recorded on bedrock areas adjacent to extensive wetlands south of Pottsville (Gilmore *et al.*, 1985). Other records by Hunter (1991, pers. comm.) are on the northern side of the Terranora Broadwater, on a toeslope adjacent to littoral rainforest at Fingal Head, on alluvium between Fingal and Kingscliffe, in palm rainforest at the eastern base of Round Mountain, at Tanglewood, and on floodplain east of Mooball.
Thozetia racemosa (Asclepiadaceae).	Listed by Briggs and Leigh (1988) as 3VC-: range over 100 km, vulnerable, adequacy of reservation unknown. Occurs north from Iluka, on the Clarence River (Williams, 1984) and into southern Queensland. Recorded from Round Mountain (Hunter, 1985, pers. comm.).
Xeromphis sp. (Syn. ***Randia moorei***). (Rubiaceae).	Listed by Briggs and Leigh (1988) and Leigh and Briggs (1992) as 3ECi: range over 100 km, endangered, inadequately reserved; considered to be rare by Floyd (1990). Extends from Broken Head to the Logan River in southern Queensland (Floyd, 1989). Listed by Floyd (1989) from Stotts Island Nature Reserve and other Tweed localities and by Hunter (1991, pers. comm.) from Round Mountain.