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

Thesis Submitted by

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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.

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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.

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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 specifc 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 Criterium 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.

Table of Contents

Statement of the Contribution of Others iii

Acknowledgments v

Abstract vi

1 Introduction 1

1.1 Objectives of the thesis 1

1.2 Human impacts on marine ecosystems 2

1.3 Marine Protected Areas 3

1.4 Science and management 8

1.5 Ecosystem management 11

1.6 Ecosystem science 12

1.7 Systematic assessments to identify MPAs 16

1.8 Structure of the thesis 19

2 Goals and criteria for marine protected areas 22

2.1 National and NSW goals and criteria for MPAs 24

2.2 Conceptual multiple criteria goals for MPAs 28

2.3 Protection of biodiversity and ecosystem viability 31

2.3.1 Comprehensiveness 31

2.3.2 Representativeness 32

2.3.3 Adequacy 33

2.4 Managing and providing for human activities 37

3 Methods to identify Marine Protected Areas 39

3.1 *Ad hoc* and systematic selection of reserves 39

3.2 Representing spatial patterns in biodiversity 40

3.2.1 Mapping of physical and biogenic features 41

3.2.2 Biological surveys sampling organism distribution and abundance 42

3.2.3 Modelling from biological, physical and spatial predictors 43

3.2.4 Delphic consensus of experts 45

3.3 Decision support tools for MPA planning 45

3.3.1 Geographical Information Systems and databases 46

3.3.2 Planning units. 48

3.3.3 Simple scoring and graphic techniques. 49

3.3.4 Selection algorithms, complementarity and irreplaceability 51

3.3.5 Hierarchical multiple criteria analysis models. ... 56
3.3.6 Expert advice, anecdotal information and delphic workshops ... 57

3.4 Regional marine biodiversity classifications ... 58

3.5 Australian national marine classifications ... 59

3.6 Classification of marine biodiversity in the Great Barrier Reef World Heritage Area ... 62

4 Marine Protected Areas in NSW ... 81

4.1 Marine parks ... 82

4.2 Aquatic reserves ... 83

4.3 National parks and nature reserves ... 83

4.4 Commonwealth MPAs ... 84

5 Methods to identify MPAs in NSW ... 87

5.1 A marine environmental classification for NSW ... 88
5.1.1 Estuary ecosystem classes ... 89
5.1.2 Ocean ecosystem classes ... 89
5.1.3 Seagrass, mangrove and saltmarsh habitats ... 90
5.1.4 Subtidal reef habitats ... 90
5.1.5 Island habitats ... 90
5.1.6 Subtidal sediment habitats ... 91
5.1.7 Intertidal beach habitats ... 91
5.1.8 Intertidal rocky shore habitats ... 91

5.2 Data for individual species ... 91

5.3 Condition, vulnerability and previous assessments ... 92

5.4 Systematic methods to identify MPA options in NSW ... 92
5.4.1 Planning units ... 92
5.4.2 Graphical summaries and qualitative scores ... 92
5.4.3 Irreplaceability ... 94
5.4.4 Multiple Criteria Analyses ... 96

6 MPA assessment of the Manning Shelf bioregion ... 97

6.1 Introduction ... 97

6.2 Geographic extent ... 98

6.3 MPAs in the Manning Shelf bioregion ... 99

6.4 Systematic assessment ... 103
6.4.1 Estuarine ecosystems ... 103
6.4.2 Ocean ecosystems ... 105
6.4.3 Seagrass, mangrove and saltmarsh habitats ... 110
6.4.4 Subtidal reefs and shoals ... 115
6.4.5 Islands ... 117
6.4.6 Beaches ... 119
6.4.7 Intertidal rocky shore ... 122
6.4.8 Coastal rock platforms (Total Environment Centre) ... 126
6.4.9 Intertidal platform survey (Griffiths 1982) ... 126
6.4.10 Estuarine juvenile fish and invertebrates ... 128
6.4.11 NSW Fisheries commercial catch data ... 132
6.4.12 Birds of International Importance ... 135
6.4.13 Threatened birds – NSW National Parks ... 138
6.4.14 Threatened Grey Nurse Shark (Carcharias taurus) ... 141
6.4.15 NSW Fisheries threatened species database ... 144
6.4.16 Marine mammals and reptiles ... 145

6.4.17 RAMSAR sites – Nationally and internationally important wetlands 146
6.4.18 Directory of Important Wetlands in Australia 147
6.4.19 Independent inquiry into coastal lakes 149
6.4.20 Environmental inventory of estuaries and coastal lagoons 150
6.4.21 Australian Estuarine database 151
6.4.22 National parks and nature reserves 152
6.4.23 State forest 153
6.4.24 SEPP 14 wetlands 153
6.4.25 Wilderness 154
6.4.26 SEPP 26 littoral rainforest 154
6.4.27 Land capability 158
6.4.28 Built-up areas 161
6.4.29 Acid sulphate soils 161
6.4.30 Australian river and catchment condition database (ARCCD) 162
6.4.31 Irreplaceability analysis for ecosystem and habitat units 169
6.4.32 Multiple criteria decision analysis 176

6.5 Discussion – Manning Shelf Assessment 187
6.5.1 MPA options in the Manning Shelf bioregion 188

6.6 Conclusion 191

7 MPA assessment of the Hawkesbury Shelf bioregion 194

7.1 Introduction 194

7.2 Geographic extent 194

7.3 MPAs in the Hawkesbury Shelf bioregion 196

7.4 Systematic assessment 200
7.4.1 Estuarine ecosystems 200
7.4.2 NSW Fisheries assessment of wave dominated and intermittent estuaries 205
7.4.3 Oceanography - East Australian Current 211
7.4.4 Seagrass, mangrove and saltmarsh habitats 214
7.4.5 Shallow subtidal reef 221
7.4.6 Islands 223
7.4.7 Shallow subtidal sand 225
7.4.8 Intertidal beach 225
7.4.9 Intertidal rocky shore 226
7.4.10 NSW Fisheries assessment of rocky intertidal communities 228
7.4.11 Coastal rock platforms (Total Environment Centre) 230
7.4.12 Irreplaceability analysis for ecosystem and habitat units 231
7.4.13 Estuarine juvenile fish and invertebrate biodiversity 235
7.4.14 NSW Fisheries commercial catch data 237
7.4.15 NSW Fisheries threatened species database 240
7.4.16 Threatened Grey Nurse Shark (Carcharias taurus) 242
7.4.17 Threatened Birds - National Parks and Wildlife Service 244
7.4.18 Significant areas for shore birds and sea bird islands 252
7.4.19 Marine mammals and reptiles 255
7.4.20 RAMSAR sites - Nationally and Internationally important wetlands 256
7.4.21 Directory of important wetlands in Australia 257
7.4.22 Independent inquiry into coastal lakes 259
7.4.23 Environmental inventory of estuaries and coastal lagoons 261
7.4.24 Australian Estuaries and the OzEstuaries database 263
7.4.25 Adjacent national parks and nature reserves 265
7.4.26 Wilderness 266
7.4.27 SEPP 14 wetlands 266
7.4.28 State forest 267
7.4.29 Land capability 270
7.4.30 Built-up areas 273

7.4.31 Acid Sulphate Soils 274
7.4.32 ARCCD – Australian river and catchment condition database 275

7.5 Discussion 281
7.5.1 MPA options in the Hawkesbury Shelf bioregion 282

7.6 Conclusion. 285

8 MPA assessment of the Batemans and Twofold Shelf bioregions 287

8.1 Introduction 287

8.2 Geographic extent 288

8.3 MPAs in the Batemans and Twofold Shelf bioregions 289

8.4 Systematic assessment 291
8.4.1 Estuarine ecosystems 291
8.4.2 NSW Fisheries assessment of wave dominated and intermittent estuaries 302
8.4.3 Ocean ecosystems 307
8.4.4 Oceanography - East Australian Current 310
8.4.5 Seagrass, mangrove and saltmarsh habitats 313
8.4.6 Shallow subtidal reef and shoal 322
8.4.7 Islands 324
8.4.8 Shallow subtidal sediments 324
8.4.9 Exposed intertidal beach 327
8.4.10 Intertidal rocky shore 328
8.4.11 NSW Fisheries assessment of rocky intertidal communities 330
8.4.12 Coastal rock platforms (Total Environment Centre) 332
8.4.13 Irreplaceability analysis for ecosystem and habitat units 333
8.4.14 Estuarine juvenile fish and invertebrate biodiversity 341
8.4.15 NSW Fisheries commercial catch data 343
8.4.16 Threatened fish species sightings database 348
8.4.17 Threatened Grey Nurse Shark 350
8.4.18 Threatened Birds 352
8.4.19 Significant areas for shore birds and sea bird islands – Department of Environment and Heritage. 359
8.4.20 Marine mammals and reptiles 362
8.4.21 Directory of important wetlands in Australia 363
8.4.22 Independent inquiry into coastal lakes 365
8.4.23 Environmental inventory of estuaries and coastal lagoons 368
8.4.24 Australian Estuaries and the OzEstuaries database 371
8.4.25 Adjacent national parks and nature reserves 373
8.4.26 Wilderness 375
8.4.27 State forest 375
8.4.28 State Environmental Planning Policy – Wetlands (SEPP 14) 376
8.4.29 Land capability 380
8.4.30 Built-up areas 383
8.4.31 Acid Sulphate Soils 383
8.4.32 Australian river and catchment condition database 384
8.4.33 MPAs in the Victorian and Tasmanian sections of the Twofold Shelf bioregion 390

8.5 Discussion 394
8.5.1 MPA options for the Batemans and Twofold Shelf bioregions 395

8.6 Conclusion 405

9 Geographic Information tools for broad scale marine planning in NSW

9.1 Introduction 407
9.1.1 Previous assessments for marine protected areas in NSW 407
9.1.2 A Marine Geographic Information System for NSW 408
9.1.3 C-Plan 409
9.1.4 Marxan 409
9.1.5 Multiple criteria analysis 411
9.2 Methods 412
9.2.1 Data 412
9.2.2 Planning frame 413
9.2.3 Planning units 415
9.2.4 C-Plan models for broad scale MPA planning in NSW 415
9.2.5 Simulated annealing to identify MPA options 416
9.2.6 Multiple criteria analysis to assess Marine Parks for NSW 417
9.3 Results 420
9.3.1 C-Plan models for MPA planning in NSW 420
9.3.2 Simulated annealing to identify MPA options 424
9.3.3 Multiple criteria models for MPA planning in NSW 434
9.4 Discussion 443
9.5 Conclusion 446

10 Geographic Information Tools to plan the Cape Byron Marine Park

10.1 Introduction 447
10.2 Methods 448
10.2.1 Planning Units 448
10.2.2 Biodiversity surrogates 449
10.2.3 Socioeconomic information 450
10.2.4 Analysis 451
10.2.5 Community workshop 452
10.3 Results 453
10.3.1 Fine scale environmental surrogates for Cape Byron Marine Park 453
10.3.2 Recreation in the Marine Park 454
10.3.3 Commercial fishing in the Marine Park 461
10.3.4 Irreplaceability analyses in C-Plan 461
10.3.5 Simulated annealing in Marxan 462
10.3.6 Advisory committee and draft zoning workshop 474
10.4 Discussion 481
10.5 Conclusion 485

11 General Discussion

11.1 What is out there? What is happening to it? What are we doing ? Is it working? 488
11.2 Awareness, education and motivation 489
11.3 Institutions, individuals and political support.. 490
11.4 Processes to engage scientists and communities 491
11.5 Objectives, criteria and performance assessment 494
11.6 Comprehensive, relevant and useful data.. 494
11.7 Integrated data management.. 500
11.8 A scientific approach to develop and test marine management hypotheses 501
11.9 Real world applications of systematic marine planning and decision support tools......................... 504
11.9.1 Systematic conservation assessments and decision support tools in NSW 506
11.10 Application of decision support tools for other MPAs 508
11.11 Systematic marine conservation planning and decision support tools 509
11.12 Conclusion.. 511

References 514

Appendices

Appendix 1.
Ecological reserve guidelines to identify MPAs in NSW 3

Appendix 2.
Options for MPAs in the Manning Shelf Marine Bioregion 6
2.1 A multiple use marine park in the Manning Shelf Bioregion 6
2.2 Khappinghat Creek 10
2.3 Lakes Innes & Cathie 10
2.4 Camden Haven River, Queens Lake, Watson Taylors Lake and Gogleys Lagoon 11
2.5 Korogoro Creek 12
2.6 South West Rocks Creek 12
2.7 Saltwater Creek and Saltwater Lagoon 12
2.8 Killick Creek 12
2.9 Unamed Creek (Big Hill Point) 13
2.10 Limeburners Creek and Saltwater Lake – Hastings River 13
2.11 Kooragang Island and Fullerton Cove 14
2.12 Macleay River Delta and Macleay Arm 15
2.13 Warrell Creek – Nambucca River 16
2.14 Manning River (Harrington) and Manning River (Farquhar Inlet) 16
2.15 Intertidal rocky shores and inshore reefs 16
2.16 Offshore reefs, islands, and aggregations of Grey Nurse Sharks 17

Appendix 3.
Options for MPAs in the Hawkesbury Shelf Marine Bioregion 18
3.1 Option A. Hunter River to Avoca Lake 18
3.2 Option B. Lake Munmorah (Wybung Point) to Narrabeen Lakes 24
3.3 Option C. Avoca Lake to Port Hacking 28
3.4 Option D. Cape Banks to Shellharbour 34

Appendix 4.
Options in the Batemans and Twofold Shelf Bioregions 38
4.1 Option A. Shellharbour to Jervis Bay Marine Park 38
4.2 Option B. Termeil Lake to the Moruya River 43
4.3 Option C. Durras Lake to Wallaga Lake 46
4.4 Option D. Middle Lagoon to Twofold Bay 50
4.5 Option E. Twofold Bay to Nadgee 53

Appendix 5.
Steering and expert committee for the Great Barrier Reef Representative Areas Project 54

Appendix 6.
Survey of marine scientists for the GBRMPA Representative Areas project 55

Appendix 7.
IUCN protected area categories 58

Appendix 8.
Electronic copy of thesis and data files 75

List of Figures

Chapters 1-5

Figure 1.1 Goals and criteria to identify marine protected areas 2
Figure 1.2 Schematic representation of a 7-step operational framework........ 17
Figure 2.1 Primary and secondary goals for a system of marine protected areas 29
Figure 2.2 Criteria for comprehensiveness 29
Figure 2.3 Criteria for representativeness........ 29
Figure 2.4 Criteria for adequacy 30
Figure 3.1 Conceptual diagram of relationships among physical environments and biodiversity........ 41
Figure 3.2 Screen view of the prototype MARES GIS based decision support tool........ 50
Figure 3.4 IMCRA (marine) and IBRA (terrestrial) bioregionalisations for Queensland........ 64
Figure 3.5 Gridded bathymetry (30 arc second) for the Great Barrier Reef region 65
Figure 3.6 Average slope derived from the 30 arc second gridded bathymetry data........ 66
Figure 3.7 Aspect (degrees from north) derived from the 30 arc second gridded bathymetry........ 67
Figure 3.8 Exposure of coast, islands, midshelf and outer reefs modelled from aspect 68
Figure 3.9 Ten year mean monthly isotherms for the Great Barrier Reef 69
Figure 3.10 Selected depth and sediment categories in the previous GBRMPA zone plan........ 70
Figure 3.11 Morphological reef types of the Great Barrier Reef 71
Figure 3.12 Regionalisation of reef morphologies for the Great Barrier Reef 72
Figure 3.13 Numerical classification of reef morphologies for the Great Barrier Reef 73
Figure 3.14 Scientists defining bioregions on an image of ArcView GIS projected onto a whiteboard..... 76
Figure 3.15 Draft reef regionalisation from the reef expert workshop for the GBRMPA 78
Figure 3.16 Draft inter-reef regionalisation from the expert workshop for the GBRMPA 79
Figure 3.17 Distribution of no-take zones (green) in the Great Barrier Reef Marine Park 80
Figure 4.1 Marine protected areas in NSW before 2006 86

Chapter 6

Figure 6.1 Manning Shelf marine bioregion 98
Figure 6.2a Protected areas in the Manning Shelf bioregion before 2005 100
Figure 6.2b Broad scale planning units and 'ecosystem' level indicators of biodiversity 101
Figure 6.3 Open water area of broad scale planning units in the Manning Shelf bioregion 102
Figure 6.4a–r Oblique aerial photographs of major estuaries in the Manning Shelf bioregion 106
Figure 6.6 a–d Estimated areas of Manning Shelf ocean ecosystems in four depth zones 108
Figure 6.7 a–d Areas of Manning Shelf ocean ecosystems in four depth zones within 3 nm 109
Figure 6.8a–g Habitat classes for estuaries and sections of exposed coast and ocean 112
Figure 6.10a–d Area of mangrove, seagrass and saltmarsh habitat 114
Figure 6.12a–c Area within a 100 m buffer of islands 118
Figure 6.13a–d Area (ha) of intertidal beach habitat 120
Figure 6.14 a–d Area of intertidal habitat mapped for estuaries and offshore islands 121
Figure 6.15a–d Lengths (km) of intertidal habitats mapped for sections of ocean coast 124
Figure 6.16a–c Area (ha) of rocky intertidal habitats for sections of ocean coast 125
Figure 6.17 Rocky intertidal shores identified in previous assessments 127
Figure 6.18a–g Number of species of juvenile fish and invertebrates sampled by seine net 129
Figure 6.19a–c Total number of species, percentage contribution and summed irreplaceability for juvenile fish and invertebrate species 130
Figure 6.20a–c Total number of species, percentage contribution and summed irreplaceability for juvenile fish and invertebrate species at a reduced number of sites 131
Figure 6.21a–c Number of species, summed irreplaceability and size (tonnes) of commercial fishing catch for estuaries 133
Figure 6.22a–c Number of species, summed irreplaceability and size (tonnes) of commercial fishing catch for ocean ports 134
Figure 6.23a–d Number of species and summed irreplaceability for sea and shore birds 136
Figure 6.24a–d Areas of important estuary and ocean coast for protected birds 137
Figure 6.25 Maximum numbers of Grey Nurse Shark (*Carcharias taurus*) observed at dive sites 142
Figure 6.26a–c Maximum, mean maximum (+ s.e.) and percent occurrence of Grey Nurse Shark 143
Figure 6.27a–d Percentage area of land adjacent (within 1 km) to waterways with protection 155
Figure 6.28a–d Percentage area of land within 1 km of ocean coast with protection 156
Figure 6.29a–c Percentage of land within 1 km of ocean coast: as wilderness; in built-up areas; or with disturbed or high risk acid sulphate soils 157
Figure 6.30a–d Percentage of land within 1 km of waterways classed by land capability 159
Figure 6.31a–c Percentage of land within 1 km of ocean coast classed by land capability (continued) .. 160
Figure 6.32 Australian river and catchment condition index for overall river disturbance 164
Figure 6.33a–d Percentage of land within 1 km of estuaries with high risk acid sulphate soils; and mean Australian river and catchment condition indices for estuarine subcatchments 165
Figure 6.34a–d Australian river and catchment condition indices for estuarine subcatchments 166
Figure 6.35a–c Mean catchment and river condition measures for land within 5 km of ocean coast 167
Figure 6.36a–d Mean river and catchment condition measures for land within 5 km of ocean coast 168
Figure 6.37 Site irreplaceability of fine scale planning units for ecosystem and habitat units 172
Figure 6.38 Summed irreplaceability of fine scale planning units for ecosystem and habitat units 173
Figure 6.39a–c Summed irreplaceability for broad scale estuarine planning units 174
Figure 6.40a–c Summed irreplaceability of broad scale sections of exposed coast 175
Figure 6.41b Multiple criteria model and ranked scores for whole estuary plan units assessed for comprehensiveness and representativeness 183
Figure 6.42b Multiple criteria model and ranked decision scores for estuaries assessed for adequacy ... 184
Figure 6.43b Multiple criteria model and ranked scores for ocean plan units assessed for comprehensiveness and representativeness 185
Figure 6.44b Multiple criteria model and ranked scores for ocean plan units assessed for adequacy 186
Figure 6.45 Habitat map of the Port Stephens - Great Lakes Marine Park 192
Figure 6.46 Draft zoning map of Port Stephens - Great Lakes Marine Park 193

Chapter 7

Figure 7.1 Hawkesbury Shelf marine bioregion 195
Figure 7.2 Marine protected areas in the Hawkesbury Shelf bioregion 198
Figure 7.3 Intertidal protected areas in the Sydney region 199
Figure 7.4 Large scale planning units of whole estuaries and sections of exposed coast 202
Figure 7.5a-d Area (km^2) of open water for different types of estuaries 203
Figure 7.6a-s Oblique aerial photographs of major estuaries in the Hawkesbury Shelf bioregion 204
Figure 7.7 Previous candidate aquatic reserves in estuaries 207
Figure 7.8 Previous candidate aquatic reserves in estuaries (continued).................... 207
Figure 7.9a-c Area (km^2) of ocean depth zones in marine protected areas 209
Figure 7.10a-c Area (km^2) of ocean depth zones (outside of 3 nm) 210
Figure 7.11 Mean sea surface temperature off NSW coast 212
Figure 7.12 Broad scale oceanographic processes off the NSW continental shelf 213
Figure 7.13a-c Area (km^2) of seagrass, mangrove and saltmarsh habitat 216
Figure 7.14 Mapped habitat types between the Hunter River and Tuggerah Lakes.................... 217
Figure 7.15 Mapped habitat types between Tuggerah Lakes and Sydney Harbour 218
Figure 7.16 Mapped habitat types between Sydney Harbour and Port Hacking.................... 219
Figure 7.17 Mapped habitat types between Port Hacking and Shellharbour 220
Figure 7.18 Area of mapped shallow reef for sections of ocean coast 222
Figure 7.19a-c Area (km^2) of total, inshore and offshore islands.................... 224
Figure 7.20a-c Area (km^2) of mapped (inshore) sub-tidal sand, intertidal beach, and rocky shore 227
Figure 7.21 Towoon Bay candidate rocky intertidal aquatic reserve 229
Figure 7.22 Tudibaring Head candidate rocky intertidal aquatic reserve 229
Figure 7.23 Brickyard Point candidate rocky intertidal aquatic reserve 229
Figure 7.24 Summed irreplaceability of fine scale (4 km^2) planning units 232
Figure 7.25 Summed irreplaceability scores for estuaries 233
Figure 7.26 Summed irreplaceability scores for sections of coast 234
Figure 7.27 a-h Summed irreplaceability for representation of juvenile fish and invertebrates 236
Figure 7.29 Summed irreplaceability, number of species and weight of commercial catch 239
Figure 7.30 Maximum numbers of Grey Nurse Shark (*Carcharias taurus*) observed at dive sites 243
Figure 7.31 Critical habitat for the Little Penguin in North Sydney Harbour.................... 249
Figure 7.32 Number of threatened bird species sighted, number of sightings and irreplaceability 250
Figure 7.33 Number of threatened bird species sighted, number of sightings and irreplaceability (cont.)251
Figure 7.34 Area, number of species, number of birds and summed irreplaceability 253
Figure 7.35 Area, number of species, number of birds and summed irreplaceability (continued) 254
Figure 7.36 Percentage area of lands within 1 km of estuaries within national parks or nature reserves, wilderness areas, State Environmental Planning Policy 14 (wetland) areas and State Forest 268
Figure 7.37 Percentage area of land within 1 km of coast in national park or nature reserve, SEPP 14 areas, built up areas and disturbed or high risk acid sulphate soil areas 269
Figure 7.38 Percentage area of lands within 1 km of estuaries suited to different land uses and within built up areas.................... 271
Figure 7.39 Percentage area of land within 1 km of coast in areas suitable for cultivation, grazing and timber or natural vegetation.................... 272
Figure 7.40 Percentage area of lands within 1 km of estuaries with disturbed or high risk acid sulphate soils and mean Australian river and catchment condition indices for estuaries 277
Figure 7.41 Mean Australian river and catchment condition indices (continued) for estuaries 278
Figure 7.42 Mean Australian river and catchment condition indices within 5 km of coast 279
Figure 7.43 Mean Australian river and catchment condition indices within 5 km of coast for land use, extractive industries and pollution, and infrastructure 280

Chapter 8

Figure 8.1 Batemans Shelf and Twofold Shelf marine bioregions ... 288
Figure 8.2 Marine protected areas in the Batemans Shelf and Twofold Shelf bioregions ... 291
Figure 8.3 Broad scale planning units of whole estuaries and sections of exposed coast with mapped estuarine and ocean ecosystem types – Shellharbour to Burrill Lake ... 293
Figure 8.4 Broad scale planning units of whole estuaries and sections of exposed coast with mapped estuarine and ocean ecosystem types – Burrill Lake to Tuross Lake ... 294
Figure 8.5 Broad scale planning units of whole estuaries and sections of exposed coast with mapped estuarine and ocean ecosystem types – Tuross Lake to Wallagoot Lake ... 295
Figure 8.6 Broad scale planning units of whole estuaries and sections of exposed coast with mapped estuarine and ocean ecosystem types – Wallagoot Lake to the Victorian border ... 296
Figure 8.7a-c Area (km^2) of open water within and outside MPAs for estuary types ... 297
Figure 8.8 Area of open water (km^2) within MPAs for intermittent lagoons and creeks ... 298
Figure 8.9a-v Oblique aerial photographs of estuaries in the Batemans Shelf bioregion ... 299
Figure 8.10a-t Oblique aerial photographs of estuaries in the Batemans Shelf bioregion (continued) ... 300
Figure 8.11a-o Oblique aerial photographs of estuaries in the Batemans and Twofold Shelf ... 301
Figure 8.12 Previous candidate aquatic reserve at Wallaga Lake ... 306
Figure 8.13 Previous candidate aquatic reserve at Nelson Lagoon ... 306
Figure 8.14 Previous candidate aquatic reserve at Durras Lake ... 306
Figure 8.15a-c Area (km^2) of ocean depth zones in marine protected areas ... 308
Figure 8.16a-c Area (km^2) of ocean depth zones in marine protected areas outside of 3nm ... 309
Figure 8.17 Mean sea surface temperature off NSW coast ... 311
Figure 8.18 Broad scale oceanographic processes off the NSW continental shelf ... 312
Figure 8.19 Area (km^2) of seagrass habitat in marine protected areas ... 315
Figure 8.20 Area (km^2) of mangrove habitat in marine protected areas ... 316
Figure 8.21 Area (km^2) of saltmarsh habitat in marine protected areas ... 317
Figure 8.22 Mapped marine habitat types between Shellharbour and Burrill Lake ... 318
Figure 8.23 Mapped marine habitat types between Burrill Lake and Tuross Lake ... 319
Figure 8.24 Mapped marine habitat types between Tuross Lake and Wallagoot Lake ... 320
Figure 8.25 Mapped marine habitat types between Wallagoot Lake and the Victorian border ... 321
Figure 8.26 Area of mapped shallow reef for sections of ocean coast ... 323
Figure 8.27a-c Area (km^2) of total, inshore and offshore islands ... 326
Figure 8.28a-c Area (km^2) of mapped (inshore) sub-tidal sand, intertidal beach, and rocky shore ... 329
Figure 8.29 Bass Point and Bombo Head, previous candidate rocky intertidal aquatic reserves ... 331
Figure 8.30 Inyadda Point and Preservation Point, previous candidate intertidal aquatic reserves ... 331
Figure 8.31 Warden Head and Wagonga Head, previous candidate intertidal aquatic reserves ... 331
Figure 8.32 Summed irreplaceabilities of fine scale (4 km2) planning units in the Batemans Shelf ... 335
Figure 8.33 Summed irreplaceabilities of fine scale (4 km2) planning units in the Twofold Shelf ... 336
Figure 8.34 Summed irreplaceabilities of estuaries, ignoring existing MPAs ... 337
Figure 8.35 Summed irreplaceabilities of estuaries, including marine parks and aquatic reserves ... 338
Figure 8.36 Summed irreplaceabilities of estuaries, including all MPAs ... 339
Figure 8.37 Summed irreplaceabilities of ocean planning units ... 340
Figure 8.38a-h Summed irreplaceability for representation of at least one of each species of juvenile fish and invertebrates sampled by seine net ... 342
Figure 8.39 Summed irreplaceability for representation of at least one of each species in the commercial catch for estuaries ... 344
Figure 8.40 Number of species in commercial catch for estuaries ... 345
Figure 8.41 Weight of commercial catch (kg) for estuaries ... 346
Figure 8.42 Summed irreplaceability, number of species and weight of commercial catch for ocean ports in the Batemans and Twofold Shelf bioregions ... 347
Figure 8.43 Maximum numbers of Grey Nurse Shark (*Carcharias taurus*) observed at dive sites in the Hawkesbury, Batemans and Twofold Shelf bioregions during eight survey seasons ... 351
Figure 8.44 Number of threatened bird species sighted near estuaries ... 355
Figure 8.45 Number of sightings of threatened bird species near estuaries ... 356
Figure 8.46 Summed irreplaceability for representation of at least one sighting of each threatened bird species for estuaries ... 357
Figure 8.47 Number of threatened bird species sighted, number of sightings and summed irreplaceability for representation of each species at least once for sections of ocean ... 358

Figure 8.48 Area, number of species, number of birds and summed irreplaceability for representation of each species at least once for significant shore bird locations 360
Figure 8.49 Area, number of species, number of birds and summed irreplaceability for representation of each species at least once for sea bird breeding islands 362
Figure 8.50 Percentage area of lands within 1 km of estuaries within national parks or nature reserves, wilderness areas, state forest and State Environmental Planning Policy 14 377
Figure 8.51 Percentage area of land within 1 km of coast in national park or nature reserve, wilderness or State Forest 378
Figure 8.52 Percentage area of land within 1 km of coast in SEPP 14 areas, built up areas and with high risk or disturbed acid sulphate soils 379
Figure 8.53 Percentage area of lands within 1 km of estuaries suited to different land uses and within built up areas 381
Figure 8.54 Percentage area of land within 1 km of coast in areas suitable for cultivation, grazing and timber or natural vegetation 382
Figure 8.55 Percentage area of lands within 1 km of estuaries with disturbed or high risk acid sulphate soils and mean Australian river and catchment condition indices for estuaries 386
Figure 8.56 Mean Australian river and catchment condition indices (continued) for estuaries 387
Figure 8.57 Mean Australian river and catchment condition indices within 5 km of coast for overall river disturbance, catchment disturbance and settlement 388
Figure 8.58 Mean Australian river and catchment condition indices within 5 km of coast for land use, extractive industries and pollution, and infrastructure 389
Figure 8.59 Victorian Marine National Parks 391
Figure 8.60 The Ninety Mile Beach Marine National Park 391
Figure 8.61 The Point Hicks Marine National Park 392
Figure 8.62 The Cape Howe Marine National Park 392
Figure 8.63 The Beware Reef Marine Sanctuary 393
Figure 8.64 The Kent Group Marine Reserve 393
Figure 8.65 Final zone plan for the Batemans Marine Park 406

Chapter 9

Figure 9.1 Four options identified for a marine park in the Hawkesbury Shelf bioregion 418
Figure 9.2 Three options identified for a marine park in the Batemans Shelf bioregion 419
Figure 9.3 Site irreplaceability for large scale plan units in northern NSW state marine waters 422
Figure 9.4 Site irreplaceability for large scale plan units in southern NSW state marine waters 423
Figure 9.5 Curves showing the final stages of improvement in Marxan simulated annealing 425
Figure 9.6 Areas and boundary lengths of MPAs selected by Marxan ignoring existing MPAs 426
Figure 9.7 Areas and boundary lengths of MPAs selected by Marxan including existing MPAs 427
Figure 9.8 Irreplaceability for northern NSW marine waters ignoring marine protected areas 430
Figure 9.9 Irreplaceability for northern NSW marine waters including marine protected areas 431
Figure 9.10 Irreplaceability for southern NSW marine waters ignoring marine protected areas 432
Figure 9.11 Irreplaceability for southern NSW marine waters including marine protected areas 433
Figure 9.12 A multiple criteria model to assess the ‘comprehensiveness’ of nine MPA options 435
Figure 9.13 A multiple criteria model to assess the ‘representativeness’ of nine MPA options 436
Figure 9.14 A multiple criteria model to assess the ‘adequacy’ of nine MPA options 437
Figure 9.15 Interactive priority weighting for the four main MPA selection criteria 438
Figure 9.16 Seagrass modelled as a linear value function 439
Figure 9.17 Multiple criteria scores for marine parks with all sub-criteria weighted equally 441
Figure 9.18 Multiple criteria scores weighted only for comprehensiveness 441
Figure 9.19 Multiple criteria scores weighted only for representativeness 442
Figure 9.20 Multiple criteria scores weighted only for adequacy 442
Figure 9.21 Multiple criteria scores weighted only for cost 442

Chapter 10

Figure 10.1 Broad scale marine environmental classes in Cape Byron Marine Park.............................. 455
Figure 10.2 Fine scale marine environmental classes in Cape Byron Marine Park 456
Figure 10.3 Percentage of respondents using the Cape Byron Marine Park for activities 457
Figure 10.4 Number of respondents reporting use of the Marine Park for swimming 458
Figure 10.5 Number of respondents reporting use of the Marine Park for SCUBA diving 459
Figure 10.6 Number of respondents reporting use of the Marine Park for recreational fishing 460
Figure 10.7 Areas of reserve systems aiming to represent between 10 and 50% of all habitats.............. 463
Figure 10.8 Relative impact on commercial fishing grounds for 10 and 50% of all habitats.................. 464
Figure 10.9a Site irreplaceability for representation of 30% of each environmental class 467
Figure 10.10a Number of prawn trawl licenses and number of times a planning unit is selected 468
Figure 10.11a Number of spanner crab licenses and number of times a planning unit is selected 469
Figure 10.12a Number of purse seine licenses and number of times a planning unit is selected 470
Figure 10.13a Number of line fishing licenses and number of times a planning unit is selected 471
Figure 10.14a Number of hauling licenses and number of times a planning unit is selected 472
Figure 10.15a Total commercial fishing licenses and number of times a planning unit is selected 473
Figure 10.16 Draft zone plans for Cape Byron Marine Park 476
Figure 10.17 The ‘no-take’ Sanctuary zone (pink) offshore of Byron Bay and around Julian Rocks and Wide Wilsons Reef 477
Figure 10.18 The ‘no-take’ Sanctuary zone (pink) extending north from Cape Byron to the northern wall of the Brunswick River mouth 478
Figure 10.19 A ‘no-take’ Sanctuary zone (pink) offshore of Broken Head 479
Figure 10.20 ‘No-take’ Sanctuary zones (pink) offshore of Lennox Head 480

Chapter 11

Figure 11.1 The support required for systematic conservation tools to be effective 487
Figure 11.2 Increasing area (km^2) of MPAs in New South Wales.. 507

List of Tables

Chapters 1-3

Table 1.1 Summary of conservation planning procedures 8
Table 1.2 Contrasting perspectives between scientists and policy makers 9
Table 1.3 Increasing complexity and decreasing understanding of natural systems 12
Table 1.4 Comparing the two cultures of biological ecology........ 13
Table 2.1 Objectives of marine protected areas 23
Table 2.2 Desirable characteristics of ecosystem management goals........ 24
Table 2.3 National goals for Australian marine protected areas........ 25
Table 2.4 National identification criteria for marine protected areas 26
Table 2.5 National selection criteria for marine protected areas 27
Table 3.1 Proposed classification scheme........ 61
Table 3.2 Physical and biological data sets for the GBRMPA Representative Areas Program........ 75

Chapter 6

Table 6.1 MPAs in the Manning Shelf bioregion before 2005........ 99
Table 6.2 Threatened intertidal waders and sea birds recorded in the Manning Shelf bioregion........ 138
Table 6.3 Important wetlands in the Manning Shelf bioregion 148
Table 6.4 Classification of coastal lakes in the Manning Shelf bioregion (Healthy Rivers 2002)........ .149
Table 6.5 Summary of measures for estuaries of comprehensiveness and representativeness 178
Table 6.6 Summary of measures assessing estuaries for adequacy 179
Table 6.7 Summary of measures for ocean of comprehensiveness and representativeness........ 180
Table 6.8 Summary of measures assessing ocean for adequacy 181

Chapter 7

Table 7.1 MPAs in the Hawkesbury Shelf bioregion........ 197
Table 7.2 Delphic ranking and priorities for estuarine aquatic reserve candidates 206
Table 7.3 Sightings of threatened fish species in the Hawkesbury Shelf bioregion........ 241
Table 7.4 Threatened intertidal waders and sea birds........ 244
Table 7.5 Nesting sites of Little Tern in the Hawkesbury Shelf (NPWS 2000d)........ 246
Table 7.6 Important Wetlands in the Hawkesbury Shelf bioregion (ANCA 1996) 258
Table 7.7 Classification of coastal lakes in the Hawkesbury Shelf bioregion........ 260
Table 7.8 Disturbance scores for estuaries in the Hawkesbury Shelf bioregion 261
Table 7.9 Condition of estuaries listed in the OzEstuaries database 264
Table 7.10 Area (km^2) and percentage of ecosystems and habitats in the Hawkesbury Shelf 286

Chapter 8.

Table 8.1 MPAs in Batemans Shelf and Twofold Shelf marine bioregions 289
Table 8.2 Ratings for youthful wave dominated and intermittent estuaries 303
Table 8.3 Ratings for mature wave dominated estuaries 304
Table 8.4 Ratings mature intermittent estuaries 305
Table 8.5 Sightings of threatened fish species in the Batemans and Twofold Shelf bioregions .... .349
Table 8.6 Threatened intertidal waders and sea birds........ 352
Table 8.7 Nesting sites of Little Tern in the Batemans and Twofold Shelf bioregions........ 353
Table 8.8 Important wetlands in the Batemans and Twofold Shelf bioregions........ 364
Table 8.9 Classification of coastal lakes in the Batemans and Twofold Shelf bioregions 367
Table 8.10 Disturbance scores for estuaries in the Batemans and Twofold Shelf bioregions........ 369
Table 8.11 Condition of estuaries listed in the OzEstuaries database........ 372
Table 8.12 Area (km^2) and percentage of ecosystems and habitats in the Batemans Shelf 397
Table 8.13 Area (km^2) and percentage of ecosystems and habitats in the Twofold Shelf 398

Chapters 9-11

Table 9.1 Data sets used to define the extent of marine areas 414
Table 11.1 Similarities and differences between MPA and experimental designs 503