Assessing the health of Tasmanian rivers: collecting the evidence

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Abstract

The Tasmanian Natural Resource Management Associations (NRMs) have commissioned the development of a River Condition Index (RCI) framework for Tasmania. Designed to inform NRM investment priorities, this project builds on existing methods and recent advances in state-wide stream condition assessment methods. The River Condition Index is designed to give an indication of the health of the 'whole' of river systems by assessing five key features of rivers: Aquatic life; Hydrology; Physical Form; Streamside Zone; and Water Quality. It will be used to inform the development of State policy and provide an informed platform from which priorities for management and rehabilitation can be identified and implemented. Consistent and comparable information will be collected from a range of streams and reported at a state-wide scale. The results of these assessments provide a uniform approach for identifying values and threats, setting strategic objectives and determining resource condition targets. The River Condition Index will also be an effective medium for communicating results to stakeholders and the public. This paper describes the first phase of the development of the River Condition Index framework for Tasmanian streams. The review of existing methods and the development of a recommended approach for the assessment of the five component sub-indices: Aquatic life; Hydrology; Physical Form; Streamside Zone; and Water Quality are discussed.

Keywords

River Condition Index, Tasmania, environmental assessment, stream-health, NRM investment, prioritisation

Introduction

State-wide stream condition assessments provide a consistent approach to identifying values and threats, setting strategic objectives and resource condition targets. The results of these assessments provide a measure of stream health and a medium for effectively communicating results to stakeholders and the public. Numerous stream health assessment techniques have been applied in Australia over the last decade. These include but are not limited to: The Anderson method (Anderson, 1993), mainly used in Queensland, The Index of Stream Condition (ISC, Department of Sustainability and Environment, 2005) developed in Victoria; the National Land and Water Resources Audit (NLWRA, Norris *et al.*, 2001) and the Sustainable Rivers Audit (SRA) for the Murray-Darling Basin Commission (MDBC, 2004).

In Tasmania, the Index of River Condition (TIRC) has provided a rapid assessment of stream condition based on physical stream form, streamside habitat and hydrological connectivity (DPIWE, 1999). This approach was a regional scale method based on the 1999 ISC and the Anderson method. As a result of significant advances in stream condition assessment techniques since 1999, a detailed review of the TIRC is required to update assessment methods and ensure the applicability of these methods to Tasmanian conditions. The development of a River Condition Index (RCI) framework for Tasmania was therefore commissioned by the Tasmanian Natural Resource Management Associations (NRMs) in 2006. The RCI will assess five key features of rivers: Aquatic life; Hydrology; Physical Form; Streamside Zone; and Water Quality. These are known as 'sub-indices' within the RCI.

The element that differentiates the RCI from other similar assessment approaches within Australia and overseas is that the assessment of the five key features of the rivers is driven by the recognition that each feature of the river is of value in its own right. Most other assessment approaches are based on the assessment of biota, habitat for biota, or biologically relevant physical and chemical parameters, for example Victoria's ISC, 2004 (DSE, 2005) the Sustainable Rivers Audit (Whittington *et al.*, 2001) and the United Kingdom's River Habitat Survey (Raven *et al.*, 1998). In contrast, within the RCI, the features of the stream

that are to be assessed are not driven by those that are considered biologically relevant; rather they independently represent the whole of the river system.

The objectives of the RCI method are to provide a scientifically defensible and repeatable analysis of stream condition/river health which provides an indication of the health of the "whole" of river systems. Stream condition ranking and outcomes will be produced that can be incorporated into and assessed as part of state and regional monitoring and reporting programs. The method will be applicable to the range of stream types found in Tasmania, suitable to be undertaken to an acceptable level of confidence, capable of being undertaken for a nominated dollar amount per site and able to be modified in the future. The method will provide an informed platform from which priorities for stream management and rehabilitation can be identified and implemented.

Method

Project team
The RCI project team comprises an expert panel and five working groups, one for each sub-index (Aquatic Life, Hydrology, Physical Form, Streamside Zone and Water Quality). The expert panel provides guidance and review to the development of the method, ensuring credibility and scientific rigor. This panel is serviced by five small working groups of experienced on-ground and stream management engineers and scientists, one for each sub-index. The working groups research, develop and recommend methods while the expert panel comment and sign-off on these recommendations. This approach was used successfully in the development of the Victorian ISC and has been applied to the development of a stream condition assessment method for the Murray Darling Basin Commission, the Sustainable Rivers Audit (SRA).

Key to the delivery of the RCI framework is the involvement of representatives from the NRMs and the Tasmanian Department of Primary Industries and Water (DPIW) during the development and ground-testing of the RCI. The Cross Regional Water Program Steering Group (CRWPSG), comprised of the programs managers from the three Tasmanian NRMs, give final approval to the project outcomes. The project structure is presented in Figure 1.

Project approach
The project will be completed in three phases: 1. the development of tools and methods; 2. application and ground testing; and 3. training and roll-out.

Phase One includes recommending an approach for each of the five sub-indices and the development of a draft method. A review document outlining methods in use in Australia was compiled (Ladson & Grove, 2006) as the basis from which the working groups developed a recommended approach for each sub-index. Working groups developed an approach either based on modifications of existing methods; using new research; or the integration of other models and concepts in-use in Tasmania. The recommended approach was reviewed and approved by the expert panel and the CRWPSG.

Following the acceptance of the recommended approach, the draft method was developed. This initially involved a workshop in which key project team members determined integration and aggregation methods for the sub-indices and finalised sampling strategies and scales of reporting. Following the workshop, the teams formulated and tested draft methods. The draft method for each sub-index was then reviewed and commented on by the expert panel and is currently being finalised for approval by the expert panel and the CRWPSG.

Phase Two involves the application and ground testing of the method in a range of Tasmanian catchments. This phase will commence with a review of the capacity of the regions to perform assessments and will be followed by potential assessment staff being trained by the project team to apply the method. The first round of the testing program will roll-out across a range of Tasmanian catchments in Spring 2007. Following the initial testing, results will be presented to the project team for analysis, review and modification of the method where required. It is anticipated that the final method, field manual, data storage tool and project website will be released at the end of 2007.

Phase Three of the project, training and roll-out, includes the training of RCI assessment staff and the roll-out of the assessment program, using the final method. Training courses will be run for assessors, most likely by testing staff. Assessment staff are likely to be sourced from DPIW, NRMs, Greening Australia (Tas), other relevant agencies and NRM consultancies, depending on outcomes from the review of the capacity of the regions.

It is anticipated that the benchmarking assessment program will be run in Autumn 2008, in a range of Tasmanian catchments. Following the assessment program, results will be published on the project website and presented at various industry and community forums. Opportunities for community consultation, involvement and discussions of stream health issues are likely to arise at assessor training sessions, during on-site field assessments and following the release of results. The results will not only provide "an indication of the health of the 'whole' of river systems, offering an informed platform from which priorities for management and rehabilitation can be identified and implemented, but also an opportunity to raise the profile of stream health issues in the community.

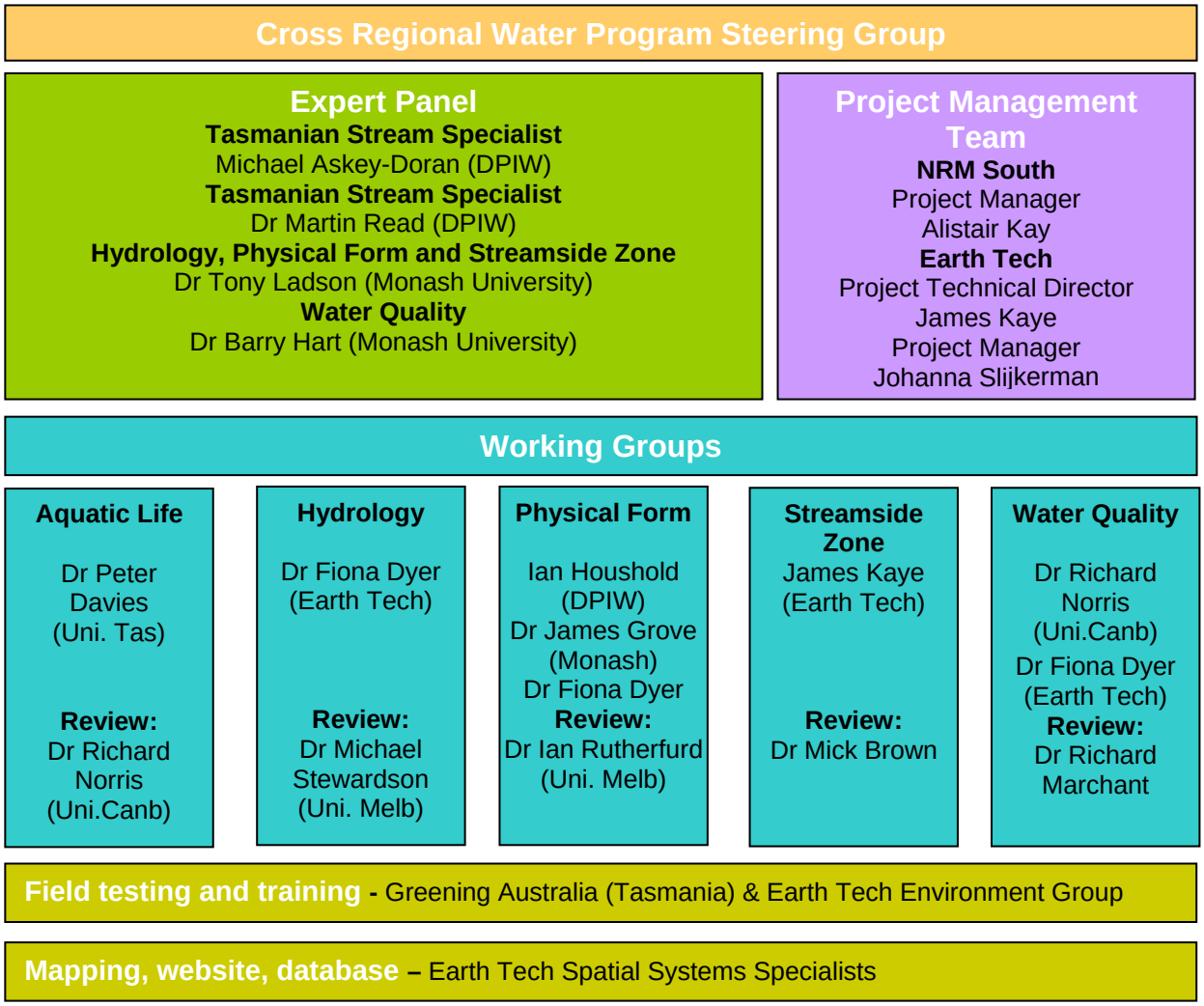

Figure 1. Project team structure for the development of the RCI

Preliminary results and discussion

At the time of publication, Phase One of this project was in progress. A recommended approach, for each of the five sub-indices, has been developed and is summarised below.

Aquatic life

Four elements of aquatic life were recommended for assessment using existing or readily adaptable methods: macroinvertebrates, algae, macrophytes and fish.

It was recommended that macroinvertebrates be assessed using a modified version of AUSRIVAS assessment. The modifications are the addition of information such as relative abundance, absolute abundance, changes in diversity and composition at genus-species level. AUSRIVAS is routinely used in state assessment and reporting, and has the advantage of statewide/regional context and a history of data collection since the mid 1990's. In Tasmania, the quality of AUSRIVAS assessment is also sustained by the presence of reference site data from sites which are often in near-pristine condition (though confounding with forestry disturbance may be a problem in some areas). As such, the continued use of AUSRIVAS within the RCI is supported, but with some enhancements to provide a more comprehensive assessment of macroinvertebrate community condition.

It was recommended that benthic algal components be included in the RCI, notably chlorophyll-a and diatom assemblages because of the key role played by algae in Tasmanian stream systems and the use of diatoms to interpret water quality information. The caveat placed upon this recommendation was that it should only be performed if centrally managed to ensure development of key reference data sets and to account/control for major sources of variation.

Macrophytes are a key component of biodiversity, habitat and ecosystem function in riverine systems, particularly in lowland and floodplain reaches. A rapid survey method, based on % cover, dominant assemblages/species and departure from reference conditions was the recommended assessment method. The reference condition macrophyte assemblages in the CFEV framework was recommended for use as the basis for defining reference conditions for RCI assessment.

Freshwater fish should be included within the RCI indicator set as they play key ecological roles, indicate aspects of river function at broad spatial and temporal scales, and have high conservation value in Tasmania (with many species listed under legislation). The SRA metrics and derived indicators are highly relevant to the Tasmanian situation, and were recommended for direct adoption. Reference conditions can be developed directly from the CFEV native assemblage data while abundance/biomass reference information can be derived from the extensive sets of existing data, combined with expert input.

Hydrology

The use of the five Flow Stress Ranking (FSR) indices (low flow index, high flow index, proportion of zero flow index, monthly variation index, seasonal period index, SKM, 2005) in conjunction with a mean annual flow index is recommended for the assessment of hydrological change. Such an approach builds on earlier work from the SRA and the NLWRA and is emerging as the standard for hydrological assessment in South Eastern Australia. The inclusion of the mean annual flow index (the change in mean annual flow volumes) is recommended as it provides an easily understood index for local communities and is comparable with data collected as part of the CFEV program. It was also recommended that the surface water models used to derive the data from which the hydrology indices are calculated should be modified to include the influences of land use changes and groundwater extractions in those catchments where such issues are of management concern. Testing of the zero flow index must also be undertaken to determine its relevance to Tasmanian conditions.

Physical form

None of the reviewed existing methods for the assessment of physical form were considered suitable for the RCI without modification. Consequently it was recommended that an approach be developed where river categorisations (Jerie *et al.*, 2003) are used to define both the sampling program and the expected conditions against which reaches can be assessed. A set of indicators/metrics will then be chosen from existing methods to characterise river features and allow detection of change. Such an approach provides an advance on similar condition index methods for Australia (and internationally).

The existing categorisation of river domains and fluvial mosaics (Jerie *et al.*, 2003) has provided the opportunity to develop a similar approach to physical form assessment to that used by the Department of Sustainability and Environment (DSE) in Victoria for assessing streamside vegetation. The approach to the assessment of the physical form of Tasmanian Rivers aims to use the attribute tables associated with the fluvial mosaics to suggest relevant parameters that can be used to provide a measure of condition. The attribute tables associated with the fluvial mosaics may also be used to predict the degree of variation likely

within each parameter, which will vary regionally. The number, and types, of measurements to be taken would be guided by the time constraints associated with the number of sites that need to be assessed.

In addition to assessing reaches against expected conditions, a set of indicators/metrics will also be chosen from existing methods to characterise river features and allow detection of change. Most indicators of physical form are qualitative in nature and will require adjustment to provide a quantitative assessment without having to undertake some form of predictive modelling.

Streamside zone
A method combining modified TASVEG Vegetation Condition Assessment (VCA) and Rapid Appraisal of Riparian Condition (RARC) parameters was recommended. These concepts have been widely applied, well tested and subject to peer review. The use of the VCA method is dependent on the development of riparian benchmarks, a process that is currently under investigation and anticipated to occur during Phase 2 of this project in conjunction with DPIW. Additional indicators may be included which are based on the ISC. The indicators recommended for use include; longitudinal continuity; width of riparian vegetation; lifeform cover and height; dominant life form cover; large trees, including hollow bearing trees and standing dead trees; persistence potential and regeneration potential/capacity; tree canopy cover; litter; logs; weediness; landscape attributes; waterway shade and aspect; disturbance regime and land-use impact.

These indicators have been recommended as they provide a measure of: the ecological health and the structural integrity of the vegetation in the riparian zone; potential threats; habitat availability, both in-stream and in the riparian zone; and bank stability.

Water quality
A combination of spot measurements used in the ISC and NLWRA 1 process based assessments were recommended for the assessment of water quality. Combining measurements based on condition assessments with NLWRA 1 SedNet process based assessments provides a more comprehensive assessment of conditions and is sensitive to a wider range of factors that may be impairing condition than the individual measures. The ISC water quality index is based directly on concentration measurements that represent ambient or low-flow conditions well, while high-flow event conditions are better assessed considering the fluxes used in the NLWRA 1 indices. This approach improves both the spatial and temporal resolution of the assessments. Existing spot measurement assessments incorporate detailed point data that depend on data availability but can direct attention to local processes, while SedNet assesses processes throughout river networks using more widely available spatial datasets to connect catchment sources with downstream impacts. Recent changes are encapsulated in spot measurement data and the NLWRA 1 indices use longer-term data to provide a time-integrated measure less sensitive to short-term hydrological variation. Finally, this approach provides information on both current condition and the processes which cause it, to enable priorities for improving condition to be identified.

Integration of sub indices
The five sub-indices will need to be combined or assembled in some way to produce an overall RCI measure for each assessed reach. There are a variety of methods available for integrating indices, ranging from the application of expert rules to simple addition of scores. Following the development of the draft methods, and the collection of test data sets for each of the sub-indices, the working groups and expert panel will test a variety of different approaches to combining the sub-indices to produce an overall index. Such testing will enable the effects of missing or unreliable data (both at the sub-index and individual metric scale) to be determined. The outcomes of the testing will enable the most appropriate method of integration to be chosen.

Draft method
The draft method is currently under development. Each of the working groups is using the Recommended Approach for the sub-indices as a basis for developing a method to collect the required data. Extensive field testing is an essential component of this phase of the project. Once a preliminary draft method has been tested and developed by the working groups, it will be presented to the expert panel for review and comment. The working groups will incorporate modifications, comments and suggestions into the drafts, perform further field testing and finalise the draft method for approval by the expert panel and the CRWPSG.

Once the draft RCI method has been developed, it is envisaged that Phases Two and Three of this project (extensive testing and the roll out of a State-wide assessment program) will be completed by mid-2008. Ground-testing will be completed in as many regions as possible in Tasmania to adequately explore variation, representative types and the practical application of the approach. Following rigorous ground-testing, a single methodology will be produced which will enable the identification of priority rivers for NRM investment, management and rehabilitation. This approach will balance and integrate the various models and concepts for stream health assessment that currently exist in Tasmania and across the rest of Australia.

Conclusion

The RCI, commissioned by the Tasmanian NRMs, will provide a scientifically defensible and repeatable analysis of stream condition/river health which provides an indication of the health of the "whole" of river systems. Stream condition ranking and outcomes will be produced that can be incorporated into and assessed as part of state and regional monitoring and reporting programs. The method will be: applicable to the range of stream types found in Tasmania; suitable to be undertaken to an acceptable level of confidence; capable of being undertaken for a nominated dollar amount per site; and able to be modified in the future. Following rigorous ground-testing, a single method will be produced which will enable the identification of priority rivers for NRM investment, management and rehabilitation. This approach will balance and integrate the various models and concepts for stream health assessment that currently exist in Tasmania and across the rest of Australia.

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