



# Local to national – the capacity for increasing the spatial scale of monitoring

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## Project Objectives

The measurement and assessment of stream ecosystem health is usually undertaken at the local or site scale, while management actions are undertaken at a regional or catchment scale. Local-scale assessments are reported at the catchment scale by aggregating all sites within a catchment. However, the manner in which this aggregation is undertaken differs between programs and, depending on the arrangement and position of sites, can provide widely differing assessments of health. These site-based assessments also preclude predicting ecosystem health along the stream network in areas where data are lacking.

Recently, a number of studies have used landscape-scale spatial data and site-based indicator data to model temperature (Isaak *et al.* 2010), water quality (Peterson & Urquhart 2006) and habitat (Perry & Bond 2009) along stream networks to assess the vulnerability, conservation risk and long-term persistence of a range of freshwater taxa at the regional scale. At a broader extent, readily-available coarse-scale global datasets have been used to undertake assessments of water security and health, with predictions relevant at the national scale (Vörösmarty *et al.* 2010).

The aim of this workshop was to explore the feasibility of a modelling approach in predicting ecosystem health (comprising multiple indicators or metrics) along stream networks for entire catchments. The development of such a methodology would provide a more robust mechanism for regional stream-health reporting, while also enabling reporting at scales relevant for management and restoration.

The objectives of this workshop were to:

- (i) explore the feasibility of a spatial modelling approach to predict ecosystem health at unsampled locations; thus providing a more robust mechanism for regional stream-health reporting;
- (ii) construct a conceptual framework that can be used to design a monitoring program that meets multi-scale objectives; and
- (iii) outline the foundations for a synthesis manuscript.

## Methods

The workshop was structured around both whole-of-group discussions and more focussed writing groups.

On Days 1 and 2 the group developed a “Conceptual Framework” describing the steps required to construct the hypothetical ‘Rolls Royce’ monitoring and assessment program. This task was challenging as workshop members came with their own perspectives on monitoring. Designing conceptual models with a group of 16 can be frustrating, but the group took to the sometimes laborious challenge and the resulting conceptual model was then used as the basis for the manuscript.

On Day 3 the group used the conceptual framework as the basis for developing the draft manuscript. The larger group broke into smaller writing groups where the basic outline for a manuscript describing the conceptual model was developed. Work on the manuscript has continued out-of-session, with submission planned for early 2013.

## Major Findings

One challenge associated with broad-scale environmental assessment is that it is typically based on static site-based measurements, while management decisions are made at broader catchment or regional scales. Therefore methods that provide a cost-effective and scientifically credible way of spatial or temporal ‘upscaling’ must be embraced. Our group has developed a conceptual framework that allows positive characteristics of design (statistically defensible) and model-based (spatially explicit) monitoring approaches to be combined. Many aspects of a hybrid-based monitoring framework are similar to those considered in more traditional design-based approaches, including setting objectives, indicator selection, assessment goals, or reporting formats (Figure 1). However, unique design considerations associated with a hybrid program must also be considered at the outset to make efficient use of monitoring data and models. For example:

- **Indicator selection:** the spatio-temporal variability of the indicator must be suitable for prediction, given the spatio-temporal characteristics of remotely derived covariates;
- **Survey design:** the probability-based survey design must be altered to ensure that the spatial location of data are suitable for model-based predictions, while maintaining the statistical integrity of the design;
- **Assessment:** design- and model-based information must be quantitatively integrated into the assessment process (Figure 1);
- **Uncertainty:** uncertainty must be quantitatively accounted for during the assessment and reporting process. In addition, it should feedback into the survey-design phase to identify areas where more/less data are needed;
- **Scenarios:** spatially explicit management scenarios allow cause-and-effect linkages to be explored; and
- **Reporting:** both design and model-based reporting is possible, with innovative visualisation techniques (e.g. continuous maps of condition, trend, and uncertainty) improving communication with stakeholders.

Considering each of these components at the outset, in addition to their relationship with one another, will ensure that a hybrid monitoring (i) is statistically defensible, (ii) makes efficient use of all available information, and (iii) provides useful information for broad-scale environmental management.

## How will this affect Australian ecosystem science and management?

In Australia there are a number of broad-scale monitoring programs that assess ecosystem health at the sitescale and then aggregate the site-based assessments from a number of sites to provide a catchment-scale assessment. These include the Ecosystem Health Monitoring Program (EHMP) in South-East Queensland (Bunn *et al.* 2010), the Sustainable Rivers Audit (SRA) in the Murray-Darling Basin (Davies *et al.* 2010) and the Index of Stream Condition (ISC) in Victoria (Ladson *et al.* 1999). Along with these site-based assessments of ecosystem health are regional spatial datasets that encompass land use, vegetation cover and water balance. The conceptual model and approach outlined by this workshop and resulting manuscript will provide direction on (a) how to maximise the use of the data obtained from these design-based assessments, and (b) provide a framework for the development of future monitoring programs that will allow the incorporation of both design-based assessment with spatial-modelling approaches.

## References

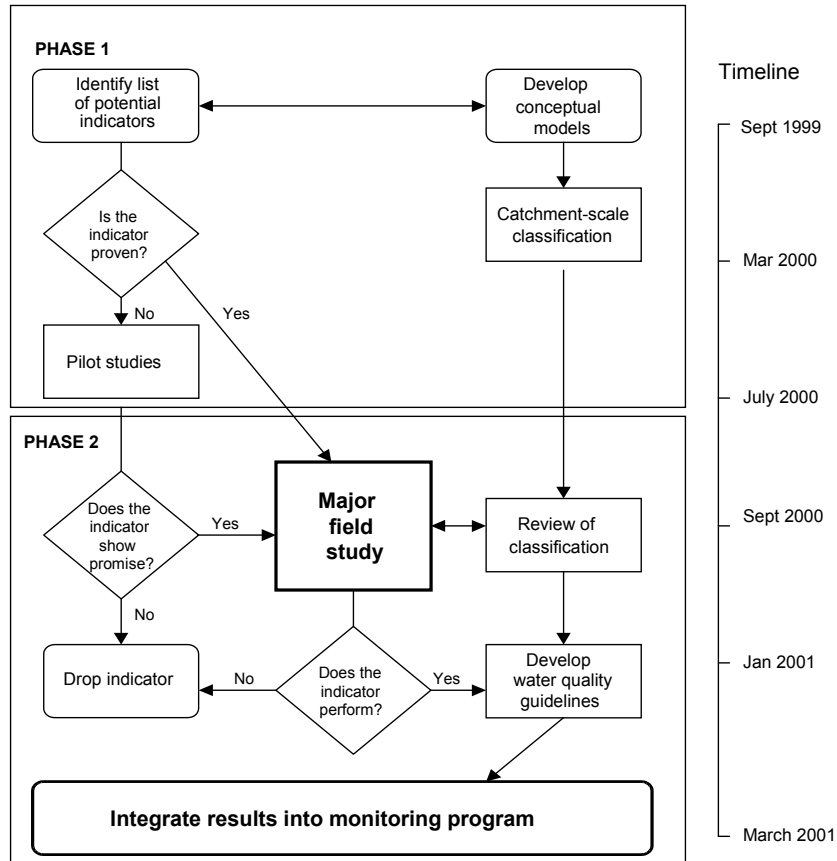
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**Above:** Sampling fish in Cooper Creek, Lake Eyre Basin. Photo Jon Marshall.



**Above:** An ephemeral river, Willochra Creek, South Australia. Photo by Peter Schultz



**Figure 1:** Example of an approach for designing a 'design based assessment'; from Bunn *et al.* (2010).

## Outcomes and products

Paper in preparation: A hybrid approach for environmental assessment: making the most of monitoring data for *Frontiers in Ecology and Environment*.

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