

2. Introduction

This document is the final report of a consultancy performed by the NSW National Parks and Wildlife Service (NPWS) for the Department of Environment, Sport and Territories (DEST). The consultancy evaluated the efficiency of environmental surrogates and modelling techniques in predicting the distribution of biological diversity. The work was conducted over a period of twenty three months (July 1994 to May 1996).

Further information relating to the consultancy is provided in the following documents:

- Consultancy Specification prepared by DEST, dated 11 December 1993
- Consultancy Proposal prepared by NPWS, dated 5 January 1994
- Consultancy Contract between DEST and NPWS, dated 24 June 1994 (and varied in November 1995)
- Consultancy Workplan prepared by NPWS, dated October 1994
- Progress Report prepared by NPWS, dated June 1995
- A report titled 'A Methodology for Evaluating the Efficiency of Environmental Surrogates' prepared by NPWS, dated December 1995

2.1 Consultancy brief

The Project Description for the consultancy was:

"This project must utilise a region or regions for which there is already in existence adequate biological and physical data in order to carry out comparisons of the efficiency of environmental surrogates and modelling techniques in predicting the distribution of biological diversity entities. Any data collection required to complete the existing data must be minimal.

The project has two main aspects:

- *the testing of environmental classifications as general surrogates for biodiversity; and*
- *testing the reliability of models (eg decision trees) for predicting the distribution of different biological diversity entities.*

The project will not involve the design of significantly different or new surrogates or models." (Consultancy Specification, page 2)

The principle output to be produced by the consultancy was a report:

"The consultant will provide a report which evaluates and compares the efficiency of selected environmental surrogates and modelling techniques in predicting the distribution of different biodiversity entities. The report should include:

- *a description of the environmental surrogates and modelling techniques selected;*
- *identification of the region or regions utilised in the study;*
- *a description of the biological and physical data utilised;*
- *an evaluation of the effectiveness of each surrogate and modelling technique selected (including identification of limiting factors in its application);*
- *a comparative evaluation of the selected methods, identifying which methods would be the most suitable for each of a set of scenarios;*
- *a comparative evaluation of the costs involved for each method; and*



Figure 2.1 Location of two study areas used in the consultancy

- *suggestions regarding further research into refinements to the methods studied in order to increase their effectiveness.” (Consultancy Specification, page 3)*

2.2 Approach adopted by consultant

The Consultant used data from two different environments in New South Wales (NSW) to evaluate the efficiency of environmental surrogates and modelling techniques. Most of the evaluation was performed using data from forested north-east NSW, with limited supplementary analysis of data from arid north-west NSW (see Figure 2.1).

Extensive environmental and biological data were already available for forested north-east NSW as a result of major biodiversity survey work conducted in this region during the past six years by NPWS. A comprehensive environmental GIS database had been established, and extensive field surveys of flora and fauna had been conducted based on an environmental stratification. All data from these surveys had been databased and subjected to rigorous checking procedures. Analysis and modelling of the biological data in relation to environmental surrogates was already well progressed prior to the commencement of the consultancy.

The data for arid north-west NSW were generated by an independent research project conducted in Sturt National Park by Bob Pressey (NPWS) aimed at evaluating the effectiveness of land system mapping as a surrogate for direct biological information. Floristic data had been collected at replicated survey plots stratified by geology, landform, land system and land unit.

The above data were used to conduct two types of testing and evaluation:

- An evaluation of the effectiveness of different types of land classification and mapping as surrogates for direct information on the distribution of biodiversity entities. The evaluation was performed by analysing the relationship between environmental surrogates and biological field survey data using two analytical techniques, one based on matrix correlation and the other on species accumulation curves. Surrogates evaluated for north-east NSW included different types of vegetation mapping, environmental domain analysis, environmental ordination, canonical ordination and predictive modelling of species distributions. These surrogates were tested using field survey data on vascular plants (canopy and understorey), vertebrate animals (small reptiles, diurnal birds and microchiropteran bats) and invertebrate animals (ground-dwelling spiders, beetles and ants). The generality of the analytical techniques applied to data from forested north-east NSW was demonstrated by application to data from arid north-west NSW (evaluating the relationship between flora survey data and mapped geology, landform, land systems and land units).
- An evaluation of the effectiveness of different modelling techniques for predicting species distributions. The biological and environmental data from forested north-east NSW were used to evaluate the predictive accuracy of a range of modelling techniques (simple profile matching, generalised linear and additive modelling, and decision tree modelling) when applied to different taxa, *ad hoc* ‘presence only’ versus rigorous ‘presence/absence’ survey data, and coarse versus fine scale environmental data. The predictive accuracy of models was assessed using statistical resampling techniques (jackknifing) and independent datasets.

2.3 Purpose and structure of this report

This report describes the methodology used in the consultancy to evaluate environmental surrogates and predictive modelling techniques, and the results obtained from the application of this methodology to selected NSW datasets. The remainder of the report is structured as follows:

- Section 3 describes the development of analytical methods for evaluating the efficiency of environmental surrogates.

- Section 4 describes the primary application of these methods to biological and environmental data from forested north east NSW, and presents the results of this evaluation.
- Section 5 describes a further application of the methods to data from arid north west NSW, thereby demonstrating the generality of the developed approach.
- Section 6 describes the development of methods designed specifically to evaluate the performance of predictive modelling techniques.
- Section 7 describes the application of these methods to predictive models derived using data from forested north east NSW.
- Section 8 presents the general conclusions and recommendations of the consultancy.