

Using Habitat Mapping to prioritise on ground investment: from little things big things grow.

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Key Points

A small volunteer organisation can utilise Local and State Governments to leverage funds to complete large environmental projects.

Good base line data can be integral in targeting works to have the greatest outcomes.

Removal of fish passage barriers can assist fish populations in diversity and abundance.

Abstract

In 2016 Central Tablelands Local Land Services (LLS) contracted NSW Department of Primary Industries (DPI) Fisheries to map the aquatic habitat features along the upper reach of the Macquarie River from the confluence of the Fish and Campbells Rivers downstream through Bathurst for a total length of 20 kms. This mapping benchmarked current conditions and made recommendations regarding the protection and improvement of stream health, threatened species habitat enhancement, weed control and improvement of other habitat features which was ultimately used to direct works for the Recovery of the Mac project.

Recovery of the Mac Stage 1 is a collaborative project developed between the Sofala Branch of the Central Acclimatisation Society (CAS), Bathurst Regional Council, Central Tablelands Local Land Services, NSW DPI Fisheries and Central West Councils Environment and Waterways Alliance with support from OZ Fish Unlimited. The project was primarily funded through the NSW DPI Fisheries (Habitat Action Grant) with in-kind and cash contributions from all other consortium members.

The Recovery of the Mac project includes targeted interventions to extend and build on existing habitat features along a specific reach of the Macquarie River. Works include modification to existing weirs to open up fish passage for 400+ km, installation of large rock assemblages to create scour holes and allow the river channel to narrow and deepen through geomorphic processes, removal of invasive plants and revegetation with native species with a view to enhance native fish refuge habitat and restore fish passage.

Keywords

Collaboration, Aquatic Habitat Mapping, Fish passage

Introduction

Central Tablelands Local Land Services identified a need to have a better understanding of the condition of the major waterways within the Central Tablelands region in order to prioritise investment in stream conservation and rehabilitation. Previous reports categorised major waterways into sub-catchments (Baker and Raisin, 2000) and though useful to give an understanding of condition in a broad sense, it didn't provide enough detail to direct works due to being predominately desk top assessments.

The River Styles framework (Brierley and Fryirs, 2000, 2005) provides a physical description and explanation of river forms and processes. It also details recovery potential and guides geomorphic priorities for conservation and rehabilitation of set reaches. Although geomorphic considerations provide the physical template upon which ecosystems operate, they may not be the ultimate determinant of ecosystem performance (Palmer et al., 2010). While geomorphic condition provides a useful rapid assessment of human impacts and geomorphic stability, further information on aquatic biodiversity values such as pool depth and length, native wood loading and barriers to fish passage are also useful in prioritising investment. This has worked well for individual projects by feeding into an Environmental Services Ratio (ESR), which is useful to give a ranking and cost share. Central Tablelands LLS identified the need to understand the condition of major waterways within the region at a greater scale so as to direct future projects to have the greatest environmental gain while also being cost effective.

Central Tablelands LLS embarked on a program of contracting NSW Fisheries Aquatic Habitat Rehabilitation Unit to complete Aquatic Habitat mapping concentrating on major waterways. Part of this larger program was a reach of the Macquarie River from the confluence of the Fish and Campbells Rivers to Eglington covering a reach length of 21 km (Figure 1). This report has the advantages of being ground-truthed and provides accurate information of the condition and habitat features of the reach.

Prioritisations are based on the concept that it is generally more cost-effective to protect reaches of stream that are in good condition (or the best first) than to rehabilitate severely degraded areas (Rutherford et al. 2000; Lovett and Edgar, 2002) and expand restoration outward from protected sites (Beechie et al. 2008; Frissell and Bayles, 1996; Ziemer, 1997).

Decision Support Systems (DSS)

The Aquatic Habitat report provides aquatic habitat condition rankings by dividing this section of the Macquarie River into 21 management reaches of 1km length with bank width of 20m along both banks.

Assessment considered geomorphological, vegetation and structural features. These specifically included:

- Large Woody Habitat (LWH) – total number of LWH
- Instream refugia – total refuge depth (sum of the deepest point of each refuge pool²)
- Regeneration of native canopy species – total extent within the reach (hectares)
- Erosion – total extent within the reach (hectares)
- Stock damage – total extent within the reach (hectares)
- Barriers to fish passage – taking into account barrier type head loss, distance and quality of upstream and downstream habitat, the number of downstream barriers and ancillary uses of the structures.

Results from the Mapping

The DSS provided a prioritisation matrix (Table 1) to guide rehabilitation activities. Results of this were that Reach 7 was in the best condition over the 21 km mapping, giving it the greatest priority for intervention, maintenance and protection. Reaches 8, 9, 10, 11, 13 and 15 were ranked as being of moderate condition and as such they were considered as the next priority for intervention. Connectivity was a consideration with works in reaches 8, 12 and 15 potentially contributing to the extent of, and linkages between, reaches of moderate condition.

Table 1. Priority Management Reaches, Upper Macquarie River Habitat Mapping Report

Management Reach	Habitat Value Scores							Priority Ranking	Total Condition Score	Condition
	Drought Refuge	Large Woody Habitat (Snags)	Native Plant Regeneration	Exotic Plants	Erosion	Stock Access/ Damage	Barrier Impact			
1	0.04	3.66	-0.77	-0.60	0.47	-3.06	0.0	9	-0.26	Moderate Health
2	-1.49	3.98	-0.29	-0.04	0.47	-0.35	0.0	7	2.29	Moderate Health
3	-0.07	2.09	1.21	-0.74	0.47	0.49	0.0	3	3.45	Moderate Health
4	1.22	2.09	-0.17	-1.45	-3.76	0.49	0.0	12	-1.57	Poorer Health
5	-1.49	1.78	-0.77	-0.31	0.47	-1.70	0.0	13	-2.02	Poorer Health
6	-1.49	1.15	-0.70	-1.08	0.47	0.49	0.0	11	-1.15	Poorer Health
7	5.54	1.15	-0.69	-0.09	0.47	0.49	0.0	1	7.95	Better Health
8	0.16	0.52	0.01	0.99	0.47	0.49	0.0	5	2.65	Moderate Health
9	1.34	0.21	-0.75	0.88	0.47	0.49	0.0	6	2.63	Moderate Health
10	2.76	-0.10	-0.78	0.66	0.46	0.49	0.0	2	3.48	Moderate Health
11	0.87	0.21	-0.77	-0.75	0.47	0.49	0.0	8	0.51	Moderate Health
12	-1.49	-0.10	0.88	0.43	-1.19	0.49	-2.7	15	-3.68	Poorer Health
13	-1.49	-0.73	2.01	1.54	-0.61	0.49	-2.1	10	-0.89	Moderate Health
14	0.52	-1.35	2.84	1.88	0.47	0.49	-1.5	4	3.33	Moderate Health
15	0.04	-1.68	0.45	-0.42	0.18	0.49	-2.7	14	-3.63	Poorer Health
16	-1.49	-1.99	0.18	1.06	-0.97	0.49	-2.1	20	-4.83	Poorer Health
17	-1.49	-2.30	0.28	-0.10	0.47	0.49	-1.5	18	-4.16	Poorer Health
18	-1.49	-2.62	-0.39	0.75	0.47	0.49	-0.9	16	-3.69	Poorer Health
19	-1.49	-0.73	-0.68	0.43	-0.15	-1.62	-0.3	19	-4.54	Poorer Health
20	1.34	-2.30	-0.72	-1.83	0.47	-1.07	0.0	17	-4.12	Poorer Health
21	-1.49	-2.93	-0.39	-1.22	-0.02	0.49	0.0	21	-5.56	Poorer Health

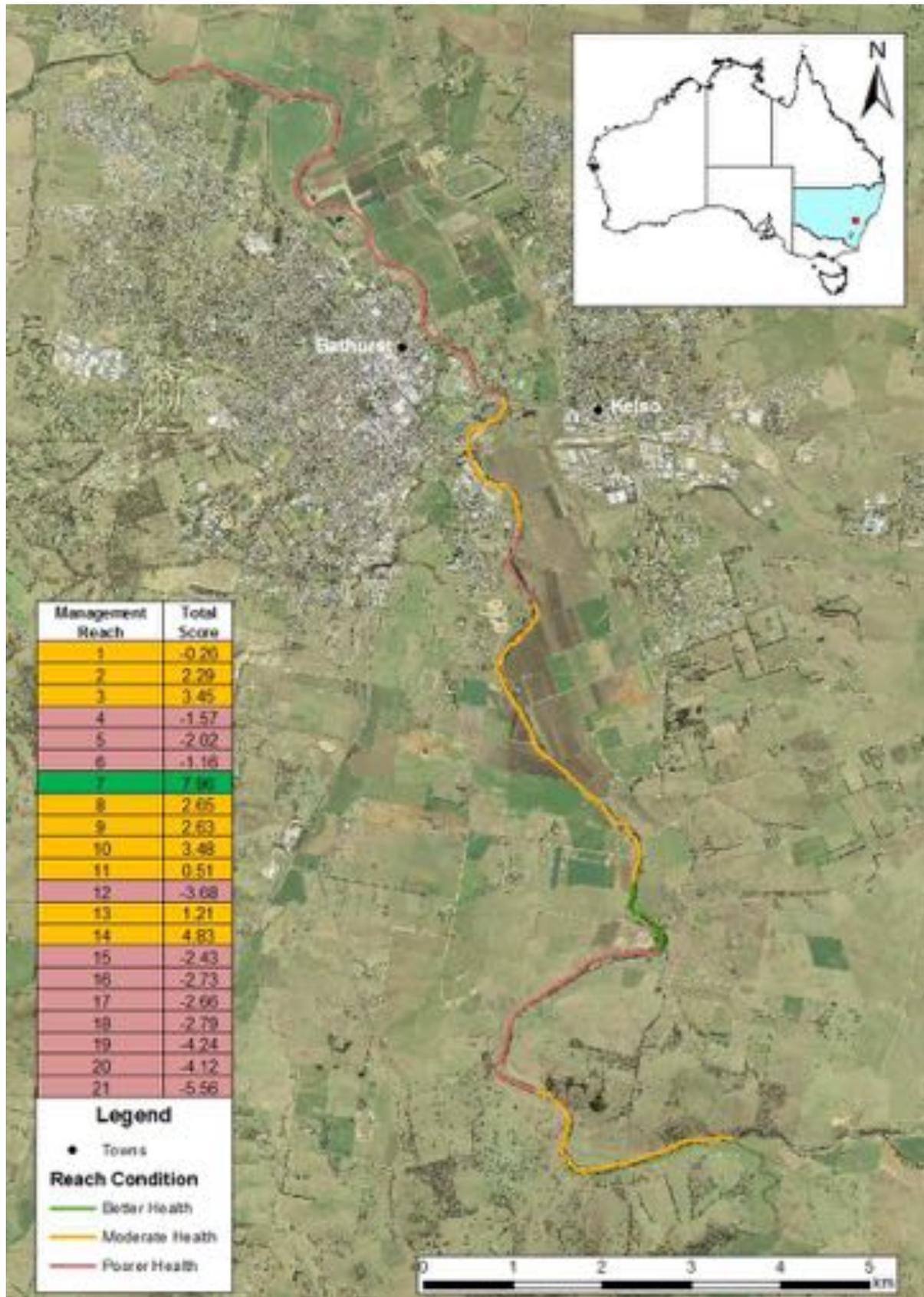


Figure 1. Macquarie River 1km reaches

Fish Habitat Action Grant

The Turon Branch of the Central Acclimatisation Society has been working to improve aquatic habitat along the river by raising awareness and completing projects that will improve the condition and potential habitat for fish. A particular focus is centered around the endangered Trout Cod with the group being involved in the National Trout Cod Recovery Plan. The completion and distribution of the Habitat mapping for this reach of river provided a catalyst for the application for funding through the Fish Habitat Action Grants issued by Department of Primary Industries. The program is provided from funds collected through the issuing of fishing licenses in NSW.

The project has commenced and aims to complete:

Willow removal Reach 8: Selectively remove willows using an excavator where suitable – leaving stumps and roots in situ – and following up with stem injection to those with difficult access.

Rock Installation Reach 8: Large bolder installation using up to 100 tonnes of large boulders (1000-1800mm) strategically placed to create turbulence and form refuges while maintaining fish passage.

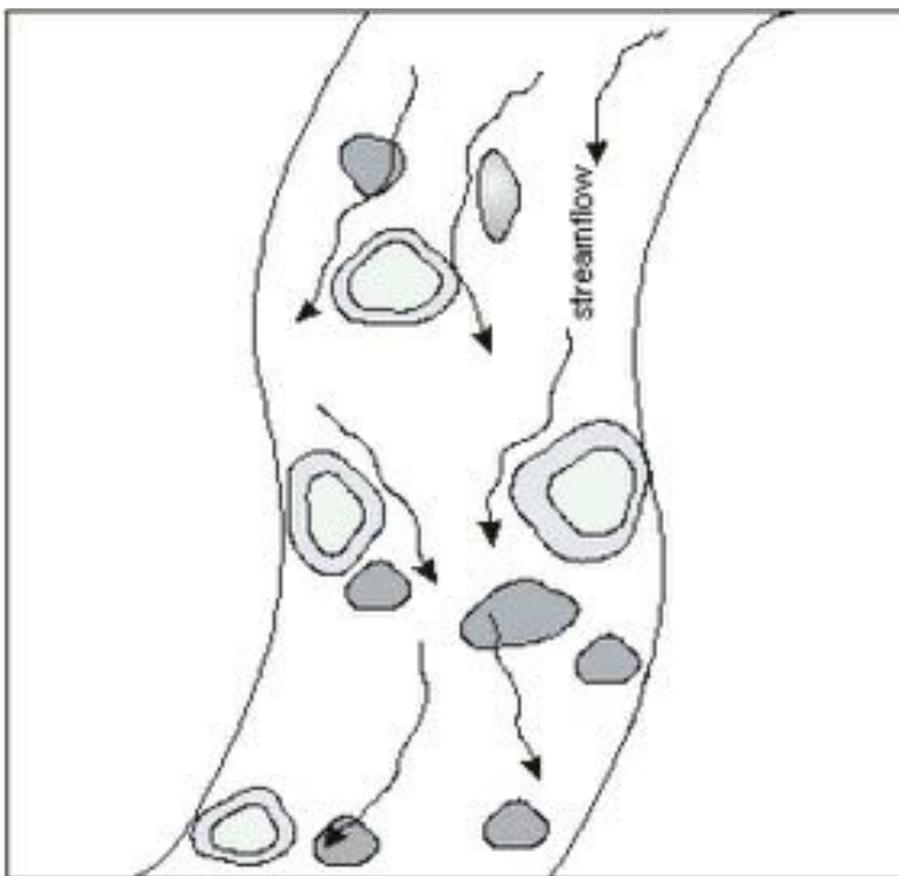


Figure 2: An example of a cross-vane diagram (left) and an in-situ example (right). (Bergstrom, J.D.)

Revegetation Reach 8: Using local endemic species of plants that will build the adjacent habitat encouraging use by native fish species.

Weir Removal (Waterworks Weir Reach 12 and two unnamed Weirs Reach 15): While the Waterworks weir was known to the community there were also two unnamed weirs that were identified through the Aquatic

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Habitat mapping and so were incorporated into this project. Removal was completed by an excavator (Figure 3), realigning rock to protect the bank, allowing for fish passage while still working as a bed control as was originally designed. The removal allowed for a potential 404km of fish passage.

Of the 55 species of native freshwater fish living in New South Wales, 32 are at present known to be migratory and to require free passage to sustain populations. Barriers to fish passage, of which there are known to be 4,308 in New South Wales streams, can cause local extinctions or greatly reduce fish abundance and diversity (Thorncraft and Harris 2000).

As a primary recommendation, NSW DPI encourages the removal of redundant structures from waterways, with weir removal providing the greatest benefit to the health of the waterway by enabling unrestricted fish passage and reinstatement of natural sediment fluxes within a system (NSW Department of Primary Industries, 2006).



Figure 3: Unnamed Weir pre-work and post work

Conclusions

By leveraging extra funds through collaboration it was possible for a small volunteer based organisation to extend their reach and instigate a major project improving the quality of habitat for our native fish species.

From their original idea and from input from Local Government and State Government organisations they accessed over \$60,000 of funding to complete this project.

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References

- Beechie, T., Pess, G., Roni, P. and Giannico, G. 2008. 'Setting River Restoration Priorities: a Review of Approaches and a General Protocol for Identifying and Prioritising Actions'. *North American Journal of Fisheries Management*, 28: 891-905.
- Brierley, G. J., & Fryirs, K. A. (2005). *Geomorphology and river management: Applications of the River Styles framework*. Oxford, UK: Blackwell Science.
- Frissel, C.A., Bayles, D. 1996. *Ecosystem Management and the conservation of aquatic biodiversity and ecological integrity*. The Journal of the American Water Resources Association.
- Lovett, S. and Edgar, B. 2002. 'Planning for River Restoration', Fact Sheet 9, Land & Water Australia, Canberra.
- NSW Department of Primary Industries (2016), Upper Macquarie River Habitat Mapping, Investment recommendations for the 21 km reach of the Macquarie River downstream of the Campbells and Fish River Junction. Report prepared for Central Tablelands Local Land Services, NSW Department of Primary Industries, Dubbo.
- NSW Department of Primary Industries (2006). *Reducing the Impact of Weirs on Aquatic Habitat - New South Wales Detailed Weir Review*. Central West CMA region. Report to the New South Wales Environmental Trust. NSW Department of Primary Industries, Flemington, NSW.
- Palmer, M.A., et al. (2010). River restoration, habitat heterogeneity and biodiversity: a failure of theory or practice? *Freshwater Biology*, 55 (Suppl. 1), 205–222
- Rutherford, I., Jerie, K. & Marsh, N. 2000. *A process for rehabilitating Australian Streams*. CD ROM. Cooperative Research Centre for Catchment Hydrology, Land & Water Australia 2000.
- Thorncraft and Harris. 2000. *Fish Passage and Fishways in New South Wales: A Status Report*. Cooperative Research Centre for Freshwater Ecology Technical Report 1/2000 May 2000.
- T. Baker & G. Raisin 2000. *An Assessment of riverine health in the Macquarie, Castlereagh and Bogan River Catchments : report, photographs and catchment summaries*.
- Ziemer, R. 1997. 'Temporal and spatial scales'. Pages 80-95 in J.E. Williams, C. A. Wood and M. P. Dembeck (eds) *Watershed Restoration: Principles and Practices*. American Fisheries Society, Bethesda, Maryland.
- USDA Natural Resources Conservation Service Soils – United States Department of Agriculture. *Natural Channel and Floodplain Restoration, Applied Fluvial Geomorphology*. Digital Image accessed 7th June 2018. <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=stelprdb1247762>