REINSTATING ESTUARINE FORESHORE HABITAT THROUGH THE INSTALLATION OF ENVIRONMENTALLY ENHANCING PROTECTION STRUCTURES

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Abstract

Urbanisation of coastal areas has led to the extensive modification of foreshore areas. One example of this modification is the construction of seawalls that aim to protect foreshore assets, guard against inundation and support reclaimed land. Traditional vertical seawalls can have a detrimental impact on estuaries as they represent a significant departure from the natural graduated intertidal foreshore habitat.

Any requirement to repair or replace seawalls provides an opportunity to create or enhance existing intertidal habitat. In addition, opportunities exist to modify seawalls and other marine structures that may not otherwise require maintenance, thereby enhancing their environmental value. In doing so, areas with diminished environmental value can be improved, providing additional habitat and enhancing biodiversity.

A condition assessment of seawalls in the Parramatta River estuary was undertaken to identify stretches of seawall requiring replacement or upgrading due to visible signs of degradation. A specific objective of the study was to prioritise stretches of seawall for environmental enhancement based on the severity of seawall degradation and the potential to improve the habitat value of the seawall.

Introduction

Urbanisation of coastal areas has resulted in extensive replacement of natural habitats with manmade structures. Seawalls, the most common form of foreshore structure, present an altered habitat for estuarine organisms (Davis, Levin, and Walther, 2002; Chapman, 2003) with traditional vertical seawalls the most significant departure from natural graduated intertidal foreshore habitats.

Despite these alterations, seawalls and other marine structures provide surfaces for colonisation by benthic organisms and have the potential to supplement natural habitat by supporting natural assemblages in terms of species composition and relative abundances (Derbyshire, 2006). This potential has been investigated in a number of studies (Blockley 2007; Bulleri, Chapman, and Underwood, 2005, Chapman and Bulleri 2003; Chapman, 2003, 2005, 2006; Chapman and Blockley, 2009; Davis et al., 2002) leading to the design of ecologically-friendly seawalls and other fish-friendly structures.

As a component of the Parramatta River Estuary Processes Study, all tidally influenced foreshore areas were inspected to identify stretches of seawall that require replacement or upgrading. A specific objective was to prioritise stretches of seawall for environmental enhancement. This was achieved through:

- Visual inspection of all seawalls to assess the condition of discrete seawall sections and document seawall degradation

- Identification of options to improve the environmental value of seawalls found to require either replacement or maintenance and/or that would be suitable for environmental enhancement
- Prioritisation of seawalls for environmental enhancement based on the severity of seawall degradation and the potential to improve the habitat value of the seawall

Study Area

The Parramatta River Estuary is the largest of three tributaries that feed into Sydney Harbour. The Lane Cove River and the smaller Middle Harbour are the second and third contributing water bodies. The study area extends from the Charles Street Weir in Parramatta, to Clarkes Point, Woolwich in the north (adjacent the Lane Cove River confluence with the harbour) and Yurulbin Point, Birchgrove on the southern foreshore of the river.

The total foreshore length of the estuary was estimated to be 135 km, which includes all tidally influenced embayments, tributaries and canals and extends across eight local government areas (LGAs) (Figure 1).

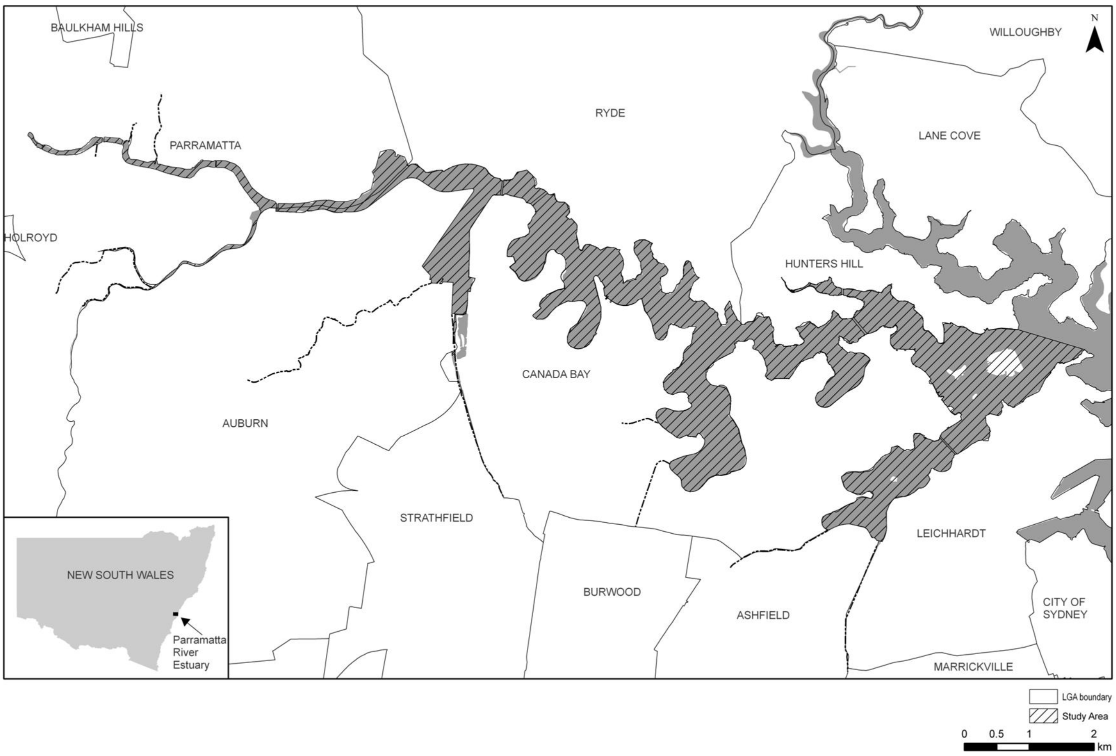

Figure 1 Study Area

Methods

Condition Assessment

Inspections were carried out in August and September 2009 between mid and low tides to ensure the most critical components of the seawalls (the structure toe and the splash zone), were visible. Generally, the inspections were carried out by boat and where boat access was not possible, inspections were undertaken from the shore.

A discrete seawall was defined as a structure distinct, either by type or condition, from those adjacent, irrespective of length. A naming convention was derived based on the LGA in which the seawall was located and a sequential numbering system assigned from east to west along the LGA foreshore (Figure 2).

While undertaking the seawall inspections the following information was recorded:

- Date, time, location, and tide level at the time of inspection
- GPS coordinates
- Type of seawall and description of the surrounding area
- Structural condition (Table 1)
- Assets supported and protected by the wall
- Habitat provided by the seawall
- Representative site photographs of each seawall section

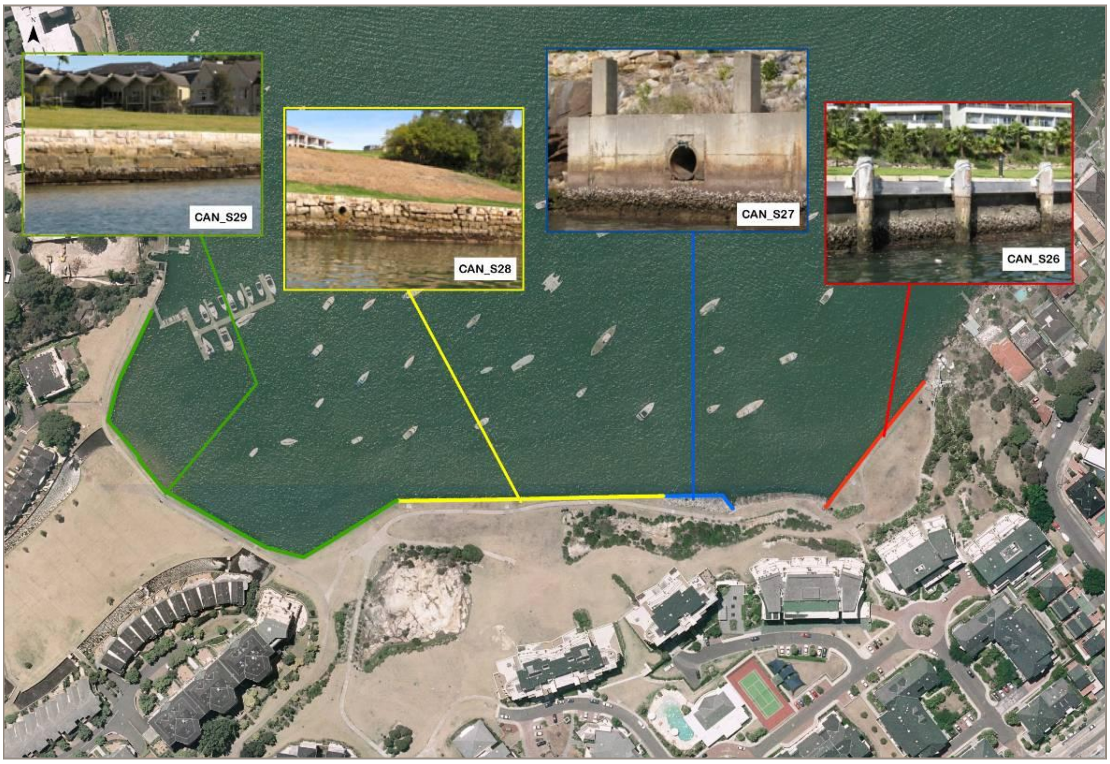

Figure 2 Seawall naming convention

Table 1 Seawall condition criteria

Seawall Condition Description	Example
Excellent: • No defects observed • Structure is functioning as intended	
Good: • Minor defects observed such as weathering and loss of grout • Structure is functioning as intended	
Poor • Major defects observed • Structure is at risk of failure without remedial action • Reduced functionality	
Failed • Major defects observed • Structure or parts of structure have collapsed • Structure is no longer functioning as intended	

Prioritisation

To determine the most appropriate locations for habitat creation (as part of repairs or replacement), seawall sections categorised as 'poor' or 'failed' were further assessed to understand the following:

a) Existing function of the seawall

b) Potential value of each seawall section following environmental enhancement works

The existing function of each seawall section is an important consideration as most seawalls in the study area provide support for other foreshore structures and reclaimed land. Failure of seawalls that structurally support other foreshore facilities (e.g. pathways, jetties) may result in replacement costs of more than just the seawall and also impact on aesthetics and public amenity.

Where seawalls protect reclaimed land, seawall failure may result in the liberation of 'potentially contaminated' landfill. This in turn would impact on water quality and aquatic biota. Furthermore, the potential for loss of land to the estuary may exist where unconsolidated landfill is no longer supported. Some seawalls have been constructed to mitigate erosion and/or protect native vegetation. Therefore, support of existing vegetation is also considered as a function.

The surrounding environment was the main factor in determining potential values of each seawall section following repair or replacement works. For example:

- Public access, in particular multi-directional access (i.e. the site can be entered and exited from different directions and is potentially linked to other foreshore areas)
- Aesthetic and passive recreational amenity
- Education/interpretation opportunities (e.g. high usage area)

Ecological outcomes were considered too complicated for use as an attribute without further and considerable investigation. Therefore ecological benefits of creating habitat in seawalls were assumed as a positive constant for all sites.

Results

Condition assessment

Thirty six kilometres of seawalls were inspected in the study area, which were assessed as 185 discrete sections of seawall. While undertaking seawall inspections, varying maintenance regimes were encountered including repair of single blocks, re-grouting, concrete capping, and replacement of entire lengths of seawall. It was also evident that in many cases no regular inspection or maintenance regime exists as many seawalls were in a poor condition or showed evidence of structural deterioration.

Seawalls varied considerably in design, age, construction material, and condition. Nearly half of all seawalls inspected were found to be in poor condition (42%) or had some form of major defect (7%), while just over half of all seawalls were either in good (41%) or excellent condition (10%).

The most common causes of seawall deterioration observed were as follows:

- Inadequate drainage and overtopping and resultant loss of fine sediments from behind the wall and the development of sinkholes
- Toe scour where the foundations of seawalls and coastal revetments have been undermined by wind and vessel-induced waves
- Differential settlement which has occurred where the structure is located on unconsolidated sediments or other inadequate foundation
- Unit failure where the individual units that form seawalls have deteriorated over time and have eventually affected the function of the structure
- Poor construction or design

Seawall Prioritisation

Eighty four seawall sections were either categorised as 'poor' or 'failed', of which 37 sections were identified to be the most appropriate for environmental enhancement. The remaining 47 were considered less suitable for a range of reasons, but most commonly due to constraints both landward and seaward, limited access, and high energy zones due to wind or vessel wash.

High priority seawall stretches were typically found to:

- Support reclaimed land.
- Provide structural support for other assets
- Are located adjacent open space
- Provide multi-directional public access

Environmental Enhancement

Guidelines prepared by the NSW DECCW in conjunction with the SM-CMA (Wiecek, 2009) provide a comprehensive range of techniques for consideration when planning for repairs or replacement of seawalls and other marine structures. A combination of these approaches was recommended for the study area. However, a more detailed analysis would be required on a site-by-site basis so that improvements are designed to suitably accommodate any constraints and maximise opportunities.

Conceptual design options for seawalls in the study area included:

- Creation of an artificial reef habitat using boulders, woody debris, or rock clumps (Figure 3)
- Increased roughness and texture of seawall surfaces through the attachment of objects
- Provision of cavities or not grouting between blocks to create sub-tidal cave habitat or smaller habitat pockets and crevices
- Intertidal vegetation planting area provided by outer and inner sill and appropriate planting media between sills (Figure 4)
- Creation of rock pools that retain water at low tide and Figure 5)

Figure 3. (left) Seawall prior enhancement (right) Rock rubble - artificial reef habitat

Figure 4. Intertidal saltmarsh area between rock sills

Figure 5. Rock pool created to retain water at low tide

Outcomes and Further Considerations

The condition of 36 km of seawall was assessed using a standardised inspection procedure developed specifically for the study area. One hundred and eighty five discrete sections of seawall were allocated one of four condition categories (failed, poor, good, or excellent). Just under half of all seawall stretches in the study area were found to be in poor condition or exhibited some form of major defect.

Seawall sections categorised as either ‘failed’ or ‘poor’ were further investigated in terms of function, constraints and opportunities in order to prioritise environmental enhancement works. Across the study area, 84 seawall sections categorised as either ‘failed’ or ‘poor’, were assessed this way, of which 37 were identified as the most appropriate seawall sections for environmental enhancement.

The condition of seawalls supporting land on which recent development has occurred was of concern. Prior to undertaking inspections in this study area, it was expected that lengths of seawall adjacent to newly developed land (i.e. in the last five to 10 years) would have been rebuilt or appropriately repaired as part of the redevelopment process. This was rarely observed to be the case, with only recapping or maintenance of the crest of the seawall typically undertaken and little or no attention paid to the structural integrity of the seawall toe.

Consequently, a recommendation of this study is that development approval and compliancy certification ensures appropriate seawall construction and habitat creation for foreshore developments where seawalls occur.

The standardised approach used for this project enabled the collection of informative data over a very large study area in a relatively short period of time. The resultant dataset is maintained in a project GIS database which can be continually interrogated and updated as the need arises. The dataset in combination with a simple method of prioritisation was used to guide where future investment may be directed at both estuary and LGA scales.

This project provides a template which may have many applications. Examples include:

- Planning guidance and the issuing of conditional approvals for land where existing seawalls could be improved for environmental gain
- Asset management. Although, a more complex risk assessment approach may be required and field data collection modified accordingly
- Condition assessment of foreshore recreational facilities and/or erosion of natural shorelines. Both of which were also undertaken as part of the estuary processes study for the Parramatta River.

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