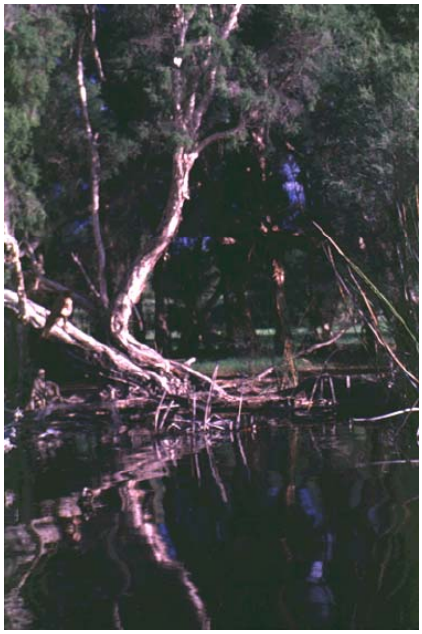
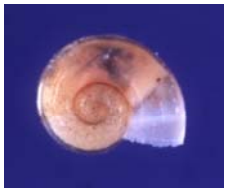
Monitoring wetland health: are National River Health Program protocols applicable?





Final Report
National Wetlands Research and Development Program

Final Report

Monitoring wetland health: are National River Health Program protocols applicable?

Funded by:
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1. Research Findings

The results of this research project are described in detail, in standard scientific report format, in a separate research report submitted in conjunction with this report. A summary of the research findings is given below and overleaf.

Summary

- The application of predictive modelling, incorporating macroinvertebrate and environmental data, and reference and test sites, to the monitoring and assessment of Australian wetlands, was investigated at wetlands of the Swan Coastal Plain, Western Australia. A combined habitat and season model, similar to those developed for Australian rivers (AUSRIVAS), was constructed using a pre-existing dataset collected from 23 wetlands on the Swan Coastal Plain, sampled up to three times, in summer and spring,1989 and spring,1990. Four main groups of reference (least undisturbed) wetlands were identified by UPGMA classification (using the Bray-Curtis dissimilarity measure) as part of the model construction process. These groups comprised highly coloured (high gilvin) wetlands, saline wetlands and geographically-related groups. Predictor variables for these groups were identified by Multiple Discriminant Function Analysis as: calcium, colour (gilvin), latitude, longitude, sodium and organic carbon.

- The model, given the acronym AUSWAMP (Australian Wetlands Assessment and Monitoring Program), was tested by sampling 23 Swan Coastal Plain wetlands in spring (October) 1997. Two highly degraded wetlands (Yangebup Lake and Lake Gnangara) were correctly identified as well below reference condition due to human impacts. However, other wetlands appeared to be below reference condition as a result of low water levels arising from human impacts (groundwater abstraction) or climatic variation. The test wetlands sampled in spring,1997, were approximately 50 cm shallower than reference wetlands sampled in spring,1989 and spring,1990, because of below average annual rainfall in 1997. The occurrence of fewer taxa than predicted in shallower systems indicted that wetland water levels have considerable influence on the composition of wetland invertebrate communities. This finding was further supported by a long-term dataset collected for Thomsons Lake, which revealed the presence of a significantly richer fauna under high rainfall/high water level conditions. Predictive modelling is a potentially useful method for assessing the impact of groundwater abstraction on wetland ecosystems, and other impacts, provided sufficient reference wetlands are sampled to adequately characterise /natural variation in wetland water regimes.

- Comparison of AUSWAMP with other methods of bioassessment revealed that different methods provided different information on wetland condition. The AUSWAMP OE50 ratios were significantly correlated with pH and depth of sampling sites. The biotic index, SWAMPS, was significantly correlated with pH and log total

P. Ordination of the dataset revealed that one axis was significantly correlated with log total P, total N nitrate/nitrite and maximum wetland depth, whilst the other was correlated with pH, ammonia, total N and depth of sampling site. AUSWAMP OE50 ratios were not significantly correlated with any indices of disturbance. In contrast, SWAMPS values were significantly correlated with all disturbance indices except sediment contamination. Richness (number of families) was significantly correlated with contamination and one ordination axis was significantly correlated with the presence of introduced fish.

- These results indicate that a rapid bioassessment approach, utilising macroinvertebrates, is a useful technique for wetland assessment and monitoring, particularly when a suite of analyses, rather than a single approach, is used. Consideration of mismatches, i.e, wetlands that receive high and low scores with different methods of assessment, provides additional insight into wetland condition.

- Model results for wetlands sampled using a rapid bioassessment protocol were not significantly different from the results obtained with the original sampling method, which used random sampling and laboratory processing of invertebrate material. This suggests that the rapid protocol can be used where quicker and cheaper bioassessment is required.

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- Wetland habitats (particularly plant communities) were important in determining the composition and richness of invertebrate communities. This finding has implications for the design of macroinvertebrate biomonitoring protocols and also suggests the need for some form of rapid assessment of wetland condition based on the composition and abundance of submerged, emergent and fringing vegetation. It is recommended that a protocol for wetland habitat assessment be developed and used in conjunction with a rapid bioassessment protocol. This would enable inferences to be made as to whether a low invertebrate bioassessment score reflected poor water quality or poor habitat condition, or both.

- A rapid bioassessment protocol for wetlands has been developed, on the basis of the results of this study, which incorporates the following features:

  i) Sampling is undertaken during the period of maximum water level (which is late spring in southwestern Australia, but may vary according to climatic zone).

  ii) As most wetland assessments are undertaken with the objective of describing the 'health' or integrity' of the entire waterbody it is recommended that sampling incorporates a minimum of four sites per wetland – corresponding (approximately) to the four sectors, north, south, east and west. One site per wetland is unlikely to adequately represent the biotic heterogeneity present in all but the most highly disturbed of systems.

iii) The habitats most likely to be present in all wetlands are those of submerged macrophytes (which may include bare substrate) and emergent or fringing macrophytes (sedges and rushes such as *Baumea, Typha* and *Schoenoplectus)*. Separate sampling, and modelling, of submerged and emergent plant habitats is recommended because it is difficult to predict in advance the extent of each type of habitat, in a particular wetland, in a particular year.

iv) Invertebrate samples should be collected from each of the two habitats, from each of the four sectors (north, south, east and west) of an approximately circular or elliptical wetland. Larger wetlands or long, linear wetlands may need to be subdivided into two or three sections to ensure that the entire wetland is adequately characterised. Each subsection is then assessed separately.

v) For wetlands of high conservation value, or of particular management concern, the collection of environmental data at monthly, or bimonthly intervals, is also recommended. Rapid bioassessment and use of a rapid habitat assessment protocol provide useful instantaneous information. However, the collection of continuous records for parameters such as wetland depth is also important to characterise wetland condition and environmental change. Ideally, regular monitoring of simple physical and chemical variables (conductivity, pH, colour and turbidity) and nutrients should also be conducted, particularly if nutrient enrichment is a major management issue.

2. Assessment and evaluation of the project

Achievement of outcomes

This project has achieved the outcomes stated in the project proposal and Attachment 1 of the project contract. These are:

- A predictive model, AUSWAMP, has been constructed, run and evaluated using data from 23 test wetlands.

- A Wetland Bioassessment Manual has been written. This manual describes a standard protocol that can be adopted for the monitoring and assessment of wetlands using macroinvertebrate and environmental data. This protocol is specifically for the implementation of an AUSWAMP model but data collected can also be processed with other rapid bioassessment techniques.

Appropriateness and effectiveness of approaches used

Budgetary constraints from the outset of this project required that we use a pre-existing dataset for model construction. This historical dataset had been collected from wetlands on the Swan Coastal Plain, Western Australia, in 1989 and 1990, under a partnership grant, with support of approximately $300,000 from AWRAC, the EPA and the Water Authority of Western Australia. The results obtained were creditable enough to suggest that this dataset, collected ten years earlier, was still relevant and appropriate for the task. However, it must also be noted that a more sensitive model is likely to have been obtained if a greater number of reference sites had been sampled.

Other data, collected between 1986 and 1998, as part of wetland monitoring, assessment and research projects funded by state government agencies and Murdoch University, was used to more fully evaluate the model. The approaches used in this project appear to have been appropriate and effective, resulting in successful outcomes.

Degree to which project has met objectives

This project has fulfilled the objectives initially proposed as follows:

- To determine the validity of applying a 'RIVPACS' type predictive model, incorporating macroinvertebrate and environmental data, and reference and monitoring sites, to the monitoring and assessment of Australian wetlands.

- To develop a National Wetland Bioassessment Protocol similar to the National River Bioassessment Protocol.

Additional objectives were formulated, to test the following hypotheses, as a means of evaluating and comparing output from the model against other information available for the test wetlands. These included:

- that model outputs for samples collected using a rapid bioassessment protocol (incorporating field processing of invertebrates from selected habitats) were not significantly different from those collected using a more intensive protocol (incorporating randomly allocated sites and laboratory processing of invertebrates).
- that wetlands with the highest trophic status would receive the lowest rankings, in terms of the model output, if the model reflects poor water quality and ecological integrity arising from nutrient enrichment.
- that classifying or ranking wetlands on the basis of model outputs was in agreement with the results of other bioassessment techniques applied to the same dataset.
- that temporal variation in annual rainfall and wetland water regime results in the presence of different wetland macroinvertebrate assemblages, and different model outputs, for the same wetland

3. Demonstration/communication activities

- Outputs from the model AUSWAMP have been included within the 1998 and 1999 monitoring programs undertaken for the Water and Rivers Commission to assess the impact of groundwater abstraction on Perth wetlands.
- A paper describing this project, and preliminary results, was presented at the joint meeting of ASLO/ESA held at St Louis, in June,1998.
- Further presentations will be given at the joint meeeting of ASL and NZSL, in New Zealand, in December,1999, and at a symposium on the use of invertebrates in bioassessment in Perth, in May,1999.
- Scientific papers describing the results of this project are currently being prepared.

4. Recommendations for future effective management of wetlands

- The incorporation of AUSWAMP into the monitoring program undertaken by the Western Australian Water and Rivers Commission, to assess the impact of groundwater abstraction on Perth wetlands is recommended, provided a much larger set of reference wetlands is used for model construction.
- The use of AUSWAMP for broad 'State of the Wetlands' assessment or similar reporting is recommended for wetlands in southwestern Australia and other regions of Australia where wetland condition is a major environmental concern.
- Further refinement of the biotic index, SWAMPS, is suggested to provide a eutrophication index for wetlands.
- Development of a protocol for wetland habitat assessment is recommended to compliment information provided by rapid bioassessment using invertebrates. The protocol should include an assessment of the extent and condition of submerged, emergent and fringing vegetation.
- Development of an Australian-wide version of 'The guide to wetland invertebrates of southwestern Australia' and the CD-ROM 'Western Australian Aquatic Invertebrate Fauna' is suggested to more fully support national wetland rapid bioassessment programs.
- The need for long-term monitoring of selected wetlands must to be addressed. Long term monitoring is required to ensure that we have the capacity to distinguish human impacts on wetlands from changes occurring as a result of climatic variability.