Department of Environment & Climate Change NSW

MANAGEMENT GUIDELINES FOR IMPROVING THE ENVIRONMENTAL VALUE OF SEAWALLS AND SEAWALL-LINED ESTUARY FORESHORES

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Presentation Structure

1. Introduction and background to why seawall environmental guidelines are needed for estuaries
2. Differences between seawall-lined and natural intertidal shores and resultant impacts
3. Techniques to improve the environmental value of existing seawalls in estuaries
4. Environmental design principles for building new seawalls in estuaries

1. Why seawall environmental guidelines are needed for estuaries

- Seawalls have been used for a variety of purposes in estuaries over many years:
  - utilised with reclamation of bays
  - foreshore protection structures to armor the shore against erosion and prevent inundation of low lying areas
  - Provide easy boating access and associated with recreational pathways and promenades
- Hence, seawalls are now a dominant feature of urban estuaries e.g. Sydney Harbour

1. Why seawall environmental guidelines are needed for estuaries

- We expect the demand to build more and repair existing seawalls to increase with sea level rise (climate change) & aging of current seawalls
- Significant implications – Seawalls result in the loss, fragmentation & degradation of important intertidal habitat such as saltmarsh >> impacts on species who utilise them
- Need to ensure that when new seawalls are built or old ones repaired they provide improved habitat and have less environmental impacts

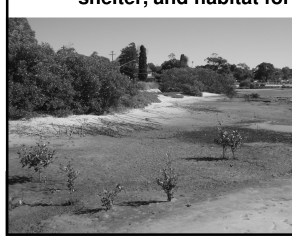
2. Differences between natural and seawall-lined intertidal shores

Three main groups of differences:

1. Substrate, composition and surface features including provision of microhabitats
2. Size and slope
3. Ability to act as buffers between terrestrial and aquatic environments

2.1 Substrate and composition

- Natural – provide a soft and highly diverse substrate of sediment and vegetation (saltmarsh, mangroves, mudflats, beaches) providing food, shelter, and habitat for range of organisms



2.1 Substrate and composition

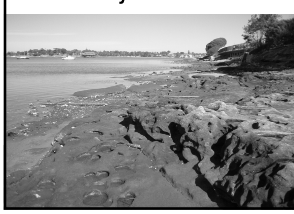
- Seawall – hard homogenous substrate of rock or cement often in areas where hard substrate is absent

2.1 Substrate and composition

- Impact – important habitats lost & replaced, impacting on the many species who utilise them (e.g. for breeding, shelter, food) leading to decline & loss of species and flow on ecosystem changes
- Replacement of natural intertidal habitats with seawalls favours only those species that require a hard substrate

2.1 Provision of microhabitats

- Natural rocky estuarine shores – microhabitats such as crevices, pools, & overhangs provide diverse and sheltered habitat types for species not commonly found on more exposed parts of rocky intertidal estuarine shores

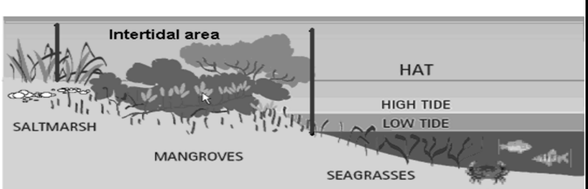


2.1 Provision of microhabitats

- Seawalls – little variety or complexity of habitat types, particularly those that retain water or moisture during low tide
- Impact - reduction of species diversity

2.2 Size and Slope

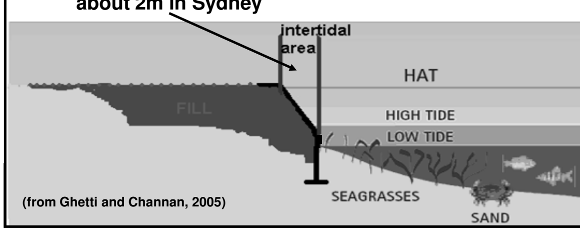
- Natural – Generally horizontal, so can be 10's of metres in width, providing a large amount of available intertidal habitat



(adapted from Kailola et al. 1993)

2.2 Size and Slope

- Seawalls – have significantly reduced available habitat as a result of the natural foreshore slope being changed from <u>horizontal</u> to <u>near-vertical</u>.
- Habitat availability is reduced to the height of the tidal range bandwidth of the seawall, commonly about 2m in Sydney



(from Ghetti and Channan, 2005)

2.2 Size and Slope

Impacts:

- Less habitat means less species
- Many intertidal plants and animals have been shown to be strongly influenced by the slope of the substratum, and species type, abundance and behaviour can be different between vertical and horizontal shores

2.3 Ability to act as buffers

- Natural estuary shores - consist of wetlands that form a buffer between terrestrial & aquatic habitats
- Low sloping and dissipate energy from waves over a distance
- Prevent erosion, reduce currents, and encourage sediment deposition and accretion
- Filter overland runoff of pollutants
- Allows seagrass rack to be deposited and spread out over the intertidal shore where it naturally breaks down

2.3 Ability to act as buffers

- Seawalls - wetlands removed / eventually die off
- The ability to encourage sediment deposition and filtration of catchment runoff is lost and flow patterns can be changed - erosion exacerbated
- Sediment movement close to seawalls is increased & can result in loss of fine grain sediments from an increase in energy from wave reflection & currents:
  - impacts on adjacent seagrasses
  - can potentially alter benthic invertebrate and fish community composition of the area
- Floating wrack build ups and form mats in front of seawalls, which act as a barrier – impacts on seagrasses and sediments

Techniques to improve the environmental value of seawalls in estuaries

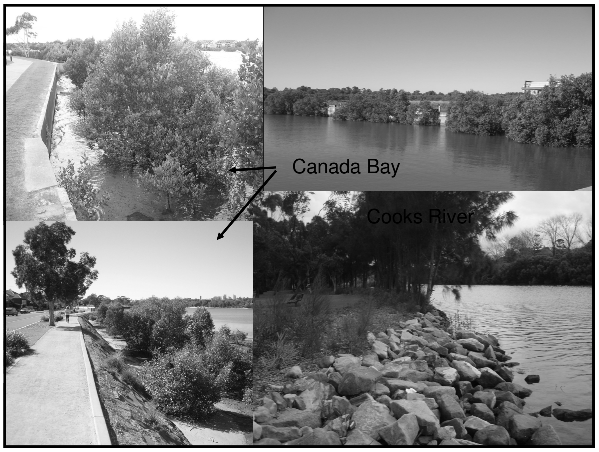
- A variety of techniques for existing seawalls and building new seawalls from Australia and overseas
- Techniques to improve the environmental value of seawalls are in their infancy and as yet there is limited research (but some!) into relevant examples of enhancement techniques and their benefits
- Nevertheless, environmental rehabilitation projects utilising various seawall enhancement techniques from Australia and around the world are occurring with positive results

3. Techniques for existing seawalls

1. Providing estuarine vegetation such as mangroves directly in front of seawalls
2. Providing a native vegetation riparian buffer landward of the seawall
3. Providing artificial reef habitat immediately in front of seawalls
4. Providing variation of texture and form on the seawall surface

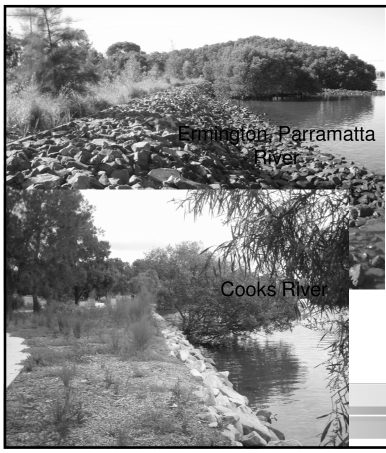
3.1 Providing estuarine vegetation e.g. mangroves directly in front of seawalls

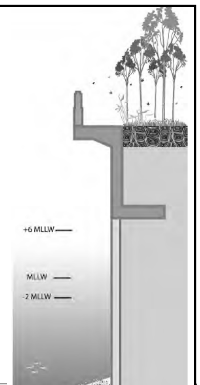
- When to Use – seawalls with adjacent shallow water, intertidal beaches / mud flats, or incorporated amongst loose boulder seawalls
- Not recommended if the exposed mud flat is recognised as important shorebird habitat
- Establish via transplanting seedlings, planting seeds, or can establish naturally in some cases
- Protection of mangrove seedlings with wave barriers important when establishing
- Benefits – important habitat, stabilises sediment in front of seawalls, provides toe protection, aesthetics



3.2 Providing a native vegetation riparian buffer landward of the seawall

- **Where to Use – directly behind the top of seawalls where available space and site constraints allow**
- **Benefits - a source of food, shelter and habitat is created that benefits both terrestrial & aquatic species**
- **Estuarine water quality can also potentially be improved through filtration of pollutants in overland runoff before it enters an estuary**
- **May be issues with view maintenance depending on species chosen**





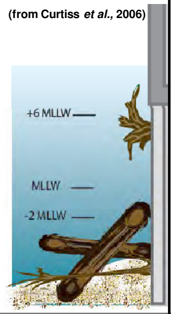
(from Curtiss *et al.*, 2006)

3.3 Providing artificial reef habitat immediately in front of seawalls

- **Where to Use - the estuary bed immediately in front of seawalls where relatively deep water**
- **Variety of materials can be used, from woody debris to artificial reef concrete structures**
- **These materials can provide a firm surface to allow attachment of organisms, and may also provide shade and refuge for small fish**
- **Should not be considered in situations where seagrasses have established in front of the seawall. In addition, it may not always be desirable to replace soft sediment habitat with artificial hard structures**

Artificial Reefs - Large Woody Debris

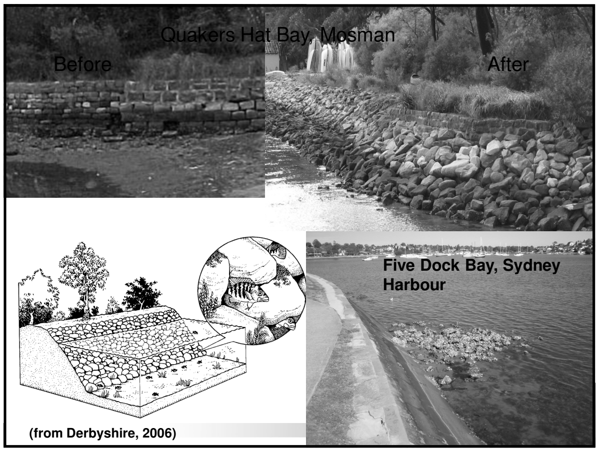
(from Curtiss *et al.*, 2006)



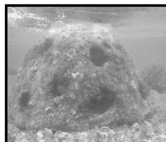
- **As with use in rivers, potential habitat benefits**
- **Anchored to the bed in front of seawalls in relatively deeper water**
- **Replacement over time needs to be considered due to the wood breaking down (depends on wood size / type)**
- **Boating safety another consideration**

Artificial Reefs - Boulders

- **Where to use - added just to the base of the seawall, as rock spurs (clumps of rock) placed intermittently along the seawall, or boulder fields that extend close to the top of existing vertical seawalls**
- **Benefits - increase total habitat surface area and diversity, provide a gentler slope, and provide habitat complexity in the form of gaps and crevices amongst the loose boulders**
- **Structural protection to the toe of the seawall preventing the underlying sediment from being eroded**

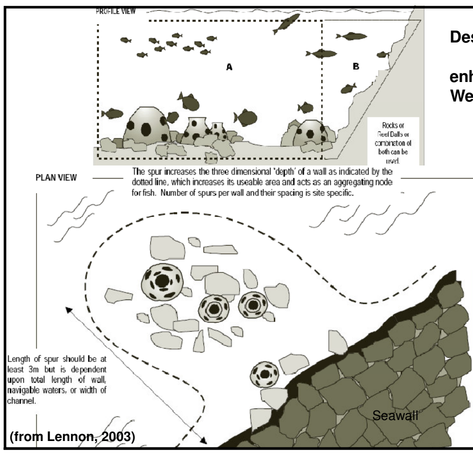


(from Derbyshire, 2006)



Artificial Reefs e.g. Reef Balls

- Hollow concrete structures that are designed to restore or create reefs for ecological enhancement
- They can be placed at the foot of seawalls over a continual distance or intermittently as clumps or spurs
- Provide a substrate for organism attachment and hence food sources & foraging areas for fish, crabs and prawns
- Holes allow aquatic life to move in and out and provide hiding places for juvenile and adult fish from predators
- Used with success in Australia and overseas e.g. in Flordia used as habitat along seawalls with an additional benefit of reduced turbidity levels due to stabilisation of bottom sediments



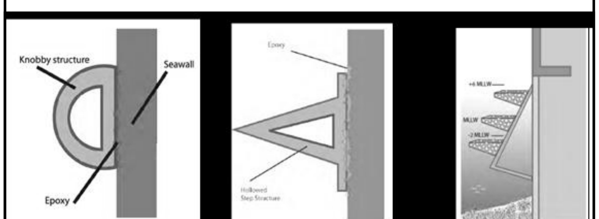
Designs prepared for seawall enhancements in Western Australia

(from Lennon, 2003)

3.4 Providing variation of texture and form on the seawall surface

- Provides surface conditions more favourable to the growth of organisms, as well as increasing surface area for colonisation, both of which can add additional food sources for other estuary life
- Roughness can be added in a variety of ways to existing seawalls including:
  - Embedding objects into the seawall
  - Cutting small holes into the seawall to form small crevices
  - Leaving any holes and cracks in degraded seawalls when performing maintenance
- Would only utilise these options where structural integrity could still be assured

Designs for prefabricated hollow concrete structures being considered for attachment to seawalls to increase surface area and roughness for habitat improvement in Seattle, USA



(diagrams from Curtiss *et al.*, 2006)

4. Environmental design principles for building new seawalls

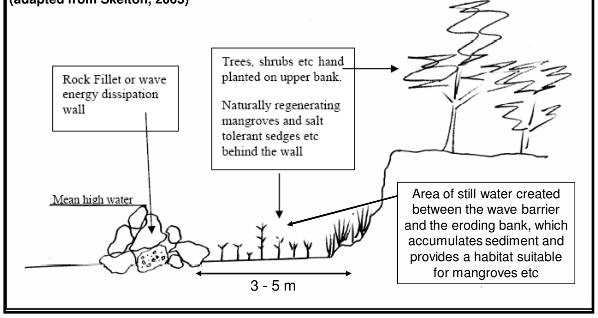
1. Deciding whether a seawall is needed and whether other more environmental options could be used such as native vegetation with temporary measures
2. Maximising the incorporation of native riparian and estuarine vegetation into the seawall
3. Maximising habitat diversity and complexity through the incorporation of microhabitats such as pools, crevices, boulders and ledges, as well as maximising surface roughness and texture
4. Creating low sloping seawalls and/or incorporating changes of slope for maximum habitat surface area

4.1 Deciding whether a seawall is needed

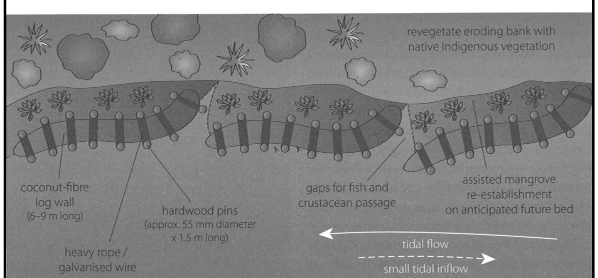
- For foreshore protection, 'softer' options utilising native vegetation and/or temporary structures should be considered first
- One successful softer option is using wave barriers and estuarine vegetation such as mangroves to stabilise the shoreline
- Wave barriers include "rock fillets", anchored timber logs/fences, temporary plastic mesh fencing, and coir logs
- These options have significant advantages over seawalls >> focused upon establishing a wide band of mangroves in front of the eroding bank, as well as upper bank revegetation

Rock Fillets

(adapted from Skelton, 2003)



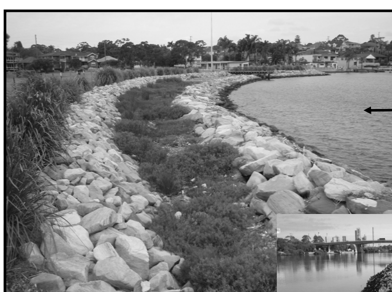
Coir log wave barrier



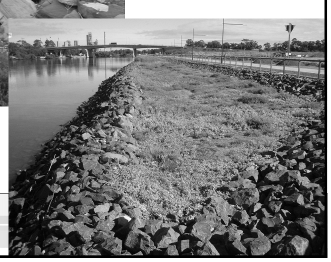
(from Schneider, 2007)

4.2 Maximising the use of native riparian and estuarine vegetation

- Native riparian vegetation can be used behind the seawall (as previously described) and estuarine vegetation as part of the seawall structure
- Step type seawall structure that incorporates a bench of estuarine vegetation that receives either daily or less frequent tidal inundation
- Similar to that of the rock fillets, where a front rock revetment is used for initial shoreline protection, except vegetation is established on a raised bench
- Two options - cutting back into the existing shoreline to create the estuarine bench so that reclamation of the intertidal area is avoided, or creating the structure seaward of the existing shoreline

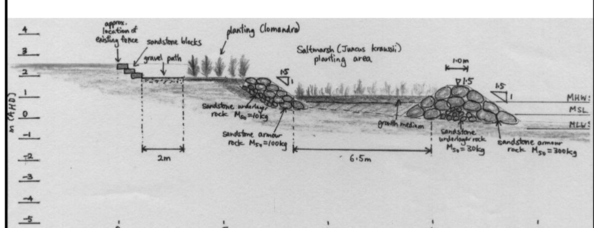


Claydon Reserve, Georges River



Ermington, Parramatta River

Step type seawall design

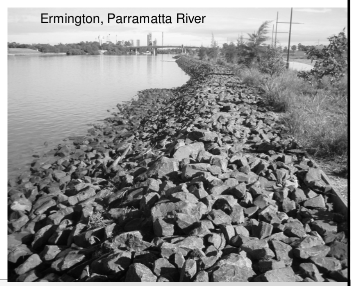


Conceptual designs for Pittwater, Rowlands Reserve (Worley Parsons)

4.3 Maximising habitat diversity and complexity

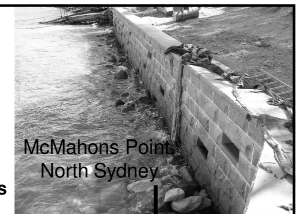
Creating seawalls made out of loose boulders:

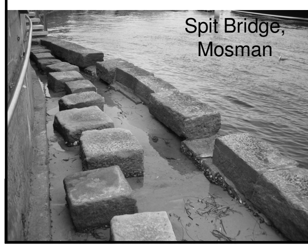
- More habitats for biota due to the spaces between the boulders e.g. crevices
- Increased benefit if different rock sizes used

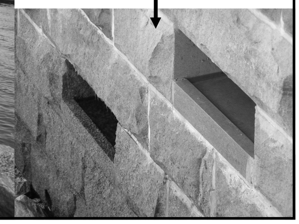


Adding cavities and pools that retain water during low tide:

- provide sheltered habitat and increase overall surface area for colonization
- habitat for species not normally found on seawalls





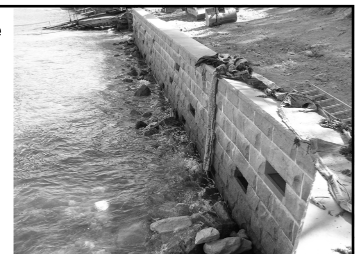


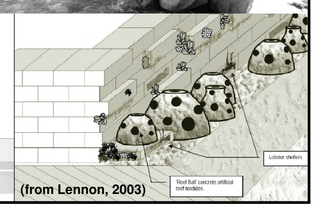
Not cementing between blocks where sandstone block seawalls are required, or indenting the cement:

- provides crevices important for protection of intertidal species
- Increases surface area

Incorporating a rubble toe where a solid vertical seawall is desired, or deploying other artificial reef structures, to provide reef like habitat directly in front of the seawall:

- habitat diversity benefits gained by boulders/reefs etc need to weighed against the possible negative impacts of loss of existing soft sediment habitat

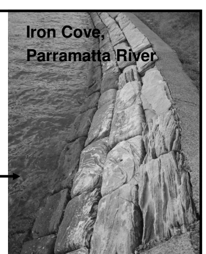


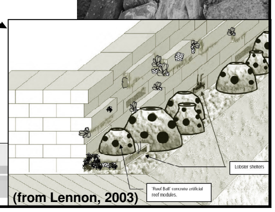


(from Lennon, 2003)

Maximising roughness and varied surface texture of the seawall face:

- using concrete panelling made from various sizes of exposed aggregate and indentations
- using irregularly shaped and/or weathered blocks
- building the seawall face with protruding blocks and ledges and indented blocks



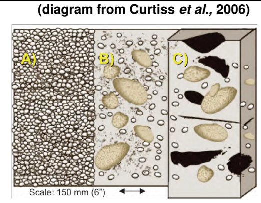


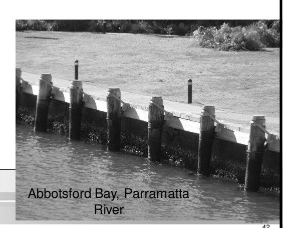
(from Lennon, 2003)

(diagram from Curtiss *et al.*, 2006)

Building the seawall with materials most compatible with the natural environment:

- Materials that encourage settlement and growth of epibiota may provide additional food and natural refuge for fish e.g.
  - Untreated timber
  - Rock (which occurs locally > sandstone)
  - Concrete (only rough and textured)





4.4 Creating low sloping seawalls and/or incorporating changes of slope

- The gentler the slope of the seawall the better, which will create a bigger intertidal area and help more closely mimic natural foreshores
- Can be created by using slight slopes or by including benches or steps into the seawall
- Incorporating benches and steps provides both horizontal and vertical surfaces and may lead to greater diversity of species

Iron Cove, Parramatta River

Bobbin Head, Cowan Creek in the Hawkesbury River

The End - Questions ?

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