# Assessing remediation works in a severely degraded reach of Umbango Creek, New South Wales

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**Abstract**
Since European settlement, many rivers in Australia have experienced significant geomorphic and ecological change due to the modification of flow regime and catchment landuse. Current Australian restoration guidelines for waterways place a low priority on the rehabilitation of highly degraded stream reaches, as it is considered pragmatic to abandon these highly degraded sites in favour of focussing on threatened sites in good condition. However, a move away from remediation within highly degraded stream reaches does not address the high incidence of these sites in rural catchments such as the Murrumbidgee. Our project monitored remediation works including channel realignment, levee bank construction and revegetation that were undertaken to stabilise severely eroded reaches of Umbango Creek in southern New South Wales. Since the remediation works were completed in May 2001 the area has been subject to prolonged drought conditions allowing replanted and naturally regenerated vegetation to establish unhindered by erosional high flows. Assessments of the remediation works were undertaken in August 2003, May 2004 and January 2005. The results demonstrate that remediation works undertaken on highly degraded creek reaches have the potential to improve vegetation cover and may assist in stabilising banks vulnerable to erosion.

**Keywords**
Channel morphology; rehabilitation; remediation assessment; vegetation survey

## INTRODUCTION

Many rivers in Australia have experienced significant geomorphic change during the period since European settlement. This has often been caused by substantial alterations to water regimes and by widespread modification of catchment land uses (Boulton & Brock, 1999; Rutherfurd, 2000). Declining water resources and increasing public awareness have prompted a move towards improved river management and more balanced decision making regarding water usage (Bennet *et al.*, 2002). However, simply halting degradation in our riverine environments is not sufficient to ensure sustainability and it is now widely acknowledged that river restoration works are required to attempt to reverse the effects of human impacts (Koehn *et al*., 2001).

Current Australian restoration guidelines place a low priority on the rehabilitation of highly degraded stream reaches, in favour of focussing on threatened sites in good condition. The analogy used by Rutherfurd *et al.* (2000) is that of attempting to save victims from the sinking *Titanic*. Where can the 'life boat' of scarce restoration resources be most effectively used? It is considered preferable to focus on threatened sites in good condition, rather than squander resources on sites with poor remediation potential. However, this approach to river restoration does not address the high incidence of severely degraded sites in rural catchments such as the Murrumbidgee. A move away from remediation within these highly degraded stream reaches may neglect an important area of need and slow research efforts to address degradation issues effectively (Watts & Wilson, 2004).

This project monitored remediation works that were undertaken to stabilise a severely eroded site on Umbango Creek, New South Wales where some reaches provide examples of acute degradation resulting from tree clearing, domestic stock grazing, exotic pest invasion and channel alteration. Since European settlement, this creek has been transformed from a sinuous, meandering channel with deep pools and reed swamps into a deeply incised, low sinuosity, bedload-dominated system that is permanently isolated from its original flood-plain (Page & Carden, 1998). The worst affected reaches are now up to 7 metres deep and 70 metres wide. Despite the low priority given to recovery initiatives in highly degraded reaches (Brierley, 1999; Rutherfurd *et al.*, 2000), strong landholder commitment led to remediation works being undertaken as part of the Rivercare Program (NSW Department of Land and Water Conservation) in May 2001. These works included channel realignment away from the undercut toe of the bank, levee bank construction and revegetation. The stated aims of the Rivercare application were to stabilise creek banks, reduce erosion, reduce sedimentation in downstream reaches, provide a vegetated corridor for native fauna and, in time, provide shade and shelter for stock (G Sykes, 1999, *pers. comm.*). Since then the area has been subject to prolonged drought conditions without any potentially erosive high flows. This has provided an opportunity to assess the success of high-risk remediation works and to monitor the trajectory of recovery within this degraded ecosystem.

## METHODS

### Study area

Umbango Creek is a tributary of Tarcutta Creek which flows into the Murrumbidgee River in southern New South Wales. Before the arrival of Europeans in the 1800's, Umbango Creek's catchment area was characterised by eucalypt woodlands, stable valley side-slopes, a low capacity meandering channel and a swampy floodplain with deep alluvial soils. European landclearing resulted in gully erosion, channel aggradation and the burial of much of the former floodplain with up to one metre of sandy sediment (Page and Carden, 1998). Attempts by landholders to improve channel flow efficiency by removing in-stream vegetation and bend elimination resulted in incision, often to bedrock, and the transformation of the channel into a deep, low sinuosity bedload system in the reach upstream of Humula (Page and Carden, 1998). Subsequent widening of the incised channel since the 1950s (G. Sykes *pers. comm.*), which resulted in the loss of valuable river flats and associated infrastructure, has prompted some landholders along Umbango Creek to undertake remediation works. Our study focused on a remediation project undertaken on the Sykes' property, upstream of the township of Humula.

The remediation works at the Umbango Creek study area were undertaken in three reaches as follows:

1. Log groyne reach – channel was realigned away from the eroding bank; timber groynes were used to reinforce the eroded bank; seedlings were planted between timber groynes and in-stream vegetation transplanted after earthworks.
2. Realignment reach – part of the bank was excavated and the channel realigned away from the eroding bank; eroded toe of the bank armoured with river cobbles; seedlings planted and in-stream vegetation transplanted after earthworks.
3. Levee bank reach – existing large bend shortened by constructing a new channel adjacent to the slip-off slope; new levee bank replanted with seedlings; bypassed bend also revegetated and in-stream vegetation transplanted after earthworks.

Although data were not available prior to the implementation of these remediation works in May 2001, assessments were undertaken in August 2003, May 2004 and January 2005. On each occasion surveys of channel morphology and vegetation were undertaken as described below.

### Vegetation surveys

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Vegetation surveys were undertaken at the three reaches where remediation work had been undertaken. Trees and shrubs occurring within 5m wide transects across the channel were surveyed with tree type and height recorded. The extent of grazing damage to each tree was categorised as: none, minor (70-80% of leaves remaining), major (50-40% of leaves remaining), severe (less than 20% of leaves remaining) and very severe (no leaves remaining). Analysis of variance (ANOVA) was used to compare tree abundance at each sampling period.

Percent vegetation cover was estimated along 5m wide transects across the channel at each reach. Vegetation (other than trees) observed along each transect was allocated to one of the following broad categories – grass, herbs and forbs, sedges, reeds, other aquatic plants, moss/lichen. Total vegetation cover for each year was calculated by adding together all cover values for each vegetation category. ANOVA was used to investigate any differences between the percent cover of vegetation across all years assessed.

### Channel morphology

Channel morphology was recorded at the three reaches within Umbango Creek where remediation work had been undertaken. Permanent survey marks were established at each reach to allow surveys to be taken at the same location every year. Cross sections were surveyed at 90° to the direction of creek flow across the channel using a Topcon total station.

## RESULTS and DISCUSSION

### Vegetation surveys

Comparison of percent vegetation cover data showed a significant increase between the first survey in 2003 and the latest in 2005 (ANOVA; $P<0.05$; Figure 1). This increase occurred despite the drought conditions existing across the catchment and the reintroduction of cattle into the remediated area for crash grazing on a number of occasions. The use of intermittent crash grazing was necessary as feed for livestock became increasingly scarce during the drought.

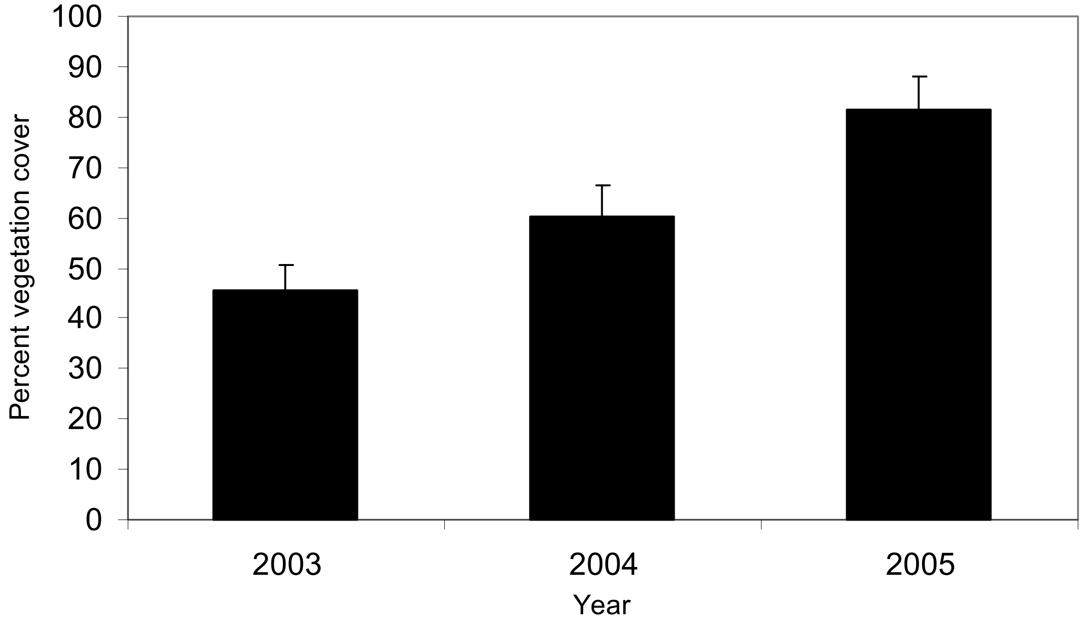


**Figure 1.** Average percent cover of vegetation along transects (*n*=3) surveyed within Umbango Creek in 2003, 2004 and 2005; only 2003 and 2005 were significantly different from each other (ANOVA; P<0.05).

The average number of trees and shrubs counted along the three sample transects within the remediated creek significantly increased between 2001 and 2004 (ANOVA; P<0.05, Figure 2) as a result of revegetation work and natural regeneration. The assessments of grazing damage inflicted on trees demonstrated substantial impacts in 2003 and 2004, where 77% and 64% of trees respectively were recorded as having severe damage. In contrast, the number of trees with severe grazing damage recorded in 2005 was only 7%. Despite these observed areas of damage, no significant difference in tree abundance was detected between 2004 and 2005. These data indicate that many of the trees within the study area were able to recover from the impacts of cattle grazing, and that few were actually destroyed as a result of crash grazing.

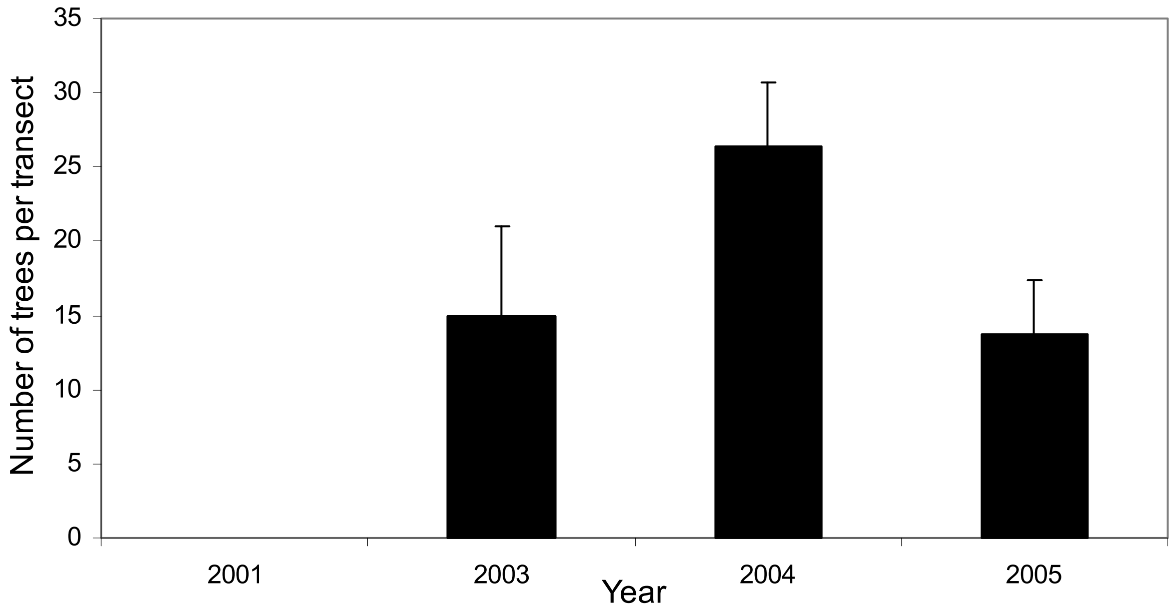


**Figure 2.** Average number of trees and shrubs per transect (*n*=3) within Umbango Creek in 2001, 2003, 2004 and 2005; only 2001 and 2004 were significantly different from each other (ANOVA; P<0.05).

**Channel morphology**

Channel cross sections surveyed at the three reaches of Umbango Creek indicated that relatively little change to channel morphology had occurred during the study period (Figure 3, Figure 4). This channel stability was the anticipated outcome of generally low flow conditions throughout 2003 and 2004 when the creek experienced relatively low discharge conditions with flow velocities below those required to entrain cobbles. Minor river freshes, which occurred in August 2003 and September 2004 following widespread rainfall in the catchment, provided an opportunity to examine the stability of the revegetated channel earthworks.

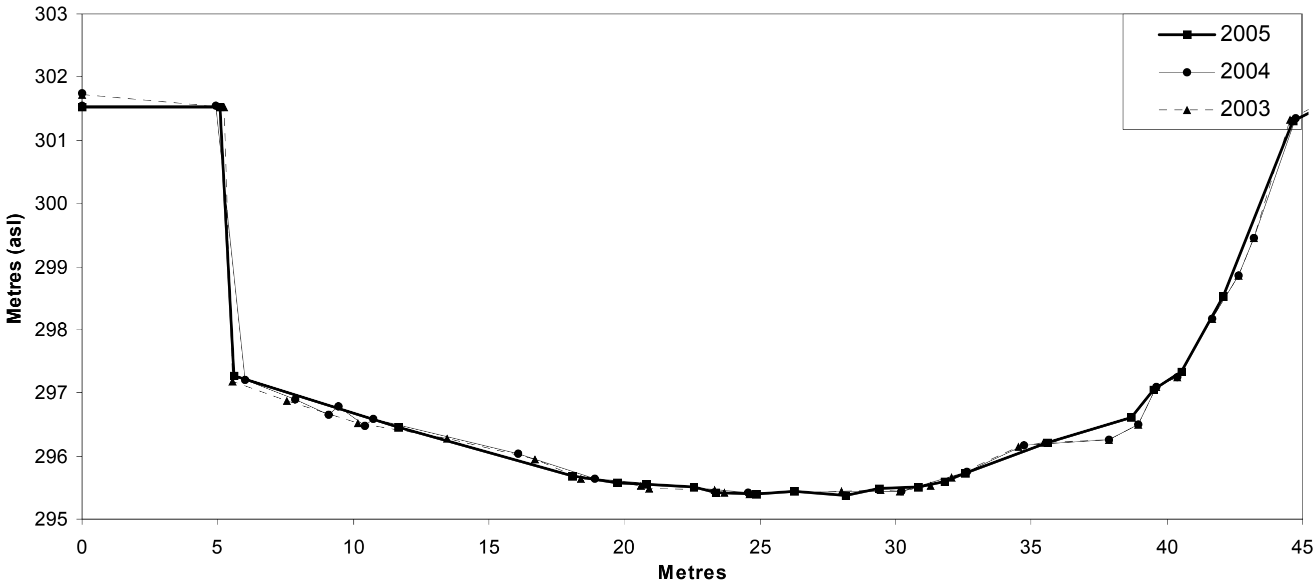


**Figure 3.** Channel cross sections at log groyne reach in Umbango Creek surveyed in 2003, 2004 and 2005.

Changes to channel morphology as a result of minor flood pulses were evident only at the levee bank reach where minor bank erosion and thalweg deepening occurred at the levee bank, which was created to short-circuit the previous large bend (Figure 4). Although continuous monitoring of creek discharge was not undertaken at the remediated reach, a nearby permanent gauging station was used to examine the peaks of flow experienced in the catchment (DIPNR http://www.dlwc.nsw.gov.au/index1.html). Flow data obtained from the Borambola gauge indicated that the two elevated flow events experienced at the study site were probably relatively small, being approximately 40% of the size of peak flows recorded in 1998 and 2000.

Despite their small magnitude, it is obvious from Figure 4 that some erosion of the levee bank occurred at the bend axis after the rains in August 2003. However, the lack of a significant change in channel morphology between the 2004 and 2005 surveys suggests that the 2004 flow (of similar magnitude) had minimal further erosive impact on the levee bank. This may indicate an increase in bank strength resulting from enhanced vegetation cover (Hickin, 1984). Bend shortening at this reach has increased local channel slope and potential bed shear. The vulnerability of the constructed levee bank to future bend erosion presents a challenge to the on-going success of remediation work in this reach and therefore requires periodic monitoring.

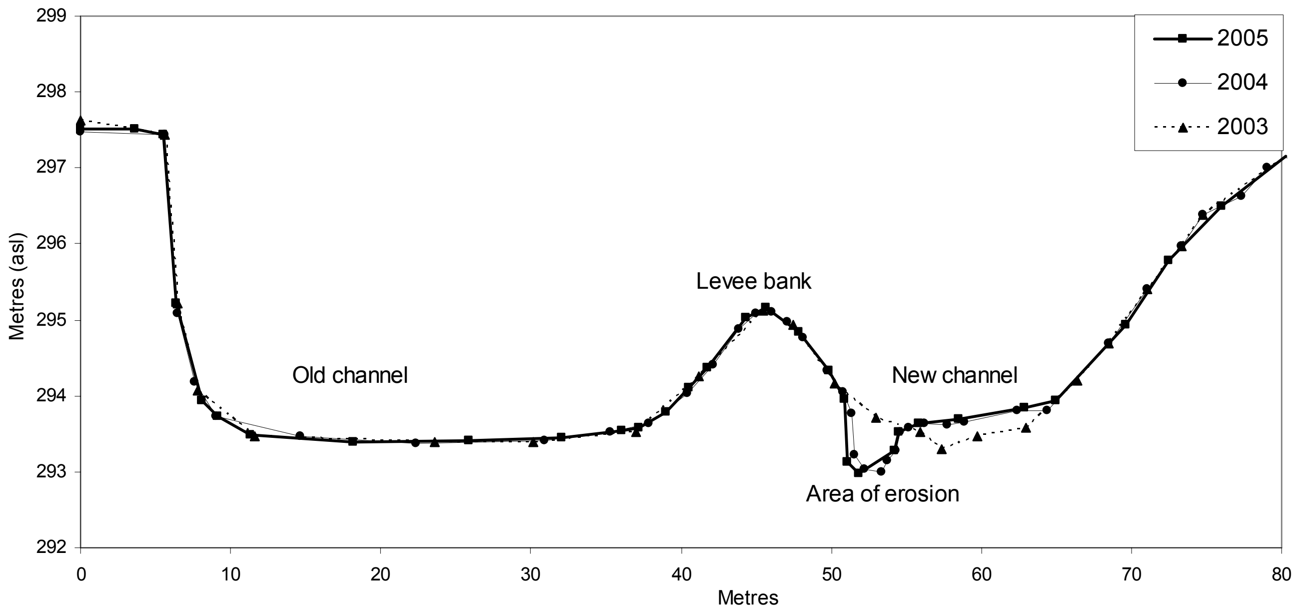


**Figure 4.** Channel cross sections at levee bank reach in Umbango Creek surveyed in 2003, 2004 and 2005.

## CONCLUSIONS

Results from this study demonstrate that remediation works undertaken on highly degraded creek reaches have the potential to improve vegetation cover and may assist in stabilising banks vulnerable to erosion. One of the strengths of this remediation project was the enthusiasm of the landholders to improve existing creek conditions, including a commitment to exclude livestock when possible and to undertake revegetation works. The weather conditions after the implementation of remediation works precluded erosive high flows from scouring the channel and enhanced the establishment of replantings. However, these remediation works have not been tested under higher flow conditions and the long-term recovery trajectory of this creek will continue to be monitored, particularly at vulnerable locations where bend shortening has raised potential bed shear.

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