

Rare and special marine and estuarine sites of the Bay of Islands, New Zealand

A report for Bay of Islands Maritime Park Incorporated,

Fish Forever Working Group



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Abstract

In developing various proposals for a network of marine reserves in the Bay of Islands that was representative of the full range of habitat types present, the Fish Forever working group of Bay of Islands Maritime Park realised that in addition to those areas that were typical of a particular habitat class, there were also a range of sites that were unique, rare or special. These were mainly sites where the biological communities or individual species were strongly influenced by factors not included as habitat drivers in the New Zealand marine environment classification scheme, namely depth, substrate and exposure within each biogeographical region.

The other factors which were identified as influencing biological communities included strong tidal or cold upwelling currents, much lower light levels than usual for the depth, greatly reduced exposure and turbulence on an open coast, biogenic structure-forming benthic habitats and the effects of intensive marine mammal or seabird use. Other factors that may contribute to a site being unique, rare or special include the anomalous presence of a rare species or behaviour, the presence of a natural sequence of biotopes in estuarine areas that are in largely intact condition, or the existence of a type locality for a species or a scientific reference site.

A search for sites expressing the influence of one or more of these factors was undertaken by Pacific Ecology during field work for a larger study of kelp forests and urchin barren relationships on the shallow reefs of the Bay of Islands from March to June 2016. This was supplemented in November 2016 by further fieldwork in the western and southern BOI, and a search of relevant literature and personal records of field work undertaken during the last 10 years.

Candidate sites were tested against a set of primary criteria, and then confirmed if they met the test of a set of supplementary criteria. The report provides information about 66 rare or special sites within the Bay of Islands. It is biased towards shallower sites as it was easier to collect information about those sites. Accordingly deeper reefs and other special sites below 30m depth are relatively poorly sampled. Some areas may be covered by more than one special site, reflecting the different sizes and types of the special sites.

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Introduction

The Fish Forever working group of Bay of Islands Maritime Park Incorporated has been assembling information about the marine environments of the Bay of Islands for the last few years. Reasons for this include:

- Improving the state of knowledge about the marine environments of the Bay of Islands, including their values, threats to those values and actions that could improve the state of those marine environments;
- Collecting information that could be used in a marine protected areas application and/or a marine protected areas forum process
- Gathering information that could be used to assist and encourage management agencies to undertake appropriate actions and develop appropriate policies to better protect the marine environments of the marine environment
- Informing the community about the values, threats and remedial actions that could be undertaken to improve the state of marine environments in the Bay of Islands

This report provides information about rare and special marine environments in the Bay of Islands. Field information has primarily been collected in association with the field data collection process for a separate kelp cover and urchin barrens project.

In determining what are “rare and special” (habitats) it is useful to consider the framework used for determining “representative habitats”. In 2008 the Department of Conservation and Ministry of Fisheries released a report that contained a marine environment classification system that forms the framework for the identification and protection of representative habitats Department of Conservation and Ministry of Fisheries (2008).

The first tier in this marine habitat classification system is the biogeographic region, of which there are 14 for the New Zealand territorial sea. The biogeographic region represents the large scale variation in physical and biological attributes. For each biogeographic region the next division is estuarine versus marine environments. Within this division the Department of Conservation and Ministry of Fisheries (2008) consider that the three main environmental factors influencing biological community structure and composition are: depth, substrate and exposure. Three depth categories are used (intertidal, shallow subtidal to 30m and deep subtidal 30-200m). There are eight substrate classes (mud, sand, gravel, cobble, boulders, bedrock, biogenic structures and artificial). Three broad-scale exposure categories are used (low, medium and high). It is intended that these factors would operate at the scale of hundreds to thousands of metres.

Selecting for protection only those sites that were good representative examples of these classes could easily exclude sites in which the dominant or important factors were not depth, substrate or exposure, but rather such factors as strong currents, shallow water shading, biogenic influences or rare species occurrences. The rare and special sites identified in this report have additional factors that strongly influence the biological composition and structure at a site. Such sites may occur at or be assessed at finer or more detailed scales.

Methodology

The first stage was to develop criteria for selecting what types of sites we would assess as potentially rare and special sites of value. The following **criteria were used for select potential sites**:

- Those that have stronger or **more concentrated tidal flows** or **upwelling currents** than is typical for the area. This influences the rate at which planktonic food can be delivered to sessile filter-feeders or schooling fish, and therefore their relative abundance.
- Those having **lower light levels** than is usual for that depth. This influences the degree to which photosynthetic organisms (mainly algae) are able to grow and out-compete sessile filter-feeding organisms such as bryozoans, anemones, corals, ascidians and sponges. Some coralline algae, both coralline paint and coralline turf, also have a competitive advantage in lower light conditions. These communities are sciaphilic or dark-loving (Morton, 2004). Below a certain light level, shallow-water ecological communities (e.g. those found in long caves with small entrances), become greatly simplified and of less ecological interest
- Those that have **both stronger** than usual **currents** and **lower light levels**, doubling the competitive advantage of sessile filter-feeders. Arches are especially important in this regard.
- Sites that have greatly **reduced exposure and turbulence** than is usual for that part of the coastline (especially sheltered lagoons on exposed coasts). These often have compressed ecological zonation across the intertidal and shallow sub-tidal.
- Habitats based on **biogenic structures**, particularly at finer scales than those provided for and mapped in the primary inshore marine classification. The Department of Conservation and Ministry of Fisheries (2008) lists the following examples of biogenic reefs: bryozoan beds, rhodolith beds, tube worm beds and sponge gardens. We would add the following: horse mussel and green-lipped mussel reefs, and oyster reefs on otherwise soft sediments.
- Areas associated with more **intensive marine mammal** and/or **seabird use**. As well as the intrinsic values associated with these iconic species, there are ecological consequences of such concentrations of predators, including localised depletion of prey and concentration of nutrient rich wastes.
- Sites that contain sequences of marine and freshwater biotopes with relatively low levels of human modification.

Sites were then confirmed as special sites if they met one or more of the following additional criteria:

- The benthic biota that characterises the site is relatively intact.
- Where there are multiple examples of a type of feature and its associated biota, the selected sites contain more diverse benthic cover or there is a group of sites that collectively contain a more diverse range of attributes
- There is a diverse range of and/or relatively high numbers of schooling fish and their predators and/or marine mammals and/or seabirds
- The biological communities are significantly different from those found in surrounding environments without higher currents or lower light levels
- The biological communities are good example of rare /unusual communities at regional and/or national levels

- The area contains intact marine and freshwater biotope sequences with relatively low levels of human modification
- The site is a scientific reference site
- The site contains significantly different benthic cover due to relatively high levels of shelter compared to surrounding waters

Information about potential special sites was collected in several ways. The first was a search of existing written information. This included Victoria Froude's detailed dive and snorkel logbooks covering the Bay of Islands and a 2012 Northland coastal natural character assessment made by Pacific Eco-Logic for Northland Regional Council (Froude, 2014). We also made several requests for information from the interested public, including the dive community. This request was made on the Fish Forever website and via a Fish Forever newsletter. No responses were received.

The third approach was to physically assess potential sites that met one or more of the potential site selection criteria. Much of this work was combined with the fieldwork for the algae-sea urchin barrens field assessments that we also undertook for Fish Forever from late March – June 2016 (Froude, 2016). In some locations we used data from earlier projects/ assessments (e.g. the large cave and arch in Motukokako (Piercy) Island. The field assessments of sites in the north-west of the Bay of Islands took place in November 2016.

Adverse weather and sea conditions over the 2016 summer and autumn meant that we were not able to assess all areas in the outer Bay of Islands before June 2016 as was originally intended. Particularly problematic were the large easterly swells that persisted almost all of the time from the start of January until April 2016. For practical and health and safety reasons we have not assessed deep reefs or other areas of deep seabed, especially those below 30m depth.

We have not included in our selection, rare and special geological features (e.g. marble reefs), unless they are also associated with rare or special biological communities (e.g. the columnar basalts on some of the Black Rocks).

Data about each selected site were collected as follows:

- GPS location (using WGS84 latitude and longitude)
- Geomorphology
- General description (geomorphology and biotic composition and distribution)
- Assessment of how the special site selection criteria were met

Results

Table 1 contains a summary of the key attributes of sites identified as rare and/or special. This table contains the data collected for each site as set out in the previous paragraph. This Table is not necessarily comprehensive as the resources available for this project were limited. In particular, areas below 30m were not able to be comprehensively assessed because this is below the depths for safe recreational diving. Common and bottlenose dolphins are resident in the waters of the Bay of Islands but it was not possible to identify specific areas that are most important for them.

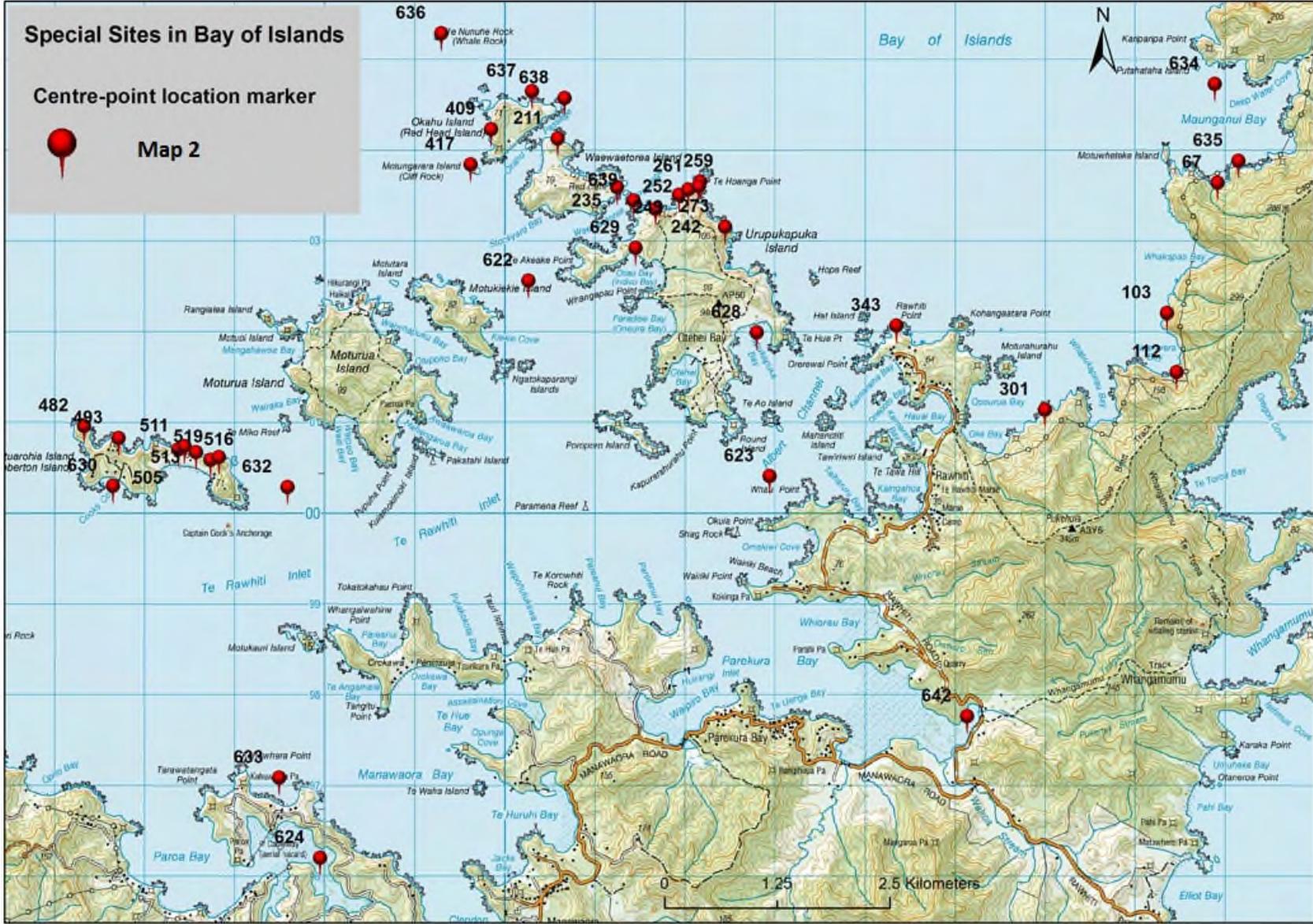
Accordingly we have identified the entire area of the waters of the Bay as special site for common and bottlenose dolphins. Other marine mammals also visit the waters of the Bay of Islands- including orca whales, false killer whales and other whale species and seals which have been regularly observed in a variety of locations, especially in the outer and middle sections of the waters of the Bay of Islands. Apart from seal haul-out locations, it is not possible to identify specific locations of particular importance for these mammals. As with dolphins we have identified the entire area of the waters of the Bay of Islands as important for other marine mammals such as orca whales.

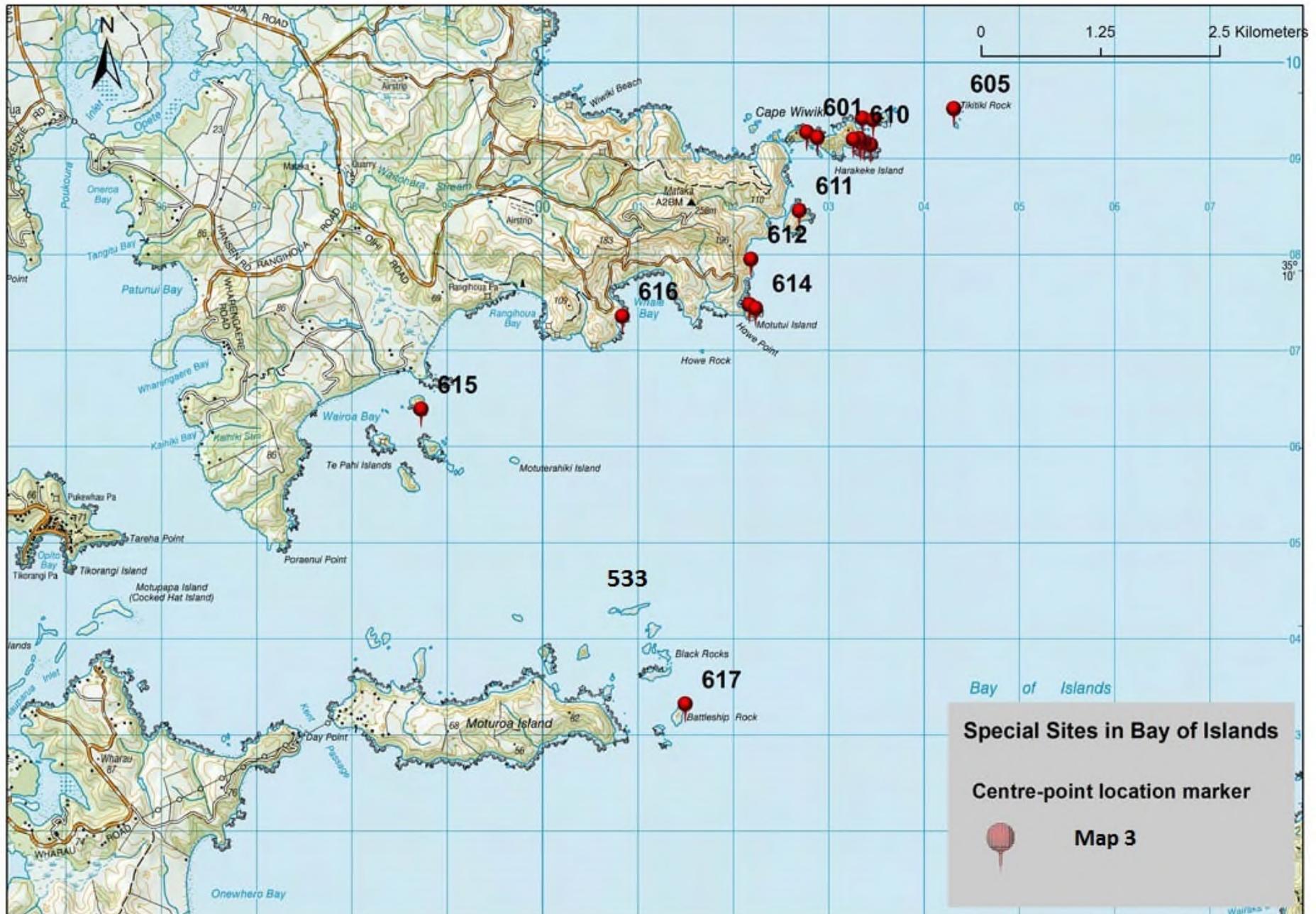
Special Sites Maps 1-4 show the location of the centre-point for identified rare and special sites along with their site identifier number. It is important to note that the sizes of the sites vary considerably. Only the centre-point for each site is shown, not the outer boundaries.

Table 1 follows with a summary of the identified rare and special marine and estuarine sites in the Bay of Islands, listed in numerical order. These are not necessarily all in a geographic sequence, as field work location varied with weather and swell conditions

Appendix 1 contains photographs of the best representative examples of the different types of sites.

Special Sites Maps





Bay of Islands

Special Sites in Bay of Islands

Centre-point location marker

 **Map 3**



Summary of rare and special marine and estuarine sites in the Bay of Islands

The following table lists the sites in numerical order in the sequence that they were assessed. Some but not all are in a geographical sequence. The site identifier number is that shown on the preceding maps.

Table 1: Summary of rare and special marine and estuarine sites in the Bay of Islands

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
67 Maunganui Bay	174 17.270'E 35 12.229'S	Field assessment 28 March 2016	Swallows cave 20m long Up to 3.5m deep	Jewel anemones, encrusting sponges, coralline paint and green algal slime (freshwater input?)	Relatively dark Diverse cave community
103 Southern Brett Peninsula	174 17.363'E 35 13.009'S	Field assessment 29 March 2016	Deep cave 3-8.5m deep Break-through arch at one end	Jewel anemones, encrusting sponges, orange golf ball sponges and white branching bryozoans	Relatively dark Diverse cave community
112 Brett Peninsula	35 13.360' 174 17.438'	Field assessment 29 March 2016	Two small arches	(not swimmable at time of assessment)	Relatively dark Currents
162 North Brett	35 11.071' 174 17.978'	Field assessment 7 April 2016 & others	Shallow double cave	White pustule sponges, jewel anemones, coralline turfs	Relatively dark Diverse cave community
168 North Brett	35 11.077' 174 18.183'	Field assessment 7 April 2016	Narrow arch, slot & cave	Bushy bryozoans, jewel anemones, encrusting sponges, coralline turfs	Relatively dark Diverse cave community
179 North Brett	35 10.999' 174 18.376'	Field assessment 7 April 2016 & 13 March 2013	Narrow slot between island and mainland 3-5m deep over rock and cobbles	The strong current area had schooling blue maomao. On the sheltered wall the cover included orange golf ball sponges; yellow, orange and green encrusting sponges; variety of jewel anemones; branching bryozoans; common anemones; coralline turfs. The island beyond the slot has more typical cover with	Strong currents Very shaded/ low light Diverse arch-like communities

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
				shallows to 3-4m dominated by <i>Carpophyllum mashalocarpum</i> , <i>Cystophora</i> corallines and <i>Pterocladia lucida</i> . Below this <i>Ecklonia</i> dominates. Relatively diverse and abundant fish community observed in 2013 including schooling fish -blue maomao, demoiselles, sweep, parore, kahawai- and short & long tailed rays, Sandagers and banded wrasse, pigfish, snapper, red moki, occasional butterflyfish, leatherjackets, big eye (under overhangs).	
181 North Brett	35 10.966' 174 18.459'	Field assessment 7 April 2016	Deep cave 5-10m wide. Surge resistant cave	Jewel anemones, bushy and branching bryozoans, coralline paint, encrusting sponges. <i>Centrostephanus</i> on walls. Schools of demoiselles and blue maomao	Relatively dark Some current Diverse cave community
185 North Brett	35 10.874' 174 18.552'	Field assessment 7 April 2016	Noisy cave (internal barrier from rock fall)	Orange bushy bryozoans, long tusk bryozoans, anemones, yellow and orange encrusting sponges, coralline paint	Relatively dark Diverse cave community
211 Eastern Waewaetorea	35 12.016' 174 12.889	Field assessment 8 April 2016	Twin caves to 3m deep	Yellow and orange encrusting sponges, white pustule sponges, coralline paint & turfs	Relatively dark Diverse cave community
242 Urupukapuka	35 12.427' 174 13.612'	Field assessment 9 April 2016	Sheltered arch with lagoon. Arch 2-3m deep, 3-4m wide	Encrusting sponges, orange golf ball sponges, coralline paints. Schools of sweep and blue maomao	Relatively dark Some current Diverse cave community
252 Urupukapuka	35 12.309' 174 13.847'	Field assessment 9 April 2016	Large cave 50m long, 5m wide, 2-3m deep.	Jewel anemones, encrusting sponges, branching white bryozoans, coralline paint & turfs	Relatively dark Diverse cave community

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
301 Oke Bay	35 13.593' 174 16.479'	Field assessment 26 April 2016	Shallow cave , 1-1.5m deep.	Encrusting sponges, jewel anemones, white branching bryozoans and coralline paint	Relatively dark Diverse cave community
343 Albert Channel	174 15.305'E 35 13.104'S	Field assessment 27 April 2016	High arch NW facing, 2-7m deep.	North wall cover includes jewel anemones, long tusk bryozoans, branching white bryozoans, encrusting sponges, orange golf ball sponges, <i>Ancorina</i> sponges	Relatively dark Some current Diverse cave community
417 Okahu Is	174 12.253'E 35 12.176'S	Field assessment 6 May 2016 & 10 February 2016	Narrow arch and cave	Motungarara Island cave and arch have a variety of encrusting sponges, jewel anemones of various colours, variety of bryozoans (including bushy and foliose forms)	Relatively dark Some current Diverse cave community
493 Motuarohia	35 13.832'S 174 09.699E	Field assessment 15 May 2016	NE facing cave	Walls had jewel anemones, encrusting sponges, coralline paint & turfs	Relatively dark Diverse cave community
505,513, 516 Motuarohia lagoons	35 13.894'S 174 10.138'E 35 13.910' 174 10.269' 35 13.956' 174 10.373'E	Field assessment 15 May 2016	Three sheltered lagoons	Sandy beaches in south Rocky base	Significantly different cover due to relatively high levels of shelter compared to surrounding waters
511 Motuarohia	35 13.874 174 10.182	Field assessment 15 May 2016	Cave facing NW . Less than 3.5m deep	Coralline paint, encrusting sponges and anemones, orange golf ball sponges, red alga <i>Methanthalia</i>	Relatively dark Diverse cave community
519 Motuarohia	35 13.938' 174 10.437'	Field assessment 15 May 2016	Dark cave, very low ceiling and very dark	Opens wide after entrance. Coralline paint, encrusting sponges, red anemones. Needs torch to fully explore	Very dark Probably has relatively diverse cave

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
					communities
524 Motuarohia	35 13.948' 174 10.519'	Field assessment 15 May 2016	Growler cave facing east, <2m deep	Range of encrusting species, golf ball sponges, coralline paints & turfs	Relatively dark Diverse cave community
533 Northern most island of the Black Rocks	35 11.946' 174 06.409'	Field assessment 16 May 2016	Vertical basaltic walls	The intertidal contained scattered mussels, limpets and abundant barnacles. The first 2m of subtidal wall had a cover of <i>Carpophyllum</i> (mostly <i>C mashalocarpum</i>) with <i>Cystophora</i> , , occasional <i>Ecklonia</i> , abundant <i>Pterocladia</i> , some mussels, and some tall coralline turfs. Where mussels had been removed there were more low turfs and algal felts. For the subtidal walls from 2-7m deep, <i>Ecklonia</i> formed 10-30% of the cover with <i>Pterocladia</i> , tall coralline turfs, encrusting fauna (sponges, anemones, bryozoans). Occasional mussels were present. Very few kina were seen. The kina that were seen were typically associated with areas of mussel removal. Abundant blue maomao and sweep.	Steep, creviced walls, relatively high tidal currents and high exposure influencing cover Good example of relatively unusual columnar basalt walls with a diversity of encrusting fauna
578 North Brett	35 10.767' 174 19.722'	Field assessment 4 June	Sheltered lagoon with freshwater inputs.	Compressed zonation in intertidal/shallow subtidal	Sheltered site on an exposed coast Compressed zonation
598 Brett Landing	35 10.316 174 19.928'	Field assessment 4 June	High current slot , between Otuwanga Island and mainland. 2-3m deep	Schools of juvenile blue maomao, black angelfish, snapper High current /surge <i>Lessonia</i> more abundant than <i>Ecklonia</i> and <i>Carpophyllum</i> Seal haul-out adjoins this area	High current Important for marine mammals and sometimes schooling fish
601	35 09.280'	Field assessment	Narrow channel	Channel depth 3-15m, width 20-40m. Highly exposed	Strong tidal currents

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
Wiwiki Islands	174 07.697'	13 Nov 2016	between islands 59MT and 71MT	to north with strong tidal currents. Rock walls with <i>Carpophyllum</i> , <i>Cystophora</i> , <i>Pterocladia</i> and corallines dominate the shallows; with more <i>Ecklonia</i> in deeper waters; and <i>Lessonia</i> on the outer walls. Schooling parore and blue maomao.	Important for schooling fish especially plankton feeders and their predators
602 Wiwiki Islands	35 09.312' 174 07.770'	Field assessment 13 Nov 2016	Shallow lagoon between MT59 and Harakeke Island	Lagoon width 20-60m, depth 1-5m with strong tidal currents. Sheltered from most wind directions except NE. Some small arches, many rock stacks. Substrate is rock shelf with boulders. High diversity of algae species but low percent-cover. Abundant kina, anemones and sponges. Lesser amounts of <i>Carpophyllum</i> , <i>Ecklonia</i> , <i>Cystophora</i> , <i>Xiphophora</i> , <i>Pterocladia</i> , <i>Zonaria</i> and corallines. Abundant fish include blue maomao, sweep, black angelfish, hiwihwi, banded wrasse, spotties, demoiselles, parore and silver drummer.	Significantly different cover and fish diversity due to relatively high levels of shelter compared to surrounding waters
603 Wiwiki Islands	35 09.199' 174 08.080'	Field assessment 13 Nov 2016	Narrow channel between Harakeke Island and islets to NE	Strong tidal currents. Rock walls and slopes have diverse algal cover. Four species of <i>Carpophyllum</i> ; <i>Pterocladia</i> , <i>Xiphophoria</i> , <i>Glossostigma</i> . Deeper walls have <i>Ecklonia</i> and <i>Lessonia</i> . School blue maomao and reef fish.	Strong tidal currents and varied topography influencing cover Important for schooling fish
604 Wiwiki Islands	35 09.206' 174 08.154'	Field assessment 13 Nov 2016	Wide channel NE of Harakeke	Channel 8-12m deep with very strong tidal currents. Abundant schooling fish, blue maomao, sweep, kahawai, parore	Strong tidal currents Important for schooling fish
605 Ninepin (Tikitiki Rock)	35 09.138' 174 08.711'	Field assessment 13 Nov 2016	Very exposed small isolated island with	Very strong currents and very exposed in all directions. Remnant mussel reefs in intertidal and subtidal. <i>Carpophyllum</i> , <i>Pterocladia</i> , <i>Cystophora</i> , and coralline	Strong tidal currents Important for schooling fish and

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
			steep walls	turf with orange branching bryozoans. Very dense barnacle beds on southern intertidal. Large gannet colony feeding in surrounding waters. Rock stack to the south has very dense barnacle beds, with some mussels. Shallow subtidal includes 3 species of <i>Carpophyllum</i> , several species red algae (including <i>Pterocladia</i> with <i>Ecklonia</i> and <i>Lessonia</i> in deeper waters. The stack has colonies of red-billed gulls and white fronted terns. Waters around both islands have schooling blue maomao, sweep and parore.	seabirds.
606 Harakeke Island	35 09.349' 174 08.140'	Field assessment 13 Nov 2016	Large archway with varying degrees of shade	Archway is 5m wide, 6m high, and 3-4m deep. Diverse sponges including <i>Ancorina</i> , encrusting and golf ball sponges. Diverse bryozoans including tusk, branching, bushy and lacy cup corals. Abundant jewel anemones.	Changed biota because of shading Diverse arch wall community
607 Harakeke Island	35 09.336' 174 08.096'	Field assessment 13 Nov 2016	Small archway, well shaded	Archway 3-4m wide, 1-3m deep. Rock and shingle bottom, Abundant jewel anemones, especially on north wall. Tusk corals and bushy bryozoans with encrusting sponges. Small area of very dense kina. School of big-eye.	Changed biota because of shading Diverse arch wall community
608 Harakeke Island	35 09.333' 174 08.069'	Field assessment 13 Nov 2016	Low roof cave, very dark interior	Very low headroom at half-tide. 3m wide, 4-5m deep. White branching bryozoans at entrance. Bushy bryozoans, encrusting sponges and jewel anemones. School of big-eye.	Changed biota because of shading Diverse cave wall community
609 Harakeke Island	35 09.314' 174 08.061'	Field assessment 13 Nov 2016	Twin caves; relatively open and light	Cave is relatively shallow at 1-2m. Pink encrusting paints in shallows, jewel anemones and encrusting sponges	Changed biota because of shading
610 Harakeke Island	35 09.318' 174 08.020'	Field assessment 13 Nov 2016	High roof cave	Sheltered cave, 2-5m deep and very long. Abundant jewel anemones and encrusting sponges. Bushy	Changed biota because of shading

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
				bryozoans and tall (30cm) white branching bryozoans.	
611 Wiwiki Islands	35 09.722' 174 07.651'	Field assessment 13 Nov 2016	Large cave exposed to swell	Cave with wide entrance. 8.5m deep, but 10m at head of cave. Extensive jewel anemones and bushy bryozoans. Encrusting sponges of various colours. Tall white branching bryozoans at 4-5m deep. Very dark head of cave (too dark for observations).	Changed biota because of shading Diverse cave wall biota
612 Purerua Peninsula	35 10.000' 174 07.321'	Field assessment 13 Nov 2016	Deep short cave	Wide entrance at 6-7m deep. Pink coralline paint at head of cave with jewel anemones, bushy bryozoans and some encrusting sponges. Short red algae at entrance with intertidal barnacles.	Changed biota because of shading
613 & 614 Motutui –Howe Point	35 10.256' 174 07.314' 35 10.276' 174 07.358'	Field assessment 13 Nov 2016	Long arch through Motutui Island at Howe Point	GPS positions mark NW and SE entrances. Very open entrances. Dark centre of archway has jewel anemones, bushy bryozoans, encrusting sponges of various colours.	Changed biota because of shading
615 Te Pahi Islands	35 10.865' 174 05.054'	Field assessment 14 Nov 2016	Pillow lava lagoon	Lagoon at southern corner of northern island (44m highest point). Are of basaltic pillow lava forms part of shallow sheltered lagoon up to 4m deep. Diverse algal cover including abundant <i>Cystophora</i> (2 sp), with a variety of small finely divided red algal species and coralline turfs. Puff ball algae (<i>Colpomenia</i>) and Neptune's necklace (<i>Hormosira</i>) abundant in shallows.	Changed biota because of shelter and unusual substrate
616 Whale Bay headland	35 10.328' 174 06.436'	Field assessment 14 Nov 2016	Triple caves	One deep and two shallower caves in sheltered cove at southern entrance to Whale Bay. Encrusting sponges, patches of jewel anemones, and coralline paint and turf communities in darker parts of caves.	Changed biota because of shading
617 Battleship Rock	35 12.509' 174 06.902'	Field assessment 14 Nov 2016	Small underwater caves, crevices and steep walls with boulders	The wall extends to 20-22m depth. At the bottom of the wall there are large boulders and rock slabs with narrow slots. The wall intertidal includes barnacles, the occasional mussel, 2 species of <i>Cystophora</i> and <i>Carpophyllum</i> . The cover on the subtidal walls is	Changed biota because of the steep topography and local shading (e.g. caves, slots etc)

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
			at the base of wall	largely encrusting fauna including abundant common anemones, white anemones, pale green anemones; some jewel anemones in a variety of colours in more shady sites;. Abundant low bushy bryozoans in various colours; some 20-30cm white or beige branching bryozoans; some tusk corals and a few rhodoliths in slots/on shelves. There is a variety of sponges in the shallows with <i>Ancorina alata</i> becoming increasingly dominant as depth increases. On the lower parts of the wall some <i>Ecklonia</i> and red algae are present. In the large boulders area there is a patchy cover (30-50%) of <i>Ecklonia</i> and red algae species. The fish species included typical reef fish and some schooling species such as sweep, blue maomao and parore. The presence of rock lobster could not be confirmed. Nudibranches were present as were crabs and the occasional subtidal mussel.	
618 Motukokako underwater cave and western walls	35 09.853' 174 20.335'	Various field assessments including 7 January 2010 & Paihia Dive website	Large deep underwater cave (by far the deepest in the Bay of Islands) and walls on both sides of cave entrance	Cave: Shallow-water wall-cover includes an excellent diversity of sponges, bryozoans (bushy, foliose and branching), & jewel anemones. Fish include snapper, butterfly perch, demoiselles, and blue maomao. In deeper locations one can find golden snapper, resident stingrays, Lord Howe coralfish, mado, and yellow-banded perch. On the bottom of the cave there are large boulders. The cave's maximum depth is about 40m. Walls outside the cave contain a variety of encrusting organisms with kelps (especially <i>Lessonia</i>) increasing in abundance as the wall's slope reduces in the NW. Fish in this area include: sweep, silver drummer, butterfly,	Wide range of darkness levels and at a range of depths Very diverse cave communities

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
				kahawai, kingfish, half-banded perch, butterfly perch.	
619 Motukokako large arch "Hole in the Rock"	35 09.950' 174 20.426'	Various field assessments	Large arch (used by large power boats including large commercial vessels)	Northern wall has a good diversity of sponges and bryozoans. Excellent schooling fish (trevally, blue maomao and parore) when not disturbed by large vessels. Yellow moray eels are present. It is difficult to assess the arch properly as there are current surges and many commercial vessels when weather and sea conditions are good.	Relatively dark Strong current Diverse arch wall community Diverse and abundant schooling fish
620 Channel between Motukokako and Dog Islands	35 10.021' 174 20.343'	Various including 29 March 2014, 7 January 2010	Strong current, exposed open waters and steep walls	Motukokako northern wall had a sparse <i>Carpophyllum</i> kelp cover in the shallows with some <i>Pterocladia lucida</i> and <i>Lessonia</i> at about 5m depth. On the western wall there is sparse <i>Cystophora</i> and <i>Carpophyllum</i> with <i>Pterocladia lucida</i> and coralline algae in the shallows. There are scattered <i>Ecklonia</i> and <i>Lessonia</i> below along with scattered sponges and bryozoans. Schooling fish included blue maomao, sweep, koheru and butterfly perch. Some kahawai were present. Usual reef fish. The north side of the Dog had amazing snorkelling with very large schools of blue maomao, grey knifefish and trevally with koheru and kahawai and some kingfish. The current here was strong. There was a good variety of reef fish. Cover in shallow waters included <i>Cystophora</i> , <i>Carpophyllum mashalocarpum</i> , <i>Pterocladia lucida</i> and corallines. Below about 10m <i>Ecklonia</i> dominated with the occasional <i>Lessonia</i> . Overall algal cover was about 50%.	Current strong in both tidal directions. Important for schooling fish (especially plankton feeders) and their predators
621 Twin Rock/ Motutara	35 10.754' 174 17.721'	Various including field assessment 1 April 2013	Rock walls and slopes around exposed islets	Upwellings lowered water temperatures compared to elsewhere. Good numbers of schooling plankton feeders including parore, blue maomao, grey knifefish, demoiselles, butterfly perch and sweep. Also	Current and upwellings Important for seabirds

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
				predators including kahawai. Unusual species included speckled moray, painted moki and bronze whaler. Reef fish included butterflyfish. The islets are seabed roosts	
622 Channel between Urupukapuka & Motukiekie	35 12.864' 174 12.686'	Field assessment February 2012	Flat coarse sand, shell and rhodolith substrate in high current channel	Horse mussel bed. This is the only area with some intact horse mussel beds that Victoria Froude has found in the Bay of Islands over the last ten years. It was at about 10-12m depth	Biogenic habitat with relatively intact patches Higher tidal currents
623 Albert Channel-Mainland-Urupukapuka cableway	35 14.010 174 14.470'	Field assessment in 2009	Flat coarse sand substrate, moderately high current. Undredged site	Diverse soft bottom benthic community that has not been subject to past dredging (because of the cable). Cover includes dense <i>Caulerpa</i> (sea rimu) and tall coralline algae with abundant dog cockles and other shellfish. Relatively intact diverse soft bottom benthic community that has not been subject to past dredging (because of the no dredging and anchoring area associated with the submarine cableway between Urupukapuka and the mainland)	Some tidal currents Relatively intact benthic biota
624 Paroa Bay Estuary	35 16.318' 174 11.211'	Various field assessments 2009-2012	Small clear-water estuary	Small clear water estuary with mangroves. Very small watershed with virtually no fine sediment inflows. Wide range of fish species visit including kingfish	Unusually clear water for an east coast estuary
625 Man-o-War Creek estuarine wetlands	35 18.145' 174 12.384'	Various field assessments for natural character mapping 2012	Extensive area of intertidal flats and subtidal channels	Extensive area of relatively intact intertidal flats with a sequence of mangroves, then saltmarsh grading into freshwater wetland. Much of the catchment and most riparian margins are in native vegetation.	Good example of relatively intact marine and freshwater biotope sequence
626 Waikino Creek estuarine	35 19.797' 174 10.410'	Various field assessments for natural character	Extensive area of intertidal flats and	Extensive area of relatively intact intertidal flats with a sequence of mangroves, then saltmarsh grading into freshwater wetland. The area of saltmarsh is one of	Good example of relatively intact marine and

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
wetlands		mapping 2012	subtidal channels	the largest in the Bay of Islands. Much of the catchment and most riparian margins are in native vegetation.	freshwater biotope sequence Large area of a diminishing habitat in the Bay of Islands (saltmarsh)
627 Keretu River estuarine wetland	35 21.862' 174 07.457'	Various field assessments for natural character mapping 2012	Extensive area of intertidal flats and subtidal channels	Extensive area of relatively intact intertidal flats with a sequence of mangroves, then saltmarsh grading into freshwater wetland. . The area of saltmarsh is one of the largest in the Bay of Islands.	Good example of relatively intact marine and freshwater biotope sequence Large area of a diminishing habitat in the Bay of Islands (saltmarsh)
628 Urupukapuka Bay,		Various field assessments. Booth, 2013, Seagrass in the Bay of Islands,	Flat soft-bottom with clear water and low exposure	Extensive subtidal seagrass meadows. Such intact habitats are becoming increasing rare because of sedimentation and lower water clarity. While relatively intact, these sea grass beds are subject to ongoing disturbance from anchoring boats.	Nationally rare habitat Relatively intact benthic cover
629 Entico/Otiao Bay and Paradise Bay		Various field assessments. Booth, 2013, Seagrass in the Bay of Islands,	Flat soft-bottom with clear water and low exposure	Extensive subtidal seagrass meadows. Such intact habitats are becoming increasing rare because of sedimentation and lower water clarity. While relatively intact, these sea grass beds are subject to ongoing disturbance from anchoring boats.	Nationally rare habitat Relatively intact benthic biota
630 Cooks Cove, Motuarohia	35 14.116' 174 09.663'	Booth 2013, Seagrass in the Bay of Islands,	Flat soft-bottom with clear water and low exposure	Relatively extensive subtidal seagrass meadows. Such intact habitats are becoming increasing rare because of sedimentation and lower water clarity. While relatively intact, these sea grass beds are subject to ongoing disturbance from anchoring boats	Nationally rare habitat Relatively intact benthic biota

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
631 Deep basin to north of Pine Island, Lower Waikare	35 18.775' 174 07.936'	Various field assessments and catch inspection	Relatively deep scour basin	Pupping and nursery area for hammerhead sharks	Important breeding/nursery area for predatory sharks (hammerhead)
632 South of Te Miko Reef	35 14.112 174 19.941	(Nelson et al., 2012)	Biogenic habitat –rhodolith beds	Good example of relatively extensive rhodolith beds with diverse infauna and epifauna. There is also diverse macroalgae. Optimal conditions for rhodolith beds with current to minimise deposition and good light needed for rhodolith growth. This is one of the two best studied rhodolith beds in New Zealand and possibly internationally. Risks include increased nutrient levels in the water, sedimentation, and ocean acidification. Alien algal species including <i>Undaria pinnatifida</i> , which is present in several eastern Far North Harbours, poses a significant risk as the <i>Undaria</i> holdfast could attach to the rhodolith beds and shade the rhodoliths thereby significantly changing the light regime.	Biogenic habitat Moderate current as required for optimal rhodolith growth Benthic biota relatively intact Scientific reference site
633 Kahuwhera Point (Bay)	35 15.844 174 10.904	(Nelson et al., 2012)	Biogenic habitat –rhodolith beds	Atypical example of relatively extensive rhodolith beds with lower light levels and minimal currents resulting in a seafloor coating of fine sediments and the burial of much of the rhodolith bed. There is a high diversity of macroalgae and invertebrates but species differ from those found in the Te Miko area. There is more sponge species associated with this rhodolith bed, including some species that have only been found in this location. There are also more echinoderms and polychaetes. This is one of the two best studied rhodolith beds in New Zealand and possibly	Biogenic habitat Benthic biota appears to be relatively intact but different to that found in site 632 Scientific reference site

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
				<p>internationally. Sedimentation rates in the Bay of Islands have increased markedly in the last century and it is uncertain whether this bed at Kahuwhera Bay is threatened by increasing sedimentation (as part of Te Rawhiti Reach which is the largest sedimentary sink in the Bay of Islands.). Other risks include increased nutrient levels in the water and ocean acidification. Alien algal species including <i>Undaria pinnatifida</i>, which is present in several eastern Far North Harbours, poses a significant risk as the <i>Undaria</i> holdfast could attach to the rhodolith beds and shade the rhodoliths thereby significantly changing the light regime.</p>	
634 Maunganui Bay artificial and natural reefs at entrance to Bay.	174 17.692'E 35 11.644'S	Various including 15 January 2016 to 28m	"Cleaned" large metal wreck (frigate) sunk in Maunganui Bay on a soft sediment substrate Natural reefs associated with the islands and reefs at the entrance to the Bay	The former 113m Leander Class frigate "The Canterbury" was sunk in 2007 in Maunganui Bay after the hull and other surfaces were cleaned to remove alien species. There has been regular monitoring since the sinking. A January 2016 dive found some kelp on the chimneys (<i>Ecklonia</i> dominant). Elsewhere cover included corallines, sponges (including red & orange encrusting, and yellow finger), jewel anemones, various bryozoans, and a variety of short red algal species. Jewel anemones were partly encrusting the railings (red, blue, purple, pink). There were large numbers of butterfly perch, demoiselles, trevally, sweep, leatherjackets and some snapper around the wreck and at least one kingfish. Fish directly on or swimming into the wreck included Sandagers and banded wrasses, red moki, pigfish, red-banded perch (uncommon), and snapper. Non-sessile invertebrates included nudibranchs and octopii.	Reduced light with deeper and less clear waters (wreck) Reduced light inside the wreck (not visited) Variety relatively new vertical and overhanging surfaces encouraging encrusting organisms (wreck) No fishing area (rahui) for six years

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
				<p>Orca whales have been photographed imitating divers descending and ascending the lines to the wreck.</p> <p>Island and mainland reefs at entrance to Maunganui Bay: These are dominated by tall brown algae species and also include significant areas of kina barrens. A range of fish species found in warmer waters has been seen around Putahataha and Motuwhetake Islands including blue knifefish, northern scorpionfish, bronze whaler sharks, and various tuna species. Typical reef and schooling fish populations seem to be recovering with the rahui, especially snapper, butterflyfish and pigfish. Breeding giant boarfish have been seen around Motuwhetake Island. Rock lobsters and packhorse lobsters are present. The entrance to the underwater cave in the SW of Putahataha is at about 18m. Inside the cave rises to 10m and it contains many big-eye fish.</p>	
635 Maunganui Bay	East entrance arch 174 17.871'E 35 12.097'S West entrance 174 17.830'E 35 12.106'S	Field assessment 28 March 2016	Long arch (70m) Up to 3m deep	Good encrusting communities on west wall with diverse bryozoans including long tusk bryozoans, anemones including jewel and solitary, encrusting sponges (purple & pink), coralline turfs. Kelps at east entrance have abundant parasitic red algae.	Relatively dark in centre Strong tidal currents Large & diverse arch and wall communities
636 Whale Rock Reef (Te Nunuhe Rock)	35 11.403' 174 12.011'	Various including 16 March 2010	Exposed waters associated with several underwater rock pinnacles	The southern-most rock pinnacle is the largest and has the most schooling fish in the shallows, especially blue maomao, sweep and parore. This area also has the most benthic cover in the shallows- predominantly anemones, corallines and the occasional bryozoan.	Upwelling Isolated underwater pinnacles

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
			close to the surface	The rock areas in the west generally have more barrens in the shallows and abundant kina and <i>Centrostephenus</i> . Here dense <i>Ecklonia</i> starts at 17-18m running to sand at 24-25m. In the east there is dense <i>Ecklonia</i> below 10m. There is a diversity of fish species including butterfly perch, short-tailed ray, pigfish, kingfish, kahawai, big-eye, goat fish and spotted goatfish, porcupine fish, snapper and Sandagers wrasse.	
637 North Okahu	35 11.743' 174 12.661'	Various including field assessment 1 May 2013	Canyons parallel to shore and pinnacles	Series of canyons and pinnacles on north shore. Assessment mostly 10-17m depth range. On the south (shady side) there are often anemones (jewel and common), various bryozoans, (bushy and foliose), encrusting sponges and coralline algae. Otherwise <i>Ecklonia</i> and <i>Carpophyllum mashalocarpum</i> dominate. Abundant parore, kahawai throughout with schools of kingfish, young snapper. Sweep & demoiselles present. Reef fish included pigfish, black angelfish and butterflyfish. Yellow moray eels	Some tidal currents in canyons running parallel with the shore Some cave-like communities Important for schooling fish especially plankton feeders and their predators
638 Okahu Passage east entrance	35 11.736' 174 12.695'	Various including 26 April 2014	Rock pinnacles, canyons with steep walls and slots. Strong tidal currents.	The outer open coast was mostly steep rock walls with <i>Cystophora</i> in the shallows, then <i>Carpophyllum</i> and <i>Pterocladia capillacea</i> . Below this was patchy <i>Carpophyllum</i> , <i>Pterocladia</i> , common anemones, corallines, coralline paints and other red algae (<i>Methanthalia</i> , <i>P. lucida</i> etc). There was also patchy <i>Ecklonia</i> and <i>Lessonia</i> on the most exposed sites. On darker slightly overhanging walls there were green and orange encrusting sponges. There were schools of blue maomao, sweep and demoiselles. Reef fish	Some tidal currents in canyons Some cave-like communities Important for schooling fish especially plankton feeders and their predators

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
				included butterfish, black angelfish. Predators of schooling fish include kahawai. Once inside the passage the biota was similar but the kelp cover was higher.	
639 Waewaetorea Passage eastern entrance	35 12.378' 174 13.448'	Various field assessments 2007-2016	Strong east-flowing tidal currents over a shallow shelf	Often good numbers of plankton feeding fish in high current areas including parore, sweep, demoiselles, blue maomao, and koheru. Predators include kahawai. Reef fish seen include painted moki The former subtidal green-lipped mussel bed has been removed.	High tidal currents over a shallow shelf Important for schooling fish especially plankton feeders and their predators
640 Otuwhanga Island	35 10.163 174 20.057	Various including field assessments 1 April 2013 and 7 January 2010	Rock wall and slopes around island with often strong tidal currents	In NE corner <i>Lessonia</i> dominates until 12-14m where <i>Ecklonia</i> becomes increasingly dominant. Schools of trevally, kahawai, blue maomao. Also small snapper. In the NW and south <i>Ecklonia</i> dominates below 4-5m. Fish in groups @12-16m include blue maomao, parore, leatherjackets, kahawai. There can be large numbers of small snapper plus variety reef fish species including butterfish. Pink maomao were seen with other schooling fish in the north in 2010.	Current Important for schooling fish especially plankton feeders and their predators
641 Bird Rock	35 09.809' 174 18.339'	Various field assessments	Upwelling waters and reefs around an exposed islet	Variety of reef and schooling fish as well as predators such as kahawai. The rock is a seabird roost.	Current and upwellings of nutrient rich waters Important for seabirds and schooling fish
642 Tangatapu Estuary	35 15.288 174 15.629	Various field assessments 2007-2016	Moderately extensive area of intertidal flats and subtidal	Moderately extensive area of relatively intact intertidal flats with a sequence of mangroves, then saltmarsh grading into freshwater wetland. Much of the catchment and most riparian margins are in native vegetation. The area is part of a comprehensive	Good example of relatively intact marine and freshwater biotope sequence

Waypoint number & Location	GPS position	Source of information	Geomorphology	Description	How criteria are met
			channels	ecological restoration programme	
All of the waters of the Bay of Islands		Various sources www.doc.govt.nz/boi-marine-mammals Accessed 2 December 2016		Used by Bay of Islands resident population of 500 bottlenose dolphins and an unknown number of common dolphins. There has been a 7.5% decline in bottlenose dolphin numbers each year and half of all calves die in their first year. There are five designated rest areas where dolphins are to be left alone.	Important for marine mammals
All of the waters of the Bay of Islands		Various sources. www.dolphincruises.co.nz Accessed 2 December 2016		Used by visiting marine mammal species not normally resident in the waters of the Bay of Islands (including orca whales, Brydes whales, pilot whales and false killer whales). There are occasional visits from migrating whale species including blue whales and humpback whales.	Important for marine mammals

Discussion and Conclusions

Table 1 provides information about 66 rare or special sites within the Bay of Islands. It is biased towards shallower sites as it is easier to collect information about those sites. Accordingly deeper reefs and other special sites below 30m depth are relatively poorly sampled. Some areas may be covered by more than one special site, reflecting the different sizes and types of the special sites. The main marine mammal sites include the entire Bay of Islands because there is insufficient information to select sites that are especially important marine mammals. These animals have been seen throughout most of the Bay of Islands.

While the identified sites met at least one criterion, they are not equally special, rare or valuable. Assessing the relative ecological value of special sites was beyond the scope of this project. However, good progress has been made in assessing larger ecological complexes and estuaries in the Bay of Islands (Kerr, 2015).

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References

Booth, J., 2013 Seagrass in the Bay of Islands: our last goodbye?: A report to Bay of Islands Maritime Park Fish Forever Working Group
http://www.fishforever.org.nz/component/easyfolderlistingpro/?view=download&format=raw&data=eNpNjOGOWjAMRe_ifUQLGmDcHctZwgFQoE4aKW2iOAEkxN1JGipmlfj7P39bYtvik3GLoJztKUDHuGkQzCg18UqpFVwn712IztKid9c00hS5uDIIiSIUrkolzdLSiTh-Z-4QzudZK9W-opMcqZQ5rzzbqpoEoNNhQJZL-Pwz5VZZSwt7CZTf-LgXFwcxLppf8SjpA6SWRwTM1krjnQzdJ-9CPSIn5_v1WcxengTIJfUNgfJGOV1KLdCd5nV30yEeVI9KMDq57TNS7zeCANoRg

Department of Conservation; Ministry of Fisheries. 2008. Marine protected areas: classification, protection standard and implementation guidelines. p 54. Ministry of Fisheries and Department of Conservation, Wellington.

Froude, V.A., 2014. Northland Regional Council Northland Mapping Project. Natural character methodology report- including amendments following Council decisions. Pacific Eco-Logic Ltd, Bay of Islands. 31pp. <http://www.nrc.govt.nz/contentassets/42f72aba3b23432ba3fbc8cfce46f976/natural-character---mapping-methodology.pdf>

Froude, V. A. 2016. Kelp cover and urchin barrens in the Bay of Islands: a 2016 baseline. A report prepared for the Bay of Islands Maritime Park Fish Forever Working Group. Russell, Pacific Eco-Logic Ltd. 70p.

Kerr, V.C., 2015. Ecologically Significant Marine Area Assessments for Northland Regional Council (<http://www.nrc.govt.nz/contentassets/95eceed9408f4873b35b5e3f781dac6d/significant-ecological-marine-area-assessment-sheet---eastern-boi-biogeinic-soft-bottom-complex.pdf>)

Morton, J. 2004. *Seashore ecology of New Zealand and the Pacific*. David Bateman New Zealand.

Nelson, W.A.; Neill, K.; Farr, T.; Barr, N.; D'Archino, R.; Miller, S.; Stewart, R. 2012. Rhodolith Beds in northern New Zealand: characterisation of associated biodiversity and vulnerability to environmental stressor. *New Zealand Aquatic Environment and Biodiversity Report No. 99*, p 102, Wellington.

Appendix 1: Photographs of examples of types of special sites:

Caves

Arches

Lagoons

High current slots and unique geological substrates

Biogenic substrates and noted organisms

Estuarine sequences

Survey methods and rare species

Caves



167 Swallows Cave, Maunganui Bay



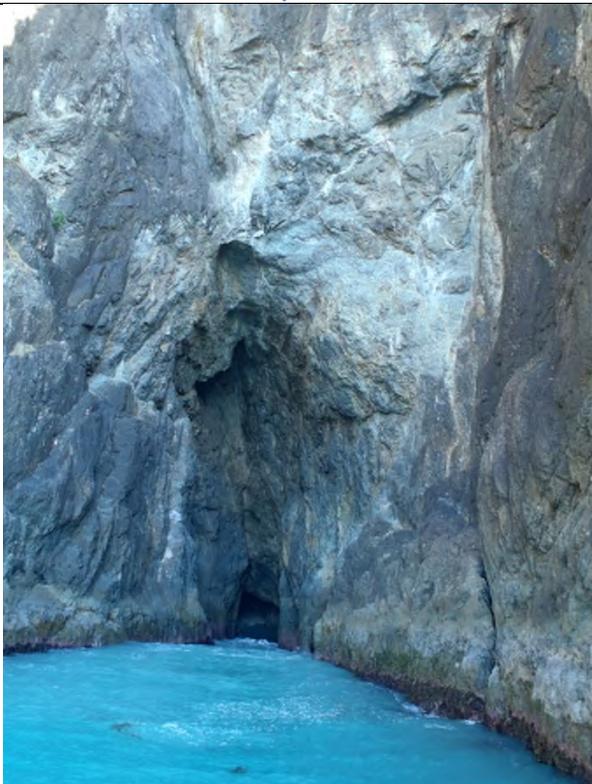
103 Deep cave southern Brett peninsula



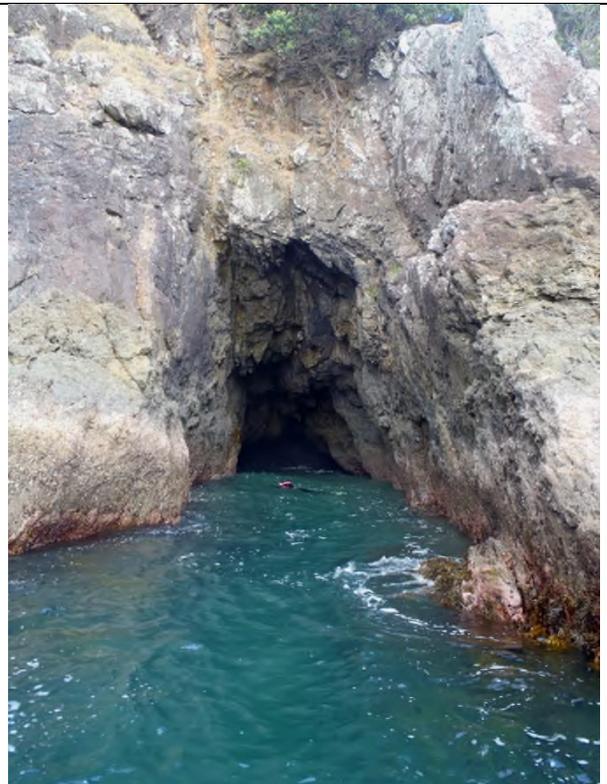
181 Colour cave north Brett peninsula



185 Noisy cave north Brett peninsula



190 Cloudy cave north Brett peninsula



409 Twin Caves Okahu Island

Caves



211 Twin caves east Waewaetoria Island 1



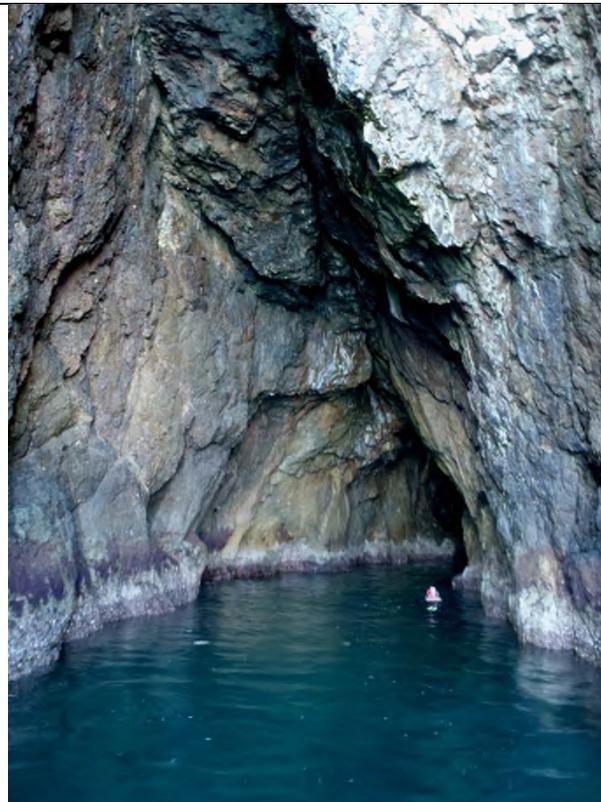
211 Twin caves interior Waewaetoria Island



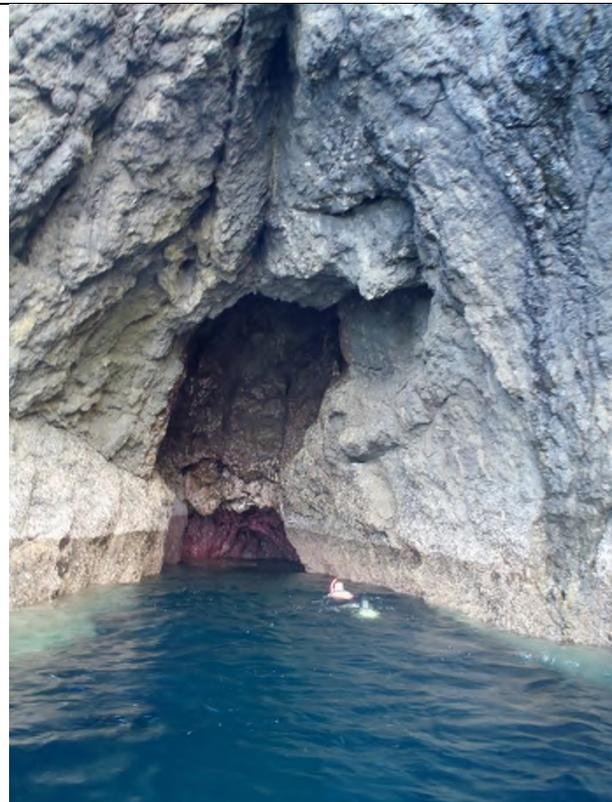
252 Long Cave north Urupukapuka Island 1



608 Low roof cave Harakeke Island



610 High Roof cave Harakeke Island



Short Deep cave Purerua peninsula

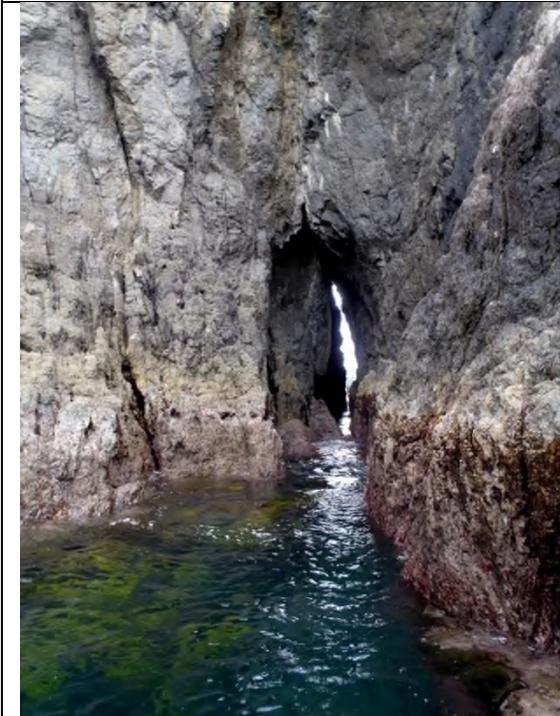
Arches



635 Big Arch Maunganui Bay east entrance



112 Twin Arches Southern Brett peninsula



259 Narrow Arch east Urupukapuka Island



343 Tall Arch Rawhiti Point



606 Big Arch Harakeke Island Wiwiki



635 Motutui Arch Howe Point

Lagoons



505 Western Lagoon Motuarohia Island



513 Middle Lagoon Motuarohia Island



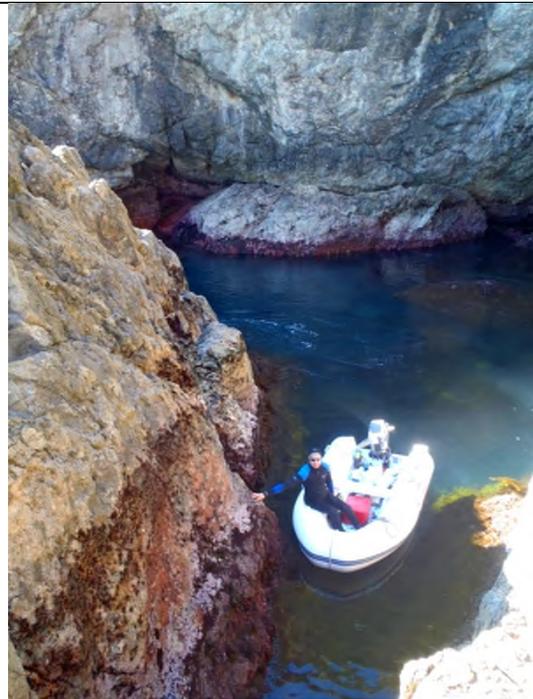
516 Eastern Lagoon Motuarohia Island



602 Shallow Lagoon Wiwiki Islands

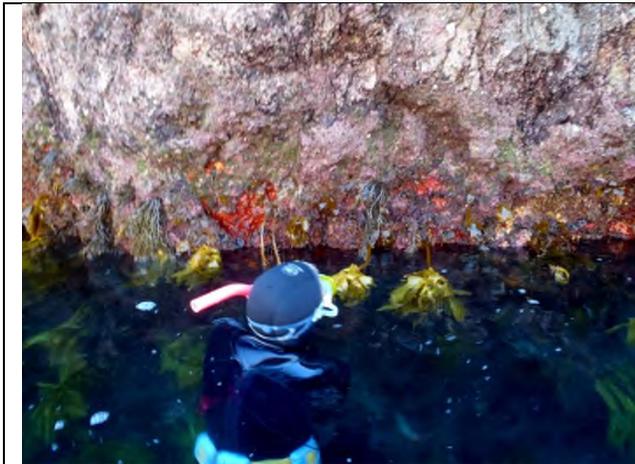


615 Te Pahi Island Pillow Lava Lagoon



578 Ohututea Bay lagoon with freshwater inflows

High Current channels and Unique Geological substrates



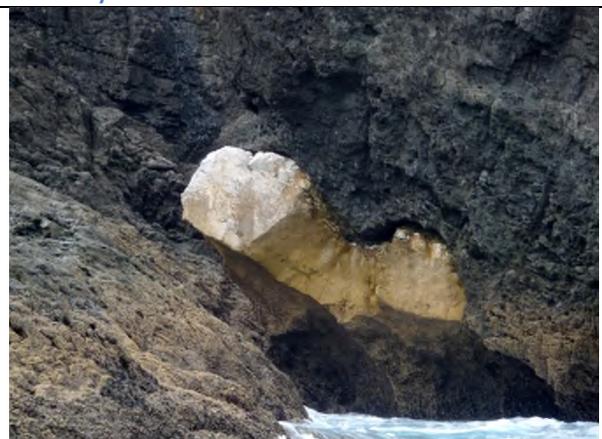
179 Shady Slot North Brett peninsula



179 Shady Slot intertidal encrusters



598 Otuwhanga Island seal channel Cape Brett



250 Marble Reef North Urupukapuka Island



617 columnar basalt intertidal Battleship Rock

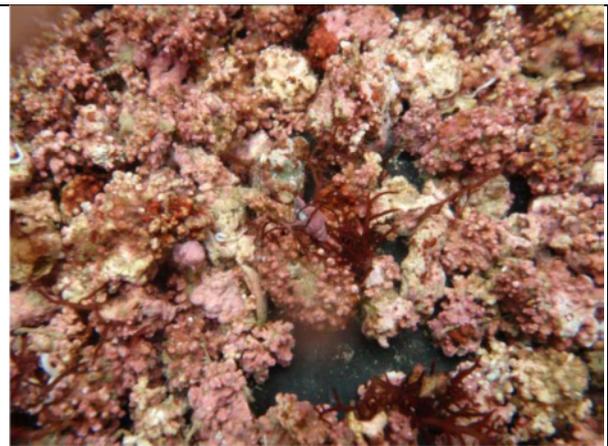


617 Basaltic caves and arches underwater
Battleship Rock

Biogenic substrates & Noted Organisms



632 Rhodolith bed Te Miko Reef (c) NIWA



632 Lithothamnion rhodoliths BOI (c) NIWA 1



Branching bryozoan



Bushy bryozoan



Bryozoan tuskers



Bryozoan tusker

Estuarine Ecological Sequences

Survey methods and rare species



Shallow reef surveying Moturua Island



Snorkel survey Motuarohia Lagoons



631 Hammerhead pup in tonic suppression



638 Giant wandering anemone Okahu Passage