CRC for FRESHWATER ECOLOGY

SCOPING STUDY ScD1

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'DIRTY WATER' MODELS. PREDICTING COMMUNITY COMPOSITION FOR STREAMS IN DISTURBED LANDSCAPES.

SUMMARY REPORT

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'Dirty water' models. Predicting community composition for streams in disturbed landscapes.

Program leader: Associate Professor Richard Norris

Background

A common element of a number of recently developed models for stream assessment is the use of reference sites (Norris & Thoms, 1999). Reference sites are analogous to control sites: they are similar to sites that will be assessed ('test sites'), but are not influenced by disturbing factors that may be affecting the test sites. Assessment models, such as AUSRIVAS (Coysh *et al.* 2000) and others derived from RIVPACS (Wright, 1995), use sets of reference sites to predict the structure of biotic assemblages at test sites. This approach is difficult to apply to the assessment of streams in and around large cities. Because humans tend to settle around lowland streams, few lowland streams or rivers exist that are free of urban disturbances. The nature of urban expansion around large cities makes it unlikely that a relevant set of reference sites could be found in the same region as a city.

This project aimed to overcome these problems by building AUSRIVAS models using sites from metropolitan and surrounding rural areas, ranging in condition from highly disturbed to minimally disturbed. Instead of using only variables that are not influenced by human activities, as in normal AUSRIVAS models, the 'dirty water models' used predictor variables that can potentially be altered by catchment managers. Thus, the models will avoid the need for a large number of reference sites and enable prediction of the effect of management actions on stream community composition.

Aims

The aims were: 1) to develop predictive models of community composition for macroinvertebrate and benthic diatom communities of the Melbourne, Brisbane and Canberra urban regions, using predictor variables representative of human impacts; and 2) to run scenarios by changing the values of the predictor

variables to assess the possible value of such models for predicting the outcomes of management activities.

Management context

- The development of AUSRIVAS models (Coysh *et al.* 2000) for use in disturbed areas has been hampered by the small number of potential reference sites. AUSRIVAS models recently developed for the Melbourne region using macroinvertebrates used sites in less developed areas just outside the metropolitan area as reference sites proved no more sensitive to disturbance than larger-scale regional models (P. Breen *et al.*, report submitted to Urban Water Research Association).
- Existing assessment models such as these are of limited use to urban managers, who are already aware of the degraded state of their waterways. The models developed in this study will enable managers to predict the effect of restoration actions on communities that are currently use for stream assessment.
- These models will build on existing work on the urban streams of Melbourne, that has identified strong correlations of community composition of both macroinvertebrates and benthic diatoms with water quality and catchment characteristics that are associated with density and nature of urban development (Walsh & Breen, 1999; Sonneman *et al.*, MS; Walsh *et al.*, MSa; Walsh *et al.*, MSb).
- The models will use the relationship between predictor variables that are affected by human activities and community composition to produce a management tool, enabling prediction of the effect of management actions on stream community composition.
- Particularly relevant for management is the ability of the models to be used for scenario testing, to answer 'What if?' questions.

Major Findings

- Using sites with a range of impacts likely to be encountered in a region for comparison and variables likely to be causing damage as predictor variables, it is possible to predict the change that would be expected in the fauna in response to an impact or restoration activity.

- Unlike AUSRIVAS models, 'dirty water' models are unable to provide a site assessment. Instead, simulated data sets with a range of values for predictor variables can be used to predict the biological change likely to occur through this range, as represented by the expected number of taxa.

- A number of prediction methods were trialled and while found to give slightly different prediction values, showed the same trends. It was not possible to assess the precision or accuracy of model predictions in this study, so the prediction methods chosen were based on their ability to meet the following criteria:

  -simultaneously vary more than one predictor variable
  -restrict the range of simulations to realistic combinations of variables
  -retain site specificity of predictions
  -produce 'sensible' predictions that captured multiple variable responses

- The usefulness and robustness of predictions was dependent on the predictor variables used. Variables most likely to be causing the damage generally gave better predictions. While variables of secondary importance were not useful in isolation, they were important covariates for variables of primary influence.

- A diatom model constructed with presence/absence data from the Melbourne region was unsuccessful, producing unstable and inconsistent predictions. This was attributed to the fact that diatom assemblages are ubiquitous and changes related to damage occurring in abundance rather than presence/absence. Diatoms also respond differently to damage than macroinvertebrates and many taxa responded positively to impact rather than declining.

- The need for model validation, for example, field testing of predictions, was recognised as an important further step if these models are to be applied.

- Dirty water models have great potential for further application in such areas as water quality scenario testing and environmental flow allocation.

Summary

Dirty water models provide managers with a tool that:

- Provides a novel approach to stream assessment, which will improve understanding of the relationship between degrading processes of urbanization and biotic condition;
- Assesses the effect on the biota of dominant processes degrading community composition at test sites;
- Predicts the effects of rehabilitation actions on communities that are currently use for stream assessment;
- Enable the testing of rehabilitation scenarios or degrading activities by running data through the models to simulate management actions.

Major Project Outputs

Models

Melbourne	- Combined Riffle model (macroinvertebrate species model)
	- Trial Diatom Model (species)
Canberra	- Combined Edge model (macroinvertebrate family level)
Brisbane	- Autumn Edge model (macroinvertebrate family level)

Publications

A paper is currently in preparation as an output from this project:

'Dirty water' models: Predicting biological change in streams using simulated impacts. Julie Coysh, Simon Linke, Richard Norris, Chris Walsh and Satish Choy.

This paper is being prepared as part of a ‘writers club’ along with four others at the University of Canberra. The club meets regularly and progresses writing in a structured fashion with vigorous feedback from all participants.

Conference presentations

- **North American Benthological Society (NABS)**
  Keystone, Colorado, USA May-June 2000
  Richard Norris presented the 'Dirty Water' models in a talk titled ‘The reference condition approach: What do we do when pristine no longer exists?’

- **Australian Society for Limnology (ASL)**
  Darwin, July 2000
  Julie Coysh presented the 'Dirty Water' models in a talk entitled:
  'Dirty water' models: Predicting biological change in streams using simulated impacts.

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