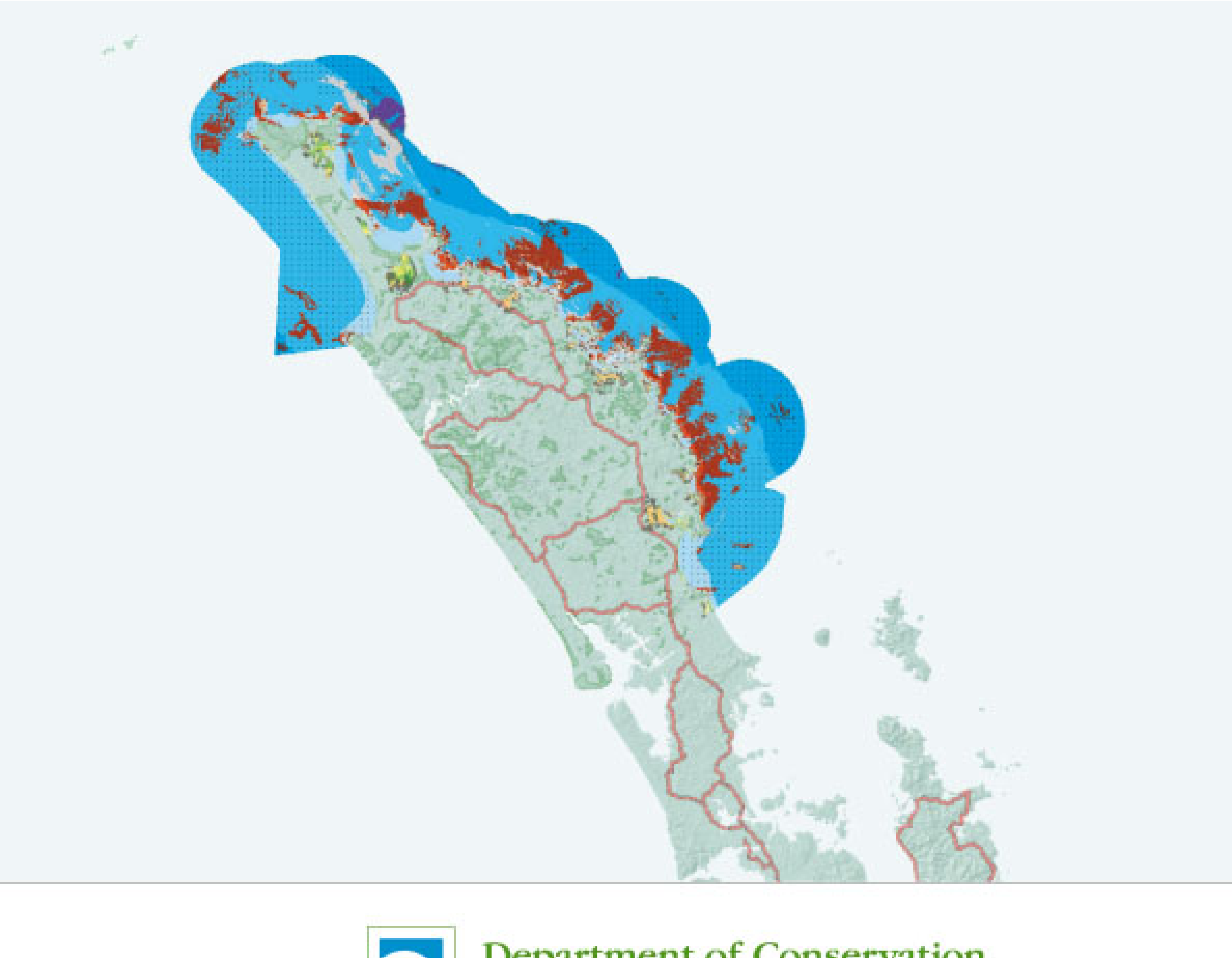
Marine habitat map of Northland: Mangawhai to Ahipara

Version 1

APRIL 2009



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Abstract

A marine habitat map for the Northland section of the Northeast Marine Bioregion in New Zealand's territorial sea has been completed and is presented in a series of maps. The maps cover an area of 1.34 million hectares extending out 12 nautical miles from the coast between Ahipara in the west to Mangawhai on the east coast.

Habitats were classified according to the Marine Protected Areas Classification, Protection Standard and Implementation Guidelines, with modifications required by insufficient data quality in some areas of the region. Data were collated from a range of recent and historic sources, and merged and analysed in ArcGIS 9.3.1 Geographical Information System. These data include multibeam and sidescan sonar data from the National Institute for Water and Atmospheric Research and Land Information New Zealand. A 'rapid sonar survey' technique was developed to fill data gaps for areas not covered by past or recent survey effort. These sources and methods are described to assist in understanding the strengths and weaknesses of the current habitat maps and to help implement improvements in this and future work

Rocky reefs make up 14.3% of the mapped area, indicating the presence of a significant array of these habitats. Estuarine areas make up 3.3% of the mapping area and include internationally significant tidal flats, *Zostera capricorni* seagrass beds and the *Avicennia marina* mangrove areas of Parengarenga and Rangaunu Harbours.

The use of the habitat maps to identify potential locations for a network of marine protected areas in Northland is discussed and recommendations are made to incorporate this information within decision support tools to assist in planning, education and community engagement. The habitat maps, underlying data and techniques developed also provide a valuable resource for other research and management projects in Northland and elsewhere.

CONTENTS

Introduction

Habitat mapping efforts by marine scientists began in New Zealand with the first marine subtidal map and methodology produced at Mimiwhangata (Ballantine, Grace & Doak, 1973). In Northland this method has been refined and used for site-based habitat maps at Leigh (Ayling, 1981), Mokohinau Islands (Creese, 1978), Mimiwhangata (Kerr & Grace, 2005), Doubtless Bay (Grace & Kerr, 2005a), Tawharanui (Grace, unpublished), Taiharuru (Grace & Kerr, 2005a) and Motukaroro (Kerr & Grace, 2006). Over this time, new technologies like multibeam and sidescan sonar and inexpensive underwater video systems have greatly increased our ability to undertake the task of large-scale mapping. The data supporting this mapping effort has been assembled from work over many years, with a substantial effort in the past two years. The main contribution has come from the surveys completed as part of the NIWA Ocean Survey 20/20 Bay of Islands Coastal Project (Ocean 20/20) (Mitchell *et al.*, 2009), contract survey work completed by NIWA for LINZ for navigational charting purposes and NIWA research projects at the Poor Knights Islands and Spirits Bay. Additional survey effort, completed by the author for the Department of Conservation, was designed to fill the gaps left in the larger data sets. Use was also made of a number of historic habitat mapping information data sets (Morrison, 2005a), with Mimiwhangata (Kerr and Grace, 2005a) and Doubtless Bay (Grace and Kerr, 2005) the most significant areas covered by previous mapping exercises.

This project aims to systematically combine these data in a reliable, quantitative GIS format to provide a comprehensive coverage of known marine habitats for the Northland section of the Northeast Marine Bioregion. The approach and methodology used here, while updated with modern data sets, draws heavily from the first effort and thinking developed in the 1973 Mimiwhangata study and refined in the subsequent Northland studies.

The aim is to develop marine habitat maps to assist the planning and implementation of a national network of marine protected areas (MPAs) for New Zealand's territorial sea. The habitat classification and methods used therefore aim to match, as closely as possible, the specifications described in the Marine Protected Areas Classification, Protection Standard and Implementation Guidelines and other related policy documents (MinFish & DOC, 2008). This is the first attempt to produce a comprehensive, region-wide coverage of marine habitats for Northland.

The underlying assumption in mapping predominantly physical habitat categories is that these are useful and readily recognised surrogates for more complex spatial patterns in biodiversity, ecosystems and ecological processes (reviewed by Costello, 2009). It is generally recognised that biotic and physical parameters such as depth, substratum and exposure are important drivers for ecological processes and species distributions (Connor *et al.,* 2004; Kingsford & Battersfield, 2003). Physical parameters are often easier to map over large areas, are relatively stable in time and can potentially include a wide range of lesser known species and processes.

However, where biological data on species distributions and life processes are available, these can provide more direct descriptions of patterns in biodiversity for the species concerned and can also act as surrogates for other related species. This can be particularly important where relationships between specific categories of different physical habitat and biodiversity are assumed rather than known and where biological interactions among species (e.g., dispersal, predation, competition, symbiosis) and their environment (e.g., behaviour, biogenic habitats, evolution) have a major in role in determining species distributions and ecological processes.

Ideally, broad-scale physical surrogates and available biological data can be combined using a rapidly evolving range of spatial, statistical and other modelling techniques. The habitat maps here provide a useful surrogate for major patterns in marine biodiversity for Northland. However, they also lay the basic foundation for more detailed modelling and are a critical component of understanding marine ecosystems and their protection throughout New Zealand (Leathwick *et al.*, 2008).

This mapping resource will, for the first time, support many of the tasks underpinning research planning in Northland, including gap analysis of marine protection in the region. In addition, the comprehensive spatial coverage of the maps will provide the raw inputs for modelling work leading to recommendations for the establishment of a network of highly protected areas and ancillary fisheries management areas in Northland and the Bioregion. Experience with MPA process shows that having good quality mapping resources and supporting software applications greatly adds to the effectiveness of the process. Commonly reported advantages are increased transparency, participation and objectivity in decision making (Beck *et al.*, 2009; Wahle *et al.*, 2009; Bernstein *et al.*, 2004).

Methods

The aim of this project was to collect all information which could be used to consistently map marine habitats in estuaries and ocean within territorial waters (12 nm of the coast) throughout the Northland section of the Bioregion. There is an inherent risk in using data from different sources in that some areas will have higher quality data and that some areas will have little or no information. As a result methods were developed to fill these gaps so that a comprehensive coverage could be achieved under the existing resource constraints.

To avoid bias remaining in the extents of different data sources, it is important to explicitly recognise limitations in different areas to avoid artefacts in subsequent models and analyses and to plan for more detailed future work. The data sources and methods are therefore described in detail below along with an appraisal of any limitations in the data and methods. To avoid repetition, some habitat categories are grouped and subdivided according to the particular methods required for different conditions such as depth. Hence similar methods for mapping intertidal and shallow subtidal (0–15 m) are discussed separately from methods for deeper waters although data were later pooled to generate categories in the National Inshore Marine Habitat Classification.

The use of a GIS (ArcGIS 9.3.1) to analyse, organise and interpret data from many sources was integral to the approach because of its ability to join disparate data sets locations, to mathematically intersect, measure and analyse these to produce habitat categories and to map and display habitats for future analyses and communications.

HABITAT CLASSIFICATION

The habitat classification used for this project (Table 1) is based on the current New Zealand MPA Implementation Plan (MinFish & DOC, 2008). One exception is the introduction of the subtidal habitat 'undefined sediments'. Sediments in this project classed as undefined sediments are described as non-reef or patch reef habitats composed of fine and/ or coarse sediments including cobbles. Use of this catch-all sediment category was adopted as a way of reflecting the low resolution of some of the data sets and methods used to differentiate sediments. In the subtidal zone, fine and coarse sediments are not further classified to sand/mud and gravel/cobble as they are in the MPA classification. This is due to high cost of the ground truthing work that would have been required to resolve sediment area boundaries given the data sets available.

TABLE 1. THE HABITAT CLASSIFICATION USED IS INDICATED ABOVE BY THE INTERSECTION OF DEPTH CLASSES (VERTICAL DIMENSION), AND SUBSTRATE (HORIZONTAL DIMENSION). THE FAR RIGHT COLUMN REPRESENTS A SPECIAL CLASS OF HABITATS (BIOGENIC) THAT ARE HABITAT FORMING BIOLOGICAL COMMUNITIES.

DEPTH	MUD	SAND	GRAVEL	UNDEFINED SUBSTRATE*	MIXED SEDIMENT AND ROCK	ROCK	BIOGENIC
Intertidal	mud	sand	gravel		rock	rock	mangrove, salt marsh, seagrass
0m<30m	fine sediments		coarse sediments	undefined sediments	reef	reef	rhodolith (maerl)
30m–200m	fine sediments		coarse sediments	undefined sediments	reef, ridge feature	reef, ridge feature	rhodolith (maerl)
>200m				undefined sediments, steep shelf, shelf canyon			

* Non high relief rock or mixed sediment with high relief rock substrates

INTERTIDAL AND SHALLOW SUBTIDAL ZONE (MLWS–15 m)

Existing GIS line and polygon data from the New Zealand 260 1:50,000 topographic series and the digitised geotiff files for the New Zealand marine charts series for Northland provided the first base layer for this area of the map. Polygons for coastline, rocky shore, and low tide line were copied to a mapping layer.

Aerial photos were selected from files held by the Information Management Unit, Northland Conservancy of DOC. Photographs were selected for conditions that allow viewing of intertidal habitats or subtidal habitats to 10-15 m depth. Typically, these were taken at low tide in the middle hours of the day and in conditions of low swell, clear water and calm or light offshore winds. Very few photos taken for terrestrial purposes, however, meet these criteria. Therefore the author, in partnership with Roger Grace and supported by DOC, undertook dedicated marine aerial photo surveys for the Northland coast during June 2003, 2005, 2006 and 2009. Details of the methods used are documented in previous reports (Grace & Kerr, 2005, 2005a). All useful photos were georeferenced against the various Northland Regional Council-commissioned ortho-registered aerial photo sets, which have a precision estimate of approximately 5 m. In some areas the Council photos were suitable to some extent for viewing intertidal and subtidal habitats. Existing boundaries from the NZ Topo series line work for all intertidal areas including all estuaries were modified after inspection of the aerial photos, working at approximately 1:10–20,000:1 scales.

Polygons for physical habitats (sand, gravel, mud) and biological habitats (mangroves, salt marsh and seagrass and low tide boundaries were determined from the aerial photos and in combination with the marine chart line work. In all areas where we could view underwater substrata and habitats with aerial photography, polygons were drawn to depict the physical substrata or biological habitats as described in Table 1. The maximum depth that could be mapped varied with the quality of the photos and ranged from less than 10 m down to 30 m (one location near Tom Bowling Bay). Typically the depth mapped by this method extended down to 10–15 m for most of the coast. This mapping was done at a scale of approximately 1:10,000.

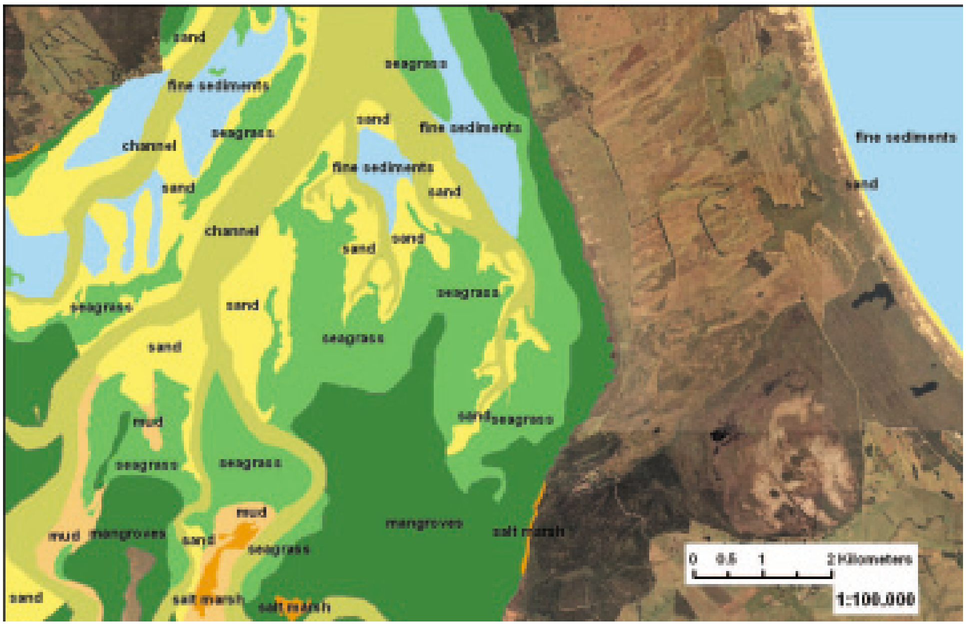

Figure 1a. Example of intertidal zone habitat mapping derived from an aerial photo at Rangaunu Harbour (1b).

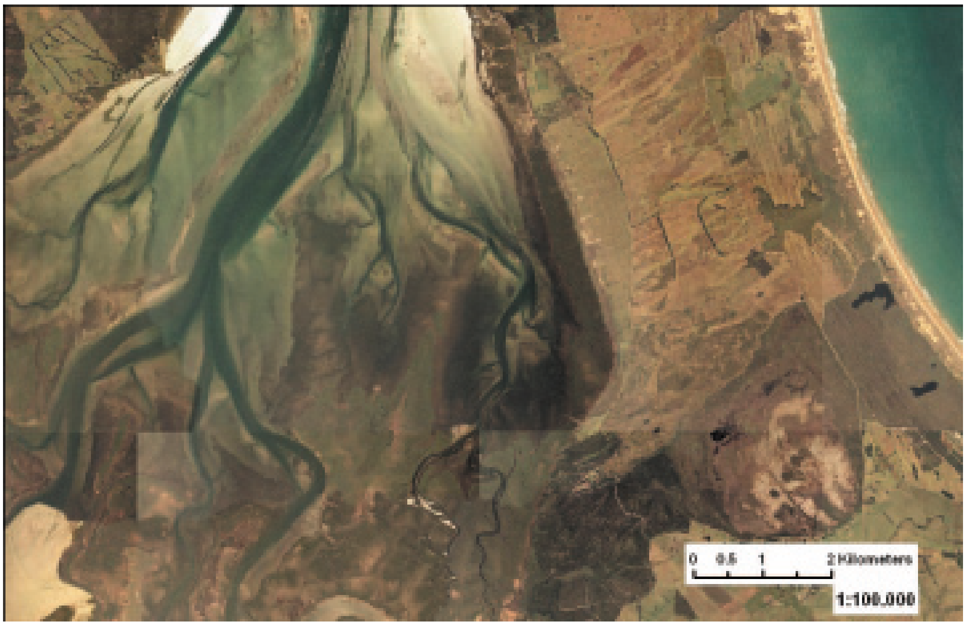

Figure 1b. Example of aerial photo at Rangaunu Harbour. Figure 1a shows habitat polygons derived from this aerial photograph.

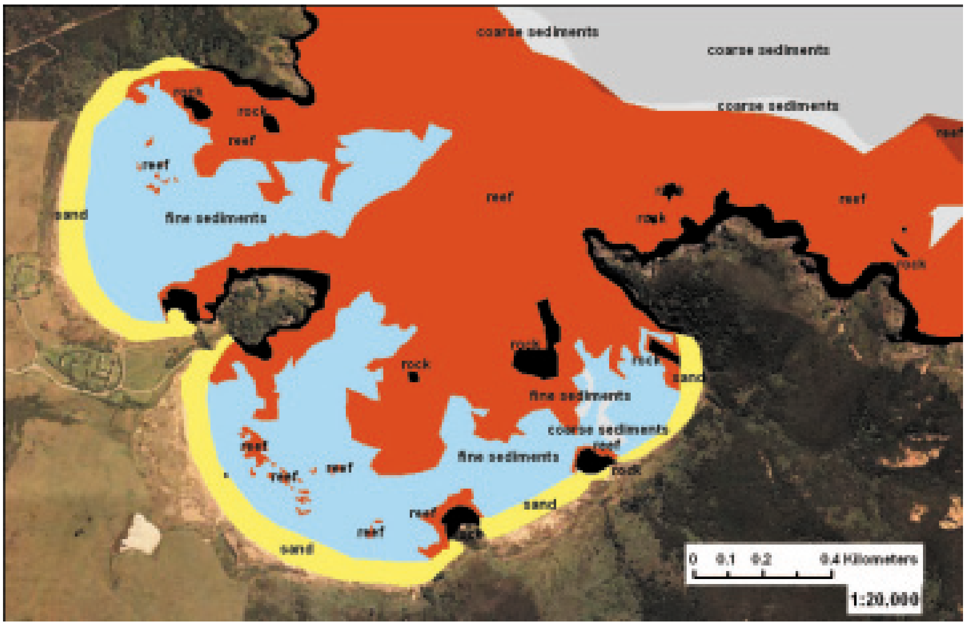

Figure 2a. Example of subtidal habitat mapping derived from aerial photo of Maitai Bay, Cape Karikari.

Figure 2b. Example of aerial photo, Maitai Bay, Cape Karikari.

SHALLOW SUBTIDAL 15–50 m

As a result of the Ocean 20/20 project, extensive high quality multibeam coverage was achieved for much of the zone along Northland's east coast from 50 m depth outwards. The zone between the outer limit of the habitat covered by aerial photography, at 10–15 m depth, and the 50 m depth inner boundary of the multibeam data sets represents an important and large area which was poorly covered by survey. Only small areas at depths between 15 and 50 m have been previously surveyed at Mimiwhangata and Doubtless Bay (Grace & Kerr, 2005, 2005a). To deal with this gap, a rapid sonar method was devised to allow for mapping between the shallow 'aerial photo zone' and the offshore multibeam surveys. Humminbird™ sidescan sounder units were used with transom mounted transducers on two speedboats (4.3 and 7.5 m), to map single beam and sidescan transects through the 15–50 m zone.

The specifications for the Humminbird sounders and examples of images are reported in previous reports (Grace & Kerr, 2005, 2005a). Prime considerations in this survey were the limitations of boat and staff time on the water and the large distances that needed to be covered. From previous work we had refined a method to do basic substratum surveys at depths up to 60 m at relatively high speed. The method requires near-calm sea conditions with boat speeds to 20 knots along survey lines parallel to the coast at 20–25 m and 35–40 m depths. Depending on the conditions the sounder was switched between its single beam view and the sidescan view. Whenever a change in substratum was detected, a waypoint was taken along with a screenshot of the sonar view. In most cases, boundaries between substrata could be determined with confidence. Where there was uncertainty, boat speed was reduced to 4–8 knots so that higher quality side scan images could be evaluated and recorded.

In this rapid method, the alternative use of single beam and sidescan imaging works well in identifying basic substrata and in most cases allows the survey to cover large areas rapidly. It does require however constant attention and experience with interpretation of the sonar images. We were able to run the minimum survey lines at two depths from Mangawhai to Tom Bowling Bay in 12 field days including time spent at the Hen & Chickens, Cavalli, Stephenson and Moturoa Island groups (Cape Karikari). In total 1,200 km of survey lines were completed. All sonar screen shots were referenced to substratum boundaries and archived for future use. One important caveat to this method is that gradual boundaries between fine and coarse substrata can be difficult to detect with consistency. This occurs for a variety of reasons. Substrata can be mixed in a wide variety of ways that make interpretation difficult. Another variable is variation in signals in relation to the shell content of the substrate. Where this difficulty occurred, we did not have sufficient time to slow down and ground truth using video and sediment grab sampling. Instead we noted the uncertainties and these areas became 'undefined sediments' undivided into fine or coarse sediments. To map this zone, boundaries between substrata were transferred to habitat lines categorised by substratum type. Polygons were then hand drawn and classified across these lines by interpolating by eye between polygons derived from the inshore aerial photography and polygons derived from offshore multibeam surveys. The relative accuracy of this method can be estimated by the distance interpreted between the rapid survey lines and the bordering inshore and offshore data sets. This spatial relationship is graphically represented in Maps 5a and 5b. The mapping precision in this zone typically varies from 100–200 m, but in some places where there is no bordering survey data, precision can extend up to 1 km. Mapping for this zone was typically done at 1:10–20,000 scale.

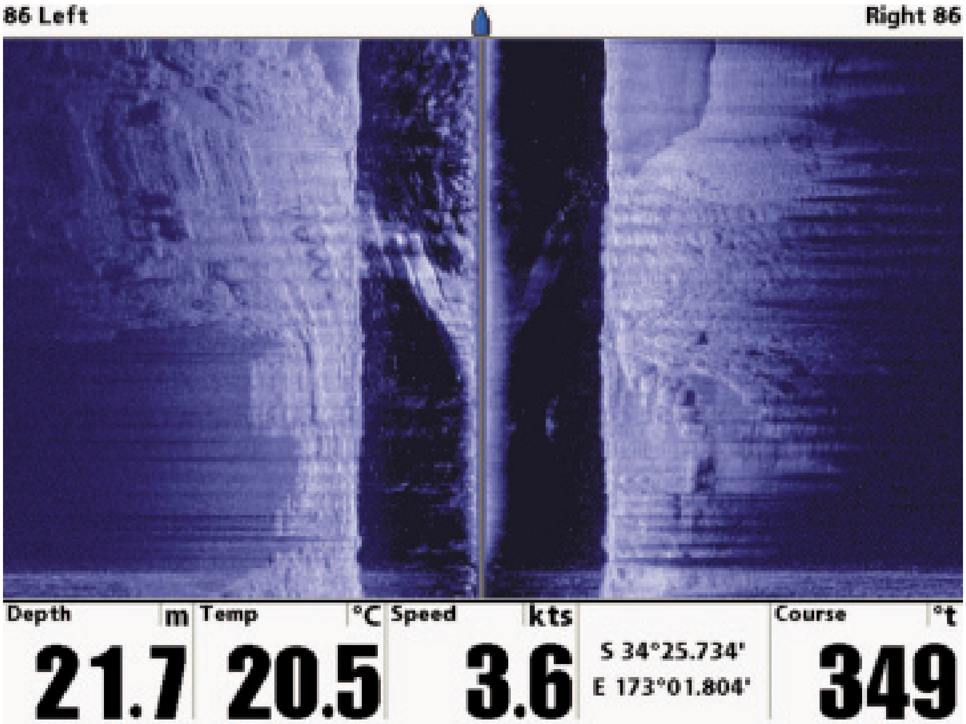

Fig 3a Sidescan screenshot image of waypoint #604 located northeast of Tom Bowling Bay. Boat is travelling north leaving the edge of the reef moving on to coarse substrate.

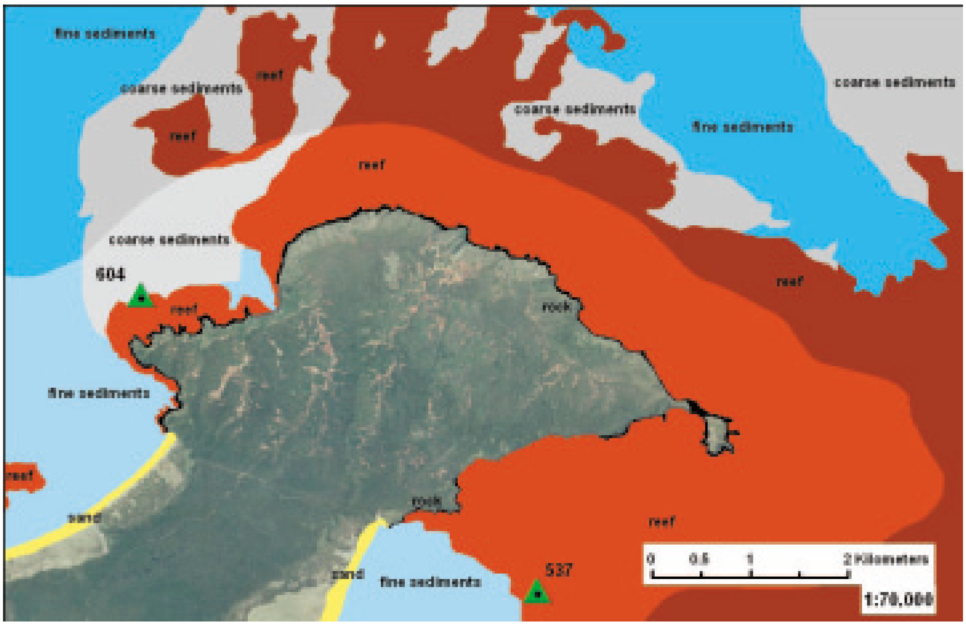

Fig 3b Habitat map showing locations of waypoints #604 and #537 at North Cape.

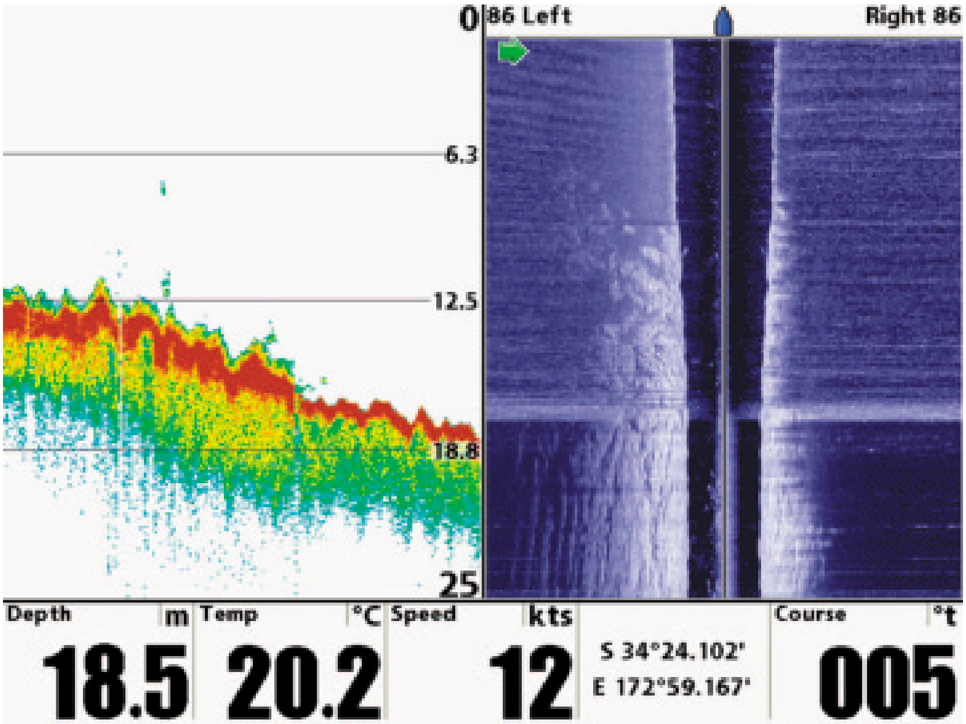

Figure 3c Split screen image view is a single beam sonar (left), and a sidescan image (right), for waypoint #537 south of North Cape. The boat has left a reef edge and has moved on to a patch of coarse substrate.

DEEP SUBTIDAL 50–200 m

Recent (1995 onwards), multibeam (EM3000) and sidescan sonar (C-Max CM2, 105 khz and 325 khz) data were acquired from several sources as a result of several independent government programs and contracts. These surveys are listed in Table 2 and their locations and extents are displayed on Maps 4a and 4b. A description of the equipment specifications can be found in the Ocean 20/20 progress report (Mitchell *et al.*, 2009).

TABLE 2 MULTIBEAM AND SIDESCAN SONAR DATA SETS IN NORTHLAND

SURVEY NAME	DATE OF SURVEY	MULTIBEAM PROCESSED GRID SIZE	MULTIBEAM BACK SCATTER IMAGE	MULTIBEAM DIGITAL TERRAIN MODEL (DTM)	SIDESCAN IMAGERY
Ocean 20/20 offshore	2008 2009	5 m	Yes	Yes	No
Ocean 20/20 inshore Bay of Islands NIWA	2008 2009	5 m	Yes	Yes	Yes
Poor Knights Is. and Pinnacles section habitat survey NIWA (unpublished data)	2007	5 m	Yes	Yes	No
Poor Knights Southern Area shipping lane survey	2009	5m	Yes	Yes	No
Shipping Lane 1 NZ Navy	1999 2000	30 m	Yes but not currently available	Yes	No