NSW MARINE HABITAT MAPPING PROJECT

EXECUTIVE SUMMARY

The NSW Marine Habitat Mapping Project has been a collaboration between the Coastal Catchment Management Authorities (CMAs), NSW Department of Environment, Climate Change and Water (DECCW) and NSW Department of Industry and Investment (DII). Jointly funded by the Commonwealth and State governments, the best available bathymetric and seabed habitat data have been compiled to create the first marine habitat maps for all NSW State coastal waters. As part of the project DECCW undertook the marine mapping and DII the estuarine mapping, with a number of external consultants conducting more detailed biodiversity assessments for key faunal and floral groups. A review of underwater volunteer groups in NSW was also undertaken to examine their capacity to collaborate with scientists on future projects.

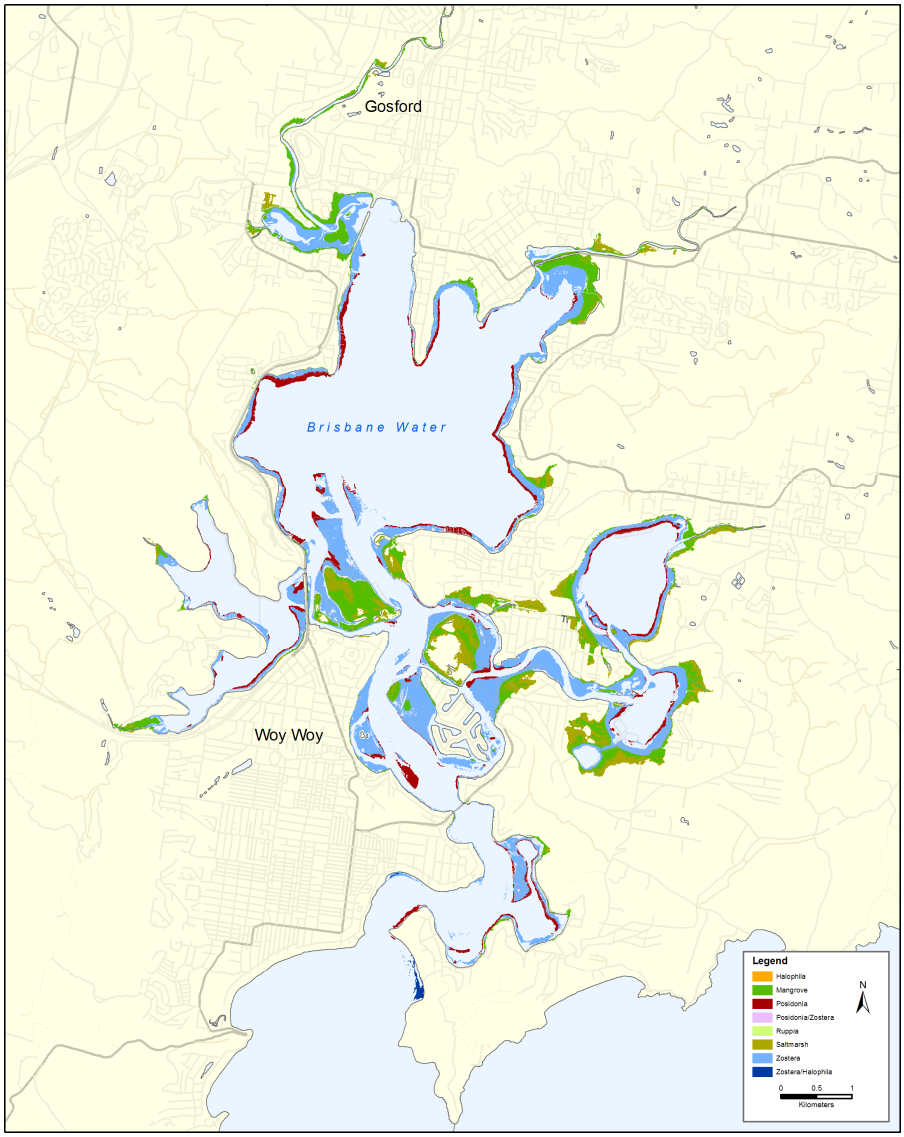
The general aim of the project was to collate all existing statewide information on the spatial distribution of key oceanic and estuarine benthic habitats in NSW, and to conduct targeted mapping surveys to fill in knowledge gaps. Marine and estuarine habitat maps are required by CMAs for sustainable natural resource management by focusing investments on activities such as seagrass friendly moorings, coastal catchment initiatives and habitat protection through community education. Baseline habitat information is also essential for monitoring, evaluation and reporting which measures performance towards natural resource management targets. The habitat map series, as well as the detailed maps of seabed bathymetry, natural and man-made estuarine foreshore features and broadscale sediments will provide natural resource managers, industry and the community with the information needed to improve sustainable natural resource management and biodiversity conservation within marine and estuarine areas of NSW.

Estuarine mapping

The key aquatic macrophytes (seagrass, mangrove and saltmarsh) have been mapped in most NSW estuaries, lakes and lagoons, and intertidal foreshore habitats and subtidal rocky reefs have been mapped in selected estuaries. The health of NSW estuaries is something that requires constant consideration and attention. The NSW Natural Resource Commission has set a target that requires that “by 2015 there is an improvement in the condition of estuaries and coastal lake ecosystems”. Coastal CMAs in NSW also have targets in their Catchment Action Plans relating to maintaining or improving the health of estuaries. An important component of estuarine condition is the status of the key biogenic habitats in estuaries – particularly seagrass, mangrove and saltmarsh. Having comprehensive data about the extent of these habitat types is a fundamental first step to being able to assess trends through time, and hence assess whether condition is, in fact, improving. The primary objective of the estuarine component of the project was to complete a state-wide GIS inventory of these three key habitats, a task that was started during the Comprehensive Coastal Assessment (CCA).

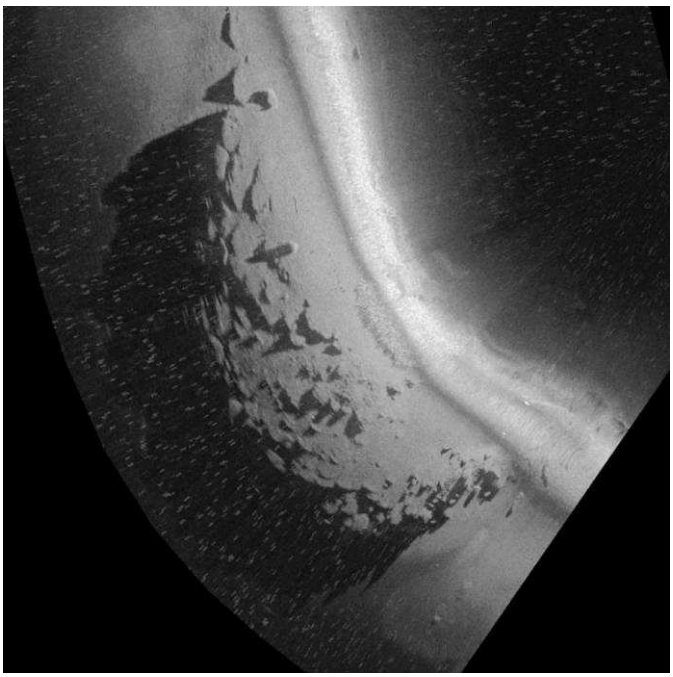
Bream swimming over seagrass (*Posidonia australis)*

The CCA had adopted a rigorous protocol for recording the extent of estuarine macrophytes and had mapped them in estuaries north of Newcastle and south of Wollongong. However, this left a significant knowledge gap along the central part of the NSW coast, a region that contained several very large drowned river systems (Hawkesbury River, Port Jackson) and the state's largest coastal lake (Lake Macquarie). The task of finalising the state-wide inventory was completed using a combination of interpreted aerial photographs and field surveys. The inventory now contains a standardised Geographic Information System (GIS) layer for macrophytes in 154 estuaries.



Map of estuarine macrophytes in Brisbane Water

While macrophytes are acknowledged as being a major contributor to the habitat structure in estuaries, non-biogenic structures such as subtidal reefs, intertidal rocky shores and shallow sediment flats are also important habitats for estuarine biodiversity. Further, many NSW estuaries contain increasing amounts of non-natural hard surfaces as a result of human activities in estuaries. Artificial rock walls, wharves, jetties, marinas, etc all provide structural habitat, especially in estuaries that are also major ports and/or are highly urbanised. During this project, a protocol was developed for recording these hard structures. The technique uses a combination of aerial photograph interpretation (as for the macrophyte habitats), field surveys, side scan sonar and underwater video to delineate a set of foreshore features and rocky reef habitats. The technique was trialled in six estuaries in the central and southern regions of the NSW coast where large amounts of hard surface habitat was known or expected. Again, the information was recorded in a GIS and can be readily used in conjunction with the macrophyte spatial layer.



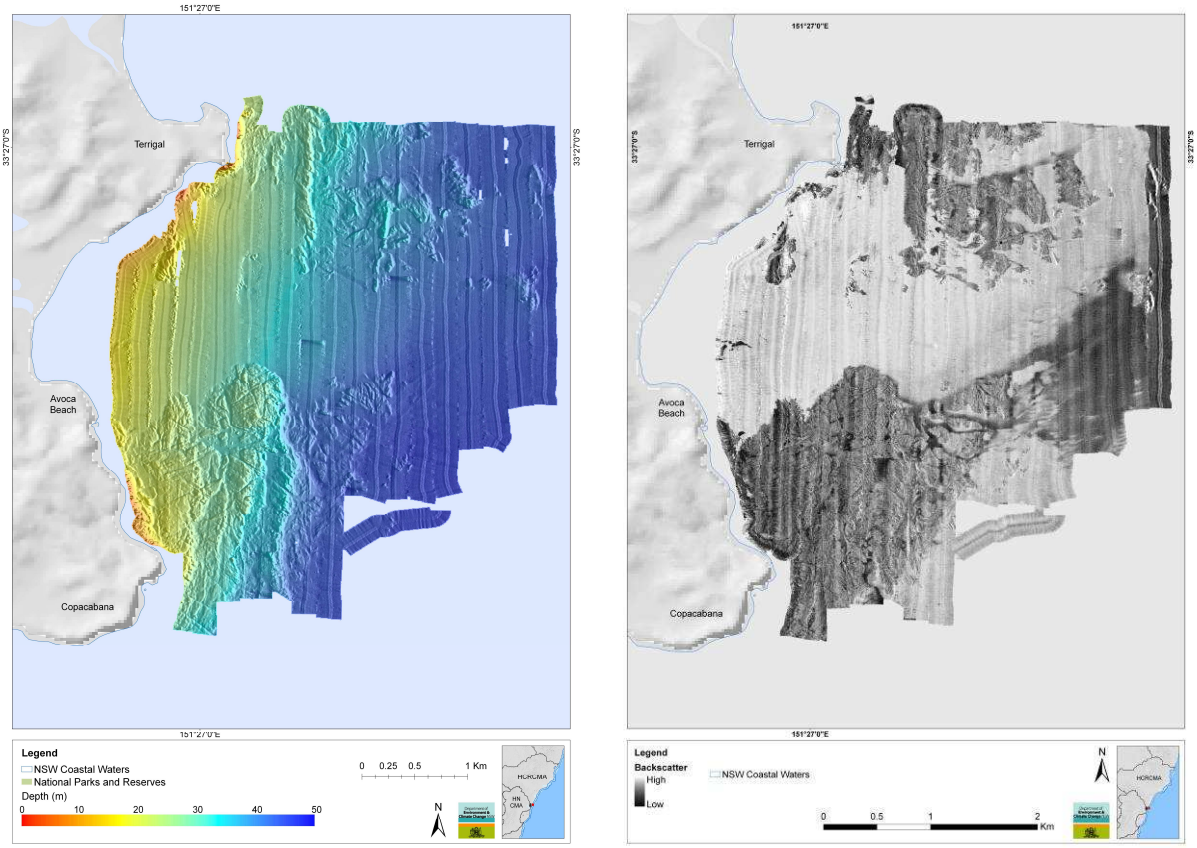
Side scan image of a shallow rocky reef in Gymea Bay, Port Hacking

These maps can now be continually updated as new information is gathered and added into the underlying GIS. While it is valuable to provide a comprehensive description of habitats in NSW estuaries, perhaps the greatest value of these products is that they provide a solid framework for making management decisions. The best way to synthesise and use all this information to determine priorities for management action is through risk analysis, and suitable frameworks for doing such analyses in coastal ecosystems have been developed in recent years. This can now readily be done in an explicit spatial context by using the habitat maps, in conjunction with knowledge about how and where the threats operate, to generate vulnerability values for key estuarine habitats. When these values are considered in the risk assessment framework, it will be possible for management agencies to assign relative values to particular locations and prioritise their investments in estuary management activities

Marine mapping

The other major component of the study detailed the distribution, extent and structure of seabed habitats on the inner and mid-continental shelf within NSW State coastal waters. This involved collating and analysing existing broadscale bathymetric and marine sediment datasets, and seabed habitat data defined from previous single-beam and swath acoustic surveys and aerial photography. This was combined with around 100 km^2 of new swath acoustic data collected using DECCW's interferometric side scan sonar system that allows the development of high resolution maps of the seabed. Data from ~120 km of underwater video surveys were also examined to allow ground-truthing of the acoustic data and a description of the dominant sessile floral and faunal assemblages.

The acoustic mapping involves sending acoustic side scan sonar beams to the sea floor and analysing the reflecting signals to estimate bathymetry and acoustic backscatter (indicating seabed roughness and hardness). Swath acoustic data were combined with existing mapping layers of nearshore reefs defined from aerial photographs, offshore reefs defined from 1:150,000 Australian Hydrographic Charts and seabed habitats digitised from historical side scan sonar data in the Byron Bay, Sydney and Central Coast regions. These datasets were used to map the fine-scale distribution and extent of seabed habitats, primarily rocky reef and unconsolidated habitats which were mapped into shallow (0-25 m depth range), intermediate (25-60 m) and deep (60-200 m) classes.



Bathymetry (left) and backscatter (right) images offshore from Avoca

In total, approximately 1500 km^2 of swath acoustic coverage from NSW continental shelf waters has been collated from various sources significantly improving the information available on the distribution, extent and structure of seabed habitats. In general, the distribution of the primary biotopes (rocky reef and unconsolidated habitats) reflects the regional patterns of geology, geological history, coastal inputs and transport of sediments. The broad distribution of rocky reef habitats reflects the patterns of bedrock geology which varies in its geomorphic attributes (e.g. hardness, grain size, jointing) and resistance to weathering. Along most of the NSW coast there are prominent rocky reef outcrops seaward of most headlands, although the present surveys have also identified significant reef systems in areas on the continental shelf that are not continuous to shore, or are continuous to shore associated with offshore islands. There are also a number of significant reef features that occur offshore of ocean beaches in the region.

In most areas swath mapped, the area of rocky reef habitat was significantly greater than can be interpreted from the existing hydrographic charts, which mostly present only locations for significant shoal areas of a larger reef system. Many of the reefs extended into Commonwealth waters within the mid-shelf region. Significant reef systems have been mapped offshore of Yamba, Solitary Islands, Nambucca region, Black Head, Port Stephens, Terrigal, Batemans Bay and Eden. The high resolution of the swath bathymetry revealed that reefs show considerable variability in terms of geomorphic structure (e.g. boulders, gutters, walls, pinnacles) and extent of patchiness, although there was no obvious latitudinal or cross-shelf trend in reef structure as such variations were often present within the same continuous reef system.

Unconsolidated (soft-sediment) habitats were often complex, with the sediments on the shelf mostly dominated by inner-shelf sand, mid-shelf muddy sand and outer-shelf coarse sand, although there are localised variations to this broad pattern. The most significant sediment variations on the inner-shelf are the patchy occurrence of finer sediments offshore of the Yamba, Wooli, Newcastle, Sydney, Wollongong and Batemans Bay regions, and the presence of coarser sand on the mid or outer shelf offshore of Byron Bay, Yamba, Nambucca Heads, Crowdy Head, Jervis Bay and Narooma. Similar areas of coarse sediment were evident on the inner shelf throughout the Solitary Islands, Port Stephens, Sydney and Wollongong regions. Nested within

these broad areas, swath mapping revealed significant fine-scale structuring of soft-sediments on the inner and mid-shelf, influenced primarily by the presence of sand ripples and waves, and variations in particle size and shell content. There are also areas that contain varying amounts of boulders, cobbles and pebbles, particularly adjacent to areas of rocky reef.

Video footage indicated that the dominant benthic assemblages from shallow, intermediate, and deep reef habitats were broadly consistent with previous surveys of these habitats on the continental shelf of NSW, with the distribution of habitats patchy and seemingly related to depth. Shallow reefs in the northern NSW region were a mosaic of corals, urchin barrens, kelp and mixed algal assemblages. Intermediate reefs were dominated by sponges and other sessile invertebrates, but also contained areas of kelp and mixed algae. Deep reefs were dominated by a diverse range of sponges with varying morphologies (e.g. massive, branching, cup), and sessile invertebrates such as ascidians, gorgonians and seawhips. Reefs in central and southern NSW have a similar composition to the sub-tropical northern region except that the coral habitat found in the north is replaced primarily with macroalgal beds. Overall, the marine mapping component of the project has significantly improved our knowledge about the distribution, extent and structure of seabed habitats on the NSW continental shelf.

Reviews of benthic assemblages

In order to provide further details on a number of particular marine benthic assemblages several sub-projects were conducted by external consultants. Firstly, a review of the ecology, diversity and distribution of NSW sponge fauna was conducted by the University of Wollongong. The review found that the sponge fauna is expected to be diverse due to the temperate, subtropical and tropical influences in the region, with a high proportion of taxa likely to be endemic. More than 5000 records are held in Australian Institutions, but only ~650 species can be identified with any reliability. The difficult taxonomy of this group has seen workers simply lump taxa under the category ‘sponges’. The poor taxonomic resolution of this group remains a significant impediment to researching, managing and conserving this dominant invertebrate group.

Sponge dominated assemblage

Considerable ecological work on sponges has been completed in the NSW region, with much of this at moderately large spatial (>100 km) or temporal scales (>2 yrs). Unfortunately this research has been almost wholly focussed in the Sydney area, and almost nothing is known of the patterns and processes that occur in deep water (>30 m). Based on the presence of sponge assemblages over much of the rocky reef surveyed with video in the present field surveys, it is likely that such assemblages cover a large proportion of the reef habitat on the NSW continental shelf. The large area of mapped rocky reef means that sponges may represent one of the dominant benthic faunal groups in NSW and highlights the need to obtain further information on sponge diversity, extent and spatial structure.

The second faunal group examined was the molluscs, and this involved field studies by the National Marine Science Centre (NMSC) that surveyed aggregations of dead mollusc shells (death

assemblages) on rocky shores. These have been shown to provide a good indicator of regional biodiversity for nearshore habitats and can provide rapid and cost-effective assessment of patterns of biodiversity over broad spatial scales. This study surveyed death assemblages at 50 sites across NSW with the objectives of evaluating patterns of assemblage structure and gradients of diversity.

Species richness showed no simple latitudinal pattern, instead the highest number of species was found in the northern section of the Solitary Islands region, with another lesser site of high species richness around Port Stephens. While there was evidence for broadscale biogeographic patterns at the community level, the most obvious patterns related to the relative prevalence of reef-associated and sand-associated taxa. Thus, while three primary community types were discernable over the state-wide scale (northern, mid- and southern), the site relationships within these clusters related primarily to the dominant taxa associated with reef or soft-sediments in the deposits. The Clarence River was identified as an important boundary between assemblage types and this is hypothesised to be due to the influence of riverine sediment plumes and northward transport of sediments on the composition of nearshore benthic habitats. Overall, the study indicates that there are obvious bioregional patterns related to disjunct distributions of species but that the structure of mollusc death assemblages is strongly influenced by biophysical processes acting at medium scales (~50-150 km).

Another sub-project by NMSC researchers examined the health and biodiversity of thirteen nearshore reefs in the north coast region, with supplementary funding from the Northern Rivers CMA (NRCMA). A suite of methods was used to provide an assessment of reef condition that was as wide as practicable. Thus, measures of biodiversity (fish and molluscs) and benthic community structure were combined with assessments of anthropogenic debris load (as an indicator of existing human impact). Neither fish or molluscs showed a clear latitude-related pattern and the results generally supported previous findings that most reefs have a distinct assemblage structure. Benthic community structure showed less variability, with several distinct groups of sites having either a high coral cover, high cover of kelp and red coralline algae, or a mixed assemblage of algae and sessile invertebrates. These results were used to recommend a list of reefs that should be included in a long-term monitoring program to assess the health and biodiversity of shallow nearshore reefs in the north coast region.

Kelp habitat

A further sub-project aimed to improve the database of algal genera and species currently held within the collection at the National Herbarium of NSW at the Royal Botanic Gardens. It also updated information on the known locations where algal species have been found along the NSW coast. New localities to the current distributional data include Clyde, Nambucca Heads, Newcastle, Port Macquarie, Lake Macquarie, Terrigal, Austinmer, Shell Harbour, Kiama, Ulladulla, Narooma, Nowra, Moruya, Tuross Head and Merimbula. A total of 838 specimens were entered into the NSW Herbarium database and thus added about 5% of data entries to our overall holdings. The following genera are now newly included: *Bangia, Porphyra, Chaetomorpha, Rhizoclonium,*

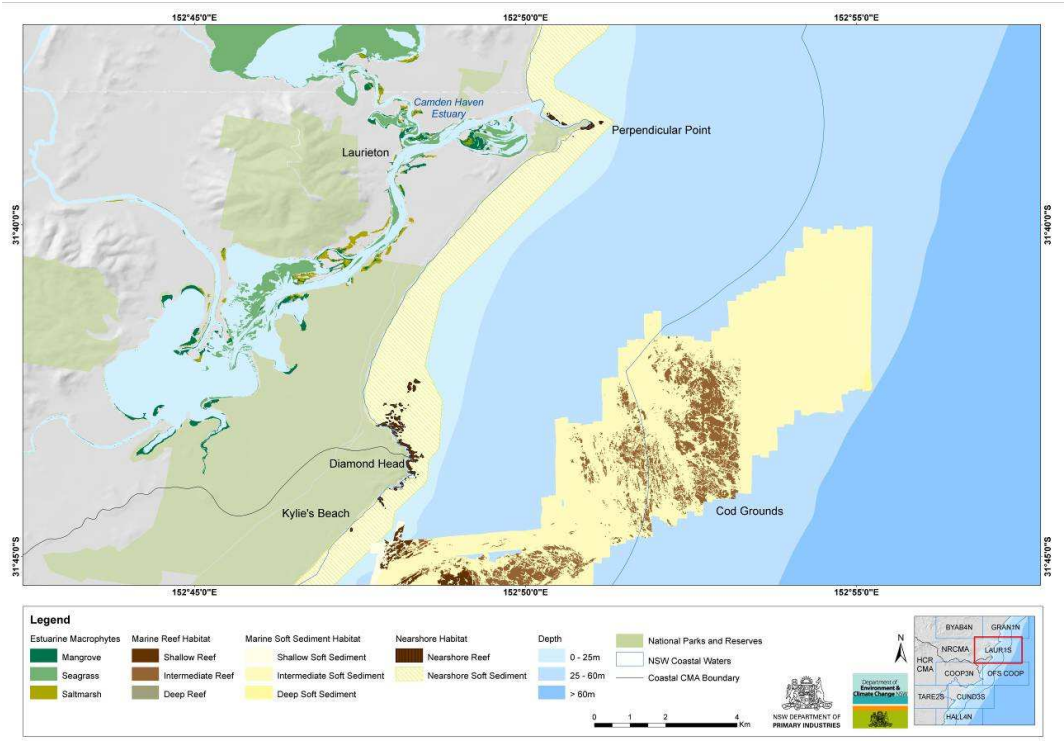
Pachyarthron, Galaxaura, Ptilophora, Nemalion, Rosenvingea, and *Blidingia*. This project has improved our site specific and biogeographic knowledge of macroalgae, which is an important component of the biological diversity in NSW coastal waters.

Review of underwater volunteer groups

The NMSC also conducted a review of volunteer groups in NSW, examining the potential for volunteers to assist with marine habitat mapping or other research and monitoring activities. A number of groups were identified in NSW and 162 members from 11 of these groups participated in surveys about their diving experience and research capacity. These surveys revealed that there was a wide range in the ability of volunteers to undertake data collection activities. While some groups had developed sound procedures for quality assurance and quality control, the review identified the need for standardised training and methods, quality assurance and ongoing support for data handling and analysis. Coastal CMAs are now planning to undertake further capacity building of underwater volunteers with funding from the Australian Government and will use the findings of this review as the basis for the new project.

Conclusion

Because the estuarine and marine habitat mapping work was done concurrently, and because both components used complementary habitat classifications and recording standards, it is now possible to combine all the information in a common GIS platform. One of the key outputs from this project is a series of seabed habitat maps (at 1:25,000 scale) for the entire NSW coast from the upper tidal limit of estuaries out to the limit of State coastal waters, and extending into Commonwealth waters in several locations. This map series, as well as the detailed maps of seabed bathymetry, natural and man-made estuarine foreshore features and broadscale sediments will provide natural resource managers, industry and the community with the information and tools needed for sustainable natural resource management and biodiversity conservation within the marine and estuarine areas of NSW. The maps, final technical reports, seabed video images, 3-D fly-throughs and further educational material will be available on the OzCoasts website (www.ozcoasts.org.au).



1:25,000 Map of known estuarine and marine habitats in the Laurieton region

Applications for marine habitat mapping information

As one of the main partners in the marine habitat mapping project, Coastal Catchment Management Authorities (CMAs) aim to ensure there is practical application of the mapping data to improve natural resource management outcomes. This information is already being used by CMAs to improve their estuarine and marine activities, including:

Monitoring artificial reefs

The ex-HMAS Adelaide is to be sunk off the Terrigal coast in 2010, with the vessel creating an artificial reef. Swath mapping in the area (page 4) provided essential information to assess the seabed habitats in the region and allow the University of Newcastle to design a monitoring program that aims to assess the impacts of the wreck on fish assemblages found on nearby reefs.

Seagrass friendly moorings

Traditional "dump weight and chain" moorings have been replaced by Coastal CMAs (Hunter-Central Rivers, Hawkesbury-Nepean and Sydney Metropolitan) with moorings that prevent damage to seabed habitats such as seagrass by lifting the mooring tackle off the seabed. Estuarine habitat maps help CMAs identify the location and species composition of seagrass beds and different moorings within an estuary can be prioritised for replacement.

Underwater volunteer groups

Swath mapping information is assisting a number of underwater volunteer groups to monitor reefs in their local area. This includes volunteers from the Great Lakes Underwater Group (GLUG), Port Macquarie Underwater Group (PURG) and the Terrigal Underwater Group (TUG). TUG volunteers are working with the University of Newcastle to monitor the impacts of the ex-HMAS Adelaide wreck (see above).

The project partners will continue to collaborate with other marine stakeholders to encourage the use of the information to improve sustainable marine resource management.

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