SUBMISSION CONCERNING
MAUNGANUI BAY SECTION 186A RAHUI RENEWAL

Marine biodiversity in Bay of Islands' Maunganui Bay, and consideration of the impact of 10 years' closure to fishing under a *Fisheries Act Section 186A* Rahui

John Booth
(Reviewed by Vicky Froude & Chris Richmond)
On behalf of *Fish Forever*

Maunganui Bay, on the Cape Brett Peninsula. Bay of Islands, with Rakaumangamanga the high peak. (Photo: Lara Kay Photography)

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This document – at a glance

The primary purpose of this document is to register the strong support of community group *Fish Forever* for a further two-year temporary closure of Maunganui Bay to the taking of all fisheries resources except kina.

The second purpose is to summarise the current state of knowledge concerning marine biodiversity in Maunganui Bay in light of 10 years' closure to fishing under a rahui.

- A Section 186A Rahui was established in Maunganui Bay in November 2010, three years after the scuttling of the frigate *Canterbury* there;
- Colonisation of the *Canterbury* by algae, invertebrates and fishes continues to take place, but has not yet reached its climax state;
- Meantime, although anecdotal reports and observations point to a growing abundance, variety and individual-size of taonga food species such as snapper, there is little scientific evidence for this;
- Furthermore, there is no evidence for any significant recovery amongst the widespread urchin barrens within Maunganui Bay;
- A Section 186A closure is primarily an intervention to improve the availability or size (or both) of species of fish, aquatic life or seaweed after previous overharvesting. For the Mana Moana of Maunganui Bay it is integral too to the recovery of mauri. On neither count has the Rahui yet achieved purpose;
- Traditionally vital to the local Hapu, and in the hearts of much of the wider community, Maunganui Bay needs further time to recover.
- Renewing the temporary closure would continue to recognise and make provision for the kaitiakitanga management of hapu by facilitating the improvement of the size and abundance of snapper, koura and other predators of kina, thereby improving the size and extent of seaweed/kelp forests as nurseries for other kaimoana and for the mauri that they embody.
- Such renewal would also meet the criteria set out in Subsection 2 of Section 186A of the Fisheries Act.

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Preamble

A Rahui instituted in November 2010 on Maunganui Bay, in the eastern Bay of Islands, under Section 186A of the Fisheries Act prohibited all fishing apart from that for kina *Evechinus chloroticus* for two years. The Rahui has since been reapplied for and renewed every two years, and Fisheries New Zealand has now called for submissions concerning an application for a further two year closure.

Fish Forever (www.fishforever.org.nz) is a Bay of Islands-local community conservation group of people who, while engaging in recreational fishing themselves, also promote, advocate, and support conservation of native life in the sea in the same way as New Zealanders do for the land. This document is *Fish Forever*'s submission in support of a further renewal of the Maunganui Bay Rahui. The submission goes further by summarising what is known about the marine biodiversity of Maunganui Bay, and any detectable changes that have taken place over the past decade. It highlights certain high – and probably improving - biodiversity and other ecological values, but the ecosystems and communities of Maunganui Bay are far from fully recovered from years of overfishing in the region. There is strong public support for the Rahui to continue, as evidenced by the level of submissions in support submitted through *Fish Forever*'s website this year, as well as two years ago.

Section 186A (posted in full in the Appendix) provides that the Minister of Fisheries may temporarily close an area, or temporarily restrict or prohibit the use of any fishing method in respect of an area, if satisfied that the closure, restriction, or prohibition will recognise and provide for the use and management practices of tangata whenua in the exercise of non-commercial fishing. Key to this document at the moment are Subsections 2 and 3.

(2) The Minister may impose such a closure, restriction, or prohibition only if he or she is satisfied that it will recognise and make provision for the use and management practices of tangata whenua in the exercise of non-commercial fishing rights by—
(a) improving the availability or size (or both) of a species of fish, aquatic life, or seaweed in the area subject to the closure, restriction, or prohibition; or
(b) recognising a customary fishing practice in that area.

(3) Before imposing a fishing method restriction or prohibition under subsection (1)(b), the Minister must be satisfied that the method is having an adverse effect on the use and management practices of tangata whenua in the exercise of non-commercial fishing rights.

The Hapu (Ngati Kuta and Patukeha) in whose rohe moana Maunganui Bay lies - and who were the instigators of the Rahui - make clear through their Hapu Plan Fisheries Baseline Principles 1 and 2 that kai moana stocks – especially Ika Taonga (particularly treasured species that include tamure [snapper] *Pagrus auratus* and koura [rock lobster] *Jasus edwardsii*) – are at all times plentiful or very plentiful (Mountain Harte 2009; Ngati Kuta 2011). Also, maintenance and enhancement of the mauri of the marine life, and practice of kaitiakitanga around marine resources, are paramount considerations (Ngati Kuta 2011). This was particularly pertinent to Maunganui Bay, the bay being a symbol of heritage and connection to homelands.

> ‘Above Maunganui Bay is Rakaumangamanga, a waypoint of the Polynesian triangle used by navigators as they neared Aotearoa. Voyagers, and later resident Maori, would pull into Maunganui Bay and nearby Ohututea for shelter and for freshwater. It was also a place where chiefs were baptised, and would karakia before their forays. For local Maori it was also significant for its kai moana: in the waters from Maunganui to Oke Bay there were always tamure, tarakihi [*Nemadactylus macropterus*], and porae [*Nemadactylus douglasii*]. These fish and the kutai (mussels) which were all along the coastline and coastal rocks were a food source for our hapu.’ [Ngati Kuta evidence currently before the Environment Court]

The Rahui in Maunganui Bay became official in November 2010 under Section 186A of the Fisheries Act, after having been imposed locally some months prior. At that time the particular objective was to prevent harvesting of kai moana that would become associated with the frigate HMNZS *Canterbury* which two years earlier had been scuttled there in 30-m depth of water as an artificial reef and dive attraction. (In the current context *Maunganui Bay* is the broader bay, with *Deep Water Cove* a small embayment in its northeastern corner.) The Rahui prohibits all fishing apart from the harvesting of kina. The Rahui did not, and still does not, require any specific monitoring of ecological change within Maunganui Bay, but the Northland Regional Council (NRC) resource consent for the sinking of the *Canterbury* did require certain observations on the vessel’s rates and levels of marine colonisation, and its use by fish, in relation to control sites nearby. With relaxation of these conditions in 2014, the main ecological focus within Maunganui Bay changed from monitoring the effects of the presence of the scuttled vessel, and changes in the plant and animal life associated with it, towards changes within Maunganui Bay as a whole that might have come about because of the Rahui.

Figure 1. Location in the Bay of Islands, and the boundaries of, the Maunganui Bay Rahui area.

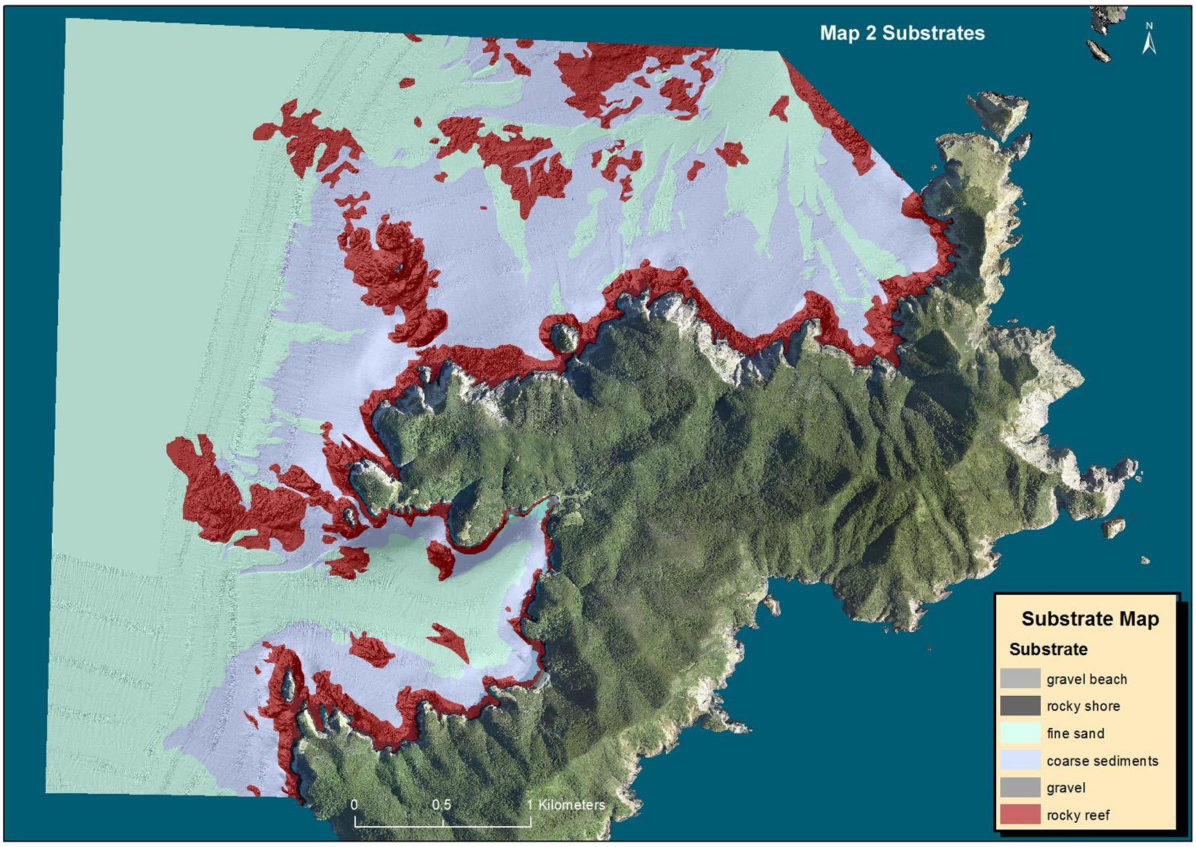
Fish Forever’s 2012 report (Fish Forever 2012) not only provided a reasonably full account of the communities of animals and plants associated with the *Canterbury*, and with the natural reefs of Maunganui Bay, but they also contextualised these observations with previous key surveys. No formal surveys of ecological change and colonisation of the *Canterbury* have been made since (although certain changes can be seen in serendipitous imagery), but a number of ecological projects have been undertaken through to the present within Maunganui Bay, several with control sites outside the Bay. These investigations form the bulk of this report.

1. Status of the marine life of Maunganui Bay today

The Rahui in Maunganui Bay has now been in place for a decade, so it is timely to bring together what we know of the status of the marine life there – the nature, vigour, variety, and individual size of native plants and animals - and whether it has changed significantly over that interval compared with adjacent shores beyond the Rahui area. Important to consider too is the establishment of any non-indigenous species (NIS). The rationale behind the Rahui is recovery and restoration of long-used and long-held harvesting opportunities; for Ngati Kuta this means not only stocks healthy enough to support sustainable fishing, but also ecosystems that are vibrant and healthy.

1.1 Substrate-mapping

Substrate maps are frequently used as a surrogate for the plant and animal habitats and communities present. The substrate maps of the entire Bay of Islands (Kerr 2009) were updated for Maunganui Bay and adjacent areas by *Fish Forever*'s Kerr (2016a) by building on the highly-detailed LINZ-funded Bay of Islands 2009 Ocean Survey 20/20 (https://marinedata.niwa.co.nz/bay-of-islands-coastal-survey-project/) seafloor mapping, and using bottom imagery and sampling of the seafloor to better understand community distribution (Figure 2).



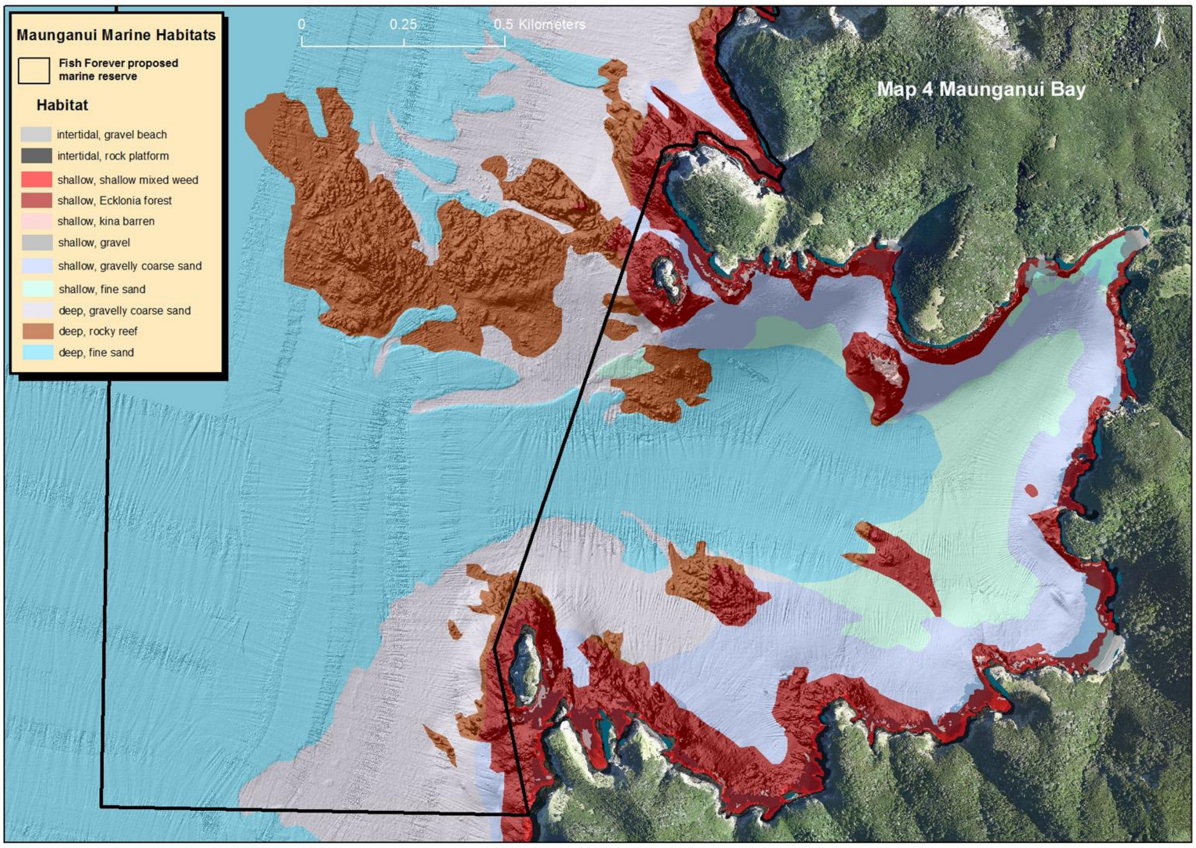


Figure 2. Substrate (upper) and habitat maps of Maunganui Bay and surrounding shores (Kerr 2016a).

1.2 Historical distribution of seaweed and fish communities

During the first half of 1991, Department of Conservation's Brook & Carlin (1992) examined the sea-life associated with rocky diveable reefs of the Bay of Islands. Based on presence/absence of laminarian (seawrack) and fucalean (true kelp) brown seaweeds, five zones were identified for exposed and semi-exposed shores. First was a shallow mixed-seaweed zone high on the shore, extending from the intertidal to the immediate subtidal, and typically dominated by seawracks (*Carpophyllum* spp.). Next was an algal turf and paint zone with sparse kelps - what we call 'urchin-(kina-) barrens' today. The third band was kelp forest most often dominated by the common kelp *Ecklonia radiata*. Beyond this was a deep zone with sparse common kelp, and below that no kelp at all.

Brook & Carlin then considered the fishes. They recorded 98 coastal species (which excluded the seasonal, pelagic oceanics) in 40 families, including 29 subtropical species - which they boiled down to three different communities. Assemblage A fish faunas (very high diversity, with many subtropical species) were present on reefs from Maunganui Bay to Motukokako. Assemblage B fish faunas (high diversity, with one or just a handful of subtropical species) occupied seaward-facing coasts elsewhere in the Bay. Assemblage C fish faunas [moderate diversity, with no subtropical species] occurred on reefs in inlets and bays of the inner Bay of Islands.

Diversity of coastal fish in the outer southeast Bay was found to be much the same as at the Poor Knights Islands, and much greater than in any other part of northern New Zealand, a feature subsequently reiterated by others (Francis & Evans 1992; Francis et al. 1999; Clements & Zemke-White 2009). Brook & Carlin (1992) concluded that the main drivers of community structure were exposure and water clarity, which led them to define six ecological habitat-types, that taking in the northern part of Maunganui Bay and extending out to Cape Brett being Type i (Exposed, low turbidity, with unique, rich algal zonation, high fish diversity, and with many subtropical species), and the southern and eastern part of Maunganui Bay being Type ii (Exposed, low turbidity, with rich open-water algae, high fish diversity and many subtropical species).

This summary – mostly formulated 30 years ago – still applies at Maunganui Bay, even to the presence of significant areas of sea-urchin barren. Degradation of the ecology of the shallow reefs have clearly been in progress in Maunganui Bay for many years.

1.3 Ocean Survey 20/20 contributes to our ecological knowledge

The Ocean Survey 20/20 involved widespread and often detailed sampling of the waters and substrates of the Bay of Islands during 2009-10, but - because of the size of the vessels used – sampling shallower than 10 m was largely confined to somewhat infrequent point samples. Only broad summaries of the work have been produced so far (as an introductory overview, together with 10 chapters [https://marinedata.niwa.co.nz/bay-of-islands-coastal-survey-project/]), with other data available online awaiting examination and interpretation). The main points revealed concerning Maunganui Bay are as follows.

1. The Cape Brett Peninsula, including Maunganui Bay, has higher-than-average levels of sightings of ***marine mammals*** of all descriptions compared with the Bay of Islands as a whole (MacDiarmid et al. 2009: 120-132);
2. Maunganui Bay/Deep Water Cove feature in many ***institutional collections*** of macroalgae and invertebrates (MacDiarmid et al. 2009: 181, 212), as well as fishes;

3. ***Water column and water quality*** Maunganui Bay was the only part of the Bay to have dissolved zinc in concentrations exceeding low ANZECC (2000) water quality thresholds, and it also had high concentrations of chromium, cadmium, lead and nickel (Maas & Nodder 2010: 9);
4. ***Seafloor assemblage and habitat assessment using DTIS (deep towed imaging system)*** Even though the benthic invertebrate infauna of Maunganui Bay was relatively ubiquitous but sparse, somehow calculated diversity indices were high (Bowden et al. 2010, pages 28-29). There were low levels of sessile fauna and mobile invertebrate fauna (pages 31-32); and the low echinoderm presence was dominated by holothurians (page 33).
5. ***Shallow rocky reefs*** Sites in the outer Bay of Islands generally had higher species richness, but the level of shelter at a site also interacted with this gradient. Accordingly, Maunganui Bay had a fish fauna that closely resembled inner Bay of Islands sites (Parsons et al. 2010, pages 5, 24). It was noted that urchin barrens were less widespread within Maunganui Bay than on nearby shores (page 12).
6. ***Soft-sediment habitats and communities*** Mega ripples on the seafloor pointed to strong oceanic influences; there were patches of tubeworms and some red filamentous algae, but little epifauna (Hewitt et al. 2010: 36).
7. ***Fish communities*** Factors influencing fish community structure included depth, distance to open water, habitat type and habitat heterogeneity (Jones et al. 2010: 72), very much in line with Brook & Carlin (1992).

1.4 Colonisation of the *Canterbury* by algae, invertebrates and fishes

Fish Forever's April 2012 ecological survey of the *Canterbury*, and of Maunganui Bay in general (Fish Forever 2012), was the most detailed synthesis of the colonisation of the vessel undertaken. It drew upon and extended the previous studies centred around the scuttled vessel but some also considered the broader Maunganui Bay (Newcombe & Retter 2007; Mountain Harte et al. 2010; Fairweather & McKenzie; McKenzie 2010; Greene & Tuterangiwhiu 2010; Jacobs & Robertson 2011).

The July 2011 survey (Jacobs & Robertson 2011) provided the most useful point of comparison for the April 2012 survey. The percentage cover by sessile organisms of both the vertical and horizontal surfaces of the *Canterbury* had increased significantly between July 2011 and April 2012, reaching the full coverage possible (although this was not necessarily the climax state). Although taxon richness changed little, there were large changes in community structure - most noticeably in sponge and tubeworm cover, with concomitant decrease in filamentous algae and lithothamnion paint. Mean numbers of fish, and mean fish-species richness, associated with the *Canterbury*, were much the same in 2012 as they were in 2011. However, the densities of an essentially unfished reef-associated generalist indicator species, the kőkiri (leatherjacket) *Parika scaber*, the planktivorous two-spot demoiselle *Chromis dispilus*, and the highly-sought generalist snapper were lower around the *Canterbury* in 2012 than in 2011, and the biomass of snapper in 2012 was only 118 g per 100 m^2, compared with 157 g in 2011. In surveys of natural reefs in Maunganui Bay, mean numbers of fish and mean species richness were much the same in 2012 as they were in 2011. Snapper biomass was greater in Maunganui Bay away from the ship than it was around the *Canterbury* itself in both years.

Ecological focus in Maunganui Bay moved away from the *Canterbury* after 2012: colonisation was progressing, and – perhaps most importantly – it became clear that the high levels of resource required in the 2012 sampling was not sustainable over the long term – and neither was such level of sampling necessary. Accordingly, the main issues for NRC became stability of the vessel, and whether there were any signs of non-indigenous species (NIS).

1.5 Ecological changes in Maunganui Bay leading up to 2012

The 2012 sampling – and observations leading up to it - formed a basis for ongoing ecological observations *within* Maunganui Bay as a whole, rather than of just the *Canterbury* itself. There was evidence for greater densities of snapper on the reefs there in 2012 than in 2011 (although sampling was very limited) (Figure 3).

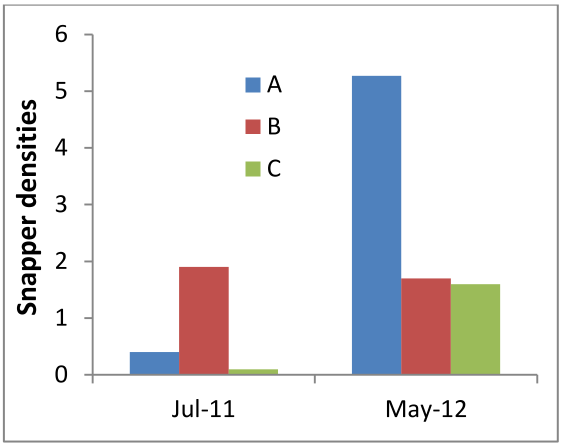


Figure 3. Densities of snapper (numbers 100 m^{-2}) seen on reefs in Maunganui Bay. A, Transects 1–3; B, Transects 4–6; C, Transects 7–9, July 2011 and April/May 2012 (± 95% C.I.) (*See* Fish Forever 2012 for details.)

Use of the Baited Underwater Video (BUV) methodology (Willis & Babcock 2000) allowed comparisons of relative abundance of predatory fish around the *Canterbury* with other parts of Maunganui Bay, as well as along the broader Cape Brett Peninsula. The densities of snapper were similar throughout, whereas no leatherjackets were seen around the *Canterbury*. The 2012 sampling also found no detectable differences in fish abundance or variety between Maunganui Bay as a whole and adjacent areas (Figure 4).

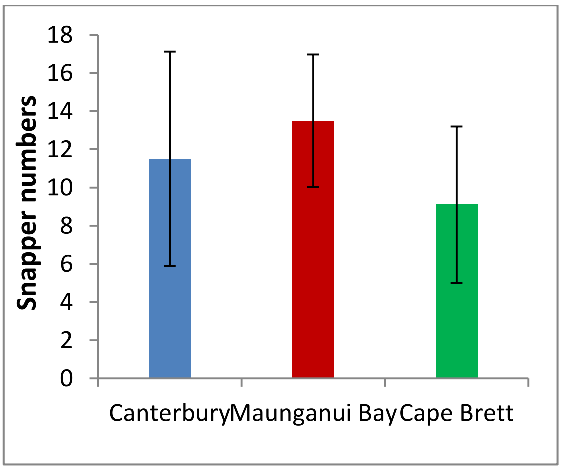


Figure 4. Baited underwater video counts of snapper around the *Canterbury*, elsewhere in Maunganui Bay, and around the broader Cape Brett Peninsula, 2012 (± 95% C.I.). (*See* Fish Forever 2012 for details.)

But diver observations of snapper size showed little change between 2008 and 2012, with numbers and sizes generally small (Figure 5).

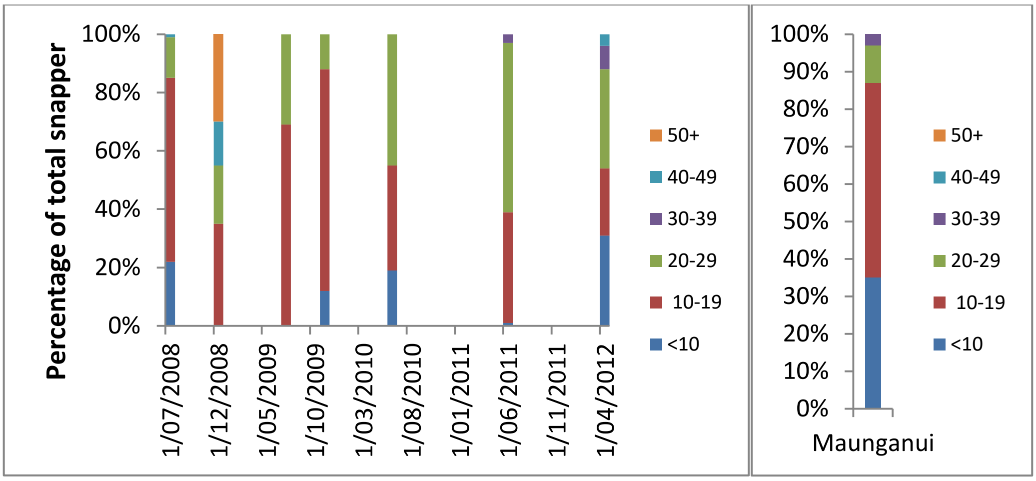


Figure 5. Proportions of snapper by estimated size (cm) in the diver fish-count sampling of the *Canterbury* 2008–12 (left), together with the sizes in April/May 2012 of snapper elsewhere in Maunganui Bay (right). (*See* Fish Forever 2012 for details.)

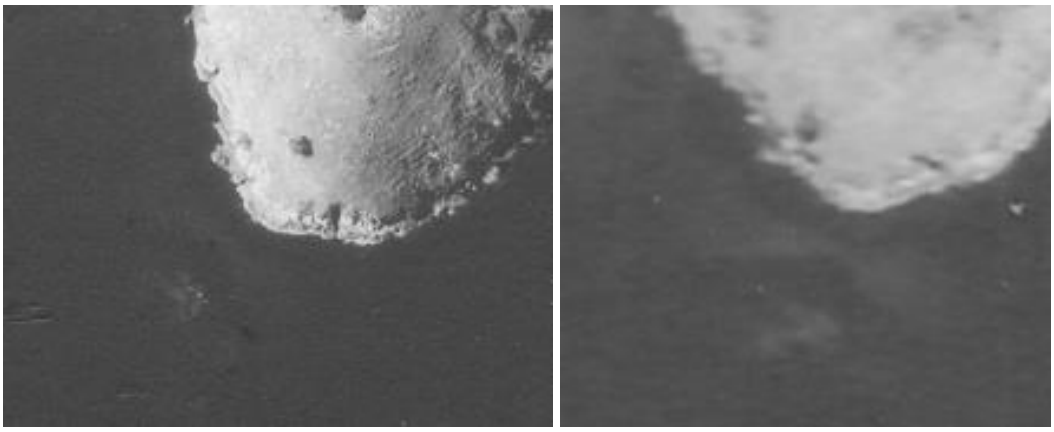
1.6 The extent and progression of sea-urchin barrens in Maunganui Bay and nearby

The urchin barrens of Maunganui Bay became a major topic of investigation by *Fish Forever* because of its potential as an indicator of ecological well-being. Urchin barrens develop on shallow reefs when key predatory species are overfished. The loss of shallow-reef kelp throughout much of the main basin of the Bay of Islands (Booth 2016, 2017; Froude 2016a, Kerr & Grace 2015; Kerr 2016b) has been among the most severe documented for the entire country, the time-trajectory of their development coinciding with the development of intense harvesting (first mainly commercial, but later recreational as well) of predatory species like snapper and rock lobsters. The ecological indicator role comes from the fact that, as demonstrated in Northland no-take reserves, when an ecosystem is fully restored, there are sufficient large snapper, large rock lobsters and other large predators to keep the sea urchins in check and for the kelp forests on shallow reefs to recover.

The extent of the urchin barrens of Maunganui Bay was examined using the Oceans 20/20 aerial imagery (*Fish Forever*'s Booth 2016, 2017). Although in many places the reef was too steep to assess, or it was in shadow, *all* of the rocky shoreline of Cape Brett Peninsula that could be examined (28% of the 34.4 km - all within Maunganui Bay) contained significant sea-urchin barrens (Figure 6).

Figure 6. Estimated extent of sea-urchin barrens (red) in the east of the Bay of Islands in November 2009. In many places the reef was too steep to assess, or was in shadow (blue). (Image: Ocean Survey 20/20)

The only part of Maunganui Bay with useful pre-2009 imagery concerning shallow-reef kelp took in White Rock (Figure 7). White Rock emerges from soft sediments at 10-20 m depth, and can break the surface at low water springs. The earliest historical image available to us is from October 1950, well before urchin barrens had become widespread in the Bay of Islands, in the 1970s. By 1981-82, the area of white had expanded to something similar to what we see today (Booth et al. 2017).



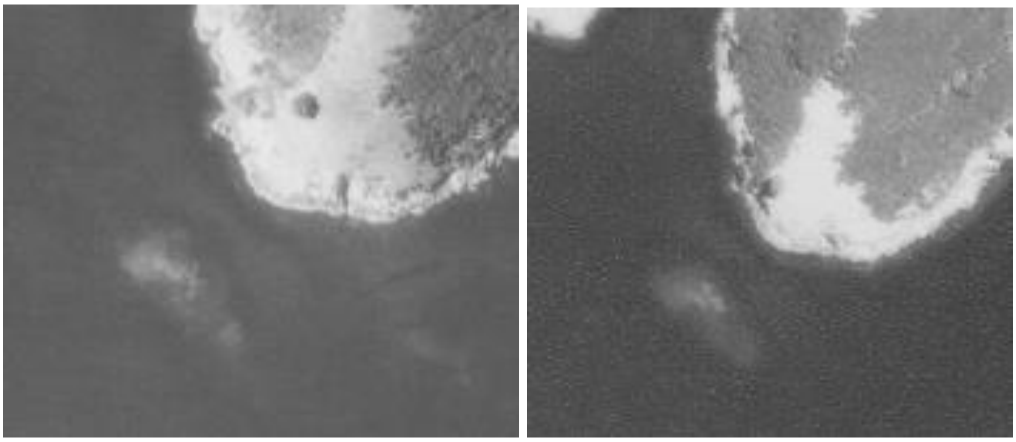


Figure 7. Aerial photographs of White Rock (not georeferenced) for October 1950 (top left), February 1959; January 1980; and February 1982 (bottom right).

The area of the mapped urchin barren at White Rock in 2009 was, in plan view, 0.326 ha, whereas in 2017 it was less than half of this (0.138 ha). Furthermore, there was much more kelp present at the top of the rock in 2017 (Figure 8).

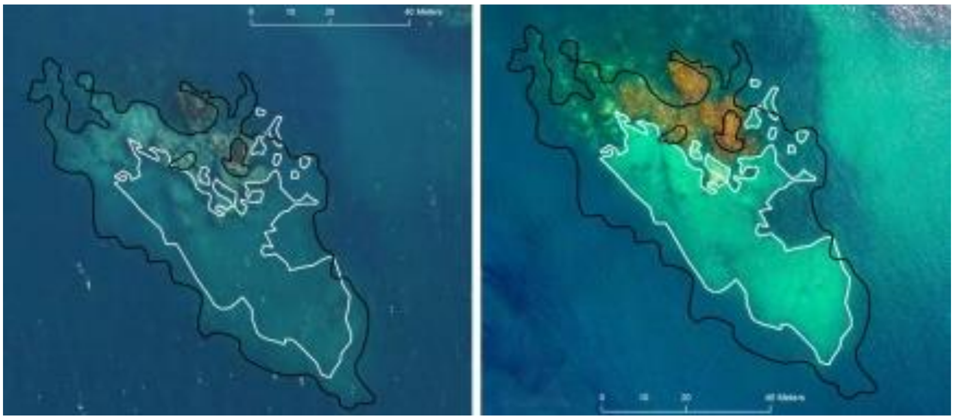


Figure 8. Georeferenced images of White Rock for 2009 (left, with estimated extent of urchin barrens indicated by black line) and 2017 (right, white line) (Booth et al. 2017).

White Rock is enigmatic for several reasons (Booth et al. 2017). It is named this in Pickmere's Atlas of Northland's East Coast New Zealand, much of this atlas being based on surveys in the 1950s – yet it is unclear why parts of the rock have always been (at least since 1950, according to our aerial images) free of kelp. In any event, the historical images suggest extensive urchin barrens had established there by 1980, which is entirely consistent with other parts of the Bay of Islands (Booth 2017). The analyses suggest there may have been some reduction in extent of kina barrens at White Rock between 2009 and 2017 – although it is hard to be sure because most of this recovery had apparently taken place at depth, where visibility issues mean it was more difficult to pinpoint reference points. White Rock is also exceptional in Maunganui Bay because it is where urchins are opened underwater by dive operators for their clientele to observe, this possibly - in turn – leading to increased abundance of large predators there.

One of the aims of *Fish Forever*'s Vicky Froude's (2016a) very intensive and extensive survey of Bay of Islands kelp cover/urchin barrens (Figure 9) was to clarify the status of the areas from the 2009 Oceans 20/20 imagery that were too steep, or were in shadow, and which had been marked blue by Booth (2015, including in Figure 6 above), with the secondary purpose being to establish baselines from which to monitor future change in kelp cover (Froude 2016a: 5). She evaluated changes in the cover of urchin barrens versus kelp forest in the outer Bay of Islands in relation to a range of environmental factors, the depth range evaluated (2-12 m) selected as being the most vulnerable to the formation of urchin barrens based on work elsewhere in northern New Zealand. Altogether 561 quadrats were assessed in 13 sectors (11 of which were in the eastern Bay of Islands), with 54 quadrats within Maunganui Bay. Percent cover was estimated for 19 cover classes, these data being aggregated to determine the extent of typical and atypical (patchy) urchin barrens and tall brown algae. In Maunganui Bay, tall brown algae cover was 46.3%, with 35.5% being *Ecklonia*. Total urchin barren cover was 42% with 32% being typical. The relatively high percentage of *Ecklonia* and the large urchin *Centrostephanus* (a subtropical sea urchin, discussed in detail later) (compared to other sectors) was probably a function of the relative shelter of Maunganui Bay from the effects of large easterly swells.

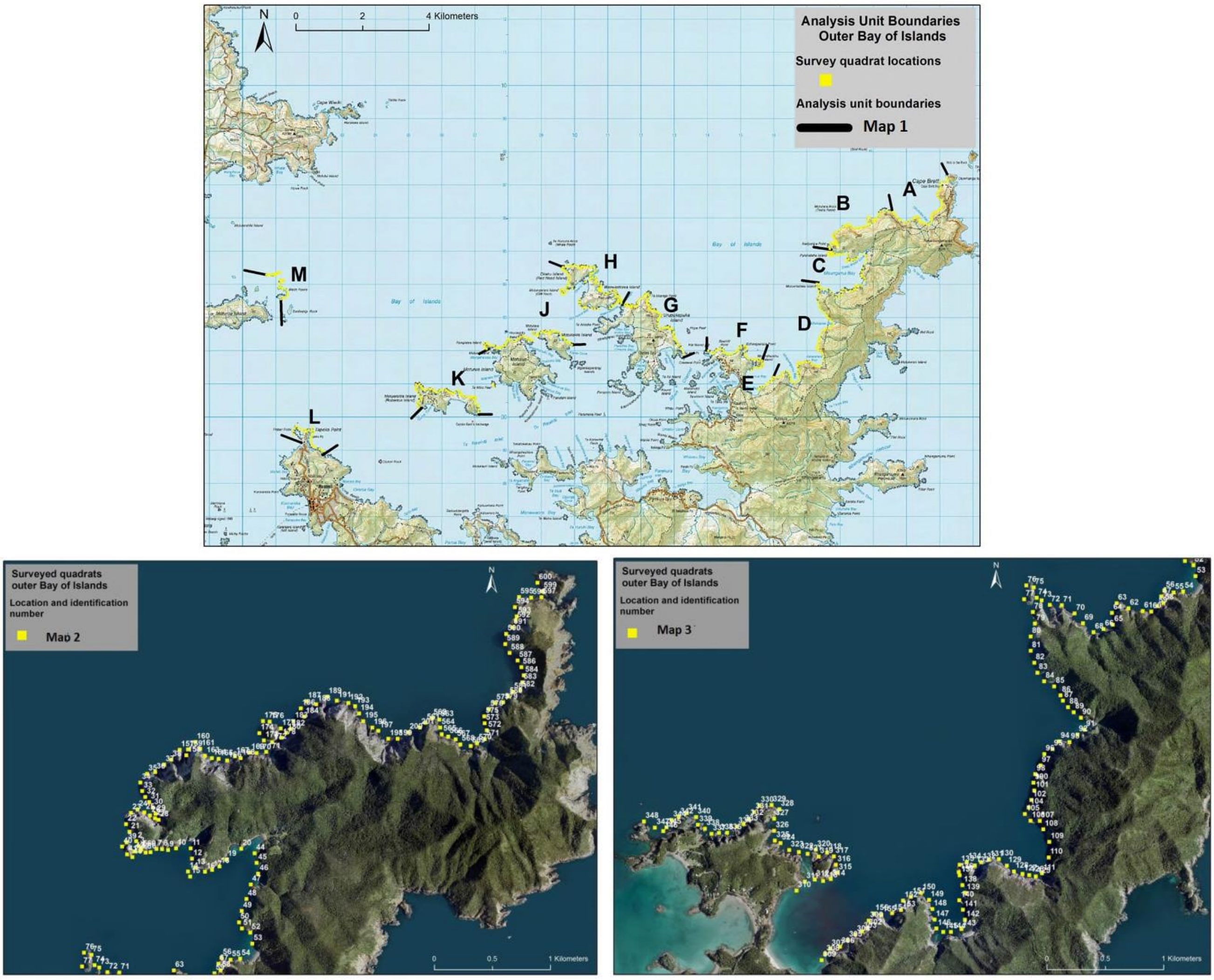


Figure 9. Froude's (2016a) analysis units (uppermost) and surveyed quadrats in the eastern Bay of Islands, including within Maunganui Bay.

There were, however, no significant differences between urchin-barren coverage within the Maunganui Bay Rahui area and that of similar shores fully open to fishing north and south of Maunganui Bay.

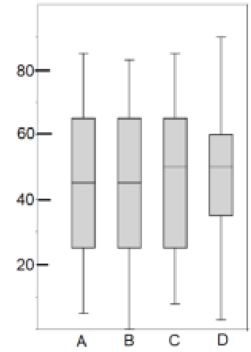


Figure 11. Box plot of percent kina barrens across analysis-units A-D, Maunganui Bay being Unit C (Froude 2016a). (Line in box = median, box = 25-75 percent quartiles, whiskers are minimum and maximum values)

In a separate but related investigation of urchin barrens in the eastern Bay of Islands, *Fish Forever*'s Vince Kerr (2016b) demonstrated that large urchin barrens (>10 m^2) can be reliably mapped at 1:500 scale when good quality aerial images are available, but can fall short when there is shadow, light reflection on the water surface, or where reef slopes are too steep. He also showed that small urchin barrens (<10 m^2) and urchin barren patches (the 'atypical' barrens of Froude 2016) were common on the Cape Brett shoreline (including within Maunganui Bay) and that these habitats were essentially underreported in habitat mapping studies carried out at a mapping scale of 1:500 (Figure 10).

Figure 10. Location of Kerr's (2016b) 12 transects on the exposed Cape Brett coast and within Maunganui Bay.

The trajectory of urchin barrens within Maunganui Bay were specifically addressed using aerial imagery in 2017 – 10 years since the Oceans 20/20 imagery and eight years after the Rahui came into effect (Booth et al. 2017), with observations concerning White Rock given above. Although there was some evidence for increased cover of shallow-reef kelp in the broader Maunganui Bay after eight years under the Rahui, this did not pertain to sufficient sites to trigger the definition of significant change (at least 75% of sites investigated showed at least 25% change in extent, with no such change found in control sites outside Maunganui Bay) using the 2009 Oceans 20/20 imagery as the benchmark (Figure 11).

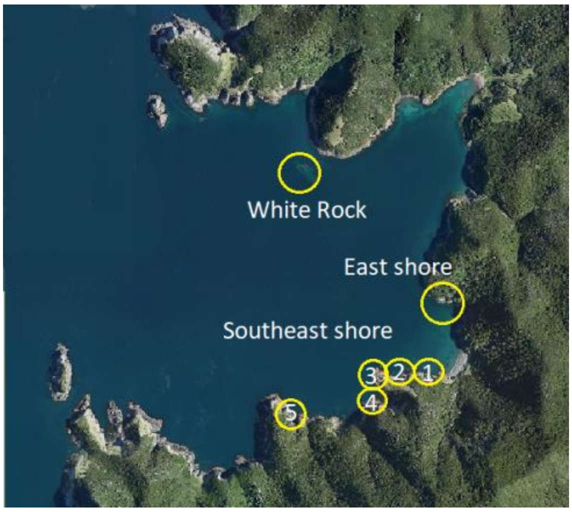


Figure 11. Location of the seven sites investigated by Booth et al. (2017) for change in extent of urchin barrens between 2009 and 2017.

1.7 Rock lobster abundance inside and outside Maunganui Bay

A pilot baseline survey of abundance of red rock lobsters (koura) and pawharu (packhorse rock lobsters) *Sagmariasus verreauxi*, and establishment of long-term sampling transects, was undertaken within the Rahui and outside it in 2016 by *Fish Forever*'s Brett Sutton (2016a). Using underwater visual census techniques to estimate size and density along <12-m deep transects with good lobster habitat (boulders, cracks and crevices), four transects were within the Rahui and four outside, all with similar reef characteristics and exposure levels (Sutton 2016a: 13) (Figure 12). Koura densities were higher (but not significantly so) across the Rahui transects than for the control sites. The Rahui area had on average larger koura, but again the difference was not significant. Pawharu occurred at 7.5 per 500 m^{-2} within the Rahui, whereas none was observed at the control sites. (Low [2015] had previously encountered lobsters inside Maunganui Bay but not outside it, in nearby Whakapae Bay.)

Figure 12. Location of Sutton's (2016a) sampled lobster monitoring sites.

1.8 Crypto-benthic reef fish inside and outside Maunganui Bay

Brett Sutton (2016b) also undertook in 2016 a pilot baseline survey of crypto-benthic reef fish within the Rahui and outside it, once again establishing potentially long-term sampling transects (Figure 13). Crypto-benthic reef fishes were defined as small (<5 cm adult) fish that are behaviourally cryptic and maintain close association with the benthos; in addition to triplefin species, morays eels, slender roughy and bigeyes are other groups of fish observed occupying cracks, crevices and caves beneath the *Ecklonia* canopy and were counted in this survey. The Rahui sites had higher species richness, this probably being explained by algal cover and habitat complexity being overall higher in the Rahui sites than in the control sites. The study found a weak positive correlation with algal cover and a slightly higher one with habitat complexity.

Figure 13. Location of Sutton's (2016b) sampling locations inside and outside Maunganui Bay Rahui in the outer Bay of Islands.

1.9 Updated predatory fish abundance inside and outside the Rahui

Using BUVs, *Fish Forever*'s Vince Kerr (2016c) re-surveyed predatory fish abundance on the inner shore of the Cape Brett Peninsula, this time at 30 locations including Maunganui Bay (Figure 14), with results directly comparable to those from 2012.

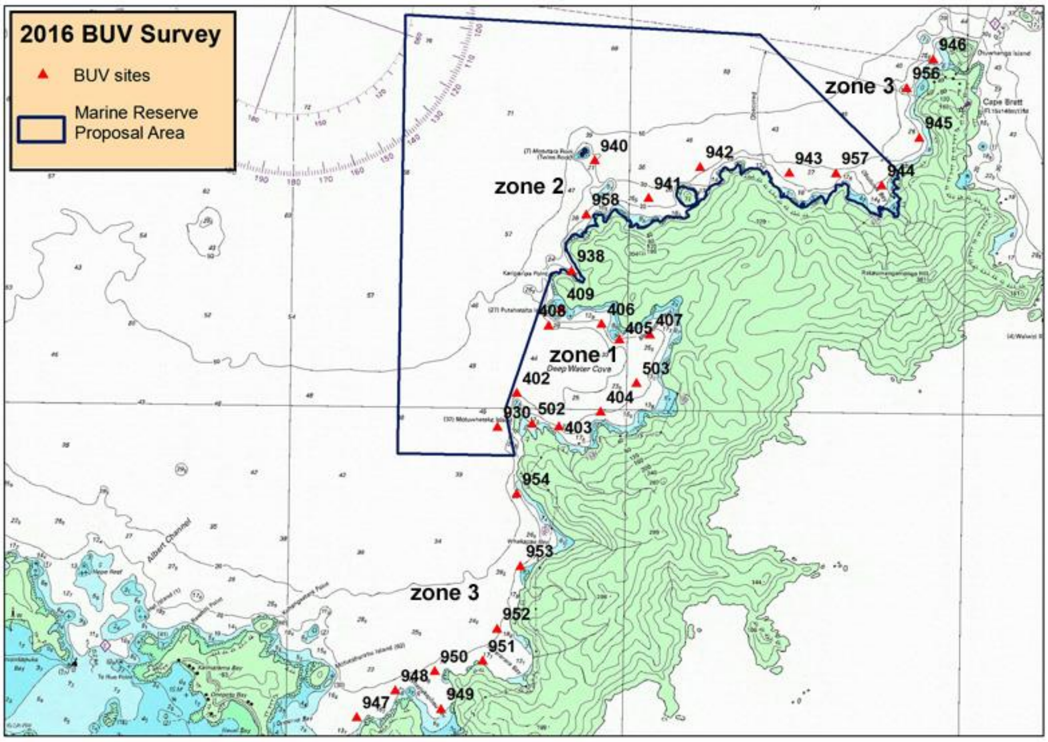


Figure 14. Location of Kerr's (2016c) sampling locations inside and outside Maunganui Bay Rahui in the outer Bay of Islands.

The main species recorded in 2016 was snapper (mostly 20-25 cm), which occurred in modest numbers throughout the sampling area. The 2012 sampling found that there were no detectable differences in fish abundance or variety between Maunganui Bay as a whole, and adjacent areas, and the follow-up BUV sampling of 2016 gave a similar result (Figures 15 and 16).

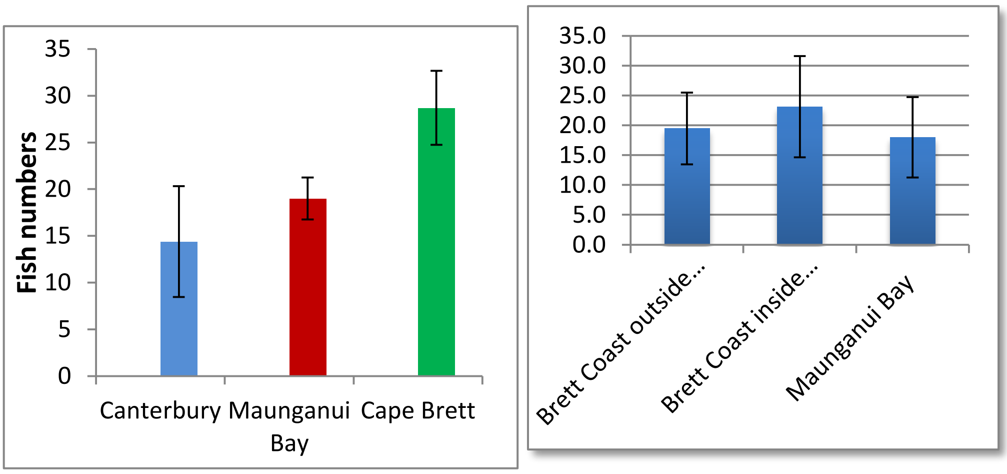


Figure 15. Mean fish count of all species for standard BUVs in Maunganui Bay in 2012 (left, Fish Forever 2012) compared with (essentially) the same sites in 2016 (right, Kerr 2016c) (± 95% C.I.).

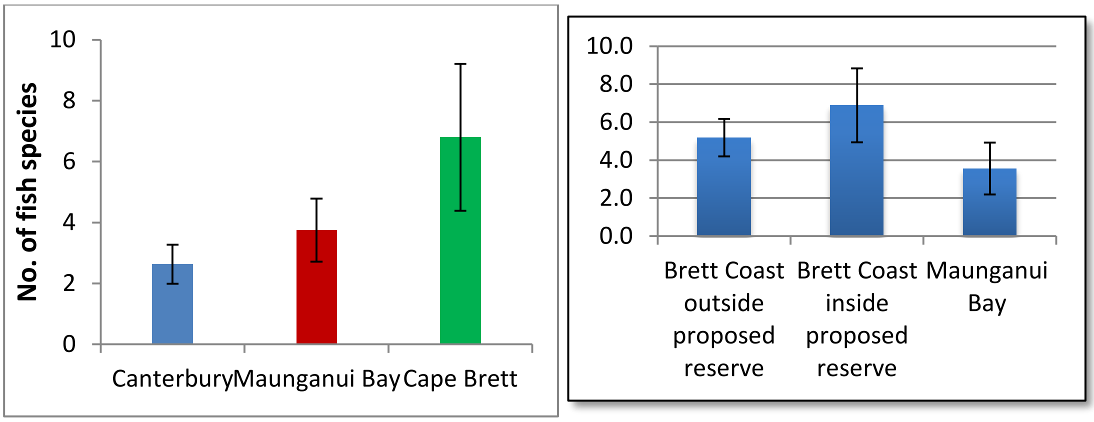


Figure 16. Fish-species richness for standard BUVs in Maunganui Bay in 2012 (left, Fish Forever 2012) compared with (essentially) the same sites in 2016 (right, Kerr 2016c) (± 95% C.I.). (Note that other comparisons between 2012 and 2016 are not possible because of different sample locations).

For snapper, there were no significant differences in the abundance of snapper inside and outside Maunganui Bay in either 2012 or 2016, their abundance comparable to previous monitoring in the area and typical of an area regularly fished.

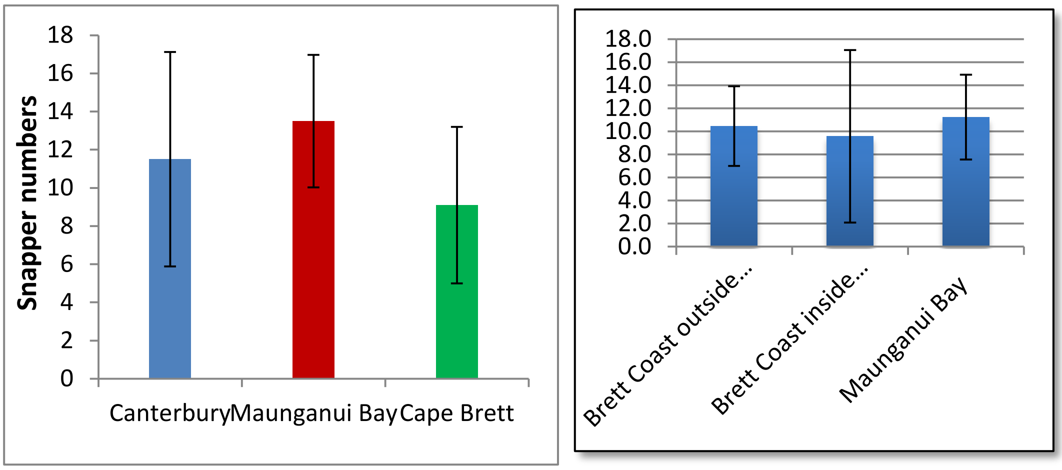


Figure 17. Baited underwater video counts of snapper numbers in Maunganui Bay, 2012 compared with essentially the same sites in 2016 (right, Kerr 2016c) (± 95% C.I.).

Finally, snapper numbers in Maunganui Bay did not change significantly between 2012 and 2016, nor did mean length (Figure 18).

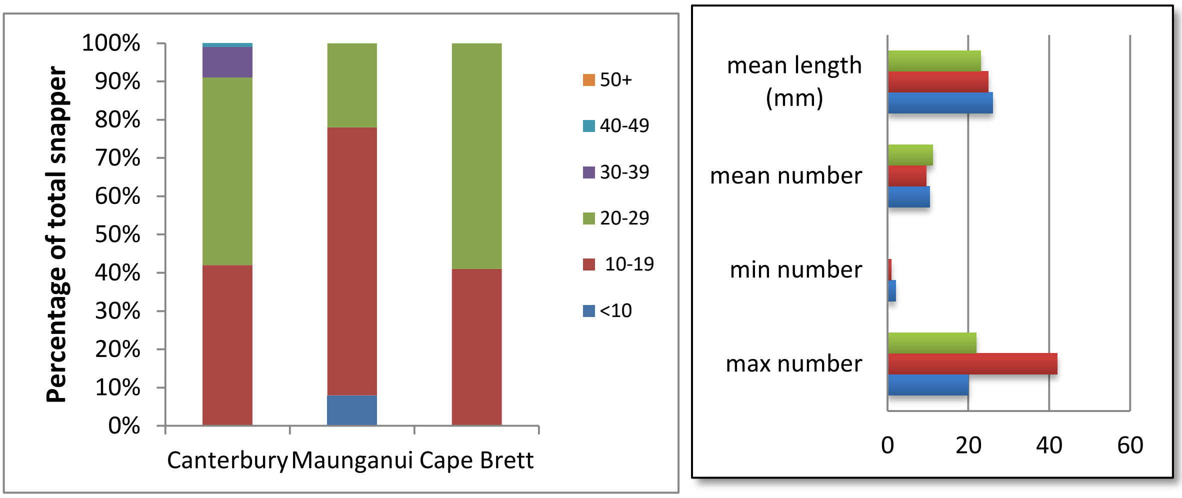


Figure 18. Proportions of snapper by estimated length (cm) from the BUV sampling in Maunganui Bay, 2012 (left, Fish Forever 2012) compared with (essentially) the same sites in 2016 (right, Kerr 2016c; Maunganui Bay is green).

Kerr (2016c) concluded that the snapper population had a long way to go before it could be described as rehabilitated, and almost certainly this was the case for other fishes as well. A more or less fully rebuilt stock is found at the Leigh Marine Reserve (a site comparable with Maunganui Bay) where in 2011 the mean length of snapper was almost 32 cm (Anon 2011). And snapper in a (presumably) close-to-pristine situation at the Poor Knights Marine Reserve, are on average more than a third larger (35 cm) than in Maunganui Bay, with a relative average biomass per BUV site of 25 kg compared to 3-4 kg for nearby fished sites and in the current study near Cape Brett (Kerr 2016c).

1.10 Outstanding, rare, distinctive or internationally or nationally important marine habitats and ecosystems

One objective of the New Zealand Biodiversity Strategy of 2007 (https://www.mfe.govt.nz/publications/biodiversity/nz-biodiversity-strategy-feb00.html) has been, through the Marine Protected Areas Policy and Implementation Plan (MPA Policy) (Department of Conservation 2005), to protect representative examples of the full range of widespread marine ecosystems in each of this country's 14 biogeographic regions, and at the same time, the strategy urges protection of the 'outstanding, rare, distinctive or internationally or nationally important' marine habitats and ecosystems. In her survey of such 'non-representative' habitats in the Bay of Islands in 2016, *Fish Forever*'s Vicky Froude (2016b) pinpointed those in Maunganui Bay to include the significant arches and caves present, with encrusting communities on walls with diverse bryozoans including long tusk bryozoans, anemones including jewel and solitary, encrusting sponges (purple & pink), coralline turfs (Sites 635 Long Arch and 67 Swallows Cave); and nearer the entrance, islands with their strong currents and the scuttled frigate with artificial reef habitats and associated fishes normally found in warmer waters including Indo-Pacific sergeant damselfish, giant boarfish, blue knifefish, northern scorpionfish, bronze whaler sharks, and various tuna (Site 634 Canterbury and entrance islands) Figure 19).

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.

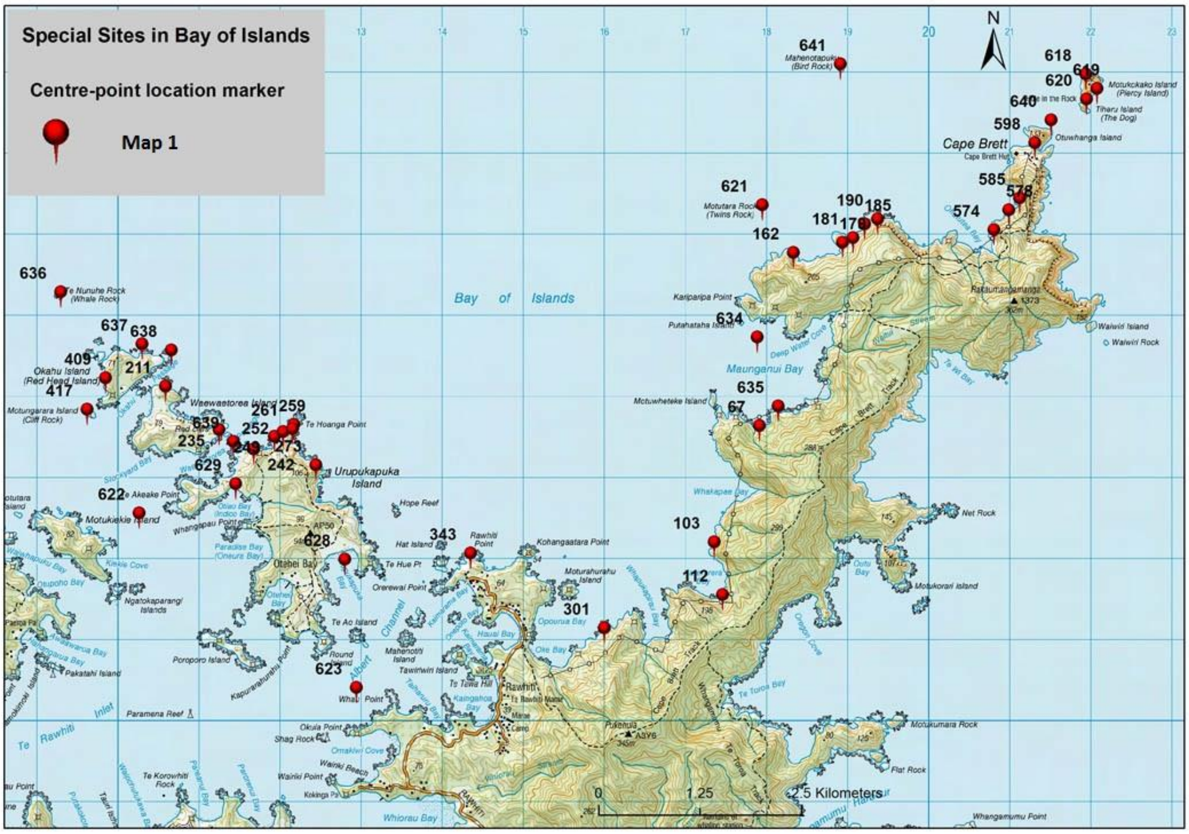


Figure 19. Rare and special habitats in the eastern Bay of Islands, including Maunganui Bay (Froude 2016b).

To the above list of warm-water species, Booth et al. (2018) were later to add Queensland groper, half-mooned groper and golden ribbon groper; Lord Howe moray eel, striated frogfish, oblong sunfish, and bullet tuna. Dive operators noted how the somewhat more commonly encountered giant boarfish were usually seen in pairs until schools of 20-30 of them appeared in spring.

1.11 Marine mammals

Sightings of marine mammals in the Bay of Islands during 1993–2009 demonstrated that orca and bottlenose dolphins used Maunganui Bay (Booth (2017: 55), but it has not been possible to obtain more-recent distributional data that might demonstrate greater usage of Maunganui Bay since the institution of the Rahui. A remarkable video recently taken in Maunganui Bay appears to show orca mimicking human divers ascending/descending a dive line (Figure 20).

Figure 20. Orca apparently mimicking divers in Maunganui Bay (https://www.youtube.com/watch?v=-0oz0Nlwc5M, screenshot at 2.02 minutes).

1.12 Non-indigenous species

Checking the *Canterbury* for NIS remains a term of the NRC resource consent, and it is reassuring that none is known to have established – but vigilance is required, particularly around the invasive laminarian kelp *Undaria* on shallower parts of the vessel.

1.13 Anecdotal - nevertheless indisputable - other ecological evidence

Today's GPS-located and time-stamped imagery means the community can – and does – contribute to our understanding around the biodiversity of places such as Maunganui Bay. Further, dive operators and others who frequently and regularly visit Maunganui Bay can provide valuable temporal data – particularly when the observations are supported by at-the-time log entries.

Regular visitors to Maunganui Bay report greater abundance of reef and schooling fish: medium and large snapper, butterfish, blue moki, pigfish, giant boarfish and blue knifefish (Froude 2016b; Kerr 2016c). Reports of rock lobsters and Spanish lobsters are also rising, with increasing mean-animal sizes among the rock lobsters (a conclusion supported to an extent by the pilot sampling above).

Figure 21. Maunganui Bay is known internationally for its variety of marine life – both within and above the water. Green turtle (April 2018; Chris Richmond), striated frogfish (April 2018; Chris Richmond), Snares Island crested penguin (February 2014; Jochen Zaeschmar).

Although the external surfaces of the *Canterbury* had become heavily colonised by algae and invertebrates by 2012 (Fish Forever 2012), serendipitous imagery is insightful into its progression. The climax state of a rocky reef at 10-30-m depth in a relatively-open location like Maunganui Bay is a forest of the common kelp *Ecklonia* (eg, Brook & Carlin 1992), so - presumably - light-infused surfaces will continue to progress towards that state. Yet – even in the absence of significant numbers of sea urchins – the *Ecklonia* remains patchy and generally insignificant (eg, Froude 2016a).

2. Singular research opportunities available at Maunganui Bay

Fish Forever's and other investigations in and near Maunganui Bay have identified opportunities for tractable scientific research that are pertinent and topical in both a national and international sense.

Maunganui Bay presents – within the context of a near-oceanic setting – a somewhat exceptional combination of habitat and maritime conditions, and therefore of marine life. On the one hand, the broad ecological assessments point to a fish fauna that closely resembles that of the inner Bay of Islands (Parsons et al. 2010), yet Maunganui Bay is home to a wide variety of warm-water (eg, Brook & Carlin 1992). Few locations within New Zealand offer this diversity within such a confined area.

The apparently-recent emergence of widespread *Centrostephanus*-dominated urchin barrens, and what appears to be increasing abundance of packhorse rock lobsters, are part of a very similar development along the east coast of mainland Australia and Tasmania – one strongly linked to climate change and therefore highly topical.

The long-spined urchin *Centrostephanus rodgersii* (Figure 22) is significant today in the overgrazing of shallow-reef kelp, particularly in parts of the outer Bay of Islands, including within Maunganui Bay (eg, Froude 2016a; Kerr 2016b). This sea urchin, which is also found on the east coast of Australia and recently reached plague status in Tasmania (Sinauer Associates 2014), was reported as early as the late 1960s to be extending its distribution and increasing in abundance in the north of New Zealand (eg, Morton & Miller 1968; Ling, 2008), and it is now common in reasonably shallow outer waters of the Bay of Islands. In the southeast of mainland Australia, this urchin has long been known as a significant contributor to sea-urchin barrens (Andrew & Underwood 1993); furthermore, the common rock lobster there (as here, *Jasus edwardsii*) is this sea urchin's important predator (Sinauer Associates 2014). *Centrostephanus* grows significantly larger than the endemic kina and its grazing in the eastern Bay of Islands has led to the development of barrens as shallow as 8 m (Froude 2016a). The suggestion is that *Centrostephanus* is not as prone to predation by fish and rock lobsters as kina (probably because of its size and its longer, stronger spines), and – with red rock lobster catch rates in east Northland being particularly low (MPI 2016) – there will be little biological control possible under current conditions. Maunganui Bay would be an excellent location to investigate this further.

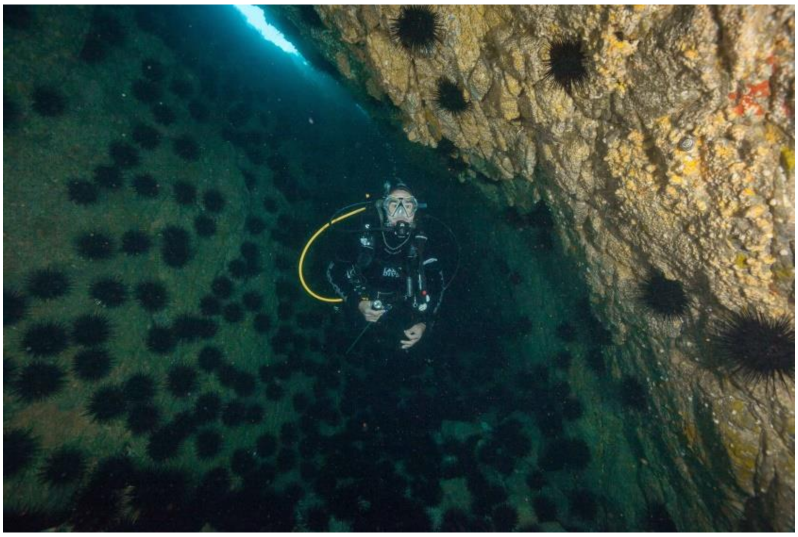


Figure 22. Large, densely-populated field of long-spined urchins *Centrostephanus rodgersii* on an urchin barren near the entrance to Maunganui Bay. (Photo: Northland Dive).

Expansion in range of *Centrostephanus* to take in the east coast of Tasmania has coincided with a similar extension for packhorse. This lobster was once largely confined to the east coast of mainland Australia, but with strengthening southward flow of the East Australian Current, it is now common off Tasmania. Packhorse are commonly encountered within Maunganui Bay (eg, Sutton 2016a), and anecdotally are increasing in abundance there. Once again, this is an ecological shift that might be observed and quantified from within the relative shelter of Maunganui Bay.

Figure 23. long-spined urchins *Centrostephanus rodgersii* (left) and packhorse rock lobsters *Sagmariasus verreauxi* (right, Paihia Dive).

The methodological investigation of Kerr (2016b), who looked into the *scale* of aerial photography in relation to its ability to allow detection of sea urchin barrens that themselves vary considerably in size (Froude 2016a; Kerr 2016b) produced an important result: most aerial imagery leads to underestimates of barrens coverage, particularly for small and patchy ('atypical') barrens. It remains unclear if the small urchin barrens are a transitional state or are size-stable. Nevertheless, collectively these small urchin barrens add up to a significant loss of shallow-water algal forest habitat and they may forewarn transition to even more expansive and persistent urchin barrens.

3. High public support for, and interest in, the Maunganui Bay Rahui

There is strong public support for the Rahui to continue (Moor 2018), as also evidenced in the high level of submissions in support registered through *Fish Forever*'s website, which provided the public with a straightforward submission platform, at the same time allowing individual testimony. For the current review, over 800 individuals had made submissions in favour of the Rahui renewal by the time this document was submitted.

Such is the interest in, and the opportunity of, Maunganui Bay that it was the focus of a successful Mountains to Sea *Experiencing Marine Reserves* day of mainly young divers gaining confidence in a mask and snorkel and coming to know about life below the surface.

Figure 24. *Experiencing Marine Reserves/Fish Forever* snorkel day, Maunganui Bay 2020. (https://us11.campaign-archive.com/?u=382a4bd1e721a918ad7a844fc&id=86d8f3860e)

4. Discussion and conclusions

A Section 186A Rahui was established in Maunganui Bay in November 2010, three years after the scuttling of the frigate *Canterbury* there: colonisation of the *Canterbury* by algae, invertebrates and fishes continues to take place, but may not have yet reached its climax state. Meantime, anecdotal reports and observations point to a growing abundance, variety and individual-size of taonga food species such as snapper and rock lobsters (although this is not *strongly* supported by the scientific evidence). But there is as yet no evidence for any significant recovery of kelp amongst the widespread urchin barrens of shallow reefs within Maunganui Bay, these barrens having developed as a result of the overharvesting of key predators that use the Bay. *Rahui* are primarily an intervention to allow kai moana stocks to recover after previous overharvesting, but for Mana Moana of Maunganui Bay, as well as local Hapu, it is integral too to the reestablishment of the mauri of the place - and a place with extensive urchin barrens is not in a healthy state.

That significant improvement in the abundance and size of taonga predatory species such as snapper has not been demonstrable in the BUV sampling is probably due to a number of factors. It is widely acknowledged that the Rahui has by no means been adhered to one hundred percent; although we know of no convictions, poaching has been observed many times by locals and by the dive companies. Next, it took 25 years of no-fishing for the shallow-reef kelp to return at the Leigh Marine Reserve just north of Auckland (Ballantine 2014), and the Rahui at Maunganui Bay has been in place for less than half this time. Further, the variability in results of the sampling (large confidence intervals) suggests that more intense sampling is required. Recovery may take longer for this site, too, because of the relatively small area of the protected zone, surrounded by intensively fished (reference MPI map) and extensive adjoining open coast and deep-reef systems.

Arguably, Maunganui Bay makes accessible to all people with access to a boat a relatively sheltered place steeped in the history and tradition of the first colonisers of this part of Aotearoa, set in an area with superb Natural Character, with waters of surprisingly diverse physical and biological attributes, and a biodiversity possibly unmatched in this country except at the most protected offshore islands. To many of us, such combinations of land, sea and life invoke feelings of being at one with Nature – and even with wider humankind.

Renewing the temporary closure would continue to recognise and make provision for the kaitiakitanga management of hapu by facilitating the improvement of the size and abundance of snapper, koura and other predators of kina, thereby improving the size and extent of seaweed/kelp forests as nurseries for other kaimoana and for the mauri that they embody.

Such a renewal would meet the criteria set out in Subsection 2 of Section 186A of the Fisheries Act.

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Appendix

http://www.legislation.govt.nz/act/public/1996/0088/latest/DLM397974.html

186A Temporary closure of fishing area or restriction on fishing methods

(1) The Minister may from time to time, by notice in the Gazette,—
(a) temporarily close any area of New Zealand fisheries waters (other than South Island fisheries waters as defined in section 186B (9)) in respect of any species of fish, aquatic life, or seaweed; or
(b) temporarily restrict or prohibit the use of any fishing method in respect of any area of New Zealand fisheries waters (other than South Island fisheries waters as defined in section 186B(9)) and any species of fish, aquatic life, or seaweed.

(2) The Minister may impose such a closure, restriction, or prohibition only if he or she is satisfied that it will recognise and make provision for the use and management practices of tangata whenua in the exercise of non-commercial fishing rights by—
(a) improving the availability or size (or both) of a species of fish, aquatic life, or seaweed in the area subject to the closure, restriction, or prohibition; or
(b) recognising a customary fishing practice in that area.

(3) Before imposing a fishing method restriction or prohibition under subsection (1)(b), the Minister must be satisfied that the method is having an adverse effect on the use and management practices of tangata whenua in the exercise of non-commercial fishing rights.

(4) A notice given under subsection (1) must be publicly notified.

(5) A notice given under subsection (1)—
(a) may be in force for a period of not more than 2 years and, unless sooner revoked, is revoked at the end of that 2-year period:
(b) subject to paragraph (a), may be expressed to be in force for any particular year or period, or for any particular date or dates, or for any particular month or months of the year, week or weeks of the month, or day or days of the week.

(6) Nothing in subsection (5)(a) prevents a further notice being given under subsection (1) in respect of any species and area before or on or about the expiry of an existing notice that relates to that species and area.

(7) Before giving a notice under subsection (1), the Minister must—
(a) consult such persons as the Minister considers are representative of persons having an interest in the species concerned or in the effects of fishing in the area concerned, including tangata whenua, environmental, commercial, recreational, and local community interests; and
(b) provide for the input and participation in the decision-making process of tangata whenua with a non-commercial interest in the species or the effects of fishing in the area concerned, having particular regard to kaitiakitanga.

(8) A person commits an offence who, in contravention of a notice given under subsection (1),—
(a) takes any fish, aquatic life, or seaweed from a closed area; or
(b) takes any fish, aquatic life, or seaweed using a prohibited fishing method.

(9) A person who commits an offence against subsection (8)—
(a) is liable to the penalty specified in section 252(6) if—
(i) the person is an individual other than a commercial fisher; and
(ii) the person satisfies the court that the fish, aquatic life, or seaweed was taken otherwise than for the purpose of sale:
(b) is liable to the penalty specified in section 252(5) in every other case.