Innovative river action planning for the Upper Collie catchment, Western Australia

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Abstract

In River Action Plans (RAPs) ecological condition is presented as a series of maps that may also indicate river values and threats. RAPs also offer advice to landholders and others about river and foreshore management. This paper describes the development of a RAP for the main rivers of the Upper Collie Catchment in southwest Western Australia (WA).

Ecological condition considers foreshore vegetation, weeds, erosion, sedimentation and water quality. In the Upper Collie it was found that 21% of rivers in the Upper Collie were in 'pristine' condition, 24% were in 'degraded' condition and 55% were in 'eroded' condition. Of the total riverbank length (161.8km), 66% was unfenced, 24% was fully fenced and 10% was partially fenced. According to the *Waterways Management Prioritization Framework* on-ground actions should secure, stabilise and maintain high-value sites before attempting restorative work on lower-value sites. Of the 217 survey sites assessed, 9.3% were classed Priority 1 (requiring immediate protective management), 26.2% were classed Priority 2 (worthy of strategic management) and 64.5% were Priority 3 (beyond viable restoration). Issues identified were: loss of vegetation; weeds; erosion/sedimentation; water extraction; water quality; and support to landholders in planning protection and rehabilitation. Banks that retain native vegetation (especially those identified as Priority 1) should be protected e.g. fencing to control livestock. Revegetation should be done using local native species (trees, shrubs, sedges, rushes, herbs and native grasses). Best management techniques should be employed to minimise soil erosion and nutrient loss, e.g. buffer strips, soil testing and fertiliser management plans.
Keywords: River Action Plans (RAPs), ecological condition, river values and threats, best management techniques.

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1 Background

River Action Plans (RAPs) have been developed in Western Australia (WA) by state government agencies and regional natural resource management (NRM) organisations to provide information to, landholders, interested community members, and other stakeholder groups on the health and current state of rivers and to provide recommendations on how to improve their management.

In the south-west of WA, three RAPs have been developed for the Lower Preston River, the Brunswick River and the Lower Collie River, which all exhibit significant degradation including: lowering water quality (salinity, turbidity), foreshore degradation (biodiversity decline, weed invasion) and bank erosion and sedimentation.

Recognising that degrading processes in the Upper Collie Catchment were negatively impacting the Lower Collie River, the WA State Government, through the Department of Water (DoW), commissioned the University of Western Australia to prepare a RAP for the main waterways in the Upper Collie Catchment.

2 The Upper Collie Catchment, Western Australia

The Collie River is a major river system in the southwest of Western Australia flowing through the town of Collie (figure 1).

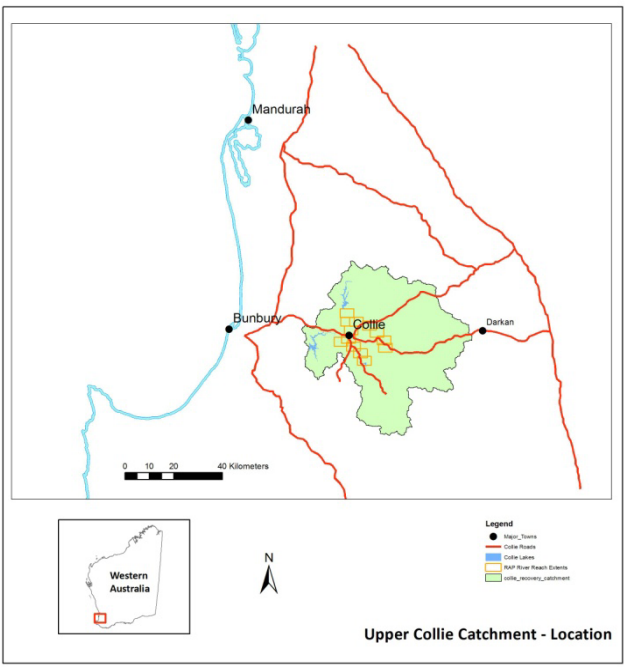

Figure 1: Location of the Upper Collie Catchment study area.

The climate of the Collie region may be regarded as 'Mediterranean' with hot, dry summers and cool, wet winters [1]. Average annual rainfall is approximately 1200mm. Average annual evaporation rates for the catchment area vary from 1200mm to 1600mm, with monthly rates between 50mm in June and 300mm in January [2].

The Upper Collie Catchment landform is made up of deeply incised valleys and the dominant geology is colluvium over metasediments and granite rocks. The soils are friable red/brown loam earths, brown loamy earths, loamy gravels, brown deep loamy duplexes, duplex sandy gravels and stony soils [3].

Rivers in the Upper Collie have been impacted by a range of land-uses and substantial levels of regulation (e.g. Harris River Dam, Wellington Dam). Since the catchment was cleared, salt from the soil has flowed into the river systems causing parts of the river to become saline. The majority of the upper catchment is forested and in the 2002 the National Land and Water Resources Audit [4] described the catchment as being in a 'moderate' condition compared with other catchments in Australia.

The rivers of the Upper Collie Catchment have a range of ecological, social and cultural values, notably: providing habitat for native fauna, water for irrigation farm stock and urban uses, tourism and recreation, as well as having cultural value to both Aboriginal and non-Aboriginal people.

3 Assessing the condition of Upper Collie rivers

The approach used to assess the condition of the rivers of the Upper Collie Catchment incorporated two methodologies: the *WA Waterway Values-Threats Assessment Framework* developed by Macgregor *et al.* [5] and the River Foreshore Condition Assessment methodology developed by Pen and Scott [6]. The Pen-Scott methodology was enhanced for this study by considering additional river erosion and sedimentation criteria (as discussed below).

3.1 The Pen-Scott foreshore condition assessment method

The Pen-Scott method of riparian zone assessment has been widely used in WA for assessing the ecological health of rivers. Surveys of rivers using the system may be carried out fairly rapidly and consequently it has been used in developing previous RAPs (e.g. [7–9]). It provides a graded description of the river foreshore from 'pristine' (A grade) through to 'ditch' (D grade). A summary of the grades of the Pen-Scott method is illustrated in figure 2.

According to the Pen-Scott method, Grade A foreshores are those where the floodway is entirely vegetated with native species. Grade B foreshores are those that have been infested with weeds but there is still abundant native species. Grade C foreshores are partially cleared and so erosion prone and while some large native shrubs and trees remain the understorey consists almost entirely of weeds, especially annual grasses. Grade D foreshores are those where the soil is exposed through heavy livestock damage. Undermined and subsided embankments are common, as are large sediment plumes.

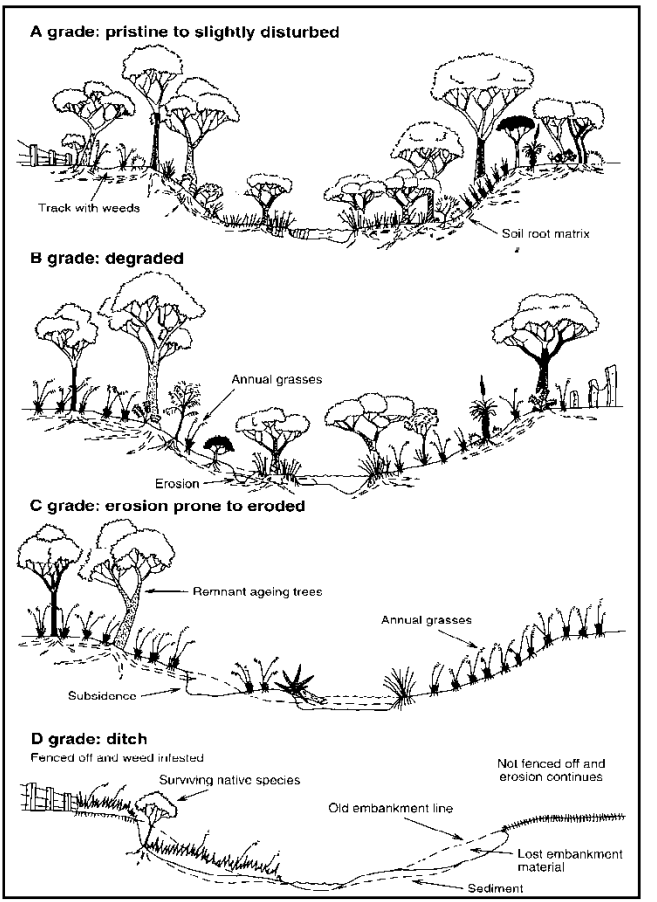

Figure 2: The four grades of river foreshore condition (A) pristine to (D) ditch (Pen and Scott [6]).

3.2 Assessing erosion and sedimentation

The Pen-Scott method considers erosion and sedimentation in a superficial manner so for the Upper Collie RAP Macgregor *et al.* [10] extended the field assessment method for bank erosion and sediment deposition by considering five specific criteria: bank undercutting (outside bends), bank slumping, point bars, pool aggradations (particularly inside meander bends) and large woody debris (table 1).

3.3 The values-threats prioritisation framework

The *WA State-wide Waterways Management Framework* [5] is an assessment methodology designed to prioritise management actions. It considers river values and threats in a simple matrix (figure 3).

Table 1: Field assessment method for river erosion and sedimentation.

Erosion/deposition process	Class	Assessment criteria
Bank undercutting – left & right banks (e.g. BB)	A B C D	Nil 0-50cm 50-100cm > 100cm
Bank slumping – left & right banks (e.g. AA)	A B C D E	Nil Occupies 5% of active channel 5-20% active channel 20-50% active channel >50% active channel
Point bars (e.g. B)	A B C D E	Nil 0-10% encroachment to active channel 10-25% active channel 25-50% active channel >50% active channel
Pool aggradation (depth determined by 'point of first refusal') (e.g. C)	A B C D E	Nil 0-10cm 10-50cm 50-100cm >100cm
Large woody debris (quantity of individual pieces >40cm diameter & at >40 degrees to angle of flow) (e.g. C)	A B C D	Nil 1 1-5 >5

		VALUES		
		High	**Medium**	**Low**
THREATENING PROCESSES	**High**	High value, high threat (HV/HT) (Priority 1a)	Medium value, high threat (MV/HT) (Priority 2a)	Low value, high threat (LV/HT) (Priority 3b)
	Medium	High value, medium threat (HV/MT) (Priority 1b)	Medium value, medium threat (MV/MT) (Priority 2b)	Low value, medium threat (LV/MT) (Priority 3c)
	Low	High value, low threat (HV/LT) (Priority 1c)	Medium value, low threat (MV/LT) (Priority 3a)	Low value, low threat (LV/LT) (Priority 3d)

Figure 3: Waterway values-threats prioritisation matrix.

River values are acknowledged over three dimensions (ecological, social and economic) and for the Upper Collie rivers, the following values were applicable:

Ecological:

- *Naturalness* (channel modifications; ecological condition rating – both banks, riparian cover (%) – both banks)
- *Diversity* (species in riparian zone, submerged vegetation, emergent vegetation, woody debris)
- *Special features* (land use e.g. reserves, forestry, agriculture, urban)

Social:

- *Visual amenity* (aesthetic appeal, picnic sites, lookouts)
- *Recreational* (fishing, boating, swimming, camping, walking, golfing)
- *Spiritual* (Aboriginal sites)

Economic:

- *Water extraction* (dams, weirs, diversions)
- *Infrastructural* (road & rail crossings)

Threats identified were:

- *Riparian zone degradation* (endemic vegetation health/vigour, riparian width, plant recruitment)
- *Livestock access* (presence/condition fencing – both banks, cattle pudging/trampling)
- *Introduced plants* (No. of weed species, % of weed cover – both banks)
- *Eutrophication* (filamentous algae)
- *Erosion* (bank undercutting and slumping – both banks)
- *Sedimentation* (water turbidity, sediment bars)

4 Field surveying and mapping

This study was concerned with approximately 81km of major rivers in the Upper Collie Catchment and included four rivers: Collie River Central, Collie River South, Collie River East and the Harris River. These rivers were surveyed using the assessment criteria described above during April and May 2009. A total of 217 individual sites were surveyed giving an approx. mean distance of 373 meters between sites. The method of scoring values and threats has been detailed elsewhere [5, 10, 11] but in essence each site surveyed was scored according to the number and significance of the values and threats found. This effectively places each site into one of nine positions on the values-threat matrix (see figure 3 and table 4).

To achieve the appropriate level of detail for mapping, the Upper Collie Catchment was broken up into 13 sections ('reaches') and each reach is represented by a pair of maps. The first map in each pair shows the foreshore condition (as assessed using the Pen-Scott method) along with the dominant weeds identified at the sites and the adjoining land titles (figure 4).

The second map in the pair (figure 5) provides an indication of fencing (left and right banks) and the degree of erosion and sedimentation of the banks e.g. BBAABCC (see table 1 for an explanation of this example). Note: the definition

of left and right banks is based on the assumption that the map reader is looking downstream. The second map also indicates sites along the reach of value to Aboriginal and non-Aboriginal people (e.g. cultural or historic value). Both maps indicate the value-threat classification for prioritising management actions e.g. MV-MT and the positions of photo points (e.g. PP36).

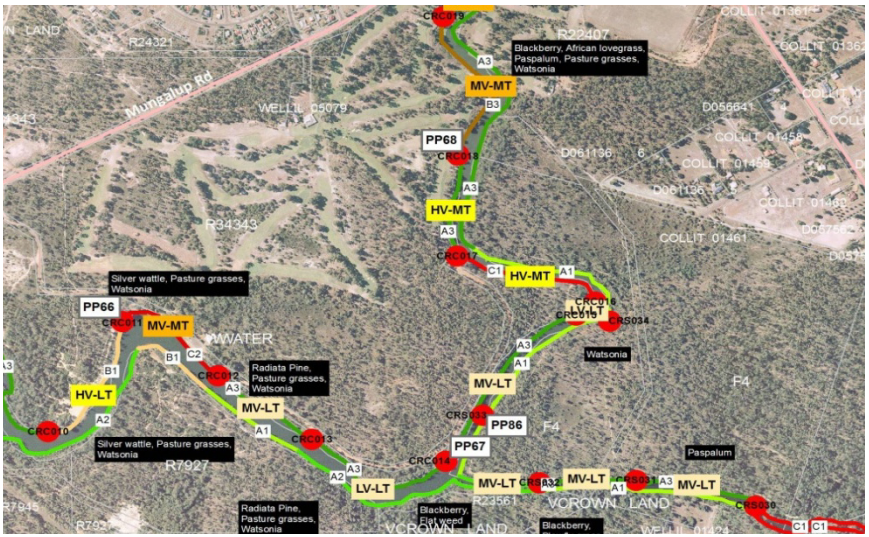

Figure 4: Example of Upper Collie foreshore condition map.

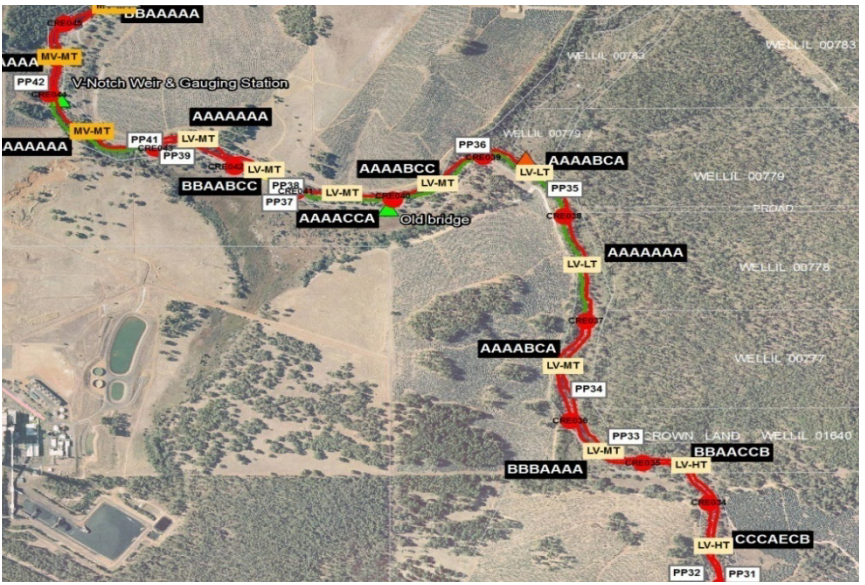

Figure 5: Example of Upper Collie fencing and erosion/sedimentation map.

5 Main findings of river condition survey

Summaries of sites' foreshore condition (Pen-Scott), length of fencing, and management priority rankings, is presented in tables 2, 3 and 4.

Tables 2 demonstrates that 21% of rivers in the Upper Collie were in 'A' condition, 24% were in 'B' condition and 55% were in 'C' condition. Much of the degradation in the poorer sites is the result of adjacent land uses – especially livestock accessing the riparian zone for feed and water. Nearly all sites in 'A' condition are those where adjacent land use is either forest or uncleared reserves (where livestock are not present).

Table 2: Summary of foreshore condition rating of Upper Collie rivers.

Foreshore condition	Total length (km)*	Total %
A1	3.7	2.3
A2	17.7	10.9
A3	12.4	7.7
B1	8.3	5.1
B2	7.2	4.4
B3	23.2	14.3
C1	75.0	46.4
C2	12.9	8.0
C3	1.4	0.9

* Both banks combined i.e. 161.8km

Of the total riverbank length (161.8km), 66% was unfenced, 24% was fully fenced and 10% was partially fenced (table 3). Most of the unfenced sections are those where there is forest or reserves and without livestock there is no need to fence these sections so long as current land use continues. However, there are many agricultural lots where fencing is either absent or in poor condition; consequently, there is no livestock access control.

Table 3: Length of fenced river embankments on Upper Collie rivers.

Fencing category (meters)	Total length (km)*	% of length
0 (zero)	106.4	65.8
1 – 75	2.1	1.3
76 – 150	9.4	5.8
151 – 225	5.1	3.2
226 - 300	38.8	24.0

* Both banks combined i.e. 161.8km

Of the 217 survey sites assessed, 9.3% were classed high-value (Priority 1), 26.2% were classed medium-value (Priority 2) and 64.5% were low-value (Priority 3) (table 4). With just 20 sites identified as high-value (approx. 7.5km) there would appear to be reasonable prospect to at least secure, stabilise and maintain the values at the sites so long as adjacent landholders are cooperative and supportive.

Table 4: Site management priority rankings.

Sub-priority ranking	No of survey sites	Total %
High value – high threat	1	0.5
High value – medium threat	8	3.7
High value – low threat	11	5.1
Medium value – high threat	5	2.3
Medium value – medium threat	40	18.4
Medium value – low threat	12	5.5
Low value – high threat	21	9.7
Low value – medium threat	82	37.8
Low value – low threat	37	17.0

6 Implications of survey findings – priority actions

There are a number of management options available to landholders and responsible government agencies for addressing issues associated with protection of the rivers and their associated foreshores in the Upper Collie including stock control, revegetation, weed control and erosion control. Management responses can be undertaken in isolation or as a combined, integrated approach. Strategically (at the catchment scale), the approach taken should consider the values-threats framework approach where the high value sites (e.g. HV/HT) have priority over medium value (MV) and low value (LV) sites (table 5).

Table 5: Generalised river management responses.

Primary priority level	Sub-priority level	Dominant Management Response/s
1	1a (HV/HT)	Secure; Stabilise; Restore
1	1b (HV/MT)	Secure; Maintain; Restore
1	1c (HV/LT)	Monitor
2	2a (MV/HT)	Stabilise; Contain; Restore
2	2b (MV/MT)	Contain
3	3a (MV/LT)	Stabilise; Restore
3	3b (LV/HT)	Stabilise; Contain
3	3c (LV/MT)	Contain
3	3d (LV/LT)	Adapt

The key issues and threats of concern identified during the foreshore assessments and community consultations were:

- Loss of native fringing vegetation and degradation of remaining vegetation;
- Weed invasion;
- Erosion and sedimentation of the waterways;
- Water extraction and regulation;
- Water quality issues, including nutrient enrichment, pollution and salinity; and,

- Need for technical assistance for landholders planning to protect and enhance the foreshore by fencing revegetating.

It is recommended that the Upper Collie Catchment stakeholders, both government and private, consider the following:

- Where livestock occupy adjacent lots, landholders are encouraged to fence the river to restrict/control livestock access;
- Government agencies and landholders are encouraged to apply for funding to continue to subsidise the cost of revegetation projects including fencing (Commonwealth and State Government grants);
- The protection of remnant areas of the river still retaining native fringing vegetation (especially those identified as 'high-value') should be protected and enhanced as a priority. It is far more cost-effective to protect these areas now than to attempt to restore them later after further degradation has occurred;
- Wherever possible landholders and weed action groups should undertake revegetation using a diverse suite of local (provenance) native species (including trees, shrubs, sedges, rushes, herbs and native grasses);
- Seek to expand and support weed and feral animal control projects in the catchment;
- Utilise best management practice (BMP) techniques that minimise soil erosion and nutrient loss to waterways such as buffer strips, soil testing and fertiliser management plans, and maximising vegetation cover on the soil;
- Landholders should work with engineers from the Department of Environment and Conservation (DEC) and Department of Water (DoW) to address serious erosion and sedimentation problems;
- DEC should expand their water monitoring program of the Upper Collie Rivers to address community concerns in regards to nutrient levels, contamination and salinity;
- Water Sensitive Urban Design (WSUD) principles should be utilised in any new and existing residential developments;
- Use 'clean site' building techniques to reduce the impact of urban development on the water quality of the Upper Collie rivers;
- Local government and developers in the Upper Collie Catchment should seek to develop and implement Foreshore Management Plans in a timely and effective manner;
- Landholders are encouraged to use Best Management Practice techniques for any rural drains.

7 Conclusions

Development of the *Upper Collie Catchment River Action Plan* demonstrates that the majority of the main rivers in the catchment are in relatively poor

condition. This finding contradicts the National Land and Water Resources Audit who described the catchment as being in moderate condition [4]. However, 35.5% of the 217 surveyed sites are regarded as being in moderate or good condition and for many of these sites there appears to be a good prospect for protecting and possibly enhancing ecological and other values so long as local support for identified actions can be engendered.

The most limiting factor in river assessments of this kind is the cost of conducting the field survey. While sufficient funding was available in this study to support surveying the optimal number of sites given the scale of the study area (every 373 meters), such funding may not always be available. While any level of assessment is better than nothing at all, any reduction in survey resolution (number of sites per given length of river) will inevitably affect the usefulness of the resulting River Action Plan.

The Pen-Scott assessment method, combined with the extended erosion and sedimentation assessment method presented in this paper, provided an effective rapid assessment technique that provided a greater level of detail about river condition that would have emerged by employing the Pen-Scott method alone. And, by combining these assessments within the *WA Waterways Prioritisation Framework*, a strategic and cost-effective management action plan has emerged. While having obvious application for developing other River Action Plans in Western Australia, the technique presented here should also be applicable to any river system, regardless of scale or location.

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