Nearshore Marine Benthic Habitat Mapping

Information for NRM Planning - South Australia






Government of South Australia

Department for Environment and Heritage

Northern & Yorke Natural Resources Management Board

Australian Government

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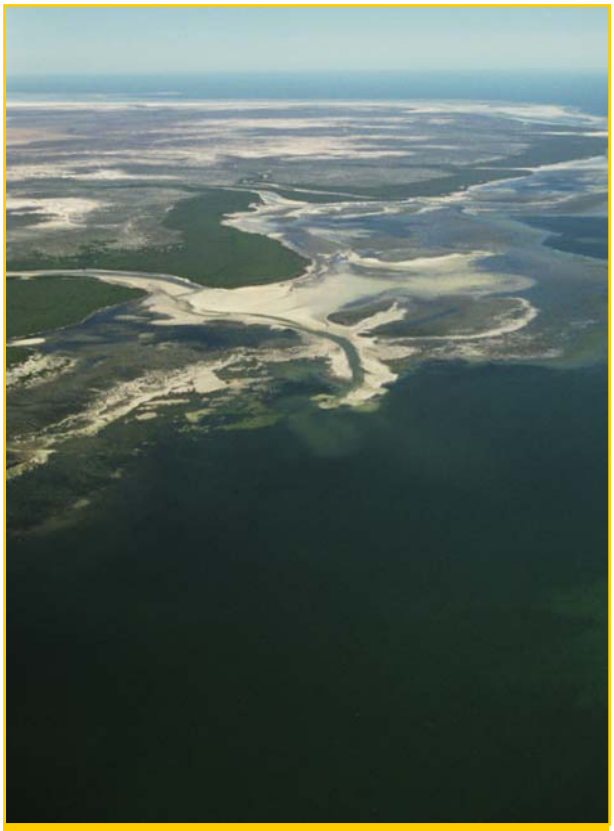
Management of the marine environment has seen a shift over the last decade from a single species, or single purpose focus, to an emphasis on maintaining whole ecosystems. Marine ecosystems, however, are difficult to define. Habitats are the building blocks of ecosystems and as such form the basis for marine resource management and a surrogate target for conserving ecosystems and ecological processes.

The implementation of the *Natural Resources Management Act 2004* and the formation of Natural Resources Management (NRM) Regions have altered the way natural resources are managed in South Australia. The Act provides the framework to coordinate and integrate the activities of the wide range of groups involved in natural resources management across the State. Regional NRM plans contain targets that aim to improve and conserve natural resources, however, the ability to develop and implement these plans is dependent upon accurate and comprehensive spatial information[1].

This document describes how nearshore marine benthic habitat information has been collected and mapped for the purposes of informing and assisting NRM Planning.



Marine benthic habitats northern Spencer Gulf, SA.

Seagrass, *Halophila australis.*

What is marine benthic habitat?

The term 'benthic' refers to anything associated with, or occurring on the 'floor' of a body of water. The animals and plants that live on or in the floor are known as the benthos. Marine benthic habitats can best be defined as seafloor environments with distinct physical, geochemical, and biological characteristics. Benthic habitats vary widely depending upon their location and depth, and they are often characterised by dominant structural features and biological communities[2].

Estuarine and nearshore marine benthic habitats can be highly diverse, including shallow submerged mudflats, rippled sandflats, rocky habitats, seagrass beds, kelp forests, shellfish beds and coral reefs[2].

Why are marine benthic habitats important?

Marine benthic habitats support a wide diversity of life by providing spawning, nursery, refuge and foraging grounds for coastal and marine species. They are also important for nutrient cycling and contribute to the removal of contaminants from the water column[2].

Marine benthic organisms play an important role at all levels of marine 'food-webs', consuming organic matter and phytoplankton, serving as food sources for higher-level consumers and/or actively preying on other species[2].

Why are marine benthic habitats of the Northern and Yorke Region important?

The Northern and Yorke (N&Y) Region accounts for a significant total of the 'gulf environments' found in South Australia. The Spencer Gulf and Gulf St. Vincent have been recognised as distinct biogeographic environments (bioregions) in South Australia[3]. They harbour the largest areas of seagrass in the State and are home to some of the largest seagrass meadows in the world[3]. Thus, the N&Y Region incorporates internationally significant areas of marine habitat, many of which are adjacent to developed areas or areas of active land-use.

Seagrass meadow, *Posidonia australis.*

A range of other important habitats such as rocky reefs, salt marshes, mangroves and intertidal flats are all recognised as productive and important habitats in the area. They provide the basis for valuable commercial and recreational industries and opportunities.

Habitat loss and degradation due to land-based impacts are most likely to manifest in nearshore waters, particularly in waters adjacent to population centres, areas of intensive land-use or major drainage catchments. Without accurate mapping of habitat boundaries at appropriate scales, it is not possible to monitor for change in ecologically important areas.

What marine benthic habitat mapping is available?

During the mid-1990s marine habitats were mapped as part of a national program undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO). CSIRO and the South Australian Research and Development Institute (SARDI) jointly undertook mapping in South Australia. Habitat boundaries were interpreted from underwater features discernable on 1:100 000 scale satellite imagery. The resulting mapping is a mixture of biological (seagrass densities) and geomorphic (reefs) cover types. This data set is used as a broad scale marine habitat layer for South Australian coastal waters. The spatial error of determining habitat boundaries at that scale, is in the order of hundreds of metres; a scale inappropriate to monitor and manage for habitat change and loss at a regional scale (Figure 1).

Figure 1. Benthic habitat mapping completed in 1996, highlighting low positional accuracy associated with mapping at large scales.

In 2003, the Department of Primary Industries and Resources, South Australia (PIRSA) produced benthic habitat maps to support the creation of an inventory of important coastal fisheries habitat. While these maps improved knowledge about the location of marine benthic habitats in many areas, their primary use was to highlight the location of important fisheries habitat[4]. The maps are a combination of coarse-scale mapping and existing spatial data of varying scales, making them difficult to reproduce. Monitoring relies on the repeatability of a process to detect changes in time, as such the maps are limited in their ability to monitor for changes in marine benthic habitat.

Furthermore, efforts to validate these mapping programs in the field were variable. Some geographic localities were surveyed comprehensively, whilst in other areas sampling data has been limited and many areas have not been validated at all.

Comprehensive and spatially accurate marine benthic habitat data can assist marine resource management initiatives and form the basis for managing in a way that targets the conservation of ecosystems and ecosystem processes.

What is being done to improve knowledge of marine benthic habitats?

In 2005, utilising funding acquired through the Australian Government's Natural Heritage Trust (NHT) initiative, work began on developing a detailed spatial data layer of South Australia's nearshore marine benthic habitats, commencing with the gulf waters of South Australia.

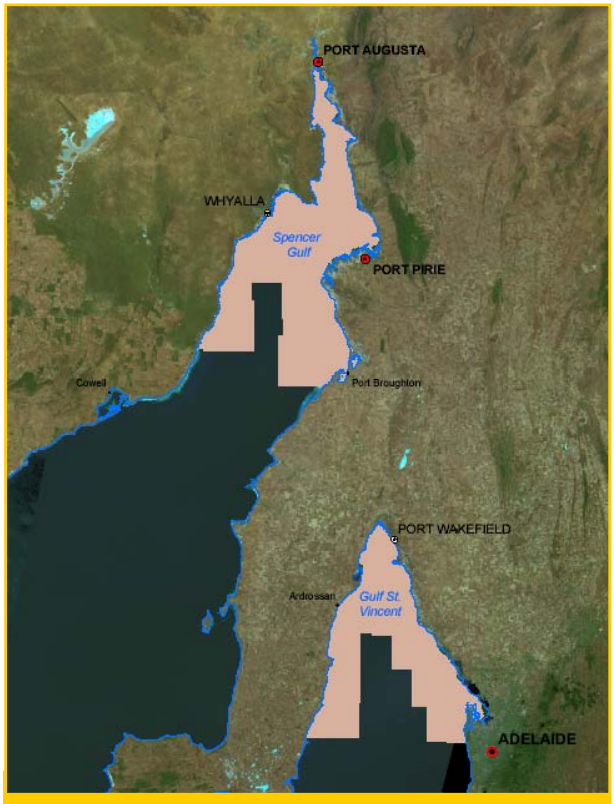


Figure 2. Focus areas for benthic habitat mapping.

The project was facilitated and administered in partnership with the Northern and Yorke NRM Board and the Department for Environment and Heritage, in conjunction with the Rangelands NRM Board.

How were marine benthic habitats mapped?

The boundaries of each benthic habitat were identified using ortho-rectified aerial photographs. Boundaries were digitally traced (digitised) using a Geographic Information System (GIS) based on varying patterns, tones and textures visible in the imagery (Figure 3).

Figure 3. Line-work delineating benthic habitat boundaries.

Benthic habitats were then assigned pre-determined classifications based on attributes such as density and percent (%) cover (Figure 4).

Figure 4. Benthic habitat boundaries with assigned cover types.

Figures 3 and 4 demonstrate the improved spatial accuracy and increased knowledge gained in delineating habitat boundaries and fine scales (eg. 1: 10 000), compared with Figure 1.

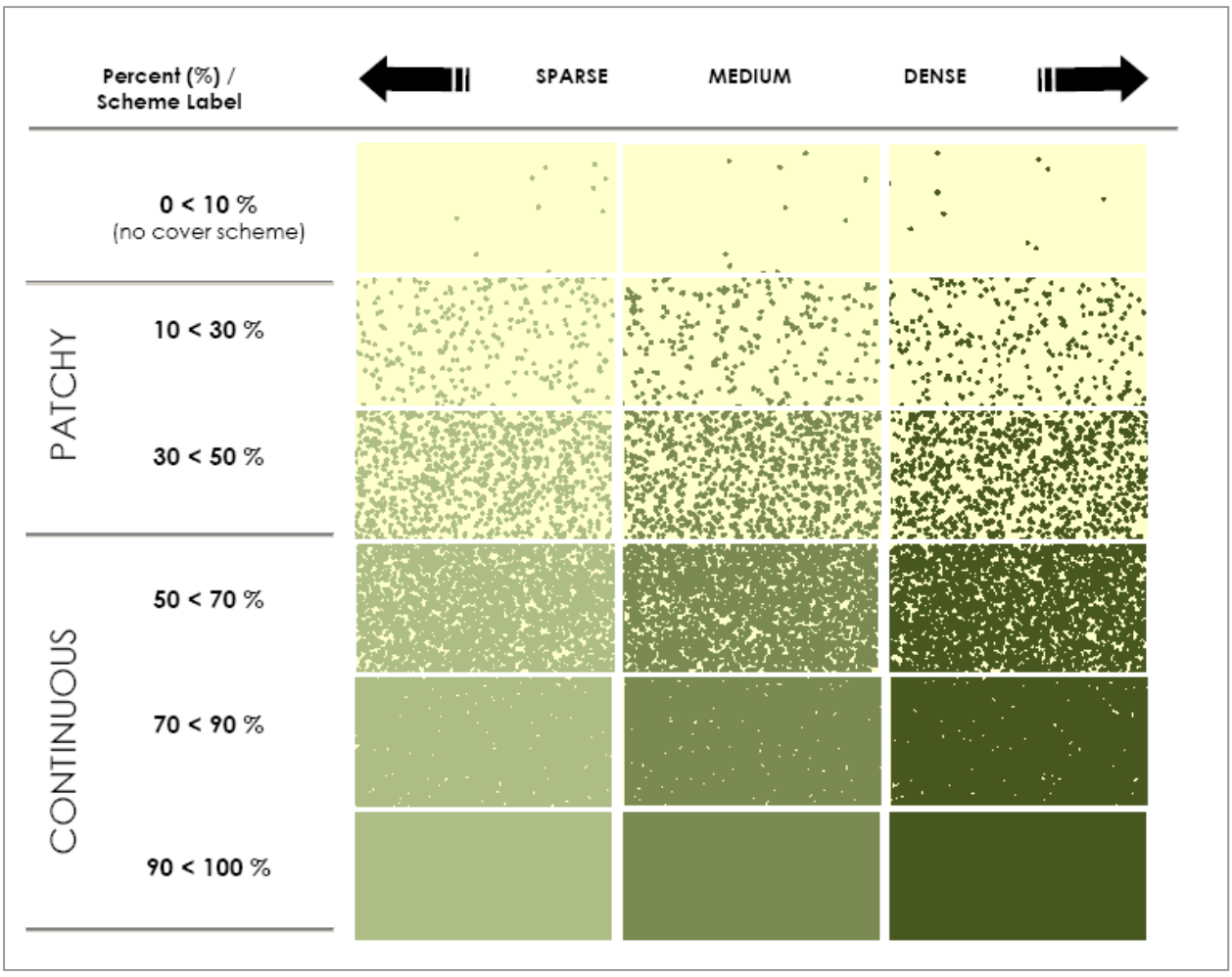


Figure 5. The above table is a visual aid, used for assigning percent (%) cover and relative density of benthic habitat cover.

A visual aid, adapted from Kendall *et al*[5], was used to assign percent (%) cover and relative density to mapped benthic habitat cover (Figure 5).

How is marine benthic habitat classified?

Although a national or international framework for describing or classifying marine benthic habitats has yet to be confirmed, benthic habitat mapping has or is being undertaken across most of Australia and in many other countries.

Efforts have been made to provide a consistent standard with other states and countries for describing and compiling data for benthic habitat types in South Australia, whilst accounting for localised variations where necessary.

Benthic habitats were delineated and defined based on a number of physical and/or biotic variables[6], including:

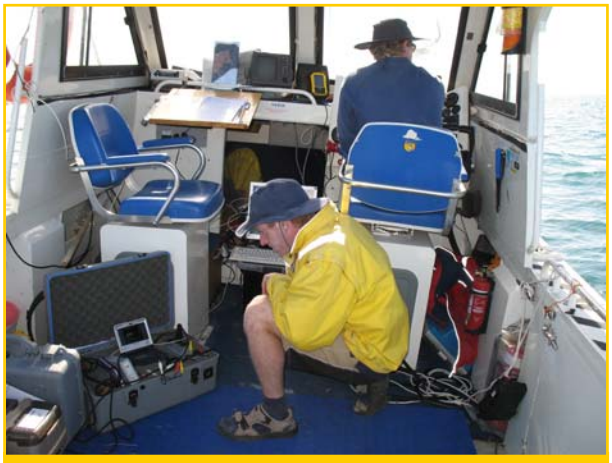
- ***Geomorphic Type***:
  - Hard or soft bottom
- ***Bio-geomorphic Type***:
  - Vegetated or un-vegetated
- ***Substratum / Ecotype***:
  - Seagrass, Algae, Sand/Silt, Reef, etc.
- ***Structure***:
  - Habit and density of cover
- ***Cover***:
  - Extent (%) of the habitat coverage

Based on a framework developed by Allee *et al*[7], and refined by the Tasmanian Aquaculture and Fisheries Institute, this system of classifying marine benthic habitat aims to describe, '*the spatial heterogeneity of marine and estuarine landscapes and is logically linked to underlying mechanisms structuring the ecosystem and biotic communities*'[7].

How was the mapping verified?

Due to the difficulties that the water column imposes on mapping submerged habitat cover, field surveys that ground-truth habitat boundaries are critical in creating accurate benthic habitat maps[8]. Following the careful evaluation of the aerial photography, and the creation of a 'preliminary' map, benthic habitats are assigned a pre-determined classification; select areas are then visited in the field for validation.

A handheld computer uploaded with the preliminary benthic mapping was used in conjunction with a Global Positioning System (GPS) to accurately navigate to and digitally record sites that were visited for ground validation. Sites included a random sample of areas across the region, as well as selected locations that were flagged for follow-up whilst digitising. Validation occurred through visual confirmation 'in-situ' and the use of video to capture images of benthic habitats. Video footage, together with field notes, were viewed and analysed to confirm the benthic cover observed. Following processing of the field data, polygon boundaries and habitat classifications were revised, updated or created as necessary.



Using video to examine benthic habitats.

The preliminary category of each benthic habitat was then compared with the post-field validation category. An accuracy assessment was undertaken to establish a confidence measure of the mapping. The assessment showed the mapping work to be approximately 90% accurate. Therefore, although accuracy levels were high, caution should still be used when interpreting habitat maps, particularly those areas where no ground-validation has been conducted.

What are the limitations of the data?

Benthic habitat mapping is not an exact science. Mapping is largely based on the interpretation of aerial photography or satellite imagery. Imagery interpretation processes can lead to inaccuracies within the mapping. While field checking is undertaken, it is not feasible to check all areas that are mapped.

Mapping for this project was undertaken at scales between 1: 5000 and 1: 10 000. When digitising, a trade-off exists between positional accuracy of lines and time spent digitising. Thus an optimum digitising scale was set that maximised accuracy and minimised map production time. As such, these datasets must not be used at a scale finer than the original capture scale (i.e. no less than 1: 5000)[5].

A minimum mapping unit (MMU) was set for the project at 1 hectare (10 000 m^2). A MMU limits the size of the features captured in a habitat map (Figure 6). Thus features while interpretable in the imagery, may be smaller than the set MMU and therefore beyond the scope or goals of the desired map product and not mapped[5].

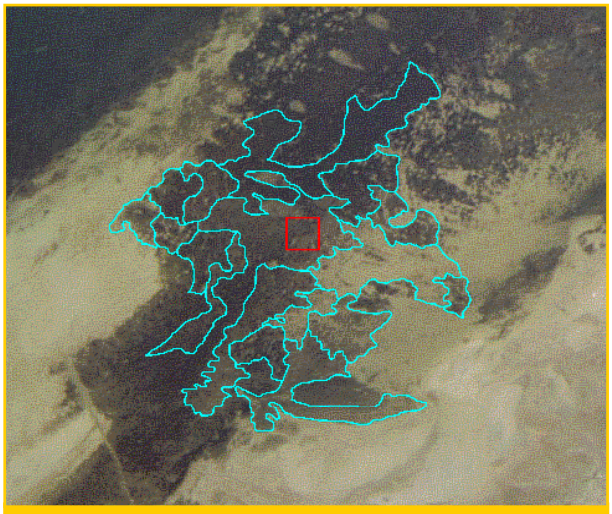


Figure 6. Minimum mapping unit (MMU) highlighted in red.

Mapping of habitat units results in approximate boundaries between two habitat types. As one habitat ends and another begins there is often a gradational change or 'ecotone' between the two, which is sometimes difficult to define. In the case of submerged aquatic areas, habitats are viewed through a layer of water. The depth and clarity of water affects the visibility, what may appear to be a habitat boundary could be a change in the water depth, the result of plumes of suspended sediment or blooms of plankton.

Seasonal variations, depending on the time of year that the aerial photos were taken, can also be quite significant. The process becomes increasingly subjective as the water deepens.

Due to the difficulties associated with discerning features on aerial photography in deep water, a bathymetry map was used to highlight those areas that were deeper than 15m. Areas deeper than 15m were considered unreliable and not mapped.

Seagrass with seed, *Posidonia australis.*

How can this information be used?

The primary use of the mapping is to provide a reference point for the status and extent of marine benthic habitats in South Australia. The overall extent of benthic habitat can be mapped or detailed cover types can be displayed.

The mapping work being conducted is at a scale relevant to regional NRM planning and as such, provides the information basis for detecting habitat change at scales of tens of metres. Previous mapping accuracies were in the hundreds of metres. This level of mapping detail establishes a marked improvement for regional planning.

The data set can also be combined with other spatial data sets to prioritise areas for on-ground works to achieve multiple NRM targets.

While regional benthic habitat mapping provides a regional perspective and is useful as a marine planning tool, it does not replace the need for on-ground inspection for decision-making at the local level[2].

How has the mapping increased knowledge of marine benthic habitats?

As a result of the mapping undertaken by this project over 4000 habitat units have been identified, including areas of seagrass, sand/silt and reef. Previous mapping of the same area delineated approximately 600 habitat areas. Prior to the project, this level of detail had only been available for marine planning and management in a limited number of sites within South Australia.

Whilst broad scale mapping has previously been undertaken in some areas of the State, the current mapping program is extending those areas and is working at much finer scales. Fine scale mapping provides more certainty about the nature and extent of marine habitats.

The current program has verified the benthic habitat cover at approximately 1400 field-sites, a marked increase upon the 100 sites verified for previous mapping of the same area.

The increased level of information being assigned to each habitat type reveals an improved level of accuracy of the structure and make-up of nearshore marine benthic habitats in South Australia.

Community monitoring marine benthic habitat.

Benthic Habitat data services and products

The current benthic habitat mapping is held and maintained by the Department for Environment and Heritage.

A number of data sets complement the marine benthic habitat mapping. These include:

- Benthic Survey Data, 2006 (DEH)
- SA Saltmarsh Mangrove Habitat Mapping, 2006 (DEH)
- SA Benthic Habitat Mapping, 2004 (DEH - CSIRO/SARDI)
- Benthic Survey Sites, 1996 (DEH - CSIRO/SARDI)

Bar-tailed godwit *Limosa lapponica*.

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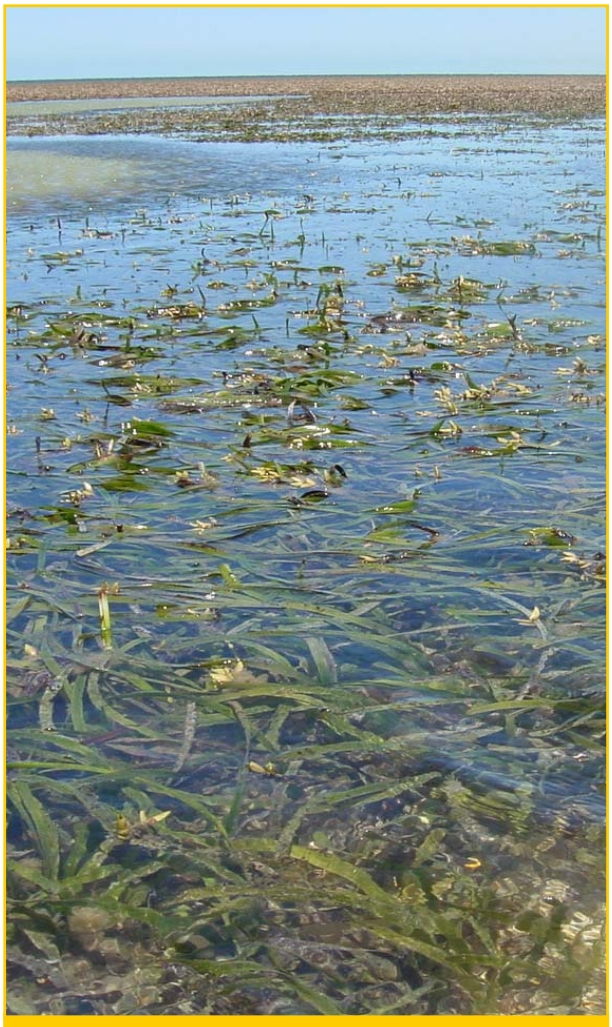

Intertidal seagrass meadow.

Maps produced by

Coast and Marine Conservation Branch
Department for Environment and Heritage
GPO Box 1047 Adelaide SA 5001
Website: www.environment.sa.gov.au/coasts

Map Source

Benthic Habitat Mapping – Coast and Marine Conservation, DEH
Topographic Data, Aerial Photography – DEH
Benthic Habitat Mapping (1996) – CSIRO, SARDI-PIRSA & DEH

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