MURRAH RIVER REHABILIATION PROJECT

S.Brennan
Southern Rivers Catchment Management Authority

Introduction

Bank erosion and poor fish habitat resulting from wave attack, a lack of riparian vegetation and unrestricted stock access are key threatening processes along the floodplain reaches of many rivers along the NSW far south coast. Identifying appropriate on-ground works to assist the recovery of high priority waterways is a key activity of the Southern Rivers Catchment Management Authority (Southern Rivers CMA).

Traditionally, hard structural 'rock based' remediation works have been used along tidal river banks to protect from erosion. However, with an increasing awareness in river management fields of the importance of improving fish habitat when implementing on-ground works there is a move towards trialing techniques that have multiple river health outcomes (e.g. installation of large woody debris can stabilise banks, provide sites for vegetation to establish and improve fish and other biotic habitat).

The Murrah River is a coastal stream located on the far south-coast of NSW. It was identified as a high conservation asset by Southern Rivers CMA via a formal estuary assessment process. Whist the mid-upper reaches were identified as relatively stable, the lowland plain was degraded and consequently identified as a strategic priority for rehabilitation. Significant bank erosion, an engaged landholder and a popular fishing destination along a 3 km tidal reach of this river provided a unique site to trial the effectiveness of a range options that simultaneously improve bank stability, fish habitat and assist in protecting a high conservation asset.

The Murrah River Rehabilitation Project was developed in partnership with the Southern Rivers CMA and the landholder at the project site in 2006. Funded by the NSW Government and Australian Government's Natural Heritage Trust and Caring for our Country Programs, the $130,000 project (including matching in-kind contributions from the landholder) was completed in 2009.

In this paper the different techniques trialed throughout this project are presented. An overview of the results achieved to date and environmental benefits are also discussed.

Murrah River Catchment Overview

The Murrah River catchment covers an area of approximately 190km^2 and is located between Tathra and Bermagui in Southern NSW (see Figure 1). The landscape of the upper catchment ranges from steep headwaters to rounded foot hills, with bedrock confined valleys in the mid-reaches and a lowland plain in the lower reaches (Fryirs and Brierley 1999).

Current land use is dominated by grazing in the headwaters and lowland plain, with most of the mid-catchment and estuary covered by state forest and national park. Thick sand slugs are present in the channel along the middle and lower reaches. This sediment was largely derived from catchment clearing and rabbit and hare plague populations in the late 1800's and was transported to the middle and lower reaches by flood events in the early 1970's (Scott, 1999).

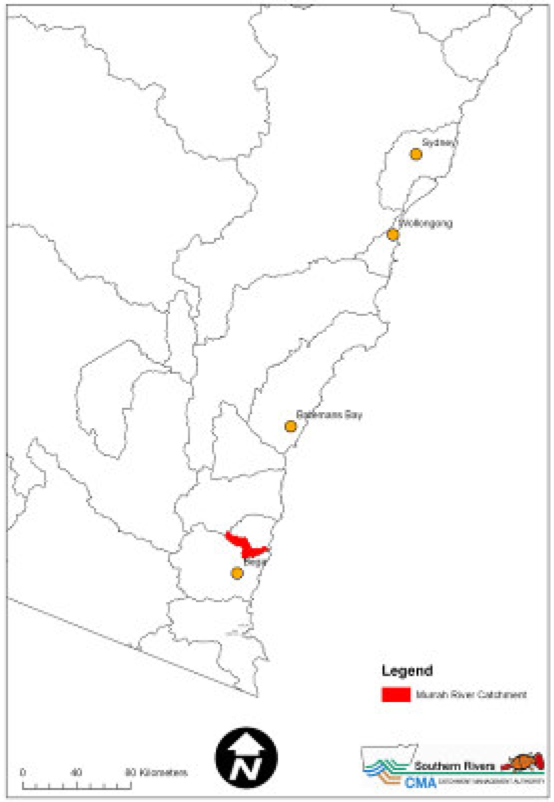

Figure 1 – Location of the Murrah River Catchment

The project site is located along tidal reaches draining the lowland plain. These reaches are characterised by laterally extensive floodplains with back swamps and large flood channels which accommodate overbank flow in flood events (Fryirs and Brieley 1999). Slopes are very low (0.0007) and valley widths are greater than 300m.

Investigations of the erosion site on initiation of the project identified a degraded condition with significant bank instability, unrestricted stock access and poor riparian vegetation cover (along the banks and floodplain). On-going bank collapse was increasing the risk of avulsion between the main river and a large flood channel which is overtopped during overbank events (see Figure 2).

A suite of erosion factors were identified as causing erosion at this site. They included (pers comm. Outhet, 2007):

- flood flows undercutting the bank toe
- lack of floodplain, bank and bed vegetation
- drawdown failure of saturated banks (slumping) on the falling stage of floods
- exposed soils dispersive in fresh (flood) water; and
- wave action largely from wind and boats (boat traffic is largely limited to small tinnies and canoes and traffic rates are low).

Figure 2 – Photo showing erosion, a lack of riparian vegetation and unrestricted stock access along the Murrah River at commencement of the project – at the narrowest point only 4 m of land remained between the main river (on the right) and the top of a flood channel (to the left).

Rehabilitation Techniques Trialed

Structural works were installed along 500 m of eroding outer river bank with an additional 2.5km of stream bank fenced and revegetated within the project site. A range of options were assessed to treat all erosion issues identified. Details of these works, including major advantages and disadvantages of each approach are outlined below.

Based on evidence of erosive factors present (e.g. high risk of avulsion and significant toe erosion) it was determined that vegetation and stock exclusion alone would be insufficient in stabilising the banks, particularly on the outer bend. Instead the use of a combination of engineered and revegetation strategies were employed throughout the design.

Log wall and rock beaching

- Design: Horizontal logs stacked and held in place with vertical pins. Rock beaching at the toe protects the toe of the wall from scour and increases roughness encouraging deposition. These works were designed to stabilise 70 m of banks most under threat from avulsion.
- Life expectancy: 10 -20 years. Key threat is marine borers. Main timber used was ironbark (for pins) and blue stringy eucalypts.
- Advantages:
    - full bank protection – protects against all causes of erosion
    - enables the bank face to planted behind the wall
- Disadvantages:

- relatively high cost, slow to build
- requires good source of logs, preferably ironbark or turpentine

Figure 3 – Log wall construction, Nov 07

Timber groynes

- Design: 19 timber based groynes were installed around 500 m of river bank to assist with protecting banks against erosion from flow. Three types of groyne were installed – fish habitat (logs crossed layered and cabled together), bundle (bundles of logs cabled together – see Figure 4a) and pin (vertical logs driven into the ground – see Figure 4b). The fish habitat and bundle groynes were built on the floodplain and lowered into position using a crane with at least 4 m of log buried into the banks. Pin groynes were driven directly into the ground from the banks. All groynes were aligned on a new curve to direct flow into the middle of the stream.
- Life expectancy: 10 -20 years. Key threat is marine borers. The primary timber used was ironbark (for pins).
- Observations to date: Since completion of works, there has been one bankfull event which demonstrated the groynes effectiveness in halting erosion from flow by slowing water between the structures and pushing the main flow into the centre of the channel. The subsequent formation of scour pools up to 2m deep around the ends of groynes (see Figure 4b) and substantial increases in the growth of sea-grass beds where sediments have deposited are key indicators of the current success of these structures.
- Advantages:
  - pin groynes – easy to install provided excavator has suitable pile driver
  - fish habitat and bundle groynes provide good fish habitat
  - form scour pools and encourage deposition
  - effective in halting flow erosion
  - enhance growth of sea grass

- Disadvantages:
  - fish habitat groynes are time consuming to build
  - wire is left instream as a result of cabling of fish habitat and bundle groynes
  - requires a good source of durable timber

Figure 4a – Fish habitat (in foreground) and bundle groynes (in background) post installation Nov 07

Figure 4b – Pin groyne and scour pool/sand deposit formed following the first bankfull flow event in Feb 08.

Brush bundles

- Design: Bundles of wattle sourced from the landholder's property were tied together with rope and staked into place using hardwood stakes 12 months after completion of stage 1 of the project (timber groynes and log wall). Brush bundles were installed primarily to stabilize the toe of banks that were still eroding from wind erosion between groynes (i.e. where no log wall was constructed – see Figure 5).
- Observations to date: Whilst there have been no flood events since construction of the bundles they are currently assisting with trapping sediment at the bank toe. Vegetation planted behind the bundles is starting to establish.
- Life expectancy: ~ 5 years
- Advantage:
    - Low cost, particularly if brush can be supplied on site
    - No heavy machinery required (i.e. can be installed manually)
    - Provides short term stabilisation of the bank toe whilst vegetation establishes
- Disadvantage:
    - Short term solution only – will not provide long-term stability if vegetation does not establish
    - Supply of brush may not be readily available and any clearing must comply with Native Vegetation Act.

Figure 5 – Brush bundles installed along the toe of the banks, Dec 2008

Revegetation works

Revegetation works have also formed an integral part of the project design. In conjunction with stock exclusion fencing, they have been carried out along 3 km of river bank (including the bank face and floodplain – see Figure 6a) to result in a continuous riparian corridor from vegetated reaches upstream of the project site to intact estuarine reaches at the downstream extent.

Monitoring to date has shown a 95% success rate achieved with planted floodplain and bank face vegetation using species that were native and endemic to the area. This suggests that the risk of avulsion will be reduced (i.e. by reducing the energy of overbank flows) and that vegetation will play an integral role in maintaining long term stability. Furthermore, the long-term role of vegetation in enhancing floodplain function by trapping and storing sediment in the floodplain zone will assist in protecting the values of the estuary.

In addition to planting along the floodplain, Grey Mangroves (*Avicennia marina*) and Sea Rush (*Juncus kraussii*) were planted along the bank toe upstream of structures and behind brush bundles (see Figure 6b). Results to date have highlighted that mangrove colonization has been very effective from seed, particularly on straighter stream reaches were energy is lower and plants were protected from existing stands of Common Reed (*Phragmites australis*). Sea rush planted from cells have also been effective in establishing at the toe of banks, particularly once brush bundles were installed.

Overall, the major advantages of revegetation works are their low cost, their ability to provide broader river outcomes, provide for long-term stability and benefits for stock (e.g. shade). The main disadvantage of vegetative methods are that results are not instantaneous – periods of 5 to 10 years may be required before roots are well established and stability is achieved.

Figure 6a – Plants established on the banks above the log wall in March 2009. Also note the young mangrove plants growing through the rock beaching and the sea grass in the water (to the left of the rock beaching).

Figure 6b – A mangrove and sea rush plant planted behind a brush bundle, March 2009

Discussion

A combination of high and low cost 'log based' rehabilitation options implemented as an alternative to rock protection through this project have proven to be an effective and aesthetically pleasing way to provide protection from a suite of erosion issues present in a sand bed stream. The approach used has provided an instant fix of structural works whilst allowing vegetation integral to river health and function to establish and improve long-term bank stability.

Major environmental outcomes observed since completion of works in 2007 have included enhanced stability and a reduced risk of avulsion, establishment of a continuous buffer of riparian vegetation, fish habitat restoration through re-instatement of large woody debris and the subsequent formation of scour pools and extended sea grass distribution. These outcomes will in-turn assist in protecting a high conservation estuary and improve floodplain functioning along 3km of lowland draining river. Benefits to the landholder include halting the loss of productive floodplain land, improved stock shelter and property management.

Assessment of technique effectiveness to date and difficulty/cost of construction have suggested that log walls with rock beaching are effective in treating a range of erosion issues but are limited by their relatively high cost and requirement for a source of large, durable timber for construction. Furthermore, timber groynes have shown to be effective in reducing erosion from flow. Pin groynes are the simplest type of groyne to construct and have demonstrated that they can create scour pools in a sand bed stream. Their single log form however suggests that fish habitat benefits are less than their more substantially constructed bundle or fish habitat groyne counterparts. Additional time and difficulty in constructing fish habitat groynes over brush bundle groynes (which contained sufficient gaps for fish) also suggested that there are minimal advantages in constructing these more complex structures.

On-going erosion of the bank toe and subsequent burial of new plants between groynes as result of wind erosion (i.e. where the log wall was not constructed) 12 months after the initial construction phase highlighted the importance of addressing all causes of erosion. Subsequent installation of brush bundles to address this issue has indicated that this technique may be a suitable, low cost approach to protect banks from wave erosion, particularly if brush can be sourced from the landholder's property. However, as a short-term solution only, it is essential that these works are followed up by extensive revegetation works to provide for long-term stream stability.

Successful colonisation of sea rush and mangroves from seed following toe stabilisation and stock removal also suggests that these species may be excellent low cost options for stabilising river banks in low energy environments. Planting of mangrove seeds amongst phragmites stands can also provide effective protection to young seedlings.

Whilst log rehabilitation works are not as enduring as rock structures they can provide additional fish habitat benefits and enhance geomorphic complexity over a relatively short period. If followed up with extensive revegetation works, which can provide long-term stability, the disadvantage of the temporary nature of these structures may be overcome. Furthermore, gradual breakdown of these structures can mimic a natural system with large woody debris falling across the banks and into the bed.

Conclusion

The Murrah River Rehabilitation Project has demonstrated a range of options for log-based structures to treat bank instability in a sand bed stream subject to a suite of erosion issues. Despite the relatively short time frame since initiation of this project (two years) and only one bankfull flood event having been experienced to date, the environmental benefits of these works are evident across the project site. In particular, the formation of deep scour pools (up to 2 m deep), significant deposition between groynes (which have enabled expansion of sea grass beds), reduced bank erosion and a 95% success rate of planted riparian vegetation are all positive indicators of the success of these works from a geomorphic, fish habitat and floodplain functioning angle.

Key learning's from this project are that log walls and fish habitat groynes, whilst effective in improving habitat and stability, require large quantities of logs and are relatively time consuming and more complex to construct than other options installed. A combination of pin or bundle groynes intermixed with brush bundles or rock protection between groynes may be a cheaper and simpler alternative. Furthermore, the use of mangroves and sea rush alone for toe protection may be a suitable option in low energy, straight sections of streams or planted in combination with structures. In order to identify the appropriate design a full understanding of all erosion issues and their causes is required.

Overall, the project is a good demonstration of a strategic intervention to protect a high conservation value natural asset in a catchment which is otherwise degraded.

References

Fryirs, F & Brierley, G 1999. *River Styles in the Dry/Murrah River Catchment, South Coast NSW*. Macquarie Research LTD.

Scott, A. 1999. *History of Land Use in the Murrah/Dry River Catchment, NSW South Coast,* CSIRO Land and Water Technical Report 54/99, CSIRO, Land and Water.