

**Systematic Conservation
Assessments for
Marine Protected Areas
in New South Wales, Australia**

**Thesis Submitted by
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**For the degree of Doctor of Philosophy
In the School of Marine and Tropical Biology,
Faculty of Science, Engineering and Information Technology
James Cook University**

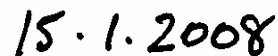
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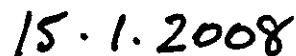
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15.1.2008

(Date)

Statement of the Contribution of Others

Ron Avery provided a foundation for this work through his previous assessment of the Tweed-Moreton marine bioregion. Ron was also an equal partner and author on the biodiversity assessment for the Manning Shelf. Ron helped develop, refine and map the broad scale environmental classification, researched literature and data sets to support the assessment and helped develop options for marine protected areas. Ron also mapped near shore reef, sand and intertidal habitats and other data for most of NSW.

Nick Otway developed the project proposal, funding, supervision and scientific foundation for the bioregional assessments. Andrew Read and Bob Creese assisted with financial, scientific and management support for the projects.

Research for the assessments in NSW was undertaken with Natural Heritage Trust funding from Environment Australia (now the Australian Government Department of Environment and Heritage) for the Marine Protected Areas Program at NSW Fisheries and the NSW Marine Parks Authority.

Staff at the NSW National Parks and Wildlife Service Conservation Assessment Unit provided the C-Plan conservation planning software, while Bob Pressey, Mal Ridges and Matthew Watts provided technical support, guidance and license codes. Chris Margules, Paul Walker (CSIRO) and Dan Faith (Australian Museum) assisted through discussions and demonstrations of approaches to reserve selection. Andrew Taplin introduced me to Spexan while its authors Ian Ball and Hugh Possingham provided the Marxan simulated annealing software adapted for the Great Barrier Reef Marine Park Authority.

For Cape Byron Marine Park:

Andrew Page, Nicola Johnston and other Cape Byron Marine Park staff organised project planning, logistics, data collection, consultation and wrote draft and final plans for the park. Vanessa Mansbridge provided maps of the draft and final zone plans and other data. Andrew Bickers and Katrina Baxter carried out the sidescan and video surveys of the marine park and provided the fine scale classification and GIS data for subtidal habitats and benthic assemblages. Simon Banks and David Scotts provided the classification of intertidal habitats. Greg West and Danielle Morrison provided maps of estuarine vegetation and expert advice and support on GIS throughout all projects.

Kellie Lobb entered, modelled and mapped data for the recreational surveys. Nick Brown entered, modelled and mapped data for the commercial fishing surveys. The late Doug Chapman analysed commercial fisheries catch returns data and estimated the costs of buying out commercial fishing endorsements. The NSW Marine Parks Authority provided a professional facilitator for the community workshops. Matthew Watts ran the initial Marxan simulations for the Cape Byron ecological and social data twice in one night. The Cape Byron Advisory Committee and other participants at the draft zone plan workshops provided local knowledge and advice.

I also wish to acknowledge the contributions of the following individuals and organisations:

The Great Barrier Reef Marine Park Authority, NSW Marine Park Authority, NSW Fisheries, NSW National Parks and Wildlife Service and the Marine Protected Areas Program of Commonwealth Department of Environment and Heritage for the provision of funding, infrastructure and project guidance.

Jon Day, David Lloyd, Jamie Oliver, Leanne Fernandes and Richard Kenchington for the management, development and support of the Representative Areas Program at the Great Barrier Reef Marine Park Authority during the classification phase of the project.

Francis Pantus, Joan Phillips, David Wachenfeld, Ken Melchert, Alan Williams, Barbara Breen, Guy Lane, Malcolm Cullen, Donna Auden, Rob Magill and Jeff Shearer for their work in the initial planning, data collection and GIS modelling for the Representative Areas Program at the Great Barrier Reef Marine Park Authority.

Rena Partridge, Brigid Kerrigan, Laura Rowe, Suzie Davies and Leanne Fernandes for organisation and support of the literature review and database, survey of research scientists and the expert workshops on biodiversity in the Great Barrier Reef World Heritage Area.

Glen De'Ath provided the Multivariate Classification and Regression Tree analyses that provided a basis for the bioregionalisations developed at the expert workshops and Trevor Ward provided advice on systematic protected area assessments.

The physical and biological scientists who provided guidance through the Representative Areas Program Steering Committee and expert workshops, and the many other scientists who supplied data sets, knowledge and advice through interviews and surveys.

The multiple criteria analysis software 'Criteria Decision Plus' was purchased from InfoHarvest, Seattle WA, USA (www.infoharvest.com) by NSW Fisheries. The GIS software ArcView and ARCInfo was licensed to NSW Fisheries from ESRI.

Acknowledgments

For their comments, advice and assistance I gratefully acknowledge:

My supervisors Dr. Geoffrey Jones, James Cook University and Dr. Nicholas Otway, NSW Fisheries.

Andrew Read, Bob Creese, Greg West, Francis Dorman, Danielle Morrison, Natalie Morrison, Michelle Belcher, Kellie Lobb, Allan Genders, Melissa Walker, Brett Loudon, Natalie Taffs, Bruce Pease, Jane Frances, Rob Williams, Steve Kennelly, Paul O'Connor, Wendy Stamp, Steve Dunn and Rob Buck from NSW Fisheries (now NSW Department of Primary Industry).

Helen Muldoon from the NSW Marine Parks Authority.

Rodney James, Simon Banks, Kevin Shanahan, Kelly Waples, Michael Wright, Bob Pressey, Matthew Watts and Mal Ridges from the NSW National Parks and Wildlife Service (now NSW Department of Environment and Conservation).

Rob Magill, Nina Morrisette, Josh Gibson, Andrew Page, Russell Hoare, Phil Laycock, Andrew Dunstan, Douglas Baird and staff at Reef Biosearch and Quicksilver Connections.

All other individuals and organisations who assisted by providing data, information and advice.

My wife Barbara Anne (Bollard) Breen and children, Cassandra Rose and Jack Gordon for their patience with constant neglect, complaints and crankiness and John and Eve Bollard for their love and support.

My father (Gordon) who never got to see me finish this and my mum (Shirley) who just might.

Abstract

Science and planning for marine conservation is a complex, cross-disciplinary task. Marine conservation involves many objectives and there is much uncertainty in how ecosystems and their human populations behave. It is therefore important for environmental managers to access the best available information and expertise and to support research that improves conservation outcomes.

This thesis demonstrates through several case studies, how the systematic use of information, decision support tools and consultation can be used to identify sites for marine protected areas (MPAs) and plan for future research. The studies differ in their immediate goals and the information available. All however, benefit from linking explicit objectives to spatial databases and tools that allow scientists, managers and communities to explore and evaluate management scenarios using realistic data.

C-Plan, Marxan, Multiple Criteria Analysis and a Geographic Information System (GIS) atlas of 35 data sets are used to identify comprehensive, adequate and representative systems of MPAs throughout the state of New South Wales (NSW), Australia. The studies identify many potential locations for MPAs in the Manning, Hawkesbury, Batemans and Twofold Shelf marine bioregions and provide information and tools to implement these options. Two of these options have now been established and zoned as large, multiple use marine parks near Port Stephens and Batemans Bay. Decisions have yet to be made on options for a third large marine park in the Hawkesbury Shelf bioregion.

Potential locations for MPAs were identified from a review of MPA network design theory and criteria derived from national identification and selection guidelines. The proposed options for multiple use marine parks aimed to include representative and complementary examples of biodiversity surrogates defined for 'ecosystems' (five estuary types and three ocean depth zones) and 'habitat' types (mangrove, saltmarsh, seagrass, rocky shore, beach, reef and island). MPAs were also selected to include important sites for threatened Grey Nurse Shark (*Carcharias taurus*), fishes, birds, mammals, wetlands and other values. Criteria with unique conservation values had a greater influence in identifying specific locations for MPAs. However, almost all options scored highly for a wide range of different criteria and contributed features to complement the overall value of the MPA network.

Options for large marine parks were selected to include the highest complementary conservation values in continuous sections of coast, estuary and ocean. However, many other smaller sites outside of these parks were identified for their high conservation values. These could be included within smaller local MPAs, within other marine parks or at least be targeted by other conservation strategies.

Where possible, locations were chosen that adjoined sections of coast and catchment with a high degree of protection in terrestrial protected areas and low levels of urban, industrial and agricultural land use. However, in the more populated regions, many distinctive areas of high conservation value were found near urban and industrial developments. Management for these areas is therefore all the more urgent and still requires attention.

Once a marine park in NSW is declared, a zone plan is required to allocate various levels of protection. These include highly protected 'no-take' sanctuary zones, habitat protection zones where recreational fishing is permitted and general use zones that allow some forms of commercial fishing. Broad scale bioregional assessments helped identify the general location of the Cape Byron Marine Park and assisted in initial planning. However, additional finer scale ecological, social and economic data were required to zone different levels of protection within the park. Detailed sidescan sonar, underwater video, aerial photography, field studies and community surveys were therefore commissioned and used to map ecological, social, and economic values.

C-Plan, Marxan and interactive GIS were then used with community workshops to develop plans that addressed conservation goals while minimising impacts on commercial, recreational and cultural interests. While a consensus among community representatives was not achieved for all areas, a plan for the park was developed that represented a range of conservation values in different zones while allowing for different human activities. This two stage approach combines broad and fine scale assessments in a cost effective way to quickly obtain reliable data for large areas of coast and ocean.

The assessments also demonstrate the value of uniting information and expertise from scientists, managers and communities in practical, science based approaches to ecosystem management. Initial proposals for NSW and previously for the Great Barrier Reef Marine Park, indicated that very little data would be available for these systematic marine conservation assessments. However, in both cases the number of useful data sets was greater than expected and provided convincing support for decision making. Many sites scored strongly for many different important values and while there was some duplication among similar data sets, this corroboration provided additional checks against uncertainty.

Collating, formatting and analysing many data sets is a specialised, labour intensive task. However, this cost is only a small fraction of the time and effort that goes into consultation and administration. Therefore, despite the effort involved, systematic assessments that provide a solid foundation of evidence are likely to reduce the overall time required in negotiations to establish MPAs. The MPAs established after the assessments in this thesis were substantial, and were implemented within a relatively short time span. This suggests that a systematic, information based approach is cost effective when compared to the more *ad hoc* approaches used previously in these regions and elsewhere.

The hierarchical approach used to map marine ecosystems and their components was applied at several different spatial scales and at varying levels of complexity. This environmental classification provided a comprehensive and cost effective way to describe large areas where only basic information was available. However, it also provided a nested framework to accommodate more detailed information and targeted research without necessarily biasing decisions towards only well studied locations. The hierarchical exploration of goals, criteria and measures through multiple criteria analyses encouraged a more thorough exploration of objectives and highlighted where more research was required. These gaps included offshore subtidal habitats, variation in species assemblages, the nature of ecological processes among marine and adjacent terrestrial ecosystems, and the impacts and values of human activities.

The level of knowledge in these fields is encouraging at a theoretical level and for specific, well studied sites. However, it is still difficult to generalise this information to the scale of whole ecosystems and regions. While techniques to map and model large ecological systems are increasingly available and affordable, better support and coordination for this work would benefit all aspects of marine research and management.

The different GIS based decision support tools used to integrate complex data sets and assess alternative MPA networks were all highly effective. All provided similar results, indeed data input, goal selection, reserve design and planning unit size and shape appeared to have a greater influence on results than the particular tool used. As these readily available and easily used tools tend to have different complementary strengths, it may, therefore, be more important to use at least one or preferably more than one tool, rather than dwelling on whether one particular approach is superior.

C-Plan was useful in providing a rapid statistical assessment of irreplaceability under changing scenarios of different targets, data and the selection or exclusion of planning units. This made it a useful 'hands on' tool for participatory conservation planning. Marxan provided a flexible and powerful tool for goal oriented reserve design with the ability to include criteria for reserve size, spatial aggregation, replication and other aspects of reserve configuration. Both were able to incorporate costs specified as areas or percentages of ocean occupied by MPAs or as more complex, customised estimates of social and economic impacts on fishing and other competing activities.

Unlike C-Plan and Marxan, the multiple criteria models built in Criterion Decision Plus did not inherently take into account the complementarity of sites in contributing towards conservation targets. However, this method was able to integrate previously calculated estimates of irreplaceability from C-Plan with over 60 other quantitative and qualitative measures for alternative sites in a hierarchically structured tree of MPA goals, priorities and scores. This tool also provided a way to assess sites according to varying priorities provided by different individual users.

These decision support tools employ relatively sophisticated techniques which continue to undergo development. The assessments explore only part of this potential but the information presented here can be easily re-analysed with new data, priorities and issues in marine research and management. The key element enabling these possibilities is the use of GIS to spatially integrate, manipulate and display this information.

MPAs are not the only way to manage and understand marine ecosystems. However, multiple use MPAs, in particular, are ideal venues to test and refine realistic hypotheses about marine ecosystems and their management. The geographic models and methods described in this thesis provide the spatial foundation on which to develop and design tests for such hypotheses. They are powerful tools to integrate diverse information and to model the potential effects of management interventions under varying scenarios. They therefore represent an important opportunity to channel the results of individual research projects into an wider, systematic and adaptive approach to ecosystem science and management.

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