



Solitary Islands Marine Park

Summary of research and monitoring

Introduction

Evaluating the effectiveness of marine protected areas in conserving marine biodiversity is a key priority of the NSW Government.

Knowledge of spatial distributions and changes in species, habitats, and ecosystem processes is crucial to effective conservation planning. Information on social, economic and cultural values will assist in understanding and managing conflict, improve consultation, education and compliance, and optimise the benefits to the community.

The *Strategic Framework for Evaluation and Monitoring of NSW Marine Parks 2004* identifies two over-arching priorities for research and monitoring, namely, the need to:

- identify and select the location and nature of marine parks and their zones
- monitor and evaluate the effectiveness of marine park zoning and related management arrangements.

This summary briefly presents the main research findings and results from studies conducted within the Solitary Islands Marine Park during the five year review period (2002 to 2007), that have direct relevance to planning and management of the marine park, or which lead to a better understanding of the conservation value of marine protected areas. Many groups and individuals have undertaken research projects within the marine park. Where relevant, their results have been included.

Research on biodiversity and ecological processes

Research into the biodiversity and ecological processes within marine protected areas is essential for determining whether the size, boundaries and locations of the parks are adequate to maintain biodiversity and ecological processes. It is also important to sustainably manage the activities that can impact on the marine park.

Biological diversity is strongly influenced by habitat. Therefore classification and mapping of habitats is essential for understanding the spatial patterns of biodiversity. A number of large-scale seabed habitat mapping programs have provided important knowledge of the seafloor in the marine park, and information for the planning and assessment of marine park zones.

The current zoning plan was developed using a habitat classification system, based on habitats and depth, as a surrogate for biodiversity. Subsequent research has indicated that as distance from shore increases, the assemblage of species also changes. The habitat classification system has been updated to take this into consideration, and also to incorporate environmental influences, such as ocean currents.

Combining maps of seabed habitats with information on species composition will also allow improved assessment of the effectiveness of zoning arrangements for representing diversity. Research has focused on identifying how different groups of fish and marine animals utilise different habitats within the marine park. Specifically, studies have focused on reef fishes and molluscs; macro-invertebrates within estuaries; and other groups of fauna, including some echinoderms and amphipods at specific locations within the marine park.

Ecological processes can influence assemblages at local scales through various mechanisms associated with population dynamics and species life histories. These include: dispersal, recruitment, and settlement; density dependence, competition and predation; and trophic-dynamics and partitioning. Various studies have contributed to increasing knowledge of ecological processes operating within the marine park.

Habitat mapping

Since 2002, there has been a number of seabed and estuarine habitat mapping projects conducted within the marine park, which build on the earlier broad scale work targeting inshore, midshelf and offshore reefs. There are a diverse range of habitats within the marine park, including: intertidal and subtidal reefs, soft-sediments, beaches, seagrass beds, mangroves, saltmarsh, and pelagic waters; which all support distinct groups of plants and animals. Recent high resolution acoustic mapping has provided precise details on the extent, distribution and structure of seabed habitats.

Outside the estuaries, subtidal habitats have been categorised into consolidated (reef) and unconsolidated (primarily sand) areas, within three depth zones: shallow (0–25 m), intermediate (25–60 m) and deep (>60 m), and reefs separated into broad sub-groups based on general distance offshore: inshore (<1.5 km offshore), mid-shelf (2-6km offshore), and offshore (>6 km offshore). This information was combined to provide a map of the known distribution of seabed habitats in the marine park (Figure 1).

Reef habitats are particularly extensive and vary considerably in terms of their depth, exposure, distribution, structure and distance from shore. Inshore reefs are dominated by temperate macroalgal communities, especially kelp. Sanctuary zones protect very similar habitats, and habitats deeper than 35 m are under represented in sanctuary zones.

Coral communities tend to be a dominant component on reefs that are more than about 1.5 to 2.5 km from the coast and less than 25 m in depth, with hard coral cover on mid-shelf reefs reasonably high (>30% at many reefs), The deeper bottom communities (>25m) are generally dominated by sponge communities, varying in coverage. These include such groups as stalked ascidians, sea-whips, gorgonians, hydrozoans, and black coral.

Overall, there are extensive subtidal rocky reefs throughout the marine park. Reefs in the Minnie Water to Sandon area are more extensive and complex than previously identified, and there are also large areas of deeper reef offshore of South Solitary Island that had previously not been mapped.

The marine park is widely recognised as an area where tropical and temperate biogeographic zones overlap on the east coast of Australia. The influence of tropical and temperate currents in combination with the varied habitats has resulted in a biologically diverse system.

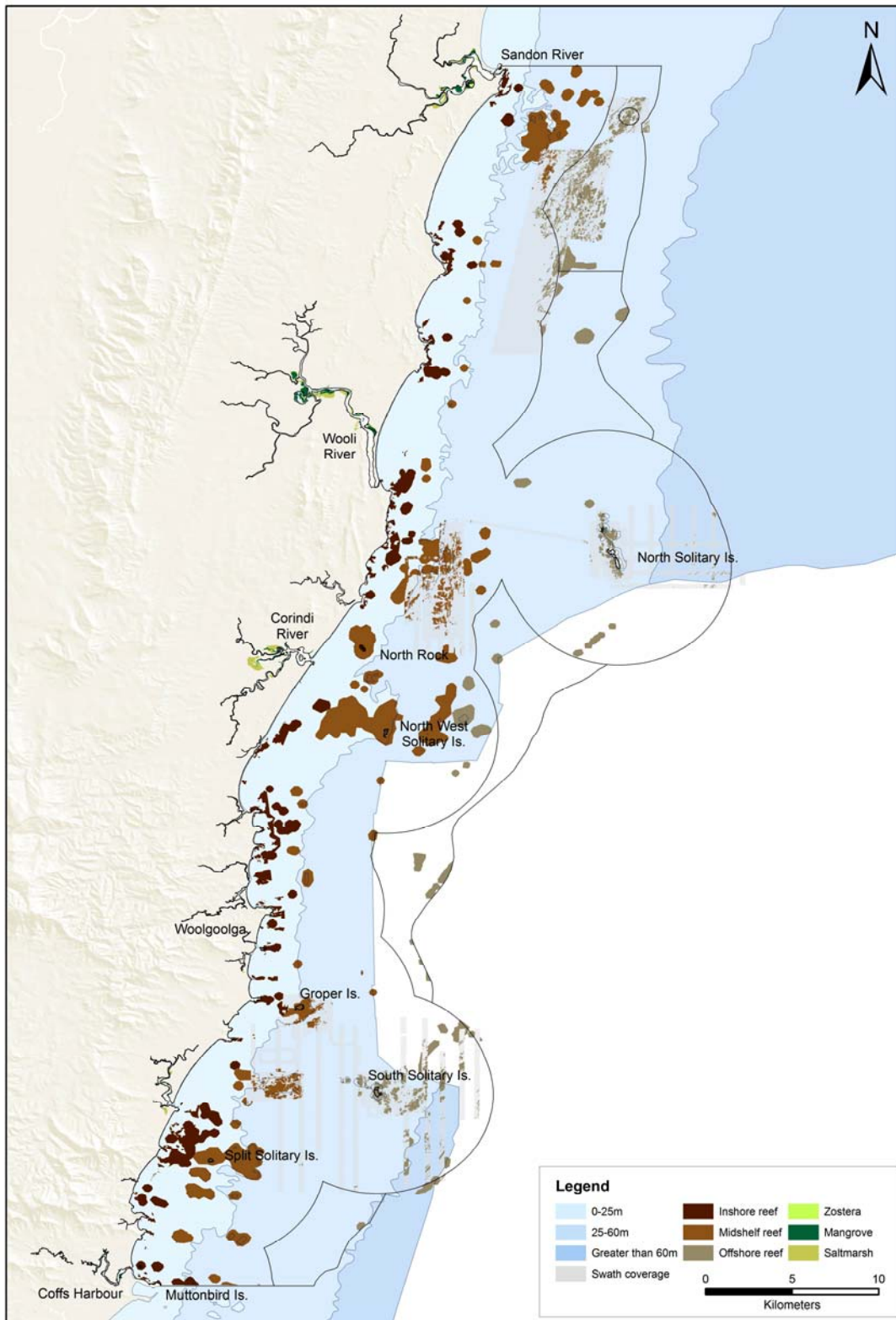


Figure 1: Map of known seabed habitats in the Solitary Islands Marine Park

Patterns of biodiversity

Reef fish are an important component of the diversity in the marine park, with 280 species previously identified, consisting of a mix of temperate and tropical species and a high level of endemism. The recent surveys on shallow reefs, in combination with other sources of fish data, have identified >530 reef fish species, reflecting the overlap of the tropical/subtropical Indo-Pacific fauna and the temperate/subtropical south eastern Australian and south western Pacific fauna. The influence of the Indo-Pacific is strong, with more than 50% of species in the marine park regarded as tropical. The temperate and subtropical species also contribute a substantial proportion of the species richness and include some of the most abundant species. Overall, high levels of Australian endemics (~30%) in the marine park were also strongly driven by higher latitude temperate species, and to a lesser extent by more restricted subtropical species (~5%), and this is consistent with high levels of endemism in south-eastern Australia.

Spatial patterns of sea temperature have also been found to play an important role in determining the composition of reef fish assemblages. This is due to both the delivery of larvae of tropical fish species in the East Australian Current, particularly to offshore reefs, and the effect of warmer waters in determining the composition of the benthic assemblages (i.e. coral-dominated mid-shelf and offshore) resulting in suitable habitats for most tropical species.

Molluscs are a diverse faunal group whose spatial patterns of diversity, and community composition, has recently been examined at a number of sites within the marine park. The current number of mollusc species identified within the marine park is 755, with gastropods (excluding microshells) and bivalve mollusc species accounting for around 600, including many taxa that have tropical and temperate affinities. Several species have not previously been identified in the region, such as *Mitra edentula* which was previously only known to occur on the southern Great Barrier Reef.

Research has provided clear evidence that reefs in close proximity to each other do not necessarily support similar benthic communities, both in terms of biodiversity and biotic composition. This indicates that while broad maps of reef habitat based on depth and distance offshore are important for the evaluation of marine park zoning arrangements, detailed information from many reefs would be required to maximize the likelihood that representative samples of biological diversity are included in sanctuary zones.

Ecologically sustainable use

Assessment of marine park zoning

Assessing the performance of management and zones within marine parks is one of the two over-arching priorities under the NSW Marine Park Authority's strategic framework. Two main monitoring programs have been conducted over the past five years to assess the management and zones of the marine park: a reef fish program and a mudcrab program.

Reef fish monitoring program: Influence of sanctuary zones on selected reef fish abundance

Annual monitoring surveys have now been conducted from 2002 to 2007 to assess the influence of sanctuary zones. The first underwater visual census in 2002 provided a 'snapshot' of the differences between sanctuary zones and non-sanctuary zones a decade after the original Solitary Island Marine Reserve zoning scheme was established in 1991. Red morwong (*Cheilodactylus fuscus*) were in greater densities in the small sanctuary zones. However, there was no 'before' data to provide a definitive conclusion that these differences

were due to sanctuary zoning, and significant variation between transects was due to the species' aggregating behaviour. Other individual species results in the small sanctuary zones were not conclusive, although species-richness and the total number of individual fish were also higher within sanctuary zones. These findings have subsequently been supported by changes in the larger 'new' sanctuary zones established in 2002. Red morwong have shown a strong increase in the larger sanctuary zones, although densities are still greater in the original small sanctuary zones established in 1991.

There are some indications that larger sanctuary zones may respond more strongly and be more effective than smaller sanctuary zones. Various other taxa, including bream and combined tropical snappers/sweetlips /emperors, appear to be showing a positive sanctuary zone response in the larger sanctuary zones although it is too early for any definite patterns or trends to emerge. Diversity, in terms of species-richness for the diversity surrogates (Labridae, Pomacentridae, Chaetodontidae), is also showing a positive trend at some sites. Both bream and red morwong show strong site influences, however not all sites have responded in the same way. This suggests another benefit of larger sanctuary zones, in that larger sanctuary zones will contain more sites or habitats preferred by certain species. This increases the probability that a sanctuary zone will include sites that respond well for a particular species.

In sanctuary zones, baited video surveys indicated that the relative abundance of snapper in 2006 was three times greater than in 2004, but in non-sanctuary zones they had returned close to 2004 levels. By 2007, the levels had dropped in both. This suggests that sanctuary zone benefits are subject to natural variation in recruitment, and may be affected by fishing in adjacent areas. Findings to date are preliminary, as five years is not long in terms of biological response. Studies elsewhere suggest that 10 to 25 years are needed for a more complete response to zoning; however, this program indicates some groups and species have benefited from protective zoning.

Mudcrab demographics and monitoring

Mudcrabs are a particularly good 'indicator' species for evaluating the effectiveness of the zones within estuarine environments. They are an important recreational and commercial targeted fishery in this area and are subject to fishing pressure. They also have a relatively short life cycle (3 to 4 years) which can provide a quick response to protected areas.

The sampling program provided evidence that no-take zones were protecting mud crabs from exploitation in the marine park, as these areas contained greater numbers of crabs in all size classes. The sanctuary zones provided spill-over of crabs to adjacent fished areas. The success of this spill-over depends, to some extent, on flooding events during which low salinity pushes crabs further downstream. However, between floods, crabs were primarily caught at the zone border where the recreational fishing pressure was greatest.

Abundances of legal-sized crabs declined within two months of opening in areas that were previously closed to fishing in the Wooli and Corindi estuaries. Reopening of sites also distributed fishing effort away from the sanctuary zone borders, enabling crabs to move further into the fished area.

Results suggest that sanctuary zones are an immediate and effective management tool for the recovery of fished mud crab stocks when populations become over-fished. At the protected site, crab numbers and the average size of crabs increased within months of closing while there was no change in the number of crabs caught each month in the area where recreational trapping effort resumed.

The results from surveys indicated a strong decline in mudcrabs in Station Creek following the announcement of the new zoning scheme in May 2002, prior to the sanctuary zone coming into force, demonstrating there is potential for pulse fishing ahead of implementation of a zoning plan.

Assessment of fishing

Recreational fishing club competitions

Recreational fishery data can provide trends in fish species through catch and effort data. Recreational fishing competition data have been collected in the marine park since 1993.

More than 100 species of fish were recorded by line anglers, with snapper, venus tuskfish, trevally, flathead and teraglin being the most abundant. More than 50 species were taken by spearfishing, with kingfish, fusilier, trevally, black-spot goatfish and mulloway being the most prominent. Overall more than 108 species were captured by angling and spearfishing methods combined. This compares with more than 77 species recorded in 1993 to 1997. The actual number of species captured is unknown due to problems with common names, species identified to family only, and potential misidentification.

A comparison of harvest values and harvest rates for the periods 1993 to 1996 and 1999 to 2003 indicated that the number of anglers, competitions, angler days, and the resultant harvest values were higher in the first period, but that overall catch-rates were higher in the later period.

The National Recreational and Indigenous Fishing Survey

An assessment into recreational fishing at the National level was conducted in 2000 to 2001. This included sampling conducted in the vicinity of the marine park, but analysis was at a broader state-wide scale. An evaluation of recreational fishing in NSW was also reported as part of this national survey.

Commercial fishing and aquaculture

Commercial fishing activity has reduced in the ocean regions that include the marine park over the last five years. Thirty commercial fishers received a buy-out from the industry in 2002 following the introduction of the zoning plan. Other factors that have caused a general decline in commercial fishing include the cost of diesel, and competition with fish imports. Catches in commercial fishing ocean zones in which the marine park is located (ocean zones 2 and 3) have declined by 50–66% since 2000. However, this decline has been mirrored in other ocean zones (1 and 4) to the north and south of the marine park and so does not appear to be directly attributable to the marine park. Estuarine catches within the marine park have declined substantially since 2000, as a result of the zoning plan prohibiting mesh netting. Some commercial crab trapping continues in the marine park. Catches within NSW estuaries in general have not changed significantly since 2000. Aquaculture within the marine park involves oyster cultivation in the Woolli Woolli and Sandon Rivers.

Specific impacts

Coral communities are an important structural habitat within the marine park. Climate change, which is causing the increase of seawater temperature and carbon dioxide saturation of oceans, has implications on reef health within the marine park, in particular for coral communities. Death of coral colonies can occur if high temperatures are maintained for several weeks. A spreading disease called 'white syndrome disease' is also present. This disease has caused loss of coral colonies at some sites, and low levels of bleaching have also been detected. However, overall coral cover, determined using video transects at 16 mid-shelf sites, has remained generally stable from 2002 to 2006.

The sea temperature monitoring program found sea temperatures to be highest in 2002 and 2006. The warmer temperatures in 2002 were related to a pulse of warm water that generated in the Coral Sea and was responsible for the strongest bleaching event on record in the Great Barrier Reef. However, in 2002 the high sea-temperatures dropped away rapidly, which may have saved coral communities from extensive bleaching in this marine park. Overall, 2006 had the greatest range in sea temperature, and appeared to have the strongest variability. The yearly average was highest in 2005 and 2006 at the offshore site. The maximum temperature was highest in 2006 at both the offshore and mid sites but not the inshore site.

Land-use change

Impacts associated with agricultural, industrial and urban development, together with the concentration of population in the coastal zone, have led to significant changes to many estuarine habitats. Trends indicate a direct correlation between an increase in human settlement patterns and a loss of seagrass, saltmarsh and sedge/coastal heath in these estuaries, along with an increase in mangroves associated with increased sedimentation.

Increasing coastal urbanisation

While debris loads were relatively low on most reefs, those with highest conservation value in the reefs surveyed, also had the highest debris loads. This suggests potential conflict between human use and long-term sustainability of reef communities.

Four-wheel drive impacts

There is evidence that 4WD access to saltmarsh areas at Saltwater Creek, Arrawarra Creek and Moonee Creek has caused extensive damage to plant cover, plant communities and has changed drainage patterns. 4WD damage to a saltmarsh area at Saltwater Creek showed almost no recovery after 2 years of vehicle exclusion.

Marine pests

Research examined the likelihood of an invasion by pest species in the marine park, and how to assist in their management. Marine pest species with the highest potential to invade the region, in order of importance, consists of the Asian green mussel, broccoli weed, the black-striped mussel, aquarium caulerpa, the giant fanworm, the Asian mussel, the Pacific oyster and the European shore crab.

Indigenous and non-Indigenous culture and heritage

The Garby Elders group of the Gumbaynggirr people are coastal people with a strong cultural tradition of harvesting marine and estuarine molluscs within the Arrawarra region. In 1991, Arrawarra Headland, an important harvesting site in the past, became a sanctuary zone within the Solitary Islands Marine Reserve (now the marine park) and harvesting ceased. By working closely with the NSW Marine Parks Authority, the Garby Elders and Yarrowarra Aboriginal Corporation negotiated the re-introduction of traditional harvesting in April 2006, with activities guided by a conservation plan. As part of this process, harvesting is being monitored in a collaborative program involving managers, biologists and traditional users.

Early findings from the research are based on only two sets of survey data, and therefore very little can be inferred from the abundance data other than that population size appears to be quite variable at some sites even over the short time intervals between the two sample periods (6 weeks). This was especially the case at Arrawarra Headland where population densities of *Turbo imperialis* changed from about 8 to 20 per 4 m² between March and April 2006. Size distributions in March 2006 also showed considerable variability across sites.

Socio-economic influences

Understanding socio-economic influences with marine parks is essential for management planning. It has direct application for allocating resources, for interpreting research data, for developing educational and communication materials, and for compliance assessment.

Visitor monitoring surveys

To better understand marine park use and visitor satisfaction, a visitor monitoring survey was initiated in 2002. The aim of the survey was to identify visitor demographics, activities undertaken, locations visited, the importance of experiences and advisory material, as well as general visitor satisfaction. Survey teams targeted popular areas adjacent to the marine park, and the beaches within the area.

Results indicate that visitors to the marine park, including locals that live adjacent to the marine park, are primarily aged between 25–55 years and 80% come from NSW (just under half live within two hours drive of the marine park). Of those travelling from over two hours away from the marine park, approximately three quarters use commercial accommodation, primarily caravan parks and holiday homes/units. The most popular activity is the usage of the beach, in particular Woolgoolga, Wooli, Minnie Water and Moonee beaches. Swimming and surfing account for about 70% of all physical activities mentioned. About 10% of respondents mentioned fishing. Of those that mentioned fishing, estuarine fishing was most popular (40%), followed by beach fishing (25%).

The 'usefulness' of marine park advisory material (signs, recreational user guide, brochures, boundary markers etc) were consistently rated useful (about five on a scale of seven), as was the importance of these products. The 'importance' of seeing marine life proved to be very important with respondents scoring about six out of seven. The importance of catching a fish was generally rated about four out of seven. The overall satisfaction of visitors to the marine park was between approximately 5.3 and 6.5 out of a possible seven.

Another study showed most people were satisfied with the zoning plan introduced in August 2002, and that most value the marine environment, although some did not believe the zoning scheme would benefit the marine environment.

Human activity and use

Human activity and use has been assessed using a combination of surveys and information sources. A stratified sampling design was conducted to examine spatial patterns of activity and use between summer (school holidays), summer (school term) and winter, and between weekdays and weekends in four barrier estuaries in the marine park (Sandon River, Wooli Wooli River, Corindi River, Moonee Creek) during 2006. These data indicate that the major usage in these estuaries is for passive activities and not those associated with a vessel, near the mouth of the estuary or in close proximity to key access points. There were similar low levels of vessel-based passive use and vessel-based fishing. Fishing was more evenly spread through the whole creek, whereas passive use was concentrated towards the mouth. Passive use was much higher during the school holidays and weekends.

Human activity on the rocky shores was examined at a number of headlands. Results suggest that human activity was highest in summer, with the highest activity observed at Woolgoolga Headland. A diversity of activity was also high at Woolgoolga with nine different activities recorded. Mapping of human activity indicated that activity is frequently limited to short distances from key access points, as was found with the estuary survey. Analysis of the effects of holiday, term-time, weekday and weekend activity levels revealed that there was no significant difference in activity between a weekday and weekend during school holidays and terms, however there was much more activity on both weekdays and weekends during holidays.

Fishing is the main activity offshore and is spread throughout the marine park. There is extensive fishing activity at the northern end associated with extensive areas of reef extending from Sandon Shoals back towards North Solitary Island. Many of the vessels are small run-abouts, and Minnie-Waters Lagoon and the Wooli Wooli River are key entry points.

Research based on 130 boat-ramp interviews at the southern end of the marine park found that most of the boats were privately owned, with 2 to 3 people on board, and many were from the local area. Commercial diving charters in the marine park focused on the islands, while charter fishing was more widespread and depended on point of access. Whale watching was concentrated at the southern end of the marine park and further south.

Notes

This document provides a brief summary of research carried out by the Marine Parks Authority and external groups and individuals in the Solitary Islands Marine Park. For further information, go to www.mpa.nsw.gov.au, or

Solitary Islands Marine Park
32 Marina Drive
Coffs Harbour NSW 2450
Phone: (02) 6652 0900
Fax: (02) 6651 9525
Email: solitary.islands@mpa.nsw.gov.au

Published by: Marine Parks Authority New South Wales

© Copyright State of NSW and Marine Parks Authority NSW 2008

DECC 2008/178
ISBN 978 1 74122 798 7
March 2008