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A shallow water benthic habitat survey and trial kina removals in the Whāngai Mokopuna Rohe Moana

New Zealand Aquatic Environment and Biodiversity Report No. 358

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PLAIN LANGUAGE SUMMARY

Tangata Whenua of Tutukaka, Ngunguru and Hora Hora seek to protect and enhance ecosystem health in their rohe. In February 2024, the Rehuotane Ki Tai 186a temporary closure was established within three nautical miles of the coast. The harvest for rock lobster, cockle, crab, garfish, mussel, octopus, pāua, pipi, rock oyster, sea cucumber, sea horse, sea snail, starfish and tuatua was prohibited and no fishing with nets was allowed in Tutukaka Harbour or the Ngunguru and Hora Hora estuaries.

The Whāngai Mokopuna Rohe Moana management group initiated this research project in conjunction with appointed Tangata Kaitiaki to identify areas of healthy kelp forest and the extent of kina barrens and to trial kina removals at two sites. A cost effective and repeatable "rapid assessment" survey method was developed using readily available mapping software and in-water observations.

A simple habitat classification system was used by two experienced freedivers who reported what they saw to the crew on the support boat. We surveyed 17 km of coastline in three days, recording the location of each observation. There were extensive mature or active kina barrens observed in water depths of 10 metres or less. These areas had low biodiversity and few reef fish.

Two areas were selected for clearance of kina using free divers. Most kina collected in August and during follow up clearance in November had edible roe. Most kina were culled in situ because dive time was limited and kina density was high but some kina were harvested and distributed to hapū members. The project demonstrated the effectiveness of the rapid assessment method and provided valuable insights for future community led surveys and restoration initiatives.

EXECUTIVE SUMMARY

Hansford[1], J.; Edney[2], G.; Wellington[3], P.; Solomon, R.; Amos, C.; Clueard[2], H.; Holdsworth[4], J. (2025). A shallow water benthic habitat survey and trial kina removals in the Whāngai Mokopuna Rohe Moana.

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The Whāngai Mokopuna Rohe Moana management group and appointed Tangata Kaitiaki have sought to protect and enhance ecosystem health in their rohe. In February 2024 the Rehuotane Ki Tai 186a temporary closure was establish within an area three nautical miles east of the rohe moana northern and southern boundaries and from the seaward end of Rauhomaumau Island. The harvest for a range of shellfish and crustacean species (rock lobster, cockle, crab, garfish, mussel, octopus, pāua, pipi, rock oyster, sea cucumber, sea horse, sea snail, starfish and tuatua) is prohibited and fishing with nets in Tutukaka Harbour, Ngunguru Estuary, and Hora Hora Estuary is not permitted.

This project aimed to develop a cost-effective and repeatable "rapid assessment" method for shallow water benthic habitats across all the rocky coastline of the temporary closure. As a first step a drone camera survey was conducted around low tide on calm winter days with clear water conditions using a DJI Matrice M30T drone. Video and some ortho mosaic images of the coast helped document the habitat types present and areas where further investigation was needed.

Next a classification system was developed. Eight habitat types were used, based on local knowledge and published studies. The survey area was split into 11 sections based on orientation and exposure to wave action. Two experienced freedivers swam 17 km of coastline over three days. The locations of observations were recorded onboard the support vessel. Extensive mature or active kina barrens were observed in water depths of 10 metres or less, characterised by low biodiversity, a lack of kelp species, and few reef fish.

Two areas were selected in which kina would be cleared by freedivers. Kina densities averaged around 20 per square metre prior to the first removals in August 2024. Given the high density and limited availability of divers, most kina were culled in situ. Some kina with edible roe were harvested from these areas and distributed to hapū members. A second kina clearance of these areas was completed in November 2024. There was some encroachment by kina from outside the clearance area at the boundaries and some cryptic kina (those hiding under rocks and in crevices) had spread out into the more open areas of reef. The kina roes were described as very fat and 185 kg of kina were harvested.

The findings highlight the significant impact of kina barrens on local biodiversity and the importance of ongoing monitoring and management efforts. The project demonstrated the effectiveness of the rapid assessment method and provided valuable insights for future community led surveys and restoration initiatives.

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[2] Te Wairua O Te Moananui-Ocean Spirit Trust
[3] Kaitiaki Ngāti Taka Rohe Moana
[4] Blue Water Marine Research Ltd

1 INTRODUCTION AND KAUPAPA

Whāngai Mokopuna Rohe Moana was gazetted in 2019. It includes a diverse range of marine and estuarine habitats, including shallow reef and rocky coastline of Tutukaka, Ngunguru and Horahora. The area has been identified as having many areas of urchin barren dominated by kina (*Evechinus chloroticus*).

The Whāngai Mokopuna Rohe Moana management group in conjunction with Ngāti Takapari, Te Waiariki and Ngati Korora tangata whenua and appointed Tangata Kaitiaki have been actively preparing fisheries management processes to protect and enhance ecosystem health. In 2024 we successfully applied for and had approved the Rehuotane Ki Tai 186a temporary closure (Figure 1) which endeavours to protect a range of species including kōura (spiny rock lobster *Jasus edwardsii* and packhorse lobster *Sagmariasus verreauxi*), natural predators of kina (Gazette notice 2024-go14) (Appendix 1). Other species included in the closure are cockle, crab, garfish, mussel, octopus, pāua, pipi, rock oyster, sea cucumber, sea horse, sea snail, starfish and tuatua.

Tangata Whenua (hapū) objectives for the Whāngai Mokopuna Rohe Moana are to restore the balance of species and mauri, within our customary fishing grounds to a healthy and sustainable level, whilst having no negative impact on the surrounding environment.

The provisions of the 186a closure were formulated to protect and increase abundance of taonga species including those that would naturally prey on kina.

Research is an important part of this process to monitor the impact within the inshore areas, of both the 186a closure and targeted kina removal trials from barren areas. We have developed a cost effective and repeatable "rapid assessment" method for shallow water benthic habitat surveys over several kilometres of rocky coast. It is based around a simple classification system with two experienced freedivers reporting the habitats observed to a recorder in the support boat. The experience gained could be used as a baseline for future surveys of this type in our rohe moana or by other hapū and community groups in their areas.

A trial of kina removals was completed in two selected areas to assess the amount of diver effort required to clear a reef of kina. The options for kina removal methods were discussed. Most kina were culled in situ because dive time was limited and kina density was high. Kina with edible roe were found in both August and November at both locations and bins of kina were harvested and distributed to hapū members.

A mātaitai in the Whāngai Mokopuna Rohe Moana will be applied for in 2025 to continue to manage, monitor, and restore the area.

The headlands along the Tutukaka coast are fully exposed to wave action from strong north-easterly and south-easterly storms or ocean swells from the South Pacific Ocean. They have shores that slope away steeply or in a broken profile. Some local shelter exists in gullies or deep channels and hardy kelp species form zones from the intertidal area (*Xiphophora chondrophylla* and Carpophyllum species) then mixed algae below that with *Lessonia variegata* and *Ecklonia radiata*. While kina density tends to be lower on vertical exposed surfaces where wave action is strong, between these exposed headlands there are convoluted bays with submerged reefs or rock platforms where kina dominate large areas of reef from a metre or two below low tide to a depth of about 10 m. There were areas dominated by low turfing algae with few kina, but little in the way of brown macroalgae or three dimensional biogenic structure. The loss of highly productive kelp forest to an "urchin barren" state results in reduced biodiversity and ecosystem services with potential negative impacts on local coastal economies (Ling, 2008; Wernberg et al., 2019). Understanding the extent of urchin barrens and kelp forests is therefore critical to marine managers in developing strategies to safeguard native biodiversity and manage the effects of fishing and catchment based pressures, and restore and conserve these important ecosystems (Shears & Lawrence 2024).

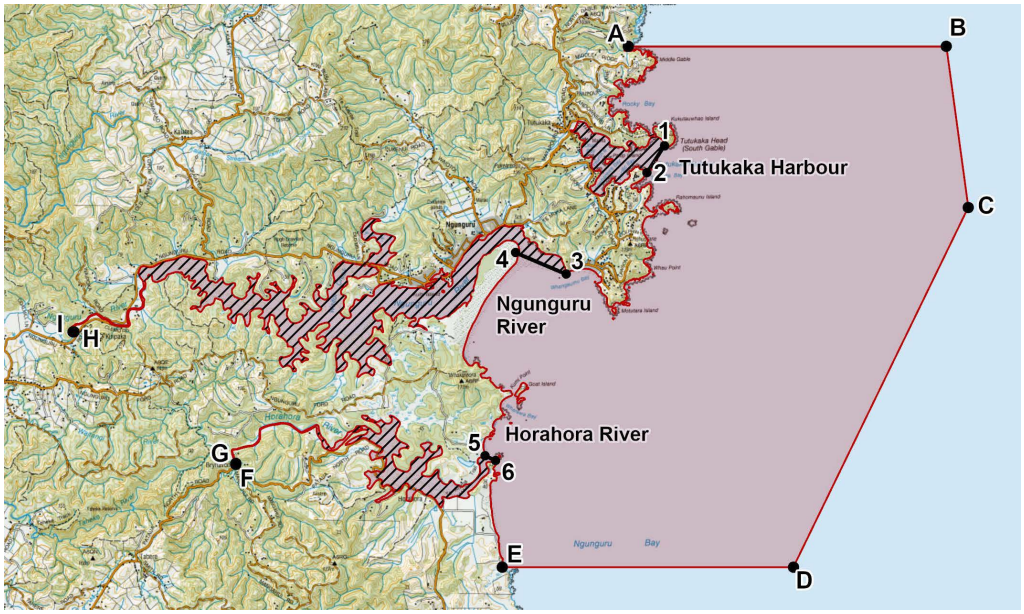


Figure 1: Shaded area is Rehuotane Ki Tai 186A Temporary Closure and Method Prohibition - from Middle Gable, including Tutukaka Harbour, Ngunguru River Horahora River to Paparoa Creek out to 3 nautical miles east from the boundaries and Rauhomaumau Island are no take for selected species. Striped areas are the harbour and rivers with netting bans.

Quote from Philip Wellington a descendant from the first inhabitants of the Ngāti Taka Hapū area.
"*I am the kaitiaki for Ngāti Taka rohe moana. I was the applicant for the Rohe Moana and the Whangai Mokopuna 186A Marine closure.*

"The decline in kōura (crayfish) started in the sixties after the first kōura boom. Prior to this, kōura weren't worth much and anyone could go out and catch them to order and sell them for pocket money. I did this myself. Then Hikurangi Fisheries secured a market in Japan and all of a sudden, the crays became valuable, the big kōura boom occurred at the Chatham Islands. Then when the boom was over most of the boats headed back to the mainland and became local crayfishermen. My father was a crayfisherman. He used a 14 foot plywood boat with a seagull outboard and he had 20 pots and he was able to make a living fishing between the second gable and Ngunguru point. At that time there were about five commercial boats craying out of Tutukaka. It wasn't uncommon to pull up a pot and find a bottle of beer in it where someone had swapped it for a kōura.

"*My memory of fishing with my father are seeing a pot come up with lots of kōura in it, a lot of them with barnacles on their shells indicating that they had long since reached maximum size and no longer needed to shed their shell. We used to set a lot of pots inside the Tutukaka Harbour when we knew it was going to be rough. There are places in the harbour in shallow water we could wade around at low tide and find a cray in a shallow hole. The kōura didn't need to hide in those days because there was no-one chasing them, it was quite common to see juveniles in the rock pools up to one and two inches long, clear in colour like a shrimp. Personally, while I have done a small amount of tank diving but mainly I free dive, I know where all of the nurseries are along the coast near Tutukaka. The lack of juvenile kōura in these nurseries is serious in my view, a few of these nurseries probably will not recover, especially the ones inside the harbour*."(Figure 2)

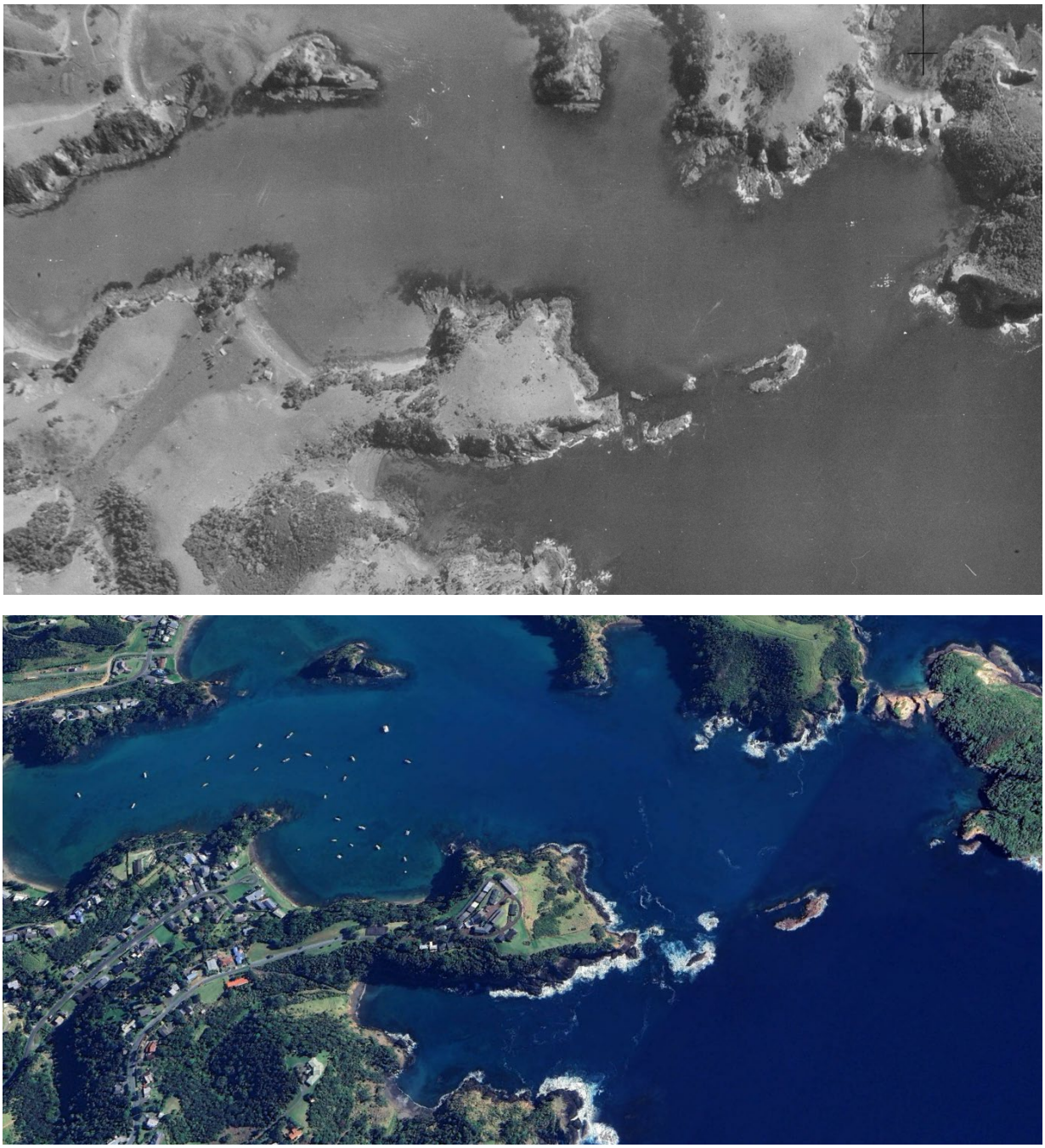


Figure 2: Tutukaka Harbour and Te Waite Bay 1942 showing the extent of dark kelp forests. Image 404/26 from http//retrolens.nz licenced by LINZ (Above) and November 2024. Image from Google Earth (below).

1.1 OBJECTIVES

An application for partial funding of the habitat surveys and kina removal was made to Fisheries New Zealand in 2024. Before this was approved, the project lead had to register as a supplier to Fisheries New Zealand and submit a Health and Safety Plan for approval, as required for all research projects deemed "high risk" by the Ministry for Primary Industries. This required passing standard maritime requirements for the dive vessel and providing an acceptable divers' safe operation plan which was time consuming.

Fisheries New Zealand required all divers and the boat skipper to have current qualifications and vessels used to be registered with Maritime New Zealand. Other funding providers may have different requirements but if grant applications are made, applicants should consider the significant time required to write the application and meet all the requirements.

Research project specific objectives:

1. Survey, classify and map shallow reef habitats within the Whāngai Mokopuna Rohe Moana.
2. Undertake targeted kina removal in two selected areas with adjacent control areas (under customary permit).

2 METHODS

2.1 Benthic habitat survey

The surveyed area was split into 11 sections of rocky coast based on exposure to wave action and orientation (Figure 3). The most exposed areas were the headlands while most of the inner bays are more sheltered.

A drone camera survey of the coast was undertaken around low tide on calm winter days with clear water conditions in June and July. A DJI Matrice M30T drone, owned and operated by a member of the Rohe Moana steering group was used. This Remote Piloted Aerial System (RPAS) has enhanced GPS stabilisation, obstacle avoidance, IP55 protection and high image quality. Each of the locations chosen for survey were checked for ground accessibility to meet the Civil Aviation Authority (CAA) Rules set in Part 101 of the Civil Aviation Act, which includes direct line of sight with the RPAS aircraft. The pilot held a RPAS operational certification from the Massey School of Aviation. The DJIs M30T pre -flight safety checks are a built-in feature of the aircraft, which must be conducted to allow the aircraft's flight capability.

4K video was recorded of most rocky coast in the Rohe Moana which showed pale areas in shallow water where there was bare rock, sand or gravel and dark areas of kelp or deeper water. An ortho mosaic image of the coast north of Tutukaka Harbour was made using ArcGIS software.
A review of published diver surveys of urchin barrens in New Zealand was undertaken and eight habitat classifications developed that focused on coverage of local seaweed species and the density of kina sea urchins. (Ballantine et al. 1973, Froude 2016, Grace 1983, Kerr & Grace 2005, Shears et al. 2004, Shears & Lawrence 2024). These were given numbers for quick communication between divers and the recorder. These classifications were discussed with Fisheries New Zealand prior to starting the survey and are summarised below.

1. Areas with mainly sand, fine gravel or bare rock. These areas are pale when recorded on drone footage or satellite images but kina are absent.
2. Active kina barrens where there was a high density of kina and poor kelp coverage.
3. Mature kina barrens with bare ground, very little kelp and lower kina density.
4. In addition, there was a classification for areas where coralline turf (*Corallina officinalis*) was dominant and few kina were present, which may also be a form of mature barren in some areas or depths where brown kelp forests used to be.
5. Areas where there was mixed weed mainly *Carpophyllum* species. These tended to be in shallow water at low tide and showed as dark areas on drone footage.
6. Areas of broken reef or large boulders often had a mix of habitats with kelp present mainly on vertical surfaces, and flat areas or guts where kina were dominant.
7. Areas of *Ecklonia* and mixed macro algae covering 60% or less of the area. Possibly areas that were in transition into kina barren or that were on the edge of the kina depth range
8. Dense *Ecklonia* dominant forest.

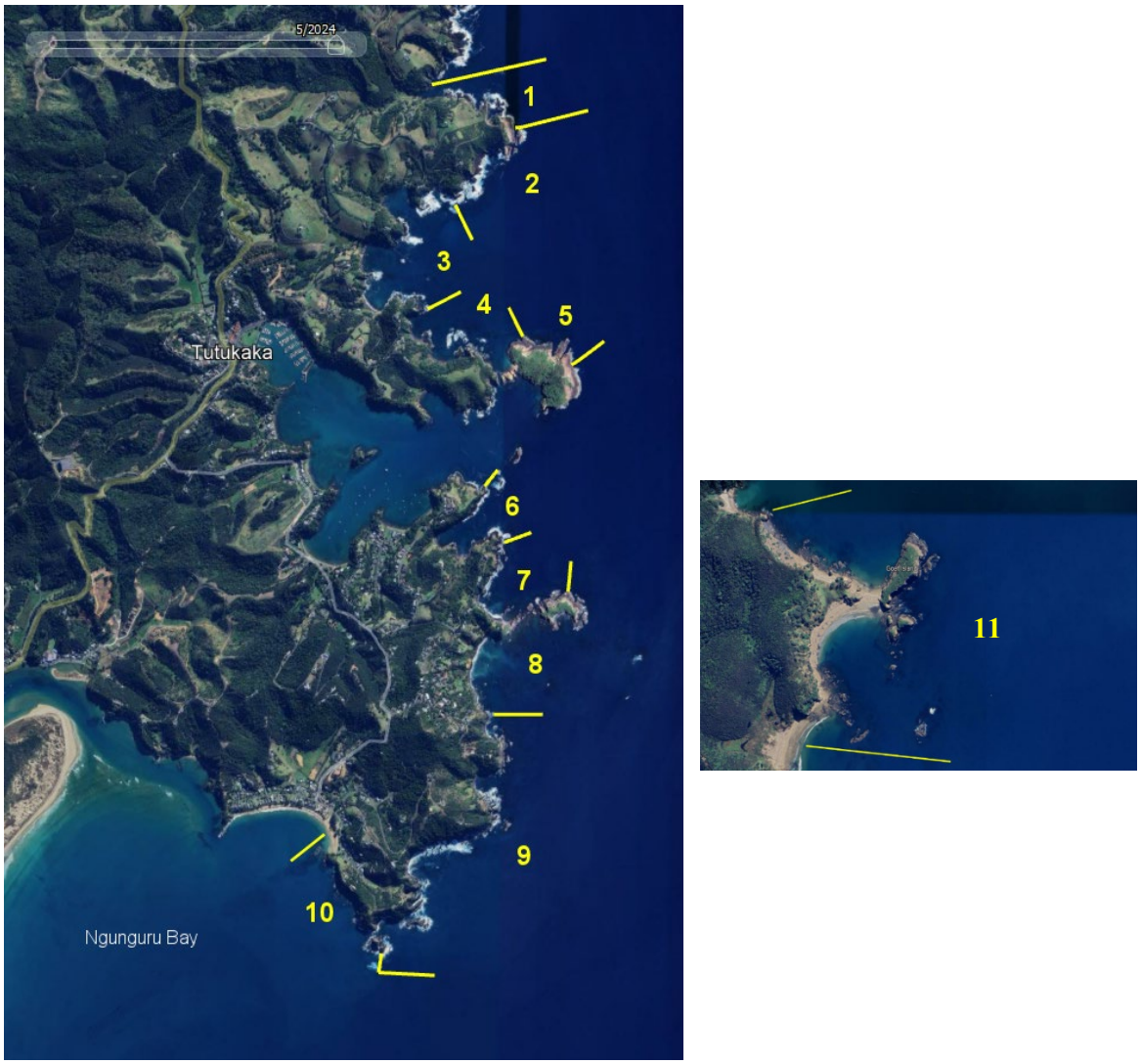


Figure 3: Location of the benthic habitat survey areas on the Tutukaka Coast and Pa Harakeke (Goat Island section 11) which is at the southern end of Ngunguru Bay.

The in-water freediver surveys started on 14 August and finished on 16 August 2024 in a suitable weather window with calm seas and reasonable underwater visibility. Rapid assessment visual survey methods have been widely used internationally and used to reliably categorise macro algal assemblages and urchin barrens on temperate reefs in New Zealand (Shears et al. 2004, Shears & Lawrence 2024).

Two experienced and qualified freedivers worked in tandem at the start of the survey in section 1 to agree on the classifications of the habitats they encountered. These were called out to the recorder on the support boat, along with any additional comments, who then logged the position and codes on a GPS enabled tablet. This was a longitudinal survey covering a large area. The divers determined the route and swam together or independently based on what they were seeing. The points on the map were where the divers chose to report the habitat type. Comments were recorded with the time of day on a paper form. At the completion of each section an audio recording of the overall description of the area was made using a cell phone. This included a qualitative assessment of the proportion of kina barrens observed in 2 to 10 metres water depth for each section. Locations and corresponding numerical codes were plotted on Google Earth Pro and the Ruler Path tool was used to measure the distance of 17 km of rocky coastline surveyed. Google Earth Pro Historical Imagery tool was used to select satellite images with calm seas and clear water to illustrate the survey sites and overlay the survey points.

2.2 Kina Removals

At the completion of the freediver survey two areas were selected for trial kina removals. The objective was to help kelp re-establish on these shallow reef areas to help to restore the balance of species and mauri, within our customary fishing grounds, to a healthy and sustainable level. The initial removal was undertaken from 20 August to 22 August 2024 under a customary permit by professional kina and pāua divers or research divers. A study on kina removal methods found that culling of kina on the bottom was 1.9 to 4.4 times faster than collecting and removing (Miller & Shears 2022). It was decided that because dive time was limited, culling would allow a larger area to be cleared (Bulmer et al. 2024). The best tool we found for culling kina was a small crowbar, 30 or 35 cm long with a 5 cm right angle at one end. Custom made harvesting rakes and bags were used to gather kina for kai (Figure 4). Before removals ten 1 m^2 quadrats were placed haphazardly on the reef and filmed using a GoPro to estimate kina density. Quadrats were made from plastic electrical conduit, right angle joiners and small dive weights. Kina were included at the edge of the quadrat if more of the shell was visible inside than outside the square.

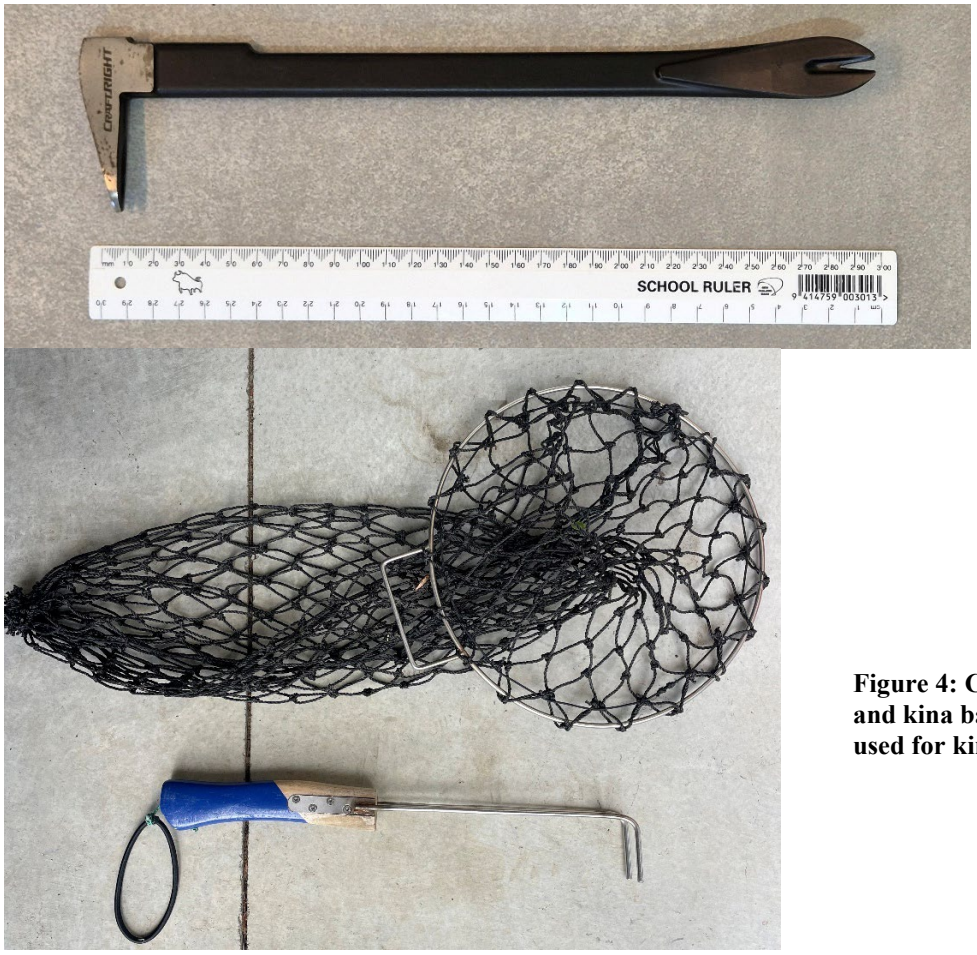


Figure 4: Crowbar (above) and kina bag and rake (left) used for kina removals.

There was edible roe present in kina in mid-August and 170 kg of kina were harvested to distribute to hapū members. Some cryptic kina were not able to be culled or harvested during this initial removal effort and follow up removals were conducted on 25 and 26 of November under a separate customary permit. At this time the kina in the cleared area were in good condition (the roe was described as very fat) and 185 kg of kina were harvested and distributed to the hapu.

The areas selected for removal were a narrow cove near the entrance of Waipouri Bay with a relatively short boundary with uncleared areas and the south side of Te Waite Bay which relatively sheltered and located on the coast south of Tutukaka Harbour and has reasonable walking access from the road. Both areas have broken reef and complex structure.

3 RESULTS

The survey started in Waipouri Bay at the northern boundary of the Rohe Moana. Some time was spent working on communication systems and level of detail to record. This area was sheltered from the south easterly wind and swell. The order that sections where surveyed was determined by the environmental conditions (Table 1).

Table 1: Habitat survey start times and environmental conditions by section

Section number and name	Date	Start time	Swell	Cloud cover	Visibility	Wind speed	Wind direction
1. Waipouri Bay	14/08/2024	11:30	0.3 m	0%	6 m	20 km	S
4. Rocky Bay Sheltered South	14/08/2024	13:50	0.2 m	10%	4 m	10 km	SE
3. Rocky Bay Sheltered North	14/08/2024	14:50	0.4 m	10%	4 m	16 km	SE
6. Te Waite Bay	15/08/2024	9:25	0.5 m	100%	6 m	10 km	Variable
8. Dolphin Bay	15/08/2024	10:45	0.4 m	90%	7 m	14 km	SE
9. Rehuotane to Motutara Is.	15/08/2024	12:10	0.8 m	80%	5 m	16 km	NW
5. Rocky Bay Tutukaka Head	16/08/2024	9:15	0.2 m	100%	8 – 10 m	12 km	WSW
2. Rocky Bay Exposed North	16/08/2024	10:15	0.2 m	100%	8 – 10 m	12 km	WSW
11. Pa Harakeke (Goat) Island	16/08/2024	11:05	0.2 m	95%	3 m	10 km	NW
10. Whangaumu to Motutara	16/08/2024	12:35	0.2 m	90%	7 m	10 km	NW
7. North Rahumaumau Island	16/08/2024	13:25	0.4 m	80%	8 m	20 km	NW

High resolution drone ortho mosaic images are a useful tool for interpreting the observations from the dive survey records. A good example is from the Rocky Bay exposed north section (Figure 5).

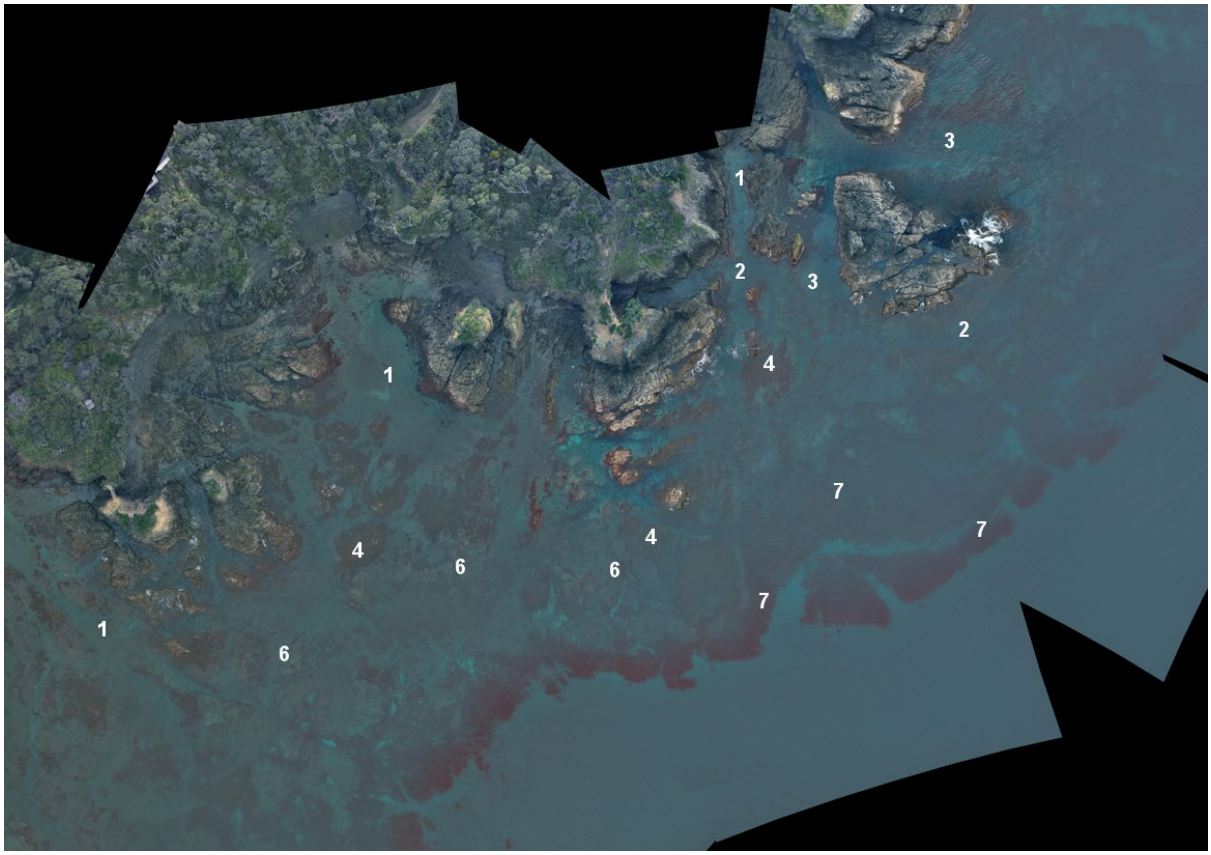
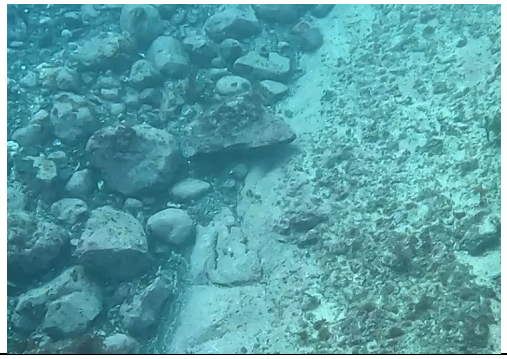


Figure 5: Part of the drone generated ortho mosaic image of Rocky Bay (section 2) showing pale rock (1) and kina barrens (2 & 3) inshore, interspersed with shallow reefs with *Carpophyllum* and mixed seaweed on top (5), with broken reef and moderate cover of turfing algae or kelp at intermediate depths(4 & 6), and *Ecklonia* and mixed macro algae forest on the outer fringe (7).

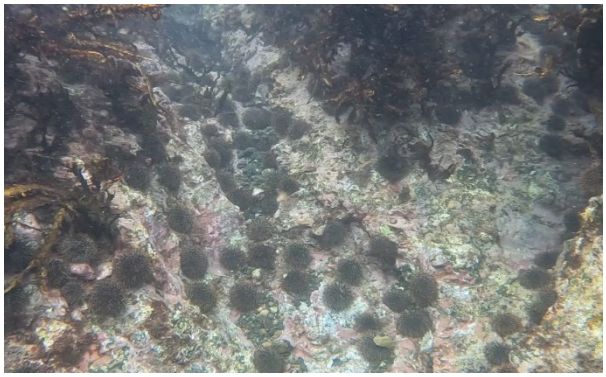
Underwater video and photographs were taken during the survey and these provide some examples of the habitat classification (Table 2).

Table 2: Examples of the eight benthic habitat classifications used in the Whāngai Mokopuna Rohe Moana habitat survey.

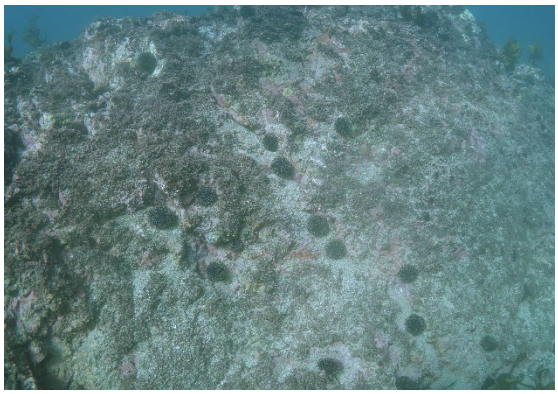
1. Mainly sand, fine gravel or bare rock

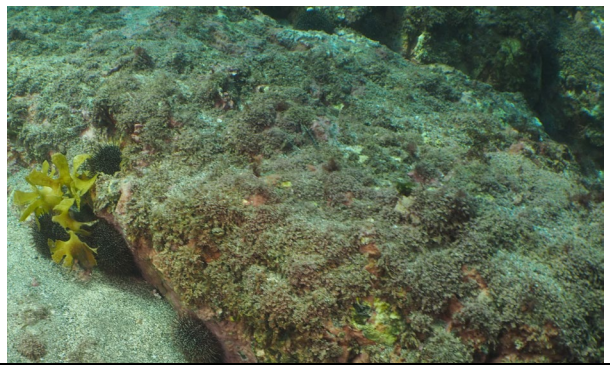
2. Active kina barren bare ground, few kelp, high kina density

3. Mature kina barren bare ground, few kelp, lower kina density

4. Coralline turf dominant, low kina density

5. Shallow mixed weed mainly *Carpophyllum* species


6. Broken reef, guts, gravel, mixed weed and kina

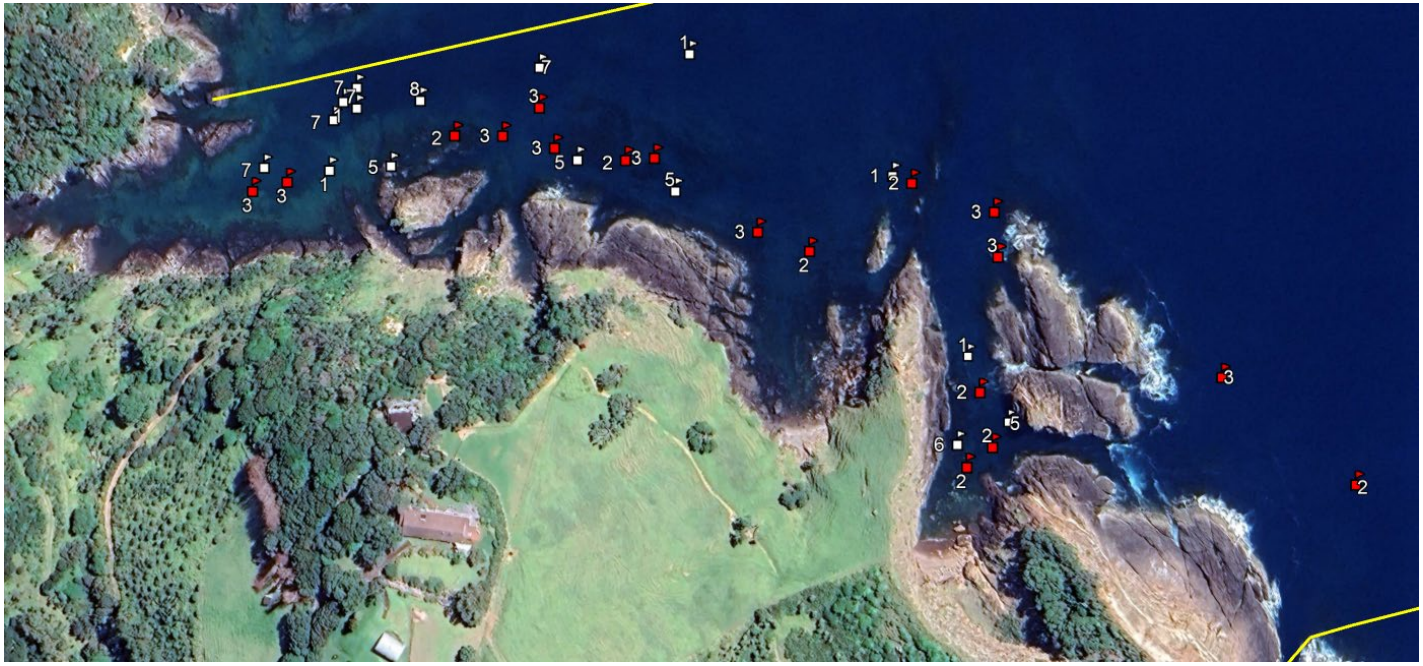

7. *Ecklonia* and mixed macro algae <60% of the area


8. Dense *Ecklonia* dominant forest.


3.1 Survey sections numbered from North to South

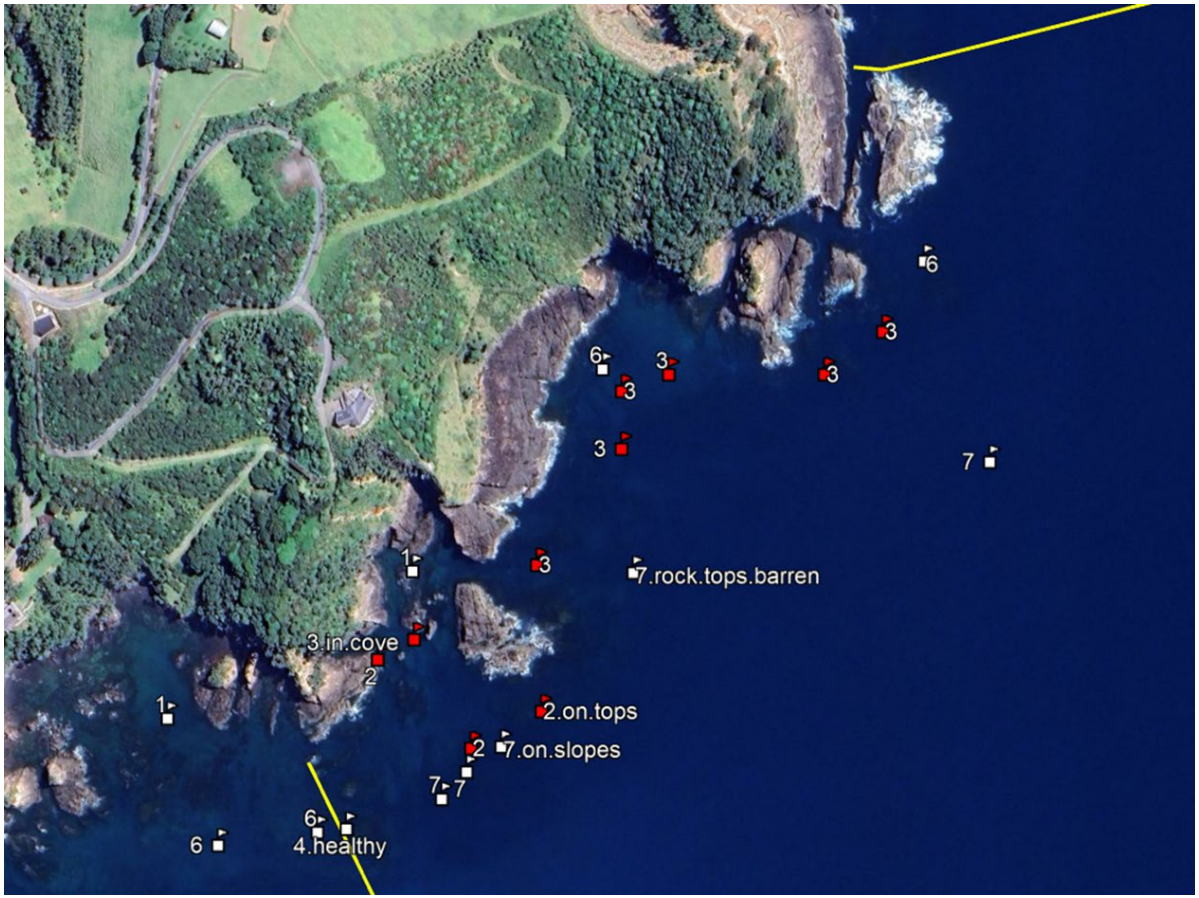
The habitat classifications by survey sections and a summary description of the terrain and habitats are shown below. Location symbols for Mature (2) and Active (3) kina barrens are highlighted in red.

1. Waipouri Bay and Second Gable



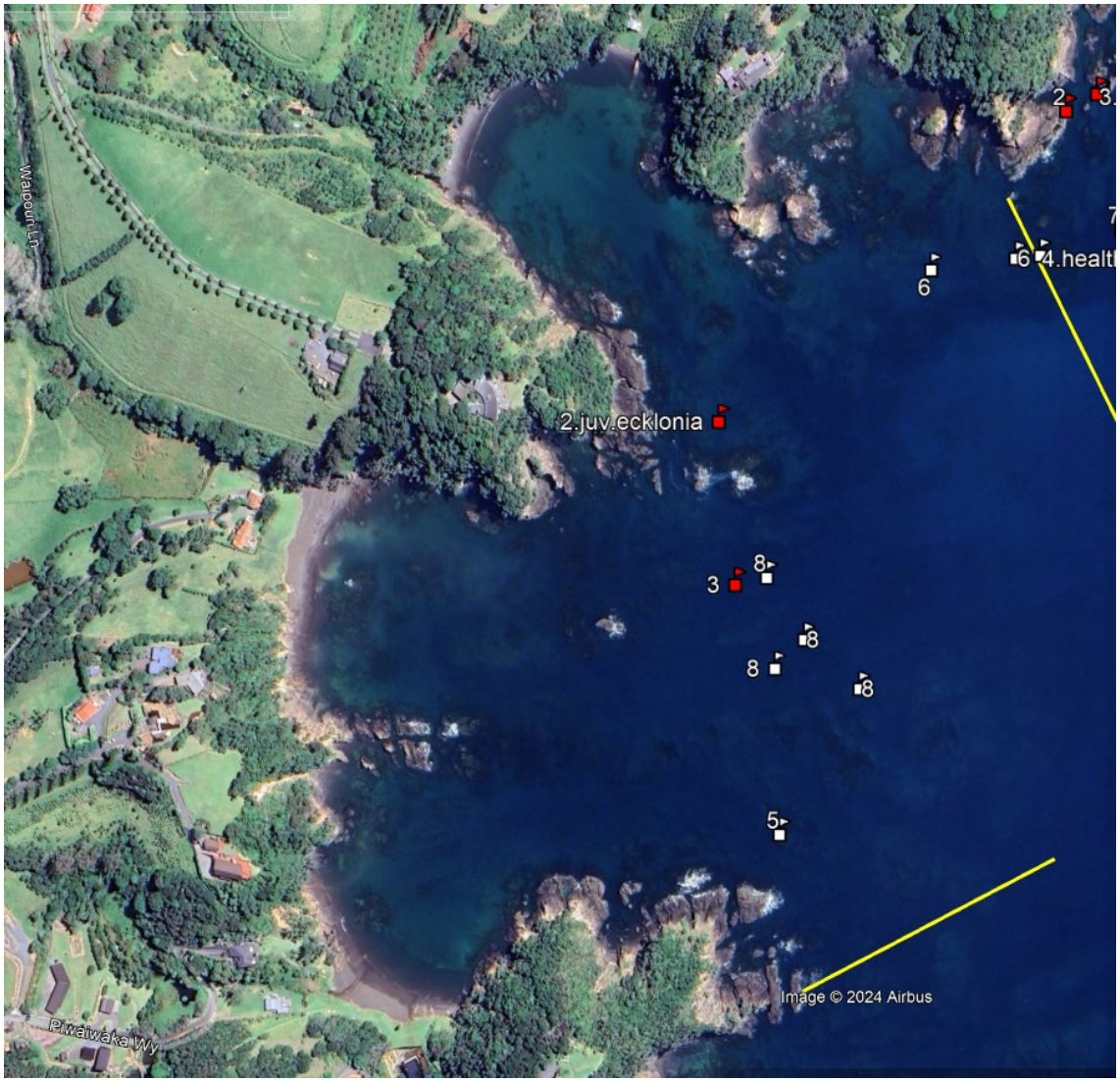
Waipouri is characterised by moderately sloping reef habitat from the shoreline down onto sand and gravel channels running through the middle of the bay. There are patch reefs interspersed amongst the sand/gravel channels and occasional broken reef guts (6). The low tide seaweed zone is predominately *Carpophyllum* species with other mixed red and brown seaweeds and turf algae (5). There are several areas where this mixed seaweed structure extends further into the sub-tidal area, down to approximately 4 m depth. These areas are more predominant further into the bay and almost completely absent further out towards the point. Active and mature kina barrens (2&3) dominate most other areas, especially into the small bay and into the cove. Kina density in these areas is somewhat variable, but reaches very high density, >10 m^2 through most of the cove. There is one reasonable size area of *Ecklonia* and mixed macro algae (7) of approximately 50 to 70 m^2 and a few other smaller patches. There is one small dense *Ecklonia* patch (8) approximately 20 to 25 m^2 in the inner bay. Turf algae areas are patchy and mostly associated with the mixed seaweed zones.

2. Rocky Bay exposed north



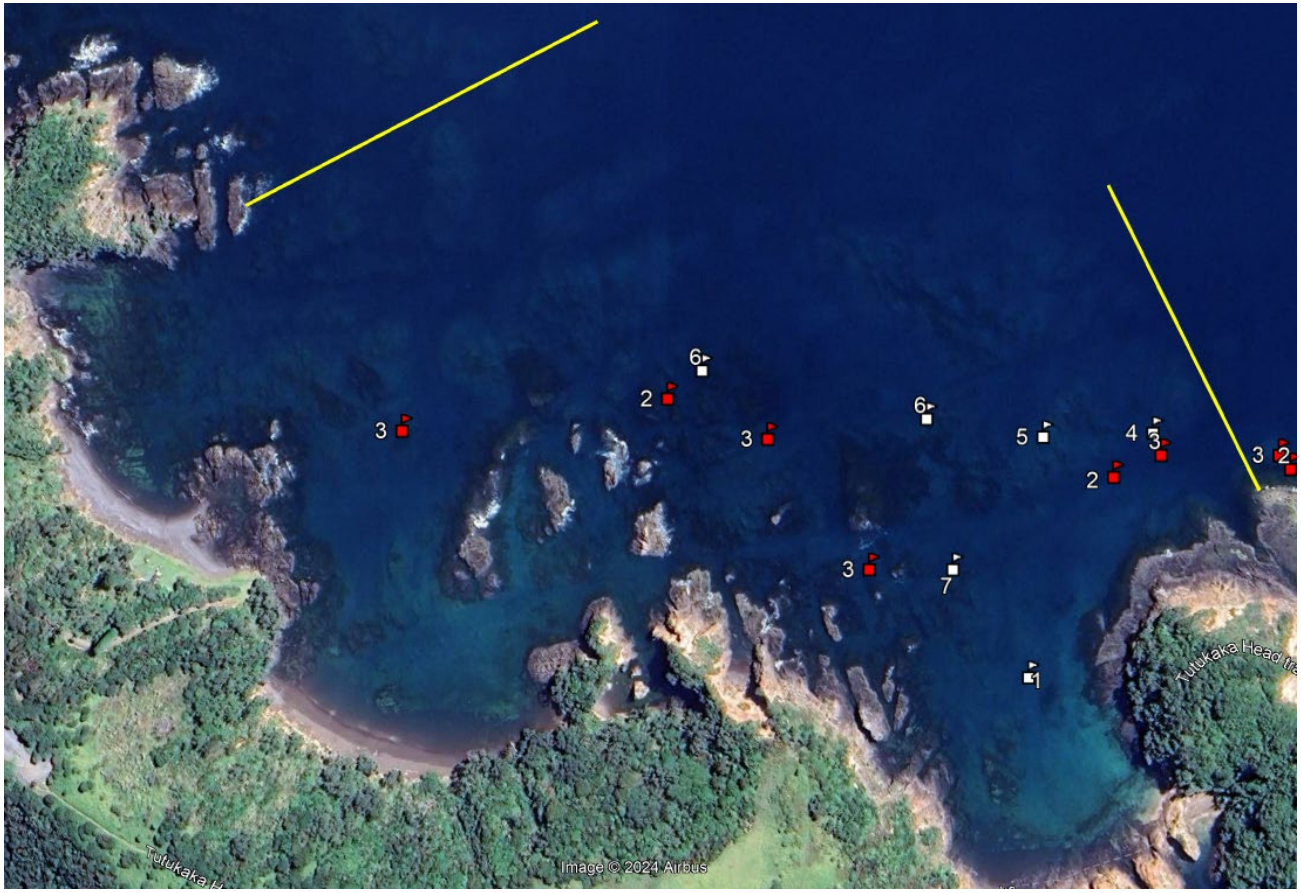
The southern side of this section, where it joins section 3, has habitat types with some relatively large areas of *Ecklonia* and mixed macro algae. However, heading further out towards the point there are several guts and channels along the coastline with extensive kina barren areas. The last small bay before reaching the point has a boulder bottom at approximately 8 to 10 m and this is almost 100% mature kina barren, extending to and up the steeply sloping cliff face. A little bit further out into the bay, there are some rocky outcrops with good *Ecklonia* and macro algae assemblages on the sides of the rocks, but with barren areas on the tops. On the northern point itself, there are extensive areas of mature kina barrens covering almost 100% of the shallow reef.

3. Rocky Bay sheltered north



The southern side of this section, which adjoins section three, has more open sand areas, but becomes more rocky towards the head of the bay, where there is a small headland. The reef extending from this headland marks a change in the condition of the bay. There is markedly more algal growth, with lush turf algae areas and mixed seaweed assemblages, as well as increased small patches of *Ecklonia*. However, kina density is high. Further out from this point there is a slightly deeper reef running out into the bay in a northeasterly direction. The top of this reef comes to within approximately 2 m of the surface and drops to about 10 m onto sand and broken shell substrate. This reef area has moderately dense *Ecklonia* cover below approximately 5 m and covers an area of approximately 500 m^2. The adjacent coastline to the NW and north is a mix of active and mature kina barrens interspersed with patches of *Ecklonia* and mixed seaweed assemblages, dominated by *Carpophyllum* species. The reef structure along this bit of coast is primarily broken reef guts of good vertical structure with many ledges and overhangs. Kina density along this area is quite variable with some areas of very high density and other areas with low density. The percentage of kina barren area (either active or mature) is approximately 30 to 40%.

4. Rocky Bay sheltered south



This area of Rocky Bay is characterised by shallow and moderately low profile platform reef structure with coarse sand/pebble channels running more or less perpendicular to the shore line. There are numerous rocky outcrops that provide higher three dimensional structure interspersed throughout the area. Many of these structures are exposed at low tide. The maximum depth in this section is approximately 8 to 10 m, but the majority of the reef structure is in the 1 to 6 m range. The reef structures in this area could provide good *Ecklonia* habitat. It is also very good habitat for shallow reef, mixed seaweed assemblages, including turf algae. The current condition of this section is mostly very poor. Kina barrens, both active and mature, cover between 80 to 90% of the reef area. The upper sub-tidal and low tide areas are predominantly *Carpophyllum* species, although coverage is patchy.

Almost all the darker areas visible from the drone footage are also *Carpophyllum* patches, with only occasional small patches of *Ecklonia* (often only a few individuals and mostly on vertical rock faces). Turf algae coverage is also patchy due to the large areas of mature kina barrens, with only one area of substantial turf algae coverage observed, although there are smaller patches throughout the section (Appendix Figure A2). Of note in this section was the very low abundance and diversity of reef fish.

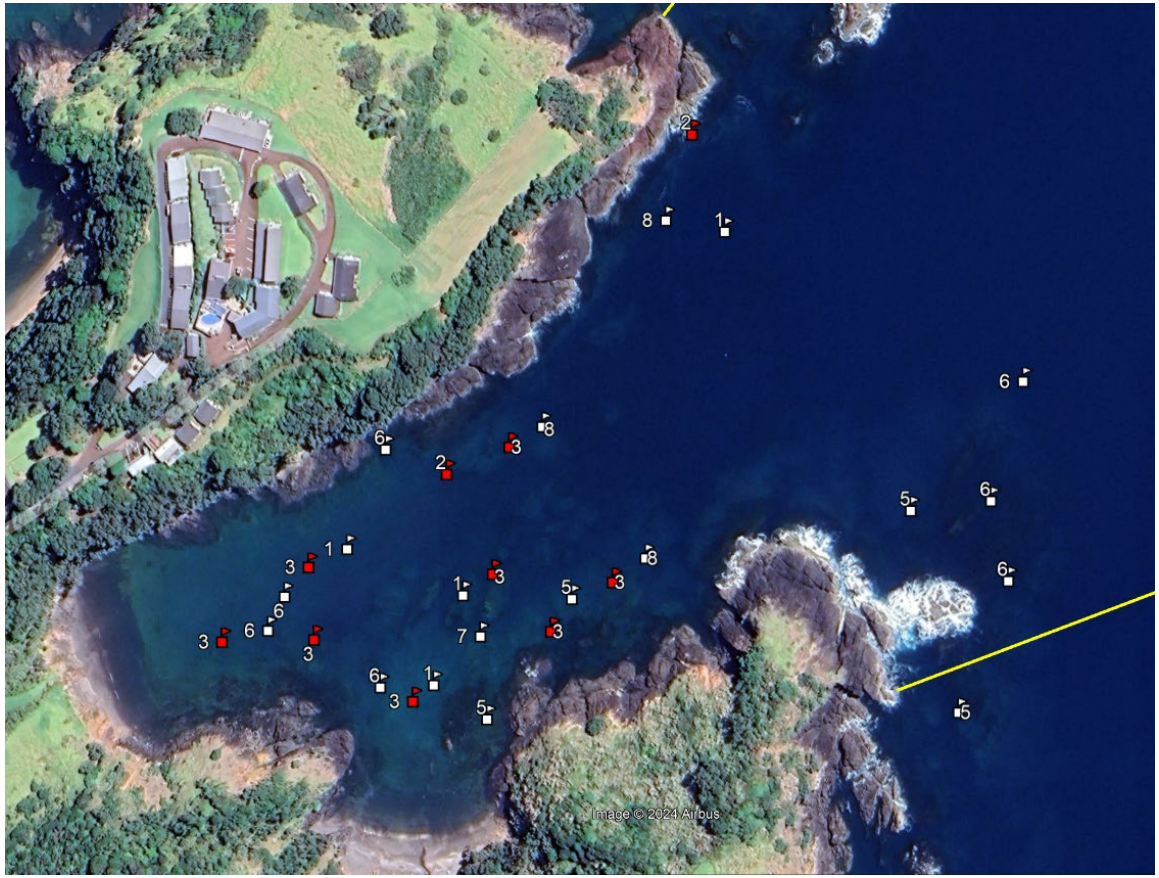
5. Rocky Bay south and Tutukaka Headland

The Tutukaka headland is a high and steep bluff with deep water (20 m+) right up to the cliff face. Because of this, the ocean swells hit the vertical face at full force. Consequently, the top 10 to 15 m of this wall is characterised by dense turf algal assemblages and strap kelp (*Lessonia variegata*), which has very strong holdfasts well suited to very high energy zones. Below approximately 12 m a deeper reef extends out from the cliff face in a northerly direction. This reef has a good coverage of *Ecklonia*, mixed with *Lessonia*. The bluff veers into the bay and finishes in a deep gut into the cliff. The gut is steep sided and ends with large boulders, creating ledges and holes that provide perfect habitat for kōura nurseries.

There is a healthy tidal/sub-tidal mixed seaweed line on the western side of the gut. Below this there is patchy turf algae with very high density of kina and a clear and obvious line of kina graze. There is less seaweed coverage on the eastern side and the wall is dominated by kina barren with very high density. To the west of the gut a shallower reef extends out to the north and this reef is primarily active kina barren on the reef top with *Ecklonia* and moderate turf algae coverage on the vertical faces. Beyond this, the reef area is quite extensive and three dimensional with many guts and overhangs. Once again, these vertical faces have some areas of spare (and occasionally moderate) *Ecklonia* cover and mixed seaweed cover, but the reef tops are very active kina barrens with high density of kina.

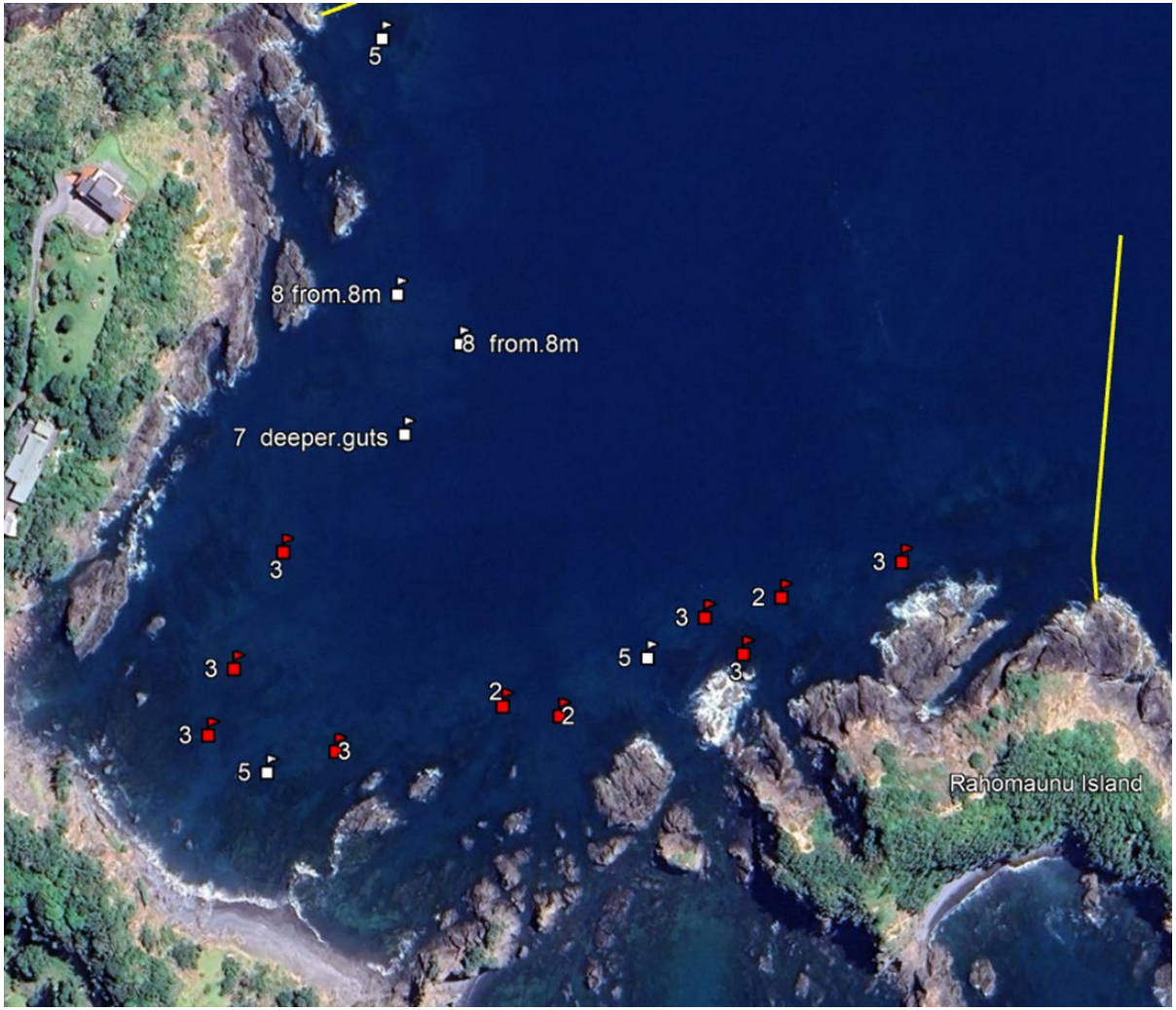
6. Te Waite Bay

Te Waite Bay sits on the southern side of the Tutukaka harbour entrance. It is somewhat protected from the southeast by Rahomaumau Island but exposed to the east and northeast swells. On the northern outer edge of the bay the reef drops moderately steeply down to about 15 m, with rocky outcrops coming up to approximately 4 m. The upper reaches of this area are well covered by turf, mixed seaweeds and interspersed with mostly small or juvenile *Ecklonia*. Kina density in this area is varied, with some areas tending towards active kina barren densities. There are some areas that would classify as mature barrens in this area. Below 8 to 10 m the reef areas are well covered in *Ecklonia*.



Moving into the bay on the north side the picture quickly changes, with the steep wall still having some algal cover, including sparse *Ecklonia*, but with the kina barren areas starting to dominate the less sloping reef structures. There is one *Ecklonia* forest area about one third of the way into the bay, but otherwise the rest of the inner bay is either active or mature kina barrens, with the only macro algae assemblages restricted primarily to the southern side of the bay in the shallow tidal/sub-tidal zone. These areas are primarily *Carpophyllum* and other macro algae, with just a few small clumps of *Ecklonia* on most vertical faces. Kina density is high. Moving along the southern side of the bay towards the point there is an area of healthy *Ecklonia* forest and around the point the shallows are dominated by mainly *Carpophyllum* and broken reef with high kina density. However, just beyond the point the reef drops away with good *Ecklonia* cover from about 10 m down to 15 m+. In terms of percentages, the inner bay is dominated by both active and mature barrens with an estimated 85 to 90% coverage. The outer bay above 10 m is approximately 40 to 50% kina barrens and below 10 m *Ecklonia* and other macro algae is dominant.

7. North Rahumaumau Island



This area starts at the headland that curves into Te Waite Bay in the north and finishes against the northern side of Rahomaumau Island in the south. There is a deep bay between the two with a course sand/shingle beach. There is extensive reef structure throughout the area, interspersed with sand/gravel channels that generally lie perpendicular to the shoreline. The reef has excellent three dimensional structure, with many guts, cracks and ledges. Depth ranges from the shallows down to 18 m or more. Historically, the whole bay was densely kelp covered and supported diverse and abundant fish and invertebrate populations.

Sadly, the southern and central area of this site is now predominantly kina barren, both mature and active (approximately 90%). Kina density is mostly high. In this area the only *Ecklonia* are small patches on vertical faces. There are some patchy turf algae areas and also patchy *Carpophyllum* assemblages. Of note was the observation of some clusters of black spiny urchin (*Centrosptephanus rodgersii*) on the reefs along the island.

The northern side of the area has some very large boulder reef structures with deep guts and channels. There are also some deeper reef areas with more horizontal structure.

These deeper areas have good *Ecklonia* coverage as do the vertical faces of the deep guts. There was also more and healthier macro algae assemblages, including areas with good juvenile *Ecklonia* settlement. Kina density was variable in this area and was notable for some areas having quite high density, but healthy and well fed kina. The estimated area of kina barrens in this area is approximately 50 to 60%.

8. Dolphin Bay

Dolphin Bay is unique along the Tutukaka coastline in that it is partially sheltered from the north and northeast by Ngunguru Reef and fully protected from the northwest by Rahomaumau Island. In addition, the bay is shallow (<10 m) and characterised by very extensive patch reefs, many of which break the surface or lie just below the low tide line. This severely limits recreational or commercial fishing boat activity within the bay. However, the bay is a popular location for shore based fishing, especially free diving for kina and kōura.

Starting from the southeastern end of Rahomaumau Island the current state consists of turf algae mixed macro algae assemblages, with mainly *Carpophyllum* species. However, this area has the highest percentage of kina barrens within the bay, with a mix of both active and mature barrens covering approximately 60 to 70% of the reef areas. Moving further into the bay the reefs are more broken and interspersed with large sand/gravel areas. This area has good coverage of *Ecklonia* and mixed macro algae assemblages with the kina barren areas covering only between 20 to 30% of the reef areas. There were also areas with some good juvenile *Ecklonia* settlement. Of particular note in this area is the relative abundance and diversity of reef fish compared to other areas on the coast. This area also had a larger number of kōura sighted than any other area. Both of these observations are significant in relation to the lower percentage of kina barrens and lower density of kina within those areas. What is particularly interesting is that this one area has significantly higher abundance of reef fish species, many of which are important predators of juvenile kina, which have a cryptic phase amongst the turf algae and other encrusting life until they reach adult size.

9. Rehuotane to Motutara Island

This section adjoins the southern end of Dolphin Bay and differs from the northern end of Dolphin Bay in that it has no protection from the prevailing swells and sea conditions. It also offers easier access to boats. There are three sand/pebble beaches along an otherwise rocky coastline The area is characterised by extensive patch reefs interspersed with sand/gravel channels, with a depth range down to approximately 12 m.

There is a mixture of mixed macro algae assemblages, turf algae and patchy *Ecklonia*. Kina density is mixed, with some areas quite high and others with relatively low kina density. The northern area has a mix of active and mature barren areas with an estimated total of approximately 80% of the area as kina barrens.

10. Whangaumu to Motutara Island

This area starts at the end of Whangaumu Bay, a very popular swimming, diving and fishing area. There is a small island at the eastern end of the beach, with an extensive shallow reef extending out from the island. This reef has patchy areas of mixed macro algae assemblages with *Carpophyllum* species dominating. At the time of this survey there was also extensive coverage of the native Caulerpa species, sea rimu (*Caulerpa flexilis*). Sea rimu, which displays seasonal variation in coverage, can act as a "pioneer" species, colonising bare areas. This seems to be the case here, as it is covering large areas of mature kina barrens. This pattern continued along the coastline heading towards the southern side of Motutara Island. There were very occasional, small patches of *Ecklonia* on vertical faces, but on the whole the lack of large macro algae was stark. The only area of any significant *Ecklonia* coverage was in slightly deeper water just off from Motutara Island. A lot of the kina barren areas are mature barrens with lower density of kina, but there are also areas of high kina density, increasing towards the island. Estimated kina barren area (including the areas currently covered with sea rimu) is approximately 80 to 90%.

11.Pa Harakeke (Goat) Island area

This section covers a large area and contains a diversity of habitat types, characterised by the open coast habitat on the outside of the island, and exposed coastline heading south back towards the sandspit. This contrasts with the sheltered, almost harbour-like habitat type on the inside of the island and associated islets and rocky outcrops. The area is also separated from the rest of the survey sites by the Ngunguru Sandspit and is subject to the sediment outflow from both the Ngunguru and Horahora rivers. The area is primarily shallow (<10 to 12 m) and the reefs are interspersed with large sand areas.

The outside of the island is characterised by a fairly narrow, sloping reef, dropping onto the sand. There is good structure to the reef with numerous guts, crevices and a few small caves. About halfway along the outside of the main island is a larger gut open at both ends.

There is also a second island off the end of Goat Island. In general, the seaweed/kelp coverage, including *Ecklonia*, is patchy but consistent most of the way along the outside of the island. The best areas of *Ecklonia* are in deeper water. Turf algae are generally patchy, but there are some very good areas, particularly in the large swim through gut. There is a band of shallow kina barrens, below the low tide algal line, but above the *Ecklonia*, along most of the area as well. Kina density is also variable, with higher densities in the guts.

Around the islets and rocky outcrops there is very little kelp cover and very high percentage of kina barrens, with very high kina density. Likewise on the inside of the islands. In these areas the kina barren percentage was at least 90%. The whole area has moderate to high levels of sediment, including on the reef areas heading from the island back towards the sand spit. In this area the depth of the reef areas is mostly <6m. Visibility was very poor in this area, but the reefs surveyed showed consistently low kelp cover, with patchy coverage of mixed macro algae assemblages and small patches of *Ecklonia* on the reef edges. There was also areas of sea rimu. Kina density was variable.

3.2 Kina removals

Two areas were selected for urchin removal. The first was a narrow cove near the entrance of Waipouri Bay that was classified as an active kina barren with little remaining kelp below the intertidal zone and high numbers of kina (Figure 6). The enclosed area has relatively short boundaries with uncleared areas. The gut to the east has steep sides with strong surge at times, from the open coast. The boundary to the north is about 40 m wide and is about 9 m deep, well within free diving range. It is surrounded by high cliffs and large blocks and boulders are scattered through the cove. In the 1990s this cove was an attractive dive site with reasonable kelp cover and many large butterfish (*Odax pullus*).

Figure 6: Areas where kina removals were undertaken In August and November 2024. Waipouri Cove in section 1 (left) and Te Waite Bay in section 6 (right).

The second area selected was in Te Waite Bay just outside Tutukaka Harbour. This is a larger and deeper bay, sheltered to some extent from southeasterly storm swells. Shallow areas of the bay are bare rock and mature kina barren. The north side is moderately steep sloping down to 15 m with a few areas of high kina density. The south side of the bay has a complex structure of broken reef and gentle slopes. There are patches of kelp on vertical surfaces or in deeper water but mostly it is mature kina barren with moderate and occasionally high numbers of kina present. The boundaries of the area cleared are quite long but not far from an area of bare rock at the shallow end and up to a stand of *Ecklonia* at the deep end (Figure 6). Access by boat is easy and there is reasonable walking access from the public road along a track across private land.

Three days of kina removals were completed in August 2024 for a total of 36 free diver hours and two days of kina removals were completed in November 2024 for a total of 25.5 free diver hours (Table 3).

Table 3: Kina clearance hours and number removed by dive session.

Site Name	Date	Divers	Hrs:mm	Kina culled	kg harvested	Visibility	Swell
Waipouri Cove	20/08/2024	2	5:30	14 000	30	8 m	Nil
Waipouri Cove	21/08/2024	2	5:00	13 600	90	8 m	Nil
Te Waite Bay	22/08/2024	3	5:00	20 400	50	6 m	0.5 m
Te Waite Bay	25/11/2024	3	2:00	4 000		4 m	1.2 m
Waipouri Cove	25/11/2024	3	1:30	3 000	35	5 m	1.2 m
Te Waite Bay	26/11/2024	3	2:00	3 600	50	5 m	1.2 m
Waipouri Cove	26/11/2024	3	3:00	5 400	100	5 m	1.2 m

The first two kina removal days were spent at Waipouri Cove with clear water and no swell. The average number of kina in 10 haphazardly placed quadrats in the cove prior to removals was 22.1 (s.d. 7.84) per square metre. The number counted ranged from 13 to 36 per square metre. We estimate that 27 600 kina were culled in 21 hours by experienced divers. Broken kina attracted feeding fish which were mostly blue maomao and wrasses. Few snapper were seen. Two black spiny urchin (*Centrostephanus rodgersii*) were found and removed. The divers observed that kina in a cave started spawning as the culling team started nearby. Enough kina were triggered to turn the water cloudy and reef fish were feeding on the eggs.

One day with three experienced divers was spent at Te Waite Bay. The average number of kina in 10 haphazardly placed quadrats on the south side of the bay was 19.8 (s.d. 7.87) per square metre. The number counted ranged from 7 to 32 per square metre. We estimate that 20 400 kina were culled in 15 hours by divers. Broken kina attracted a wider range of reef fish including demoiselles, maomao, and wrasses. The amount of area in the removal site where kina were hard to access meant that a repeat visit was planned.

Swell conditions and visibility were difficult when the dive team returned on 25 November 2024. The kina counts prior to the second round of removals in Te Waite Bay averaged 8.5 (s.d. 7.84) per square metre. The number counted ranged from 0 to 21 per square metre. After 95 days (since the first removal) there had been some encroachment by kina from outside the boundaries of the removal site, but only by a few metres. A further 7600 kina were culled and 50 kg of kina harvested during 12 diver hours.

The kina counts prior to the second round of removals in Waipouri Cove averaged 7.4 (s.d. 8.3) per square metre. The number counted ranged from 0 to 24 per square metre. Some shallow areas had bright green *Ulva australis* and some juvenile brown kelp along with the existing turfing species

present (Figure 7). The kina were in very good condition. A further 8400 kina were culled and 135 kg of kina harvested during 12 diver hours.

The current monitoring and maintenance plan is to mark the boundary of the cleared area and conduct quadrat counts followed by kina removals in that area at 3-month intervals.

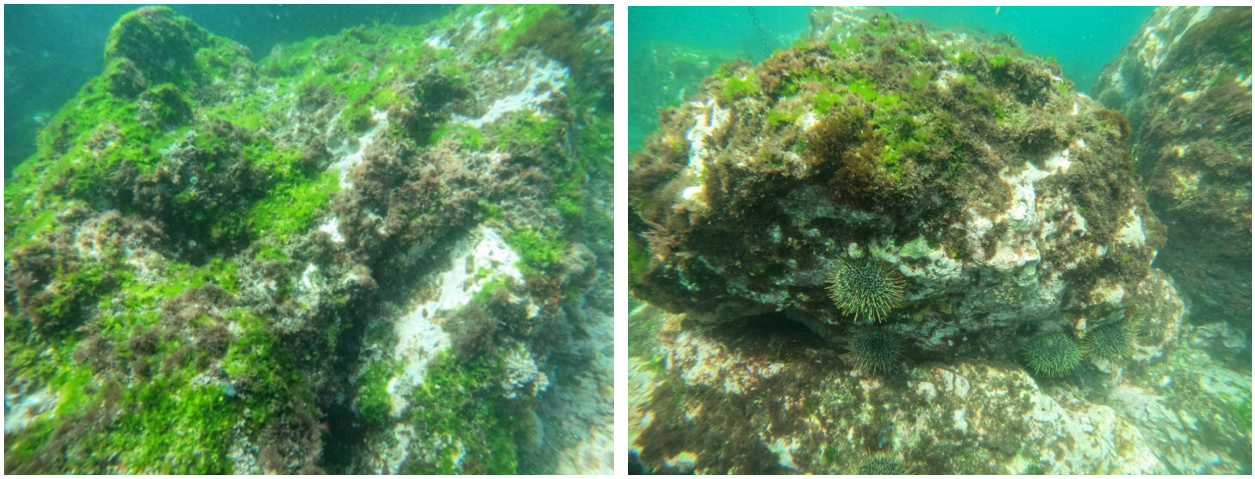


Figure 7: Seaweed cover in Waipouri Bay on 25 November 2024.

4 DISCUSSION

In 2019 Tangata Whenua of the Tutukaka, Ngunguru coastal rohe, applied successfully for Rohe Moana status of the area from Paparoa Point in the south to Waiparore (Second or middle gable) north of Tutukaka Harbour. This was because of increasing concerns about the depletion of traditional customary fishing grounds and shellfish beds, and the inevitable impact on all species and inshore habitats within the environment. Following discussions with hapū and community, it was decided that mataitai reserve legislation was the best way forward to monitor, restore and replenish the rohe moana.

The Whangai Mokopuna rohe moana management group was established to work alongside gazetted Kaitiaki, assisting to navigate the process of applications and communications between MPI, community and tangata whenua. Because of the very significant depletion of some species, a 186a closure of harvesting of selected species was applied for as an emergency measure, until an application for Mataitai application could be finalised and approved. An expectation is that a mataitai reserve will enable more hands-on and nuanced management in the Whangai Mokopuna rohe moana and more active participation in the restoration by hapū and community and a continuation of restorative measures and management.

The survey of the 17 km open rocky coastline of the Rehuotane Ki Tai 186a temporary closure has been another significant undertaking supported by Whangai Mokopuna Kaitiaki and some community members, with funding support from Fisheries New Zealand. Those of us who have dived on this coast for most of our lives have seen the change. While this survey was not designed to produce a precise measurement of the extent of kina barrens, it has established just how pervasive the problem is by providing a “rapid assessment” of the percentage of the area, from the shoreline to approximately the 10 m depth contour, that can be classified as either active or mature kina barrens. The percentages in each of the eleven areas varied, from 20 to 30% in the healthiest areas, to 80 to 90% in the worst affected areas. Overall 40% of the diver observations were active or mature kina barrens and a further 29% were broken reef or mixed weed with moderate amounts of kina.

What these results highlight is that, despite some very localised variance, the shallow reefs of the entire coastline within the rohe moana has been impacted by the expansion of the kina barrens issue, likely caused by the loss of kina predators (Doheny et al. 2023, Shears & Babcock 2002). An area on the north side of Rahumaumau Island that had good Ecklonia cover six years ago is now largely barren and the black spiny urchin *Centrostephanus rodgersii* has established there. These urchins were also observed in other areas but usually in ones or twos. This survey builds on the existing work of Te Wairua O Te Moananui-Ocean Spirit, an independent Charitable Trust, who have been monitoring and reporting on the health of local marine ecosystems since 2018 and have instigated kina clearance and a kelp regeneration project in the Tutukaka Harbour.

The kina removal part of the project consisted of five days of work by fit professional divers and resulted in the culling or harvest of about 64 000 kina from two relatively small areas of seabed with broken reef and complex structure. While it was more challenging to remove kina from the complex reef structure of the selected areas on the Tutukaka coast than it would be from a broad flat reef surface, the complexity of these reefs and the range of habitats they provide can no doubt increase the potential biodiversity in future. The initial kina removal or culling can be quite daunting, with thousands of kina in view and limited time. The approach taken was to remove most of the kina in as large an area as possible. Kina hide in cracks and holes during the day, especially when there are predators around, making them more difficult to access. Allowing time for these kina to disperse prior to the second removal period made it possible to remove or cull an overall higher percentage of the kina in the area.

There were already some positive signs of spring seaweed growth in November 2024 even though the number of kina per square metre was still high in some areas. We don't believe elimination of all kina in these removal areas is necessary or even desirable. Kina have a role in the ecosystem as well. There will be ongoing maintenance and monitoring of these areas to keep kina numbers low and community volunteers have already expressed interested in conducting these activities. We anticipate that kina in these removal areas will be in better condition than in non-managed areas (where kina density is higher and there is less food) so harvest of kina by people and natural predators will increase.

It is worth noting that an area in Dolphin Bay (section 8) that is regularly accessed by kina harvesters had good coverage of *Ecklonia* and mixed macroalgae with only 20% to 30% of the reef classified as kina barrens. Divers also observed evidence of good juvenile *Ecklonia* settlement in this area. Of particular note was the relatively high abundance and diversity of reef fish and a larger number of kōura in this part of Dolphin Bay compared to other areas on the coast.

The absence of reef fish from most other areas of shallow reef was alarming. We saw large numbers of very small kina in the shallows and under *Carpophyllum* mats. While snapper and kōura can eat large kina many reef fish are important predators of juvenile kina, during their cryptic phase amongst the turf algae and other encrusting life until they reach adult size. In addition, some reef fish (including planktivores, such as demoiselles and blue maomao) also contribute to controlling kina numbers by eating the eggs when the kina spawn. This was witnessed in Waipouri Bay during the kina removal. The loss of reef fish abundance and diversity is probably due to multiple cumulative factors over many years, including recreational and commercial set netting (recreational and commercial set netting has been banned as part of the 186a closure), recreational line fishing and habitat loss, especially the loss of kelp forest habitat. It is interesting to note that ongoing monitoring of the kelp regeneration project (being undertaken by Te Wairua O Te Moananui-Ocean Spirit Trust, in conjunction with haukāinga of Tutukaka harbour), is showing an increase of these reef fish, as well as mobile invertebrate species.

There have been some larger scale one-off urchin removal projects in New Zealand and overseas. These work best by clearing large discrete areas and utilizing natural boundaries to reduce urchin reinvasion from surrounding areas (Miller et al. 2024). Kelp will re-establish naturally, but eventually

kina barrens may reform and some ongoing removals would be needed until a more balanced ecosystem is established.

There are a number of community-based habitat restoration projects currently underway along the coast that include kina removals. A customary authorisation or special permit is required if culling or taking more than the amateur bag limit of 150 kina per person per day. Te Wairua O Te Moananui – Ocean Spirit Trust assisted by community volunteers and local haukāinga to remove approximately 3500 kina from the eastern side of Motu Te Maika (Philip Island) inside the Tutukaka Harbour. The project started in 2021 and includes the establishment of a laboratory to propagate *Ecklonia* radiata in temperature controlled conditions. Juvenile *Ecklonia* have been successfully deployed as "green gravel" that have matured into adults, which are now producing sorus (reproductive tissue) and self-regenerating the area. The kelp regeneration site is monitored and there are regular "kina removal" days where locals are invited to come and remove kina. This community involvement has extended the area of reef under kina management in preparation for deploying more green gravel. This project has also provided multiple educational opportunities for school group visits, community and rangatahi snorkel days in conjunction with the Mountains to Sea Trust's "Experiencing Marine Reserves" (EMR) program, and two, 3-day Rangatahi wānanga with Papa Taiao Earth Care. In March 2025 Papa Taiao Earth Care also included kina removal in shallow areas of Te Waite Bay as part of their freediver training with 30 Rangatahi. www.papataiaoearthcare.nz

Outside of the Whangai Mokopuna rohe moana there are other kina barren-related projects underway. Further up the coast there is a kina removal project with Northland students organised by Te Uri o Hikihiki and the Experiencing Marine Reserves project. It is focused on a shallow reef that is surrounded by sand at Te Rearea Pa Point inside the Mimiwhangata Rāhui Tapu marine protected area. Kelp has started to recover, and a diverse range of reef fish are present.

Clearly there is a role for small and medium sized kina removal projects that restore benthic habitats and encourage participation and education. These are more likely to be sustained for a long time in areas with reasonable public access, where harvest and utilisation of kina is encouraged. Most of these projects are centred around haukāinga and hapu groups but often include wider community participation and involvement. Organised community events require health and safety planning. People with a wide range of experience can participate in freediving kina removals. For deeper sites SCUBA diving would be more efficient. In our opinion, initiatives such as these, combined with appropriate fisheries management actions, provide an opportunity to address the kina barren crisis and restore the mauri in key areas of our coast

Potential next steps

- Publicise what we have achieved and the results;
- Use this work to support a Mataitai application and community engagement;
- Regular maintenance and monitoring of kina removal areas;
- Where practical, mark the boundaries of kina removal areas with chain bolted to the seabed;
- Provide new opportunities for education and research of the marine environment;
- Monitor fish species and kōura in kina removal areas, especially potential kina predators;
- Investigate high resolution bathymetric data collected by Inkfish and University of Auckland in January 2025 for kōura habitat out to 35 or 42 m depths of the rohe moana;
- Start annual monitoring of key breeding dens as an indicator of the number and size of kōura in the rohe moana;
- Deploy puerulus collectors to collect kōura settlement data.

5 ACKNOWLEDGEMENTS

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7 APPENDIX 1 New Zealand Gazette Notice

Fisheries (Rehuotane Ki Tai Temporary Closure and Method Prohibition) Notice 2024 (MPI 1709)

Under section 186A of the Fisheries Act 1996, the Minister for Oceans and Fisheries, after complying with the requirements of that section, gives the following notice.

Notice

1. Title

This notice is the Fisheries (Rehuotane Ki Tai Temporary Closure and Method Prohibition) Notice 2024.

2. Commencement

This notice comes into force on **5 February 2024**.

3. Revocation of this notice

This notice is revoked on the close of **4 February 2026**.

4. Rehuotane Ki Tai is closed in respect to cockle, crab, garfish, mussel, octopus, pāua, pipi, rock lobster, rock oyster, sea cucumber, sea horse, sea snail, starfish and tuatua.

(1) A person must not take any cockle, crab, garfish, mussel, octopus, pāua, pipi, rock lobster, rock oyster, sea cucumber, sea horse, sea snail, starfish or tuatua from Rehuotane Ki Tai.

(2) Clause 4(1) does not apply to the take of cockle and pipi, to the extent that no-take of those species is already provided for in the *New Zealand Gazette*, 10 December 2015, Issue No. 135, Notice No. 2015-go7263.

5. Fishing with nets is prohibited within Tutukaka Harbour, Ngunguru River, and Horahora River.

(1) The use of nets while fishing is prohibited within Tutukaka Harbour, Ngunguru River and Horahora River.

(2) Clause 5(1) does not apply to the use by a person of a landing net to secure fish that have been lawfully taken.

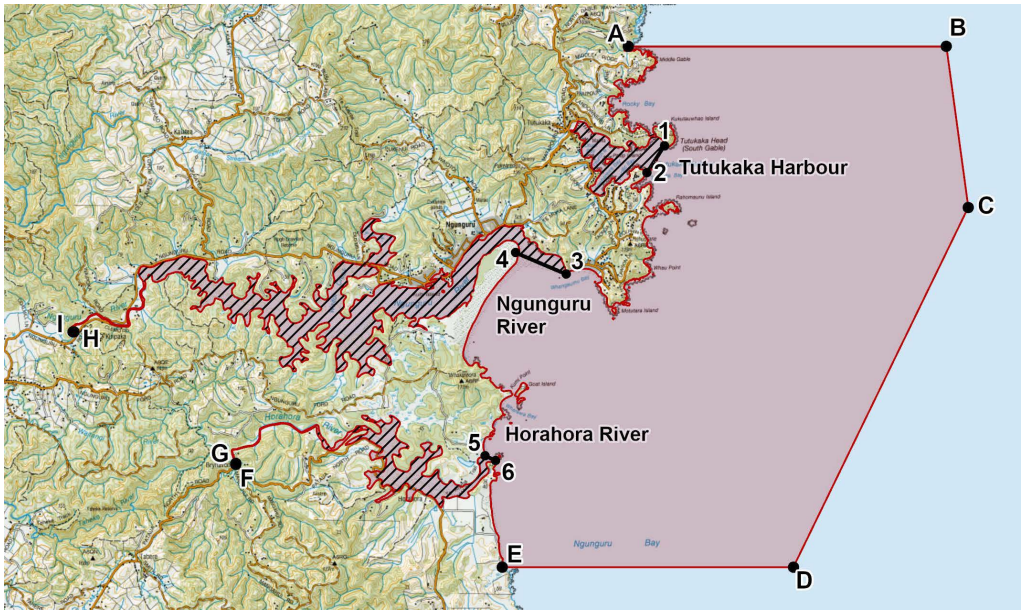

Figure A1: Shaded area is Rehuotane Ki Tai - from Middle Gable, including Tutukaka Harbour, Ngunguru River Horahora River to Paparoa Creek out to 3 nautical miles east from the boundaries and Rauhomaumau Island are no take for listed species. Striped areas are the harbour and rivers with netting bans.

8 APPENDIX 2 Drone Image

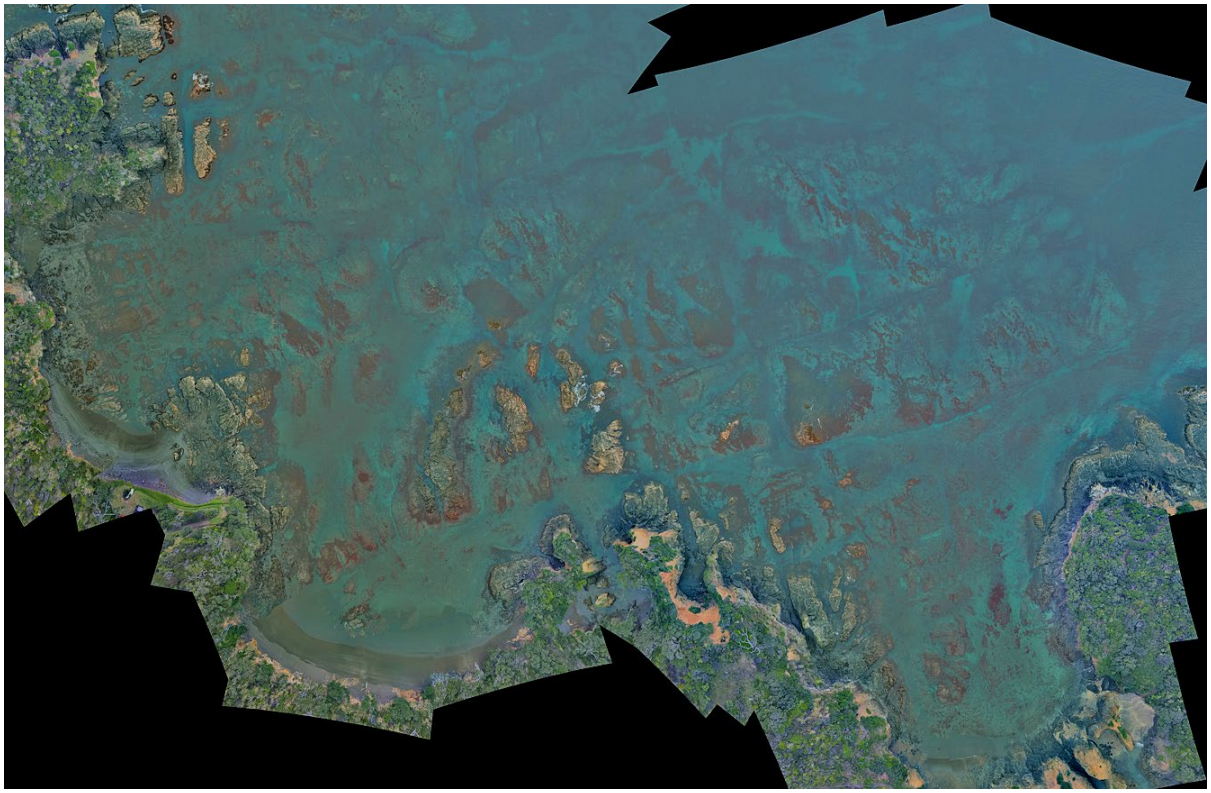

Figure A2: Part of the drone generated ortho mosaic image of Rocky Bay (section 4). Almost all the darker areas visible from the drone footage are *Carpophyllum* patches, with only occasional small patches of *Ecklonia* (often only a few individuals and mostly on vertical rock faces). Turf algae coverage is also patchy due to the large areas of mature kina barrens, with only one area of substantial turf algae coverage observed, although there are smaller patches throughout the section. Kina barrens, both active and mature, cover between 80 to 90% of the reef area. Of note in this section was the very low abundance and diversity of reef fish.