MANAGEMENT OF MANGROVES IN BRISBANE WATER GOSFORD, NEW SOUTH WALES

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ABSTRACT

The management of mangroves in Brisbane Water is currently being given high priority by Gosford City Council. Mangroves have often been regarded as wastelands fit only for reclamation, drainage and development. However, they are now being recognised as vital components of estuary and wetland ecology with both direct and indirect environmental benefits to humans.

Mangroves are threatened by processes which can be controlled and regulated via informed and effective management. Currently two processes are being used to plan for the management of mangroves within Brisbane Water. One is an overall policy based approach using a Plan of Management for the total estuary. The second approach is specific management of mangroves and other coastal wetlands within Brisbane Water through the implementation of the Brisbane Water Wetland Management Study.

Both of these planning and management approaches are supported by Council and are being undertaken by two committees with broad membership from Council, government departments and the local community.

INTRODUCTION

Mangroves are salt tolerant forest ecosystems of our intertidal shores. They are comprised of trees and shrubs which grow between mean sea level and the highest tides on tropical to mid latitude shores. The rise and fall of the tide creates an environment of continuing change. The varying salinity of the water is one of the most important changes, but the tides affect mangroves in other ways as well, including the alteration of temperatures, supply of nutrients, and the level of oxygen in the soil and water. Overall, there is no comparable community of large flowering plants which has a similarly intimate relationship with the sea, and few that experience so many short term and long term environmental changes.

Associated with this environmental change is the pressure of human-induced impacts on mangroves. All too often, mangroves have been regarded as wastelands of little or no value until they are developed. This term has usually meant conversion of the mangrove ecosystem to some other form of use of a higher or greater economic value. This viewpoint has failed to recognise the ecological benefits and natural values that mangroves can provide which range from support of commercial fisheries to shoreline protection and provision of scenic landscapes. Overall, mangroves can provide sustainable and renewable benefits to coastal communities which would be lost if such environments were otherwise converted to non-renewable land use.

In planning and managing any mangrove resource, the primary goal must be sustainable use. Failure to view mangroves in this way will lead to inefficient use and waste of their values to coastal populations and will have severe and direct social, economic and ecological impacts.

The products and services provided by mangroves are important for many coastal communities. The value of the mangrove resource in terms of its market of products can be expressed in economic terms. The "free" services provided by the mangroves are more difficult to measure and consequently are often ignored. These "free" services would require considerable energy, technology and money if they were provided from other sources. Since this is seldom taken into account, the total value of the mangrove resource is significantly underestimated.

Thus, any single purpose exploitation of the mangrove resource effectively discounts the value of developing all other forms of

mangrove goods and services and in the case of conversion forecloses alternative utilisation options. Planners and managers involved in mangrove management must recognise the potential for multi-purpose use without sacrificing ecosystem integrity.

MANGROVES WITHIN BRISBANE WATER - GOSFORD

Mangroves will only grow in quiet estuarine waters where mud or sand is fairly stable and plants can take root. They will often colonise new areas of silt deposition, which is clearly evident at sites around Brisbane Water, particularly near the entrance to Narara, Erina and Kincumber Creeks and dredge spoil disposal sites located near Saratoga, Davistown and Woy Woy.

They are the only woody species of tree which will grow where the land is periodically flooded with sea water. They live in the intertidal zone of sheltered, muddy shores where the main factors influencing their growth and location are:

Temperature
Extensive mangrove development occurs only when the average temperature of the coldest month is higher than 20°C and where the seasonal range does not exceed 10°C. Only the Grey Mangrove is able to survive in colder climates.

Substrate
Although mangroves are able to grow on sand, peat and coral, the most extensive mangroves are associated with muddy soils which are usually poorly drained, saline, airless, fine grained and rich in organic matter.

Exposure
Protected shorelines are essential as mangroves cannot develop on exposed coasts where wave action prevents the establishment of seedlings and may erode the substrate of existing trees.

Salinity
A number of mangroves achieve optimal growth in the presence of salt as a result of their ability to cope with saline environments. The presence of salt is thought to be important because mangroves are slow growing and they cannot compete with faster growing species unless these species are eliminated or their growth inhibited by saline conditions.

Tidal Range
Tidal range, coupled with local topography, influences the location and zonation of mangrove development. The greater the tidal range within an estuary, the greater the vertical range that is available for mangrove communities to colonise.

Ocean Currents
Favourable currents are essential since they disperse mangrove propagules and distribute them along the coast.

Shallow Shores
Mangroves grow in relatively shallow water as seedlings cannot become anchored in deep water. The physical size of mangroves and their requirement of having a great proportion of their body above the water, but at the same time being anchored in the soil, makes occupancy of deep water impossible (Hutchings and Saenger 1987).

Brisbane Water is a relatively small estuary located approximately 50 km north of Sydney within the City of Gosford at latitude 33° 31' south (Figure 1). It is the centre of large urbanised areas located at Gosford on the northern end and the Woy Woy peninsula at the southern end of the estuary. Brisbane Water is a broad, shallow estuary connected to the sea via a comparatively narrow channel at Half Tide Rocks running into Broken Bay. Generally, depths are from 5-6 m in the main body of water with the Kincumber Broadwater being approximately 2 to 3 m deep in the centre. There are some deeper areas such as near The Rip (38 m), while around the perimeter of the estuary there are extensive shallows (Department of Environment and Planning 1983).
There are two species of mangrove found within the Brisbane Water estuary. They are the Grey Mangrove, which is referred to as the White Mangrove in Victoria, (*Avicennia marina*) and the River Mangrove (*Aegiceras corniculatum*).

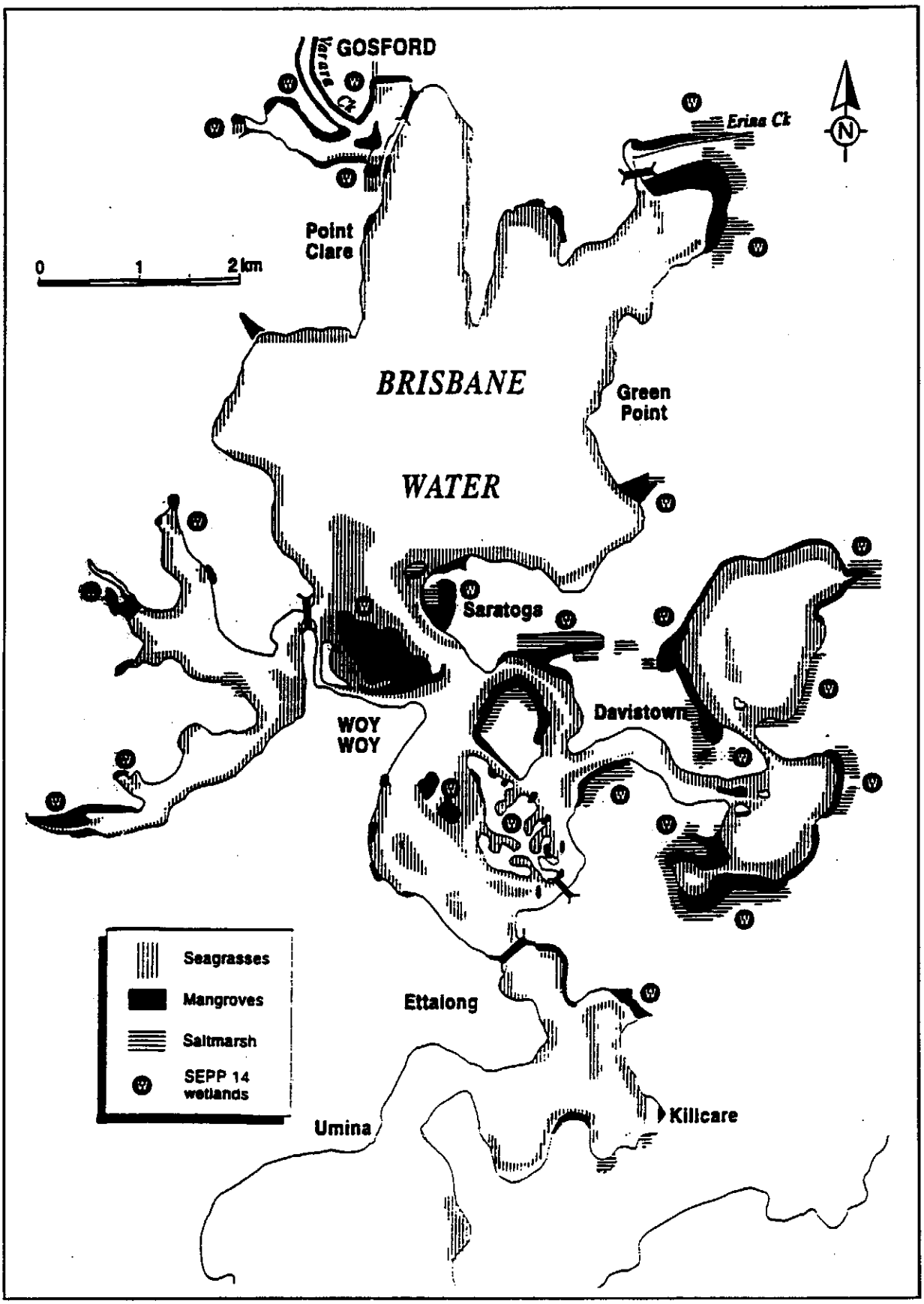

Figure 1 Distribution of mangroves, saltmarsh and seagrass in Brisbane Water (modified from West *et al.*1985, Gosford City Council).

The extensive shallows and the presence of sand and silt as predominant bottom sediments facilitate the growth of mangroves in Brisbane Water.

The estuary is generally well flushed, although flushing may be restricted in the inner parts of the system. Tides are semi diurnal. Mean tidal ranges at Woy Woy are 0.448 m (Neap) and 0.643 m (Spring), and 0.439 m (Neap) and 0.600 m (Spring) at Point Clare. The extreme tidal range is 1.609 m at Woy Woy and 2.06 m at Point Clare (Department of Environment and Planning 1983). Erina and Narara Creeks are the two major sources of freshwater inflow into the estuary and are located at the north-eastern and north-western ends of the estuary respectively.

Mangroves cover an area of approximately 163 hectares within Brisbane Water, the largest area being found on Pelican Island (43 hectares) and in Erina Creek (33 hectares) (West *et al.*1985). Many of these mangroves areas are included in the State Environmental Planning Policy No 14 - Wetlands (SEPP 14).

The typical wetland zonation within Brisbane Water travelling from the land to the sea includes swamp oak, saltmarsh, mangrove and seagrass species, as listed in Table 1.

FEATURES OF MANGROVES

The two species of mangrove found within Brisbane Water, like mangroves in other areas, have evolved special abilities to grow in the harsh environment generated by constant tidal movement, high salinity and low soil oxygen levels.

They have evolved complex salt tolerance mechanisms which include salt exclusion from the root system and/or limited salt concentrations within their leaves via the secretion of salt in solution from special glands on the leaf surface. Further removal of salt from the plant can occur as a result of salt accumulation in the older leaves which are subsequently shed and fall to the floor of the forest.

The Grey Mangrove also has specialised structures to assist with aeration of the root system. They have peg roots

TABLE 1: CHARACTERISTIC PLANTS OF ESTUARINE WETLANDS WITHIN BRISBANE WATER

(Modified from Department of Environment and Planning 1983)

WETLAND CATEGORY	BOTANICAL NAME	COMMON NAME
Fringing Vegetation Swamp Forests	*Casuarina glauca* *Melaleuca quinquenervia* *Eucalyptus robusta*	Swamp Oak Paperbark Swamp Mahogany
Saltmarsh infrequently inundated	*Juncus kraussi* *Sporobolus virginicus*	Sea Rush Salt Couch
Saltmarsh frequently inundated	*Sarcocornia quinqueflora* *Sporobolus virginicus* *Suaeda australis* *Samolus repens* *Triglochin striata*	Samphire Salt Couch Seablite Creeping Brookweed Streaked Arrowgrass
Mangrove	*Aegiceras corniculatum* *Avicennia marina*	River Mangrove Grey Mangrove
Seagrass	*Zostera capricorni* *Posidonia australis* *Halophila ovalis*	Eelgrass Strapweed Paddleweed

(pneumatophores) which protrude above the surface of the mud as finger-like projections. These peg roots then allow air to diffuse from the water to the shallow subterranean roots of the plant (Lear and Turner 1977).

The Grey Mangrove grows to a height of approximately 8-10 m in Brisbane Water. The River Mangrove, which is located further inland or upstream of a river or creek, grows to height of approximately 1-2 m.

The fruits of mangroves are specially adapted to ensure survival. These fruits can float and are unusually shaped so that when washed onto a soft substrate they will anchor themselves and start to grow. Mangroves in Brisbane Water, as well as those in other localities, are viviparous (their fruits can develop to seedlings whilst still attached to the parent tree). This feature aids rapid growth to a well-developed seedling stage.

VALUES OF MANGROVES

Mangroves have a variety of values. One of the major values lies in the wildlife, including fish, that they support. Over 30 commercially important species of fish use estuaries, including mangroves, at some stage of their life cycle. Some of these include species such as *Rhombosolea tapirina* (Greenback Flounder), *Aldrichetta forsteri* (Yellow-Eye Mullet), *Platycephalus fuscus* (Dusky Flathead), *Girella tricuspidata* (Luderick), *Sillaginodes punctatus* (King George Whiting), *Crassostrea commercialis* (Oyster), *Scylla serrata* (Mud Crab) and *Penaeus plebejus* (Eastern King Prawn) (Coleman 1988, Pollard 1988).

In 1979-80, the wholesale value of estuarine fish, prawn and crab catches in New South Wales was about $9 million. In the same year, the wholesale value of oysters produced was about $18 million. The 1983 wholesale value of oyster production in New South Wales was about $23 million and the total income generated by the estuarine-dependent fishing industry in 1979-1980 was about $120 million (Middleton 1985). In fact, it is reported that the marketable value of fish from mangrove environments is equivalent to $8,380 per hectare per year (Claridge and Burnett 1993). Consequently, the contribution of mangroves to estuarine productivity is extremely valuable and important.

Mangrove forests also provide safe roosting and feeding areas for a large range of bird life including internationally protected migratory wading birds such as *Numenius madagascariensis* (Eastern Curlew), and other wetland birds including *Phalacrocorax melanoleucos* (Little Pied Cormorant), *Cygnus atratus* (Black Swan), *Anas castanea* (Chestnut Teal), *Butorides striatus* (Mangrove Heron) and *Threskiornis molucca* (White Ibis) (Department of Environment and Planning 1983).

Mangroves also produce large amounts of leaf litter which adds to the food web for a large number of associated species. West (1985) stated that recent studies in New South Wales have shown that a square kilometre of Grey Mangrove forest contributes about 600 tonnes of leaf litter each year to the detrital food chain. The detrital food chain is the process whereby mangroves produce organic matter via photosynthesis and plant growth which, after falling from the tree, decomposes on the muddy floor and is then consumed by bacteria, algae and other larger consumers. During decomposition, soluble nutrients are leached out of the decaying leaf litter by the rain and tides, and the remaining material is colonised by microscopic fungi and bacteria. The resulting decomposed material (detritus) is eaten by small animals such as prawns and crabs. These animals excrete the undigested plant material, which is then recolonised by fungi and bacteria. The cycle continues until even the most resistant tissues are broken down. The detritus-feeders are then eaten by the larger fish and birds of the estuary.

Mangroves can also provide a physical buffer between the land and the sea thus preventing erosion by binding and trapping sediments. They protect the coast from storm damage and wave surge and trap nutrients entering the system which assists in the maintenance of water quality. Nutrients accumulated by mangroves are not lost from the system but are recycled as mangrove leaf litter through the detrital

food chain. Shapiro (1975) estimated that in Westernport Bay (Victoria) mangroves may, in one year, release into the estuary up to four times as much nitrogen and half as much phosphorus as can be found in the bay water itself.

Finally, they provide exceptional recreational potential, which can include tourism in situations where boardwalks or walkways have been developed, as well as scientific and educational value in helping to understand estuarine environments.

THREATS TO MANGROVES

Threats to mangrove wetlands can occur from many sources:

a. The cutting of mangroves to produce wood.

b. The deposition of drifting sand, as a result of natural processes, or as the outcome of mangrove clearance resulting in erosion of the muddy substrate, or from dredging off-shore.

c. The killing of mangroves by high salinity. This is unlikely on open shores, where there is free circulation of sea water, but it could occur in areas of impeded drainage.

d. The killing of mangroves by suffocation following the construction of impoundments or the restriction of water flow which allows water to remain above the pneumatophore level for long periods. This has been a cause of mangrove death at several places in New South Wales.

e. The killing of mangroves by toxic pollutants derived from urban and industrial areas.

f. The clearing of mangroves for urban development, residential sub-division, recreational sporting fields and coastal structures such as jetties and boat harbours.

g. Finally, the fragmented system of public administration and legislation dealing with mangrove areas can often overlook the importance of protecting mangroves (Shapiro, 1975).

PLANNING AND MANAGEMENT PRINCIPLES FOR MANGROVES

Mangroves are too valuable to allow them to be lost to other forms of land use, except when overriding national priorities are involved and no other alternative is economically and environmentally feasible. There is no easy short term solution to the problem of changing prevailing public opinion, which considers mangroves to be wastelands fit only for clearing and reclamation, but educational programs that inform people about the diversity of sustainable uses of the mangrove resource, may be helpful.

Both sustainable use and preservation can be incorporated into an effective planning policy if it has the following objectives:

1. To prevent further destruction of mangroves by halting unjustifiable conversion activities.

2. To manage mangroves as a renewable resource on a sustainable use basis for direct and indirect products as well as for the environmental values they provide.

3. To view mangroves as an integral part of the coastal zone rather than as an ecosystem surviving in isolation.

The implementation of any planning policy for mangroves should aim to fulfil the following management needs:

a. Avoidance, as far as possible, of conflicting foreshore uses.

b. Protection from the damaging effects of land, water, foreshore and marine uses.

c. Research to better understand the mangrove ecosystem and evaluate and quantify adverse ecological influences.

d. Public awareness of their values.

e. Reservation of appropriate areas.

f. Careful management of those areas to which appropriate protection has been accorded.

g. An overall co-ordinating body to implement the foregoing, as far as practical,

through existing legislation and administrative policies.

A PLANNING AND MANAGEMENT RESPONSE FOR MANGROVES

In response to the need to manage the mangrove resource within Brisbane Water on an ecologically sustainable use basis, the Council of the City of Gosford have initiated two approaches. The first was to resolve, in December 1991, to establish a committee to prepare a Plan of Management for the Brisbane Water Estuary. The second is to prepare and establish a committee to implement the Brisbane Water Wetlands Management Study.

Brisbane Water Plan of Management

The Brisbane Water Plan of Management is a reflection of community concern and awareness about the possible impact that unconstrained or inappropriate development can have on the estuarine resource of Brisbane Water. Accordingly, it has a strong emphasis on protecting and enhancing the natural characteristics of the waterway in the form of an overall planning and management policy.

As a result of the above, the Brisbane Water Plan of Management and Catchment Management Committee was formed to oversee the preparation of the Brisbane Water Plan of Management and to generally provide advice to Council on planning and policy matters associated with the use and management of Brisbane Water and its foreshores, including the important mangrove resource.

The committee consists of the following representatives:

- elected Council members and Council staff;
- Maritime Services Board;
- Public Works Department;
- Department of Conservation and Land Management;
- National Parks and Wildlife Service;
- NSW Fisheries;
- Gosford Sailing Club;
- Brisbane Water Oyster Farmers Association;
- a number of local community representatives; and
- Representatives from local Parliamentarians.

The objective of the committee is to: "Protect, enhance and maintain Brisbane Water and its surrounds to:

1. Minimise the urban influence on the aquatic environment;

2. Reverse undesirable impacts using catchment management principles by control of development, carrying out improvement works and adoption of management policies for all public open space."

The effective management of the mangrove wetland within Brisbane Water is included in the following objectives:

a. Ensure that full and proper consultation occurs with State Fisheries, and other estuarine management authorities, in the assessment of development proposals that are likely to have a significant impact on important estuarine habitats.

b. Preserve important estuarine habitats in their natural state through appropriate management principles and controls.

c. Ensure that adequate buffer zones are provided between important estuarine habitats and adjacent development.

d. Ensure that the water quality and circulation of Brisbane Water is not adversely affected by providing appropriate controls for development and promoting management principles which reflect this aim.

e. Facilitate and promote estuarine rehabilitation and restoration practices.

Protection for mangroves within Brisbane Water is also reinforced in the major proposed management action which states: "The Council will generally not support development proposals which will result in the destruction or degradation of mangroves, saltmarsh or seagrass beds identified around Brisbane Water since these form important estuarine habitats within Brisbane Water as well as contributing to the natural character of the waterway. All proposed development must ensure that these areas are not adversely affected".

Brisbane Water Wetlands Management Study

The second major action dealing with managing, in more detail, the mangrove resource within Brisbane Water was Council's resolution to adopt and implement the Brisbane Water Wetlands Management Study in September 1993. This study was requested by Council in December 1989 with the aim of accurately mapping all wetland vegetation in the Gosford Local Government Area and describing the status of each site. Using this information, the following objectives were considered attainable:

- establish a priority list of sites of community value which are not in public reserves;

- prepare recommendations for the Minister for Planning to amend the boundaries of State Environmental Planning Policy 14 (SEPP14) to ensure that they accurately reflect the ecological significance of the wetlands;

- provide base data for the drafting of Local Environmental Plans, Development Control Plans and site-specific Management Plans, which propose appropriate environmental protection zones to protect wetland areas;

- provide information for the assessment of developments in wetland catchments.

Council, in adopting the Wetland Management Study for Brisbane Water (which includes mangrove areas), adopted a series of smaller strategies for action and implementation. These include the following:

1. SEPP 14 Amendment
Ensure that SEPP 14 boundaries accurately reflect the ecological significance of wetland communities.

2. Local Environment Plan
Ensure that zonings accurately reflect the ecological significance of wetland communities.

3. Education
Conduct a wetland education program to encourage the community to conserve these resources.

4. Acquisition
Develop a wetland acquisition program similar to the Coastal Open Space System.

5. Government Grants
Ensure that Council effectively lobbies for any grants that may become available for the acquisition of wetlands.

6. Rate Relief
Offer rate relief on parcels of land that are not able to be developed due to their zoning and inclusion in SEPP14.

7. Development Dedication
Consider each individual case on its merits. Development dedication should be considered if the development will not detract from the value of the wetland.

8. Development Assessment
The recommendations of this study should be considered in the assessment of developments in wetland areas or their immediate catchments.

9. Total Catchment
When a Total Catchment Management Committee becomes established in this area, it should consider opportunities to assist in the management of wetland sites.

10. Water Quality Management
Conduct a water quality monitoring program to identify any water quality issues and propose any controls required. (One study has been undertaken of the coastal lagoons and a study of Brisbane Water commenced in 1993).

11. Drainage
Develop a drainage strategy incorporating the sediment and nutrient filtration abilities of wetlands.

12. Special Zone
Establish a special zone to identify wetland areas and to control land use activities.

Gosford City Council has reinforced the above-mentioned implementation actions by resolving that: "No further development or activity that will result in a direct loss of wetland that has been identified in this study should be approved in the City of Gosford, unless:

a. no feasible alternative exists;

b. there is a community benefit;

c. an equal area of similar wetland will be established, rehabilitated or enhanced to compensate for that lost."

Finally, Council has requested the establishment of a Wetlands Management Committee to implement the strategy actions previously mentioned with membership coming from interested Councillors, representatives from the Brisbane Water Plan of Management and Catchment Management Committees as well as Council's Coastline Management, Lagoon Management and Coastal Planning Committee, which is undertaking separate management plans for Gosford's coast and coastal lagoons.

A target date of 18 months has been set for completion of the implementation phase of the Brisbane Water Wetlands Management Study following the formation of the Wetlands Management Committee.

CONCLUSION

The strategic planning and management overview being undertaken by Gosford City Council raises some important issues concerning the protection and recognition being given to coastal wetlands, and mangroves in particular. The process of setting up community-, government- and council-based committees closely follows the Public Works Department Estuary Management Program. Council is supportive of taking the initiative to manage the mangrove resource within Brisbane Water by firstly, establishing an overall strategic planning policy under the Brisbane Water Plan of Management and secondly, managing the mangrove resource specifically under the implementation of Brisbane Water Wetlands Management Study.

As the majority of mangrove communities are located within public land/foreshore reserves, opportunities for these wetlands to be included within Marine and Estuarine Protected Areas, as a possible management option, may also exist.

Irrespective of the possible management actions that may be developed via Gosford City Council's waterways and wetlands planning and management process, mangroves should continue to be conserved since the possible repercussions of a substantial reduction or modification to the mangrove system may be:

i. a decline in the yield of commercial and sport fishing;

ii. lower levels of diversity and abundance of many species of shore birds;

iii. a reduction in the overall diversity and ecological stability of an estuary;

iv. alterations to the sediment regime;

v. increased development of algae and other primary producers which reflect the development of eutrophic conditions.

vi. an increase in the potential for generating acid sulphate soils which can be found within coastal wetlands, particularly when wetland soils low in oxygen, are exposed to air via any drainage, excavation or reclamation works. The acid in these soils can leach out into the waterway killing aquatic and marine organisms and corroding iron and concrete structures. Consequently, care must be taken by planners and managers in making any decisions about the future uses of estuarine wetland and mangrove areas.

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