ENHANCEMENT OF ESTUARINE HABITATS IN ASSOCIATION WITH DEVELOPMENT

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Introduction

Urban development is proceeding rapidly in sheltered estuarine and coastal areas of subtropical Australia. This trend is unlikely to slow. Fringing the estuaries there are large areas of agricultural lands that are of low ecological value, and increasingly these areas are becoming used for residential development. Most development scenarios involve the creation of canals or lakes because these lands are low-lying and require filling to raise them above flood/storm surge levels. This style of development is also related to the recent greater demand for waterfront tourism areas and recreational amenities such as marinas. The increased population residing in estuarine regions results in waterways being used to a greater extent for stormwater disposal, floodwater conveyance and recreational activities (eg. angling or boating) often leading to a need for dredging operations.

There is a need to ensure that, if such developments and associated requirements are considered to be of community benefit, they are undertaken in a manner that not only minimises impacts on existing habitats but provides the opportunity to create new or additional habitat. Conversely, if the developments are judged to result in adverse ecological impacts then there should be a requirement to compensate by creating habitat (ie. the "no net loss of estuarine productivity principle").

The problem is, if we are to require compensatory works or enhancement works, how do we design them and how do we assess the contribution of any artificial waterways created by development to the ecology of the estuary? Unfortunately, there are very few Australian studies on creating fish habitats or examining fish fauna in artificial habitats such as marinas, canals, or similar developments (Saenger and McIvor 1974; Morton 1989; Morton in press; Hair and Bell in press). We know that it should be possible to create suitable conditions for estuarine fauna and to design developments appropriately, but opportunities are only recently becoming available as environmental considerations achieve greater prominence.

Larger scale developments or operations offer an opportunity to enhance or create aquatic habitat. The amount of money involved in such projects is such that even a small percentage of the total capital investment can be sufficient to fund the creation of large areas of habitat either associated with the development or in degraded areas external to the development.

Habitat enhancement/creation schemes that can result from large scale development include (1) those which represent an integral part of the development, and (2) works which are undertaken as compensation for disturbance of ecologically important habitats.

The following discussion describes (i) a study (Tweed Heads Notional Dredge Plan and River Management Study) designed to minimise adverse impacts to aquatic fauna

resulting from required extensive dredging works and (ii) opportunities to provide additional habitat in conjunction with private waterfront developments.

Specific case studies

(i) Tweed River Plan of Management

The lower reaches of the Tweed River on the Queensland/NSW border have been shoaling over the past two decades, primarily as a result of infilling with oceanic sand, and this trend is expected to continue. There is a need to dredge some areas of the estuary to overcome significant navigation, flooding and potential water quality problems. For example, the entrance sand bar is very shallow, substantially affecting navigation, and could force the 25 trawlers based at Tweed Heads to abandon the port. Periodic flooding often causes significant damage to developed areas fringing the Tweed River. The dredging works would need to be extensive, and could result in the extraction of several million m^3 of sand. If the sand could be sold, from $7 million to $24 million could be raised in royalties depending upon the extent of dredging.

WBM Oceanics was commissioned to collaborate with the New South Wales Public Works Department to devise a Notional Dredge Plan to undertake necessary dredging (which forms part of the River Plan of Management). A primary aim of the Notional Dredge Plan is to ensure that dredging works and associated environmental compensatory/enhancement measures result in a net improvement in the overall ecological wellbeing of the Tweed River estuary.

The major ecological concern in regard to required dredging relates to hydraulic changes resulting from dredging works which will include an increase in the tidal range of the lower estuary. Depending on the degree of change, lower low tides could increase the aerial exposure of seagrass beds and perhaps result in seagrass losses. Alternatively, the higher high tides may increase mangrove extent.

The Notional Dredge Plan was designed to ensure that the most productive areas of the lower Tweed estuary are not directly disturbed. Dredging was restricted from occurring in river bank areas shallower than 2.0 m Australian Height Datum (AHD), as vegetation, bird, benthic and fish studies indicate that shallow shoreline areas (particularly bays/inlets) have a high ecological value. No seagrass beds would be dredged and buffer distances were defined around mangrove, seagrass, commercial net hauling grounds and oyster leases areas. Emphasis has been placed on avoiding potential future adverse erosion/scouring processes within the estuary which could require remedial dredging operations. Dredging schedules were designed to minimise and "stagger" alterations to the tidal regime of the estuary, whilst recognising the beneficial aspects of dredging.

The Notional Dredge Plan included designs to enhance dredged and existing habitats as well as options to create new habitat to benefit the ecology and fisheries of the Tweed River. Funds for such works would result mostly from royalties arising from the sale of extracted sands.

Dredging depths, as defined by the Plan, would not be uniform but would be contoured to provide habitat diversity. In some reaches of the river, several deep holes (to -9 m AHD) were included (Figure 1) to provide suitable habitat for large pelagic fish and thus enhance angling in these locations. Dredging of the Tweed River entrance is likely to increase the occurrence of pelagic and reef dwelling fishes in the estuary because access for these oceanic species will be easier. The Plan therefore has proposed to place artificial reefs in some areas (Figure 2) to provide habitat suitable to "attract" fish and provide additional angling opportunities for recreational fishermen. Computer modelling studies were undertaken to ensure that dredged areas would maintain high water-quality conditions.

Dredging strategies would include retention, and in some cases creation, of shallow sloping banks to provide areas for net hauling by commercial fishermen or for seagrass

establishment. Anticipated water quality conditions (eg. current velocities, substrate type) in areas created using dredge spoil were computer-modelled to ensure that created conditions would be suitable for seagrass colonisation or transplantation.

Letitia Spit, part of Fingal Peninsula which forms the eastern bank of the lower Tweed River (Figure 3), was identified as being particularly suitable for habitat creation because most of the area concerned is Crown Land isolated from densely populated urban areas by the Tweed River. The Spit has important recreational values but presently mostly supports degraded vegetation as the area was previously used for sand mining operations. Several tidally connected lagoons (eg. Kerosene Inlet, Figure 3), remnants of previous mining operations, were identified during baseline ecological studies as supporting large areas of seagrass and diverse fish/prawn populations.

The Tweed River Plan of Management therefore provides designs (Figure 3) to protect these lagoons and create additional similar lagoons to enhance the value of the lower estuary to aquatic fauna including species of fisheries importance. Detailed ecological, water quality and hydraulic studies of existing lagoons were completed to assist in the design of proposed additional lagoons. Particular emphasis would be placed on providing conditions suitable for seagrass establishment to compensate for anticipated seagrass losses occurring as a result of dredging-induced changes in the tidal regime (see above). These works, and associated habitat enhancement projects (eg. creation of bird habitat) would be funded from royalties resulting from extraction of sands occurring within the river and from Letitia Spit.

Several ecological baseline studies (benthos, mangrove and seagrass) have been completed and future monitoring studies have been designed to enable firstly, the rapid identification of any substantial impacts that may result from proposed dredging, thus enabling modification of techniques and quantification of substantial impacts where they are unavoidable (eg. alterations to the hydraulic regime of the river) and secondly, to verify the need for and scale of compensatory works (eg. habitat creation/enhancement). Monitoring studies would also include created or enhanced habitats to validate the success of such works.

The Lower Tweed River Plan of Management includes a variety of habitat creation/enhancement schemes of a magnitude that could only be achieved as a result of a large scale operation. These options could be funded as a result of dredging royalties with no cost to the community which would also benefit (eg. in terms of flood relief, enhanced recreational opportunities and improved navigation) from proposed dredging works.

(ii) Artificial habitats associated with residential development

The view that all canal developments provide "poor quality habitat" and are detrimental to an estuary is generally based upon the performance of earlier designs. However, the level of planning and design expertise is far greater than in the past and there is no reason why a canal or tidally flushed lake style development cannot be designed to provide habitat suitable for supporting large fish populations of considerable ecological value.

There are several existing canal developments that have "accidentally" provided habitat that would otherwise not be available within a natural estuary. The author has seen large areas of seagrass (*Zostera capricorni*) in residential canal developments at Forster, Port Macquarie, Yamba and Tweed Heads (NSW), and numerous other canal developments also presumably contain seagrass. Some canals provide good angling opportunities (Morton in press) and large fish often shelter in deeper regions of canals. In many cases, commercial fishermen have netted in canal developments (much to the concern of residents fringing the

canals) because of the large populations of fish present. Floating structures (such as pontoons) associated with marinas provide a unique non-tidal substrate subject to continual high light intensity and are often utilised by large numbers of juvenile fish (Hair and Bell in press), including species of fisheries value. Similarly, there are many examples of mangroves colonising man-made habitats such as stormwater drains and revetment walls. In some instances mangroves have colonised man-made structures in regions where they would not normally occur and thus enhanced the region's physical diversity and food resources for aquatic fauna.

These examples of "accidental" habitats demonstrate that habitat of value to fish, such as mangroves or seagrass, can be incorporated into waterway-orientated residential development. Mangroves could provide an attractive landscaping/screening feature of many developments. However, mangroves are protected and a permit is required to cut or lop mangrove trees. Existing legislation could be modified to protect already established views by allowing the pruning/lopping of mangroves (as would be required in such situations) which have been artificially established.

Future developments could include design attributes that specifically aim to provide habitat for fish, either within the development itself, or in nearby areas specifically dedicated for this purpose. These attributes could form a requirement of approving authorities or be included by the developer to improve the public image of the development. In some instances, man-made tidally-flushed lakes or canals constructed in non-tidal areas may be beneficial to an estuary in that they provide additional aquatic habitat. Similarly, a requirement for the creation of artificial fish habitat as compensation for the loss of small areas of natural habitat (eg. as a result of entrance channel requirements) may allow a development to be constructed without adverse ecological effects. For example, previous urban development of the catchment in many estuaries has not incorporated measures to reduce/prevent elevated sediment loads in stormwater runoff. This has lead to the siltation of many shallow creeks and bays to the detriment of the estuary. Properly planned dredging can be undertaken to restore waterway depths and therefore enhance the habitat value of many degraded areas.

Overview

Development of many areas fringing estuaries is inevitable. Large scale development offers an opportunity to plan appropriately and adopt compensatory measures where necessary. In large developments, the scale of capital expenditure is such that habitat enhancement, creation and preservation schemes (eg. dedication of parks/reserves, creation of artificial wetlands) are a realistic proposition. The piecemeal type of smaller scale development offers few such opportunities and provides little hope for conservation of estuarine resources unless long term Estuarine Management Plans are enacted and reinforced by regional town planning laws. Basic information is available to define conditions required to provide habitat of value to fish although there is a need for further studies to identify the best design attributes of artificial habitat and how such habitat can be incorporated into developments.

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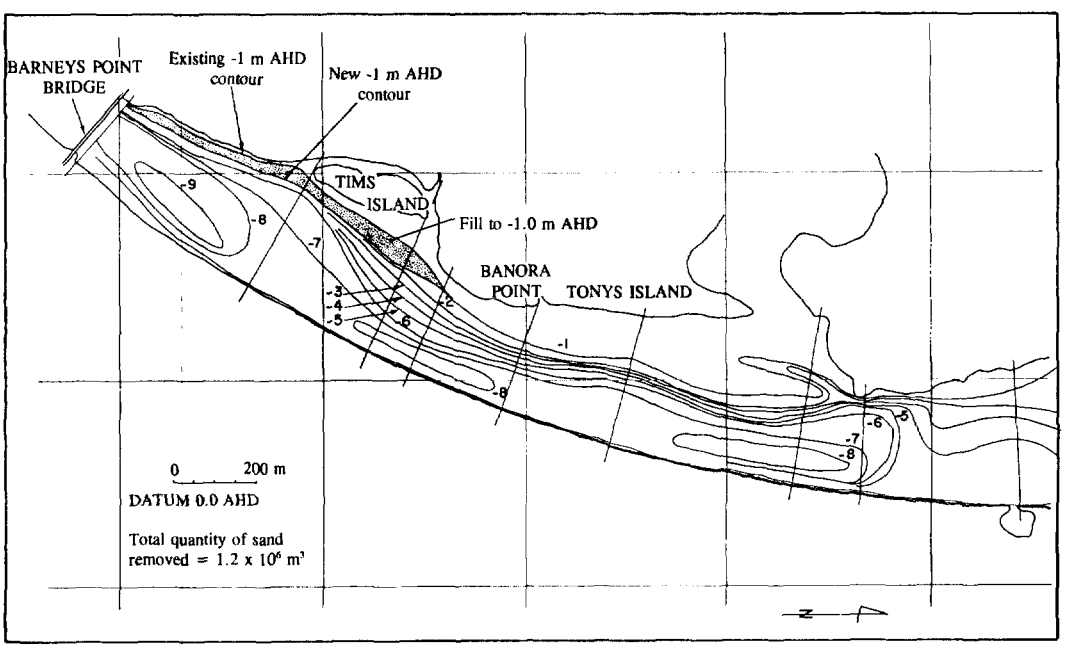

Figure 1. Example of part of Tweed River Notional Dredge Plan indicating areas proposed for filling (to create conditions suitable for seagrass establishment) and areas where deep holes will be excavated (to enhance fish abundance).

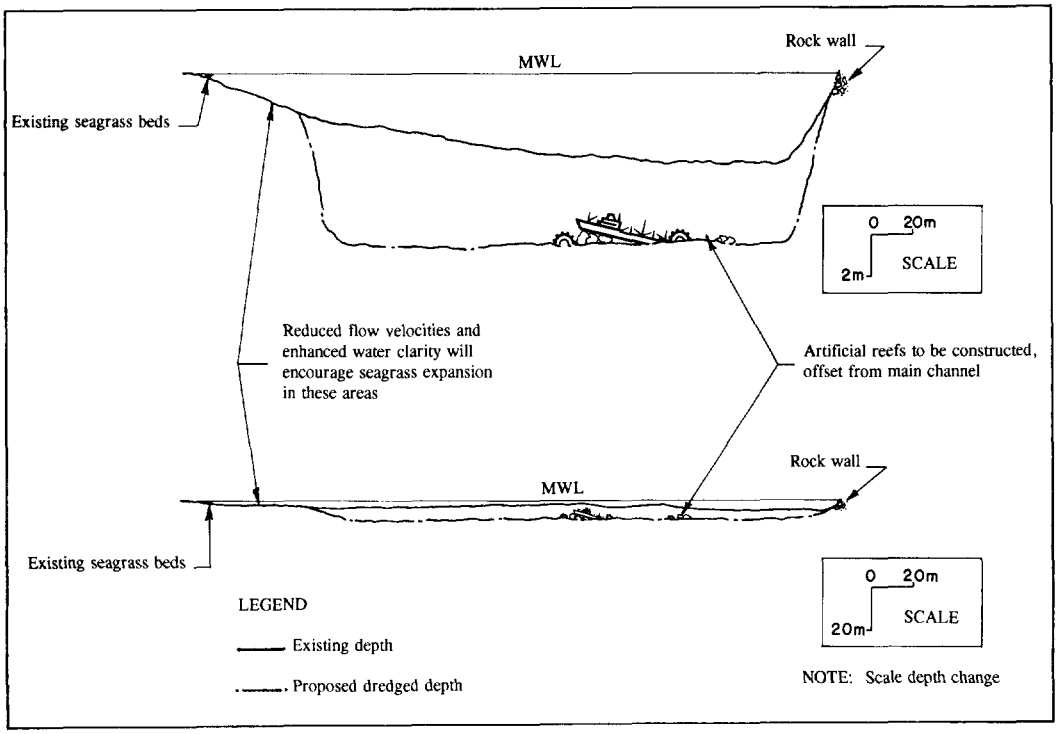

Figure 2. Typical schematic cross-section of main Tweed River channel following dredging (NB differing depth scales).

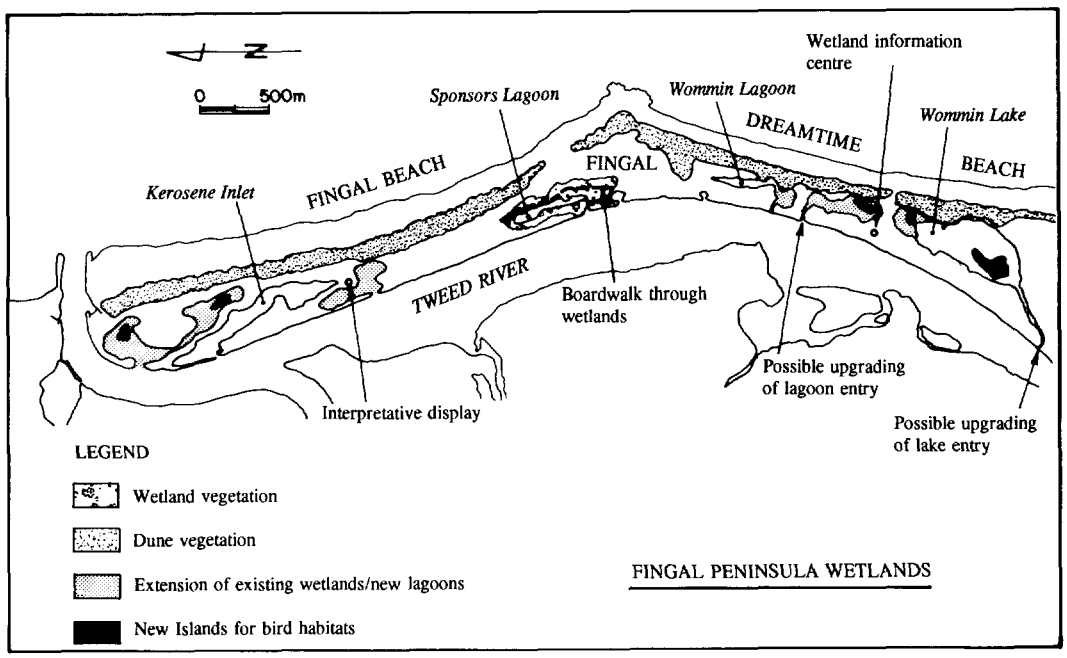

Figure 3. Conceptual diagram of habitat creation scheme for Letitia Spit (Fingal Peninsula).