Maitai Bay Rāhui Monitoring Report Year 8

Vince Kerr, August 2025

A school of juvenile trevally seek shelter on a small, isolated reef with kelp growing on it. In the summer, many schools of juvenile fish species are seen in Maitai Bay.

This report was prepared for the Te Rangi-I-Taiāwhiaotia Trust and the Whānau Moana/Te Rorohuri hapū, of Karikari Peninsula.

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Summary

This report marks a significant milestone in restoring Maitai Bay's marine ecosystem eight years after the rāhui (traditional fishing ban) was established. Monitoring data indicate a promising recovery of snapper populations, with biomass increasing sevenfold since 2018 and now reaching approximately half the levels observed in the Leigh Marine Reserve. Timed swim surveys recorded 9,487 fish across 34 transects, while baited underwater videos documented 503 fish from 32 species.

Key timed-swim findings include strong evidence that volunteer kina culling efforts boosted snapper numbers on the campground reef, with biomass reaching 71kg per transect by May—matching peak levels at Leigh. However, populations of red moki and butterfish remain low, implying their recovery depends on kelp forest restoration. A one-off survey counted 40-50 crayfish in the campground area, including juveniles, suggesting recent recruitment.

Increased sightings of *Centrostephanos* sea urchins, a subtropical species threatening kelp recovery, is a concerning trend. The report recommends continuing current monitoring methods, developing formal crayfish surveys, and considering targeted *Centrostephanos* culling to protect the emerging kelp restoration. After decades of overfishing, the rāhui is successfully showing what natural reef recovery can achieve.

Introduction

In 2017, Te Whānau Moana/Te Rorohuri hapū of Ngāti Kahu Iwi placed a rāhui over the Maitai Bay area to halt all fishing and the taking of seafood, allowing the area to recover. The hapū and Ngati Kahu hold mana moana over the waters of the Cape Karikari Peninsula. The focus of the rāhui remains unchanged today, eight years later:

- bring balance back to our moana
- restore the depleted areas
- restore tapu, restore mana
- implement a sustainability plan for future generations

With support from Mountains to Sea Conservation Trust and marine ecologists, a yearly monitoring program has been established to track the recovery of the kelp forest and return of sea life to Maitai Bay. There have been yearly surveys and reports summarising the changes taking place in the rāhui. The recovery has been slow over the early years, mainly due to the severe impact of overfishing over decades and the loss of kelp forests caused by kina overgrazing. Experiences from marine reserves in Northern New Zealand, have indicated that the return of key species, snapper and crayfish (*Jasus edwardsii*), can take 10 – 20 years to restore the balance of the reef species to a point where the kelp forest, once again, dominates the shallow reefs. Over the last three years, we have been seeing the signs that this process is now in full motion. Note: common and Māori names are used for fish species in this report. Latin names for all fish species are listed in Appendix 5.

This report marks a turning point in the restoration of marine life at Maitai Bay. In this report, we will summarise the monitoring results to date, compare our progress to the long-term marine reserve at Leigh and discuss recommendations for the future.

For those interested in the details of the monitoring program and how the methods were chosen and adapted to Maitai Bay, all the reports are available on the websites of the Te Rangi-I-Taiāwhiaotia Trust and Kerr & Associates.

(www. rāhuimaitaibay.co.nz www.kerrandassociates.co.nz/works)

Figure 1 Map of the Maitai Bay Rāhui

Methods

Timed swim

The timed-swim monitoring method and its origins are described in our 2018 and 2019 monitoring reports. These reports discuss the pros and cons of various reef-fish monitoring methods and the particular advantages of the timed-swim method for Maitai Bay. For this method, a single diver on snorkel swims slowly and as quietly as possible along a permanently mapped route for approximately 15 minutes (distance along reef typically 300m). The diver records the various fish species and a count for each species, focusing on a distance of approximately 6m to either side of the swimming path. The underwater visibility at each site is also recorded. Sizes are recorded for three important indicator species: snapper, red moki, and butterfish. These three species were selected on the basis that they are ideal indicator species to show recovery. of the reef community. The sizes of the three important indicator species of reef recovery, snapper, red moki and butterfish, are also recorded. Additionally, underwater visibility, swell height and weather conditions at each site were recorded."

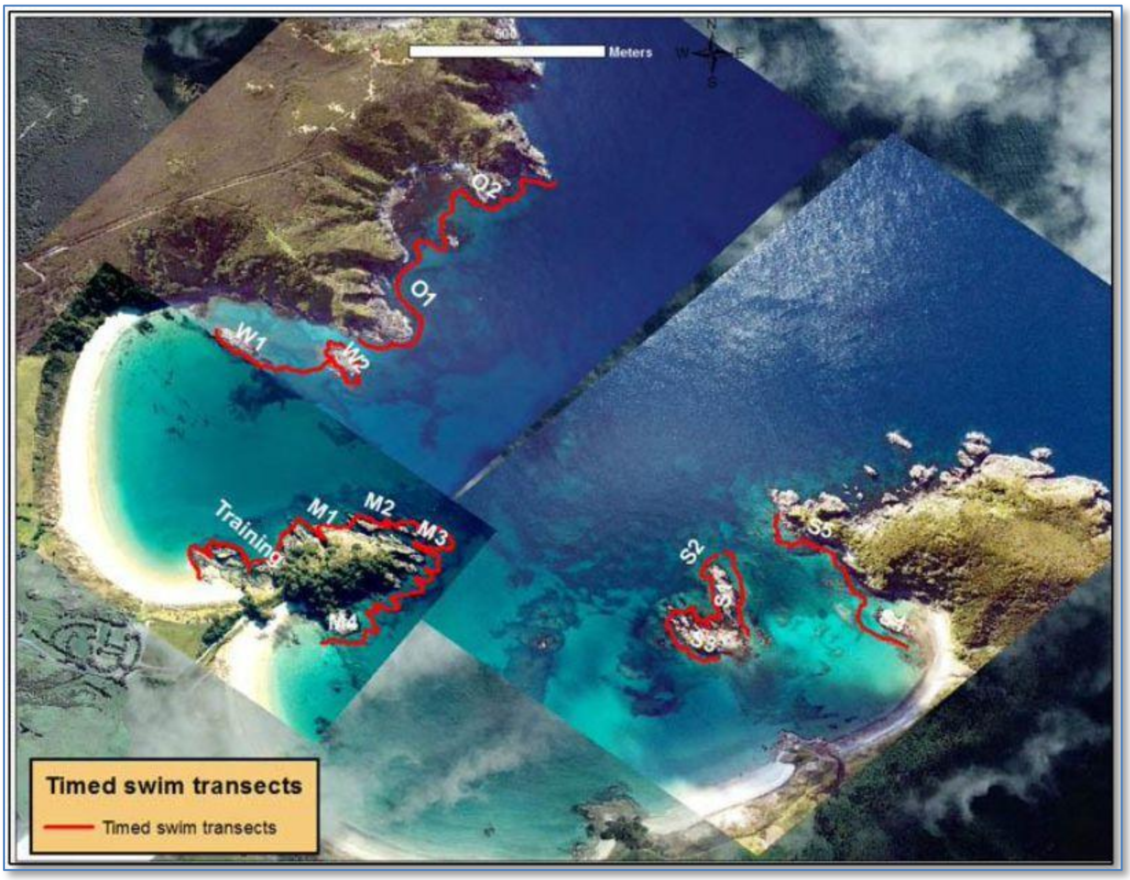

Figure 2: Location Map of the thirteen timed swim transects

In 2019, four timed-swim transects were established and surveyed in the Leigh Marine Reserve to allow for direct comparison with the data collected each year at Maitai Bay. The location of the transects at the Leigh Marine Reserve is shown below in Figure 3. In 2019, there were three transects surveyed at Leigh. This year, the Leigh survey was repeated, and a fourth timed-swim transect was added to better match the array of habitats surveyed with those at Maitai Bay.

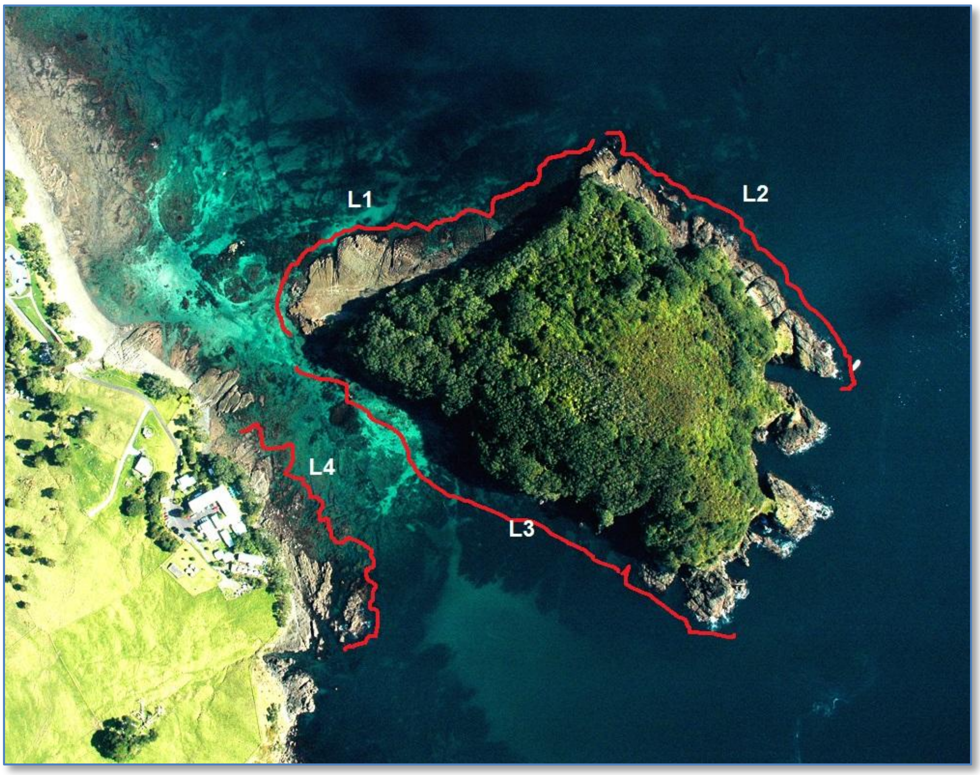

Figure 3 Location Map of the four timed swim transects monitored at the Leigh Marine Reserve in 2025. Transect L4 was added to the survey this year.

Timed swim observations of kina aggregations, feeding fronts and *Centrostephanos rogersii*

Over the course of the 2025 summer, a volunteer kina-culling project was initiated at the campground reef at Maitai Bay. For more details of this, see the report "Kerr, 2025". As the summer progressed, this culling trial became more significant in scale. The repeated dives over several months in one area allowed for observations not possible from infrequent dives or one-off monitoring work. The movement of kina and kina feeding fronts became the main focus. Subsequently, due to the concern over increased sightings of *Centrostephanos rodgersii*, an urchin species recently found to be an increasing threat to our kelp forests (Balemi 2023), we began collecting data on this species also. It was decided that the kina feeding aggregations and feeding fronts that were immediately at or advancing towards the shallow mixed forest zone, would be recorded on a trial basis.

As a preliminary method, we marked a line drawn on the bottom of our underwater slate, divided into quarters to correspond with the path of our timed swim transect.
Swimming along the transect, we marked an X for aggregations or feeding fronts of kina and a C for *Centrostephanos* urchins on the line to represent the estimated position along the transect line. The criteria we used for kina aggregations or feeding fronts were a patch of kina where the density was estimated to be at or above 15 kina per m^2. We also experimented with noting the area of the aggregation in square meters. For the *Centrostephanos* urchins, we recorded a C if there were more than two or three spotted in a location.

Baited Underwater Video (BUV)

Baited underwater video sampling involves dropping a video camera, which is attached to a frame, into the water and filming fish as they are attracted to a bait pot (Figure 4). At each sampling location, the BUV apparatus is submerged for a thirty-minute sampling period. Bait pots are filled with approximately 100g of chopped pilchards. Analysis of the videos is based on a standard method by Willis and Babcock (2000), where the video frame of the highest count of snapper is used to generate a MAXsnapper count and the sizes of each snapper are estimated, to allow further analysis of the size-class distribution and biomass. There are 26 BUV sites established at Maitai Bay, distributed across exposed and semi-sheltered sites and inside and outside of the rāhui. This design enables comparisons between these differing conditions as well as fished versus unfished status.

For more background on the origins of the BUV survey method and other surveys in New Zealand using this method, refer to the second Maitai Bay Monitoring Report by Kerr (2019) and the design research by Willis & Babcock (2000).

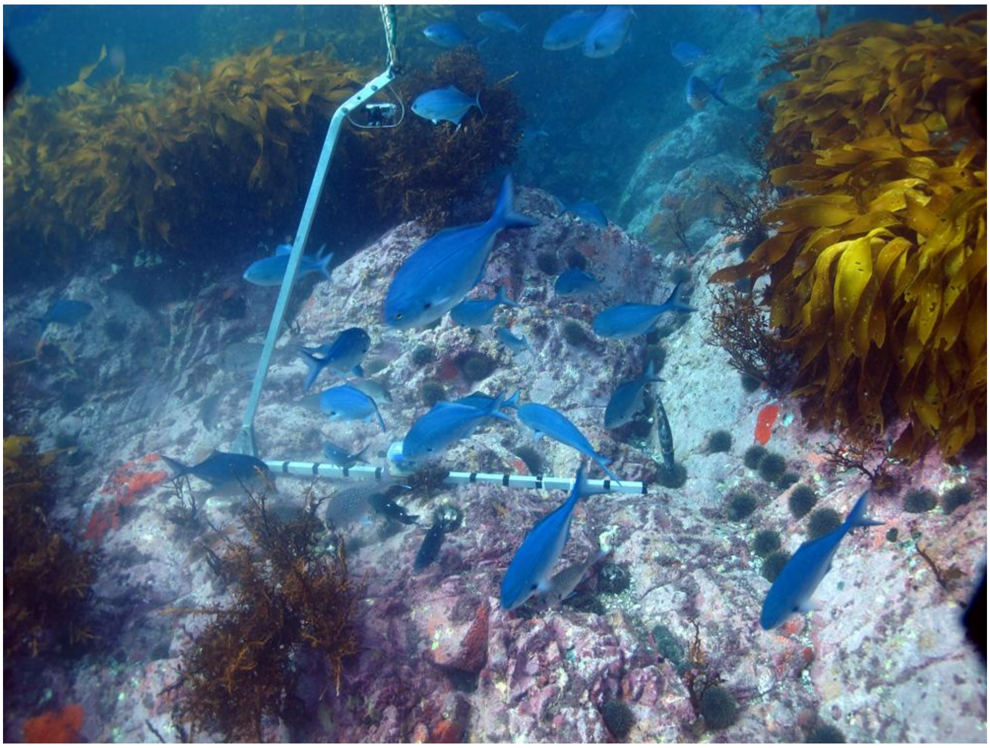

Figure 4 Blue maomao attracted to the BUV apparatus at Blue Mao Mao Point in the rāhui

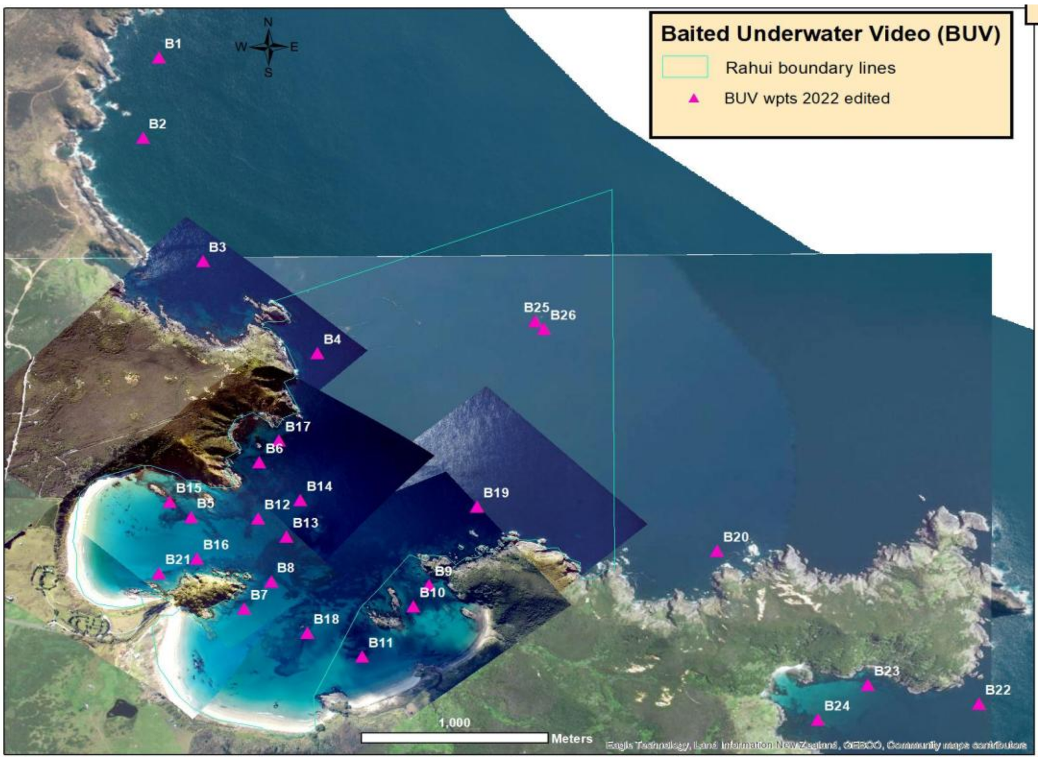

Figure 5 BUV sampling sites at Maitai Bay

Biomass Calculations

In the late 1990s, researchers at Auckland University developed the BUV method we use today. The Auckland University research team produced a method to calculate the mean biomass of snapper across the sites surveyed (Taylor & Willis, 1998) using an equation that converted fish length data into weight or biomass. The equation appears below.

W = aLb, where W is weight(g)

Where L is length, a is 7.194×10^{-5}, and b is 2.793

The biomass data generated over time from the BUV survey is useful to track recruitment of young snapper and any increase in larger fish returning to the survey area.

Crayfish Survey

The detailed observations recorded by the kina-culling, volunteer divers at the campground reef area, indicated that there was a good number of crayfish now present in that area. To investigate further, we completed a scuba-based crayfish count of the area (2 divers) and made some additional snorkel dives in the kina culling trial area. The crayfish dives were based on searching all cracks, overhangs, and caves, observing the species, sizes and numbers of crayfish.

Results

Timed-swim monitoring

The timed swim method is proving to be a very useful monitoring tool to track changes occurring in the rāhui. Table 1 (below), shows the overall extent of time we have spent on the shallow reefs recording fish numbers and total counts of fish.

Table 1: Summary statistics for timed swim statistics, Years 1-8. For more details, broken down to yearly records, see Appendix 2

	8 Year Totals	**2025**
Number of transects surveyed	**315**	**34**
Hours surveying	**79**	**9**
Distance of shoreline reef observed	**126 kms**	**14 kms**
Total number of fish counted	**133,514**	**9,487**

After eight years of no fishing, an increase in snapper fish counts is showing most clearly. The population of larger fish, which are spending more time on the reef, has also improved. Last Summer, timed swim surveys were carried out on March 6th, 22nd and May 24th. The increases in snapper are encouraging. They suggest our rāhui is about halfway to restoring a population similar to that seen at the Leigh Marine Reserve after 15-20 years of full protection. We have completed parallel timed-swims at Leigh this year, repeating the survey we did there in 2019 (see Figures 2 and 3 for maps of the timed swim transects at Maitai Bay and Leigh).

Our timed-swim data also tells another story. Our two other indicator species, red moki and butterfish, have not recovered during the first eight years of the rāhui. They remain at low numbers, showing no signs of recovery, with recorded size classes fluctuating between adults and occasional small recruits. This suggests that both species depend on the presence of the kelp forest, indicating their numbers will likely increase once the kelp forest is restored.

Table 2 Results of timed swim counts conducted over eight years for the three indicator species

Timed swim average counts per transect	2018	2019	2020	2021	2022	2023	2024	2025
Butterfish	0.06	0.18	0.42	0.39	0.16	0.03	0.54	0.12
Red moki	2.1	3.4	6.5	5.1	2.2	5.0	6.1	4.6
Snapper	12.1	33.8	8.7	20.5	34.3	48.5	29.6	29.6
n=	16	45	67	38	37	39	39	34

Timed-swim Snapper Biomass Results

Figure 6 below shows the biomass, measured as weight, calculated from the average counts of transects surveyed each year. In 2019, we adopted the timed swim method to evaluate the rāhui's progress by directly comparing our timed swim transect data with that from the Leigh Marine Reserve. In 2018, the rāhui reported an average transect snapper biomass of only 1.8 kg, composed mainly of juvenile fish and almost no legal-sized snapper. In contrast, Leigh had an average transect biomass of 43 kg, representing a more than twentyfold difference. By 2025, the rāhui achieved an average transect biomass of more than 15 kg, whereas Leigh's 2025 survey average was 33 kg. The rāhui now averages seven times more snapper biomass per transect than at its inception in 2017.

It is reasonable to expect this trend of increasing biomass to continue until the Maitai Bay figures are comparable to those of Leigh or even higher, due to the quality of the habitats in and around Maitai Bay.

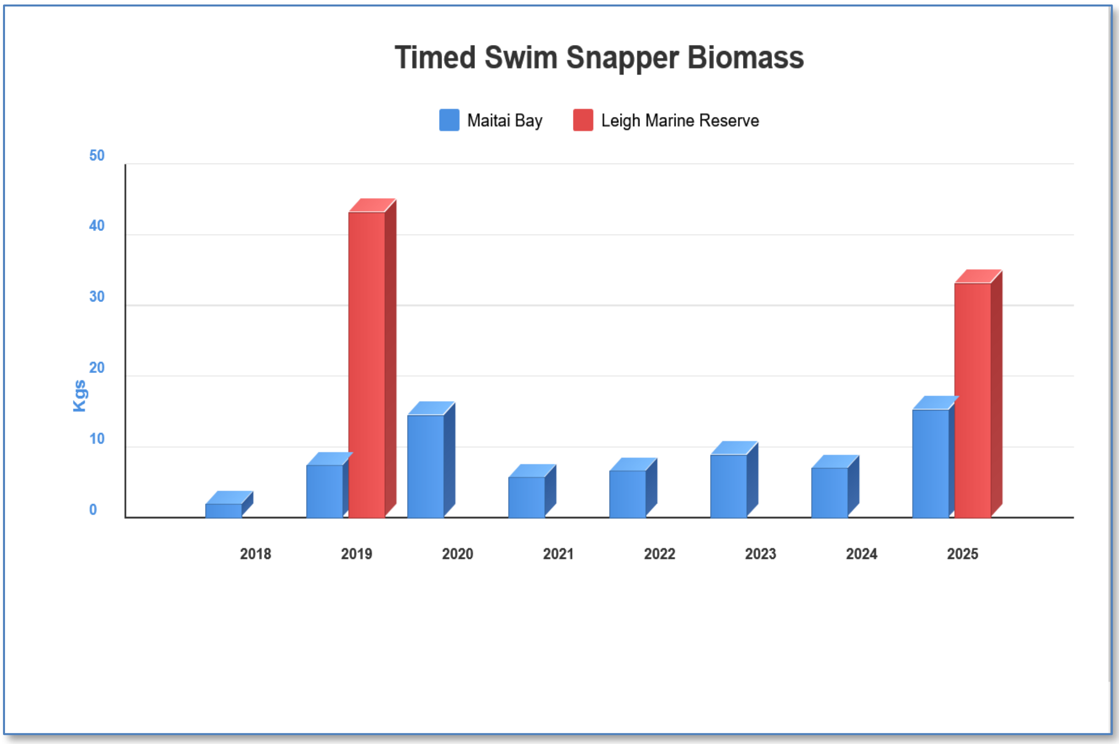

Figure 6 Timed swim results of biomass calculations for Leigh 2019 and 2025 and Maitai Bay thirteen transects 2018-2025 Timed swim results of biomass calculations for Leigh 2019 and 2025, and Maitai Bay's thirteen transects 2018-2025

Table 3 below lists the biomass calculations for surveys done at Leigh and Maitai Bay. These took place within a week of each other in March. At Maitai Bay, we compared the four transects around the Merita Peninsula directly with the four transects surveyed at Leigh. The reasons for the high variation in counts between transects at both sites are not fully known. However, we know from studies that resident snapper at Leigh can have home ranges as large as 1 km along the reef. This suggests the fish move around in larger areas than the 300 m shoreline distance of our timed swims. Specific feeding opportunities may also drive these movements. At Leigh, the top transect had a biomass calculation of 76 kg of snapper. This is five times greater than the average at Maitai Bay for 2025, and over twice the highest level of the Merita Point top transect used for comparison here. It is also interesting to note that the four transects at Maitai Bay ranged from a low of 7 kg to a high of 30 kg, 30kg being near the 2025 average for Leigh transects. In summary, these counts are expected to vary significantly, as shown in this example. The upward trend is also expected to continue.

Table 3 Results of the four timed swim transects compared at the Leigh Marine Reserve and Maitai Bay

Leigh March 2025	**kgs**	**Transect**

Avg. per transect	**33**	
Highest value	**76**	**L1**
Lowest value	**7**	**L2**
Transect high	**21**	**L4**
Transect high	**26**	**L3**

Merita March 2025	**kgs**	**Transect**
Avg. per transect	**18**	
Transect high	**20**	**M1**
Low	**8**	**M2**
Transect high	**15**	**M3**
Highest value	**30**	**M4**

Figure 7 below shows the relationship between size class and biomass. Typically, the counts of smaller-sized fish (blue bars, left scale) are high relative to their biomass (red bars, right scale). As size increases, the trend reverses: fish counts drop while biomass rises, reflecting the return of larger fish to the reef. The result for 2025 is showing that snapper of all the larger size classes are present and collectively represent an increase in total biomass.

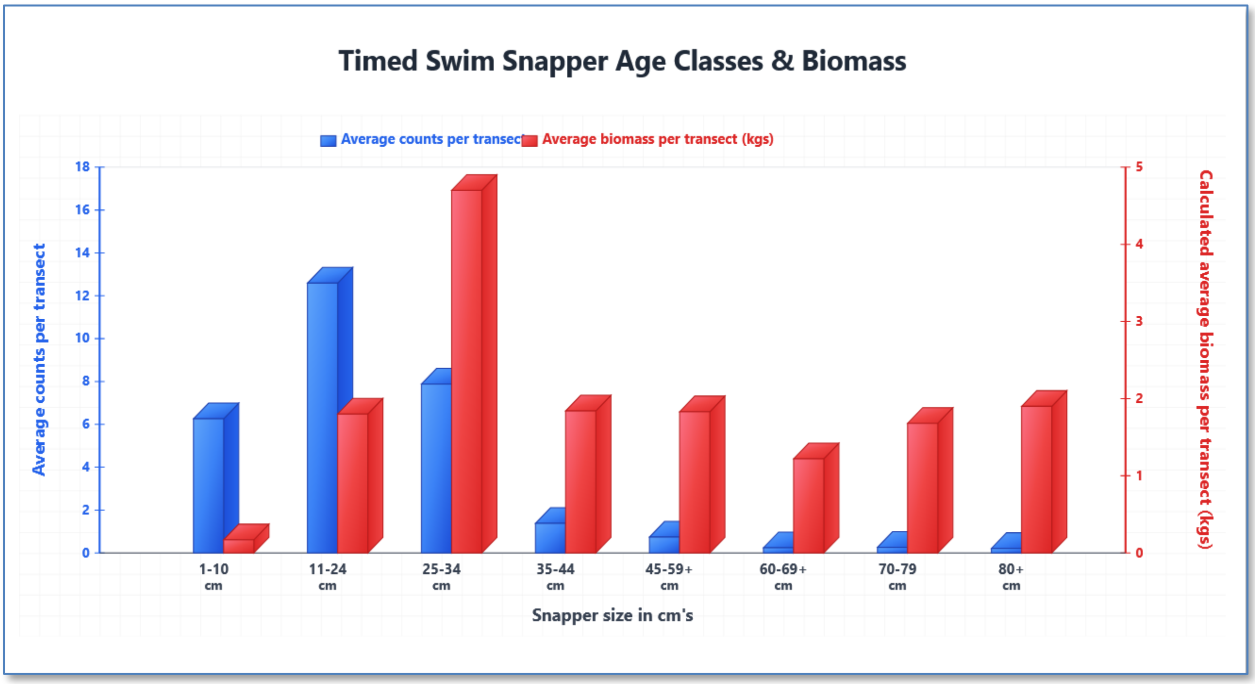

Figure 7 The 2025 timed-swim snapper counts and biomass calculations based on the averages of all transects surveyed, broken down into size classes

Did kina culling increase snapper numbers on the campground reef this summer?

The kina culling trial run by volunteers at the campground reef took place from March 1st to May 31st this summer. This opportunity arose when two volunteers took the initiative to begin the work. No formal fish monitoring was set up to record changes in fish numbers during the trial period. In the kina culling report (Kerr, 2025), observations are recorded that fish numbers, most notably snapper, increased significantly during the three months of culling. The report also discusses possible benefits of the culling, such as attracting or enhancing the return of fish to the reef and aiding the restoration process. Without a dedicated monitoring effort to quantify these observations, we turned to our timed-swim records to see if there was evidence of an increase in snapper numbers.

Most of the kina culling trial area is within the M1 timed swim transect area of the reef (see Figure 2 in this report and the maps in the kina culling trial report), As it turns out, we did four surveys of the M1 transect covering the period between March 6th and May 24th. The results of these surveys are summarised below in Table 4.

Overall, both the number of fish species and the total number of fish appear to rise over the four months. However, this trend is uncertain due to the natural variation in counts, especially given the mobility of fish and occasional schools of young fish passing through the transects. In contrast, both the snapper biomass and snapper counts consistently increase over this period. By May, snapper biomass nearly doubles any previous Maitai Bay transect count, with snapper numbers also unusually high for that time of year. This is notable because snapper counts typically decline by May as small snapper and some of the summer-only resident fish leave to become schooling fish for the winter. The recorded snapper biomass of 71 kg matches the highest level seen at Leigh. The interesting question is how long this accelerated trend of snapper coming onto the reef will last on the M1 transect? Future monitoring should be able to answer this question.

Table 4 M1 Results of timed swim monitoring

Date	Snapper biomass	Snapper count	Number of fish species observed	Number of Fish counted, all species
6-Mar	20	27	14	596
16-Mar	44	58	7	109
22-Mar	13	36	9	323
24-May	71	83	13	250
Mean	37	51	11	320

Figure 8 A volunteer kina culling divers at work with the reef fish community keen to do the clean up.

Kina aggregations, feeding fronts and *Centrostephanos* urchin sightings

Kina aggregations were recorded in a trial on ten timed swim transects. The presence of *Centrostephanos* urchins was recorded on three timed swim transects.

Kina aggregations recorded

All transects had kina aggregations near the remaining shallow mixed forest. A total of 59 kina aggregations were recorded with an average of 5.9 per transect. The range of the aggregations counted was between 2 and 9 aggregations per transect.

Centrostephanos urchin sightings

Centrostephanos urchin sightings were recorded on three transects, M2, M3, and M4. Transect results:

M2 4 sightings
M3 2 sightings
M4 2 sightings

Observations:

Kina aggregations were present on all transects. The timed swim method provides valuable data on their abundance along transects; however, the method of recording requires further thought and testing. It would be useful to include a simple way to quantify the size of the aggregations. However, if added to the timed-swim method, it would have to be simple and quick so as not to distract from the data recording of the timed-swim method.

The normal divers swim pattern swimming along the surface of the timed-swim transect does not work well for sighting the *Centrostephanos* urchins because they are distributed across the whole depth profile of the kina barren and *Ecklonia* kelp forest and have a preference for being hidden under overhangs and in crevices. Based on our experience, sightings like the one we made in this trial would likely underestimate the numbers of *Centrostephanos* urchins.

Figure 9 A large kina aggregation 'feeding front' actively feeding on the shallow mixed forest

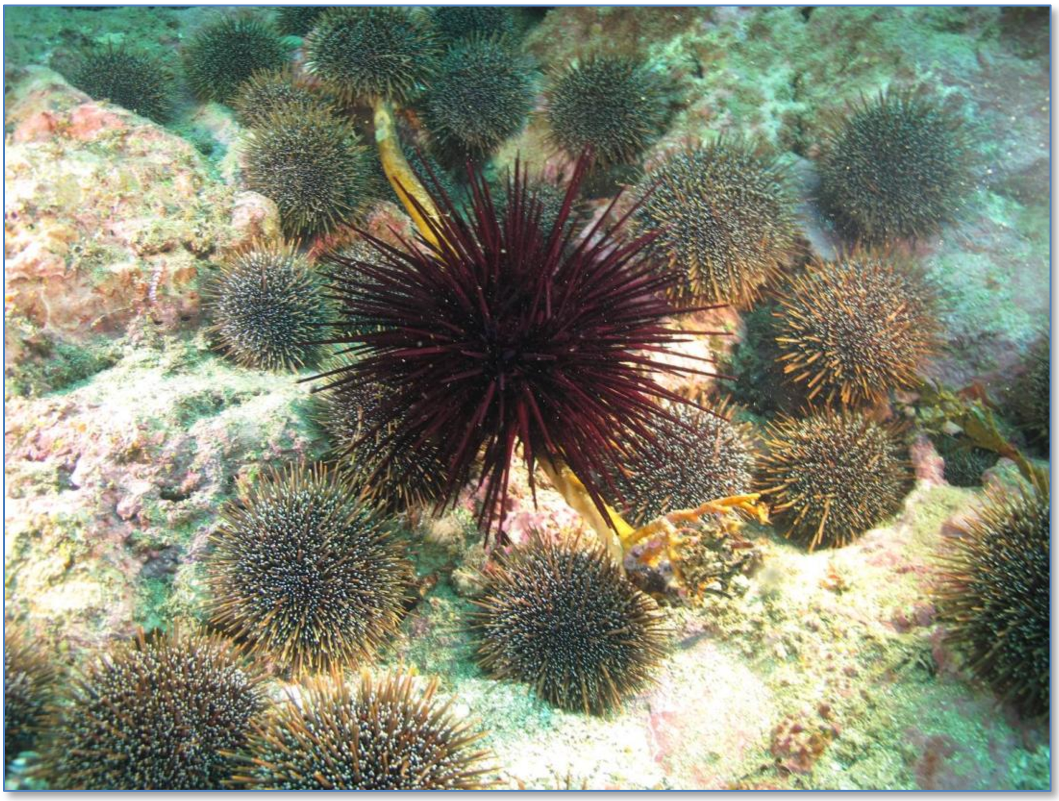

Figure 10 An example of the long-spined urchin *Centrostephanos rodgersii*

Baited underwater video monitoring

This summer, the BUV survey was carried out in March with 22 sites being successfully sampled; four sites were not analysed due to the kelp plants obscuring the view of the measurement bar of the apparatus.

503 fish were counted in total, belonging to 32 species. The top six species in abundance were snapper 345, two-spot demoiselle 47, trevally 46, pigfish 14, yellow moray eel 13, and golden snapper 12. The full data set of the fish counts for each BUV site is included in Appendix 3.

In the BUV analysis, the point in the video where the highest count of snapper is observed is used to generate the standardised measure referred to as MAXsnapper. In the MAXsnapper frame, the sizes of the snapper are individually recorded using the measured bar of the BUV apparatus as a length reference. The size data is then lumped into size classes that are used to calculate the biomass of each snapper size class. Another biomass value is calculated for all the size classes combined, producing an average biomass value for all the sites surveyed. In our survey, a third way of viewing the biomass data was produced by dividing the BUV sites into those inside the rāhui and those outside the rāhui. Comparing the results inside and outside of the rāhui becomes a measure of the changes going on inside the rāhui due to the absence of fishing.

In Figure 11 below, the average snapper biomass of all BUV sites is shown for the 2025 survey and for the previous yearly surveys starting in 2019. The average biomass calculated for 2025 for all sites surveyed was 7.14 kg. This compares with the 2019 biomass, which was 1.94 kgs and the average MAXsnapper count went from 7.33 (2019) to 15.55 (2025). This is a 3.7x increase in biomass and a 2.1x increase in the MAXsnapper count over the seven years the BUV survey has been done.

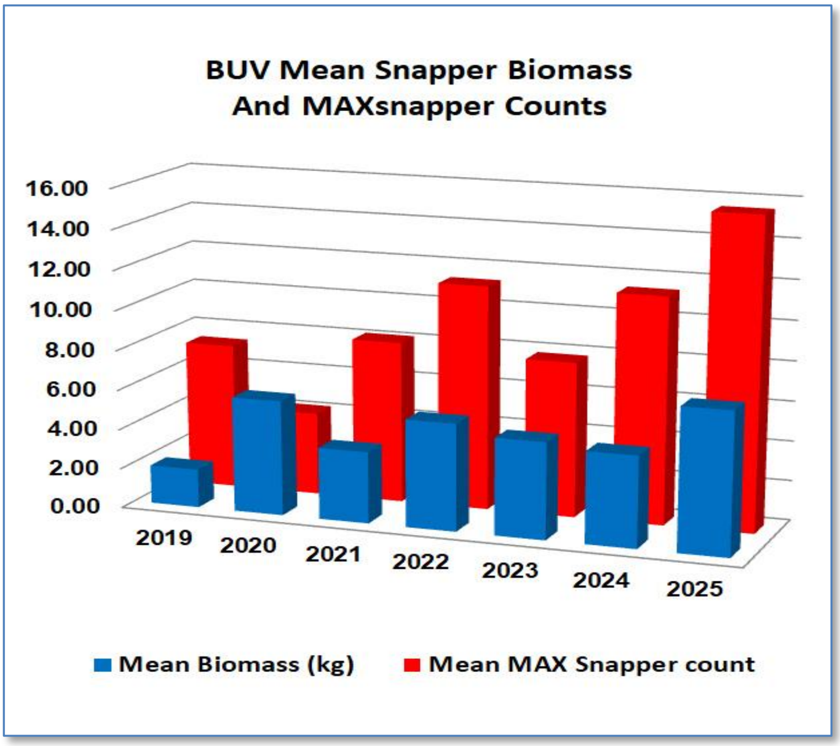

Figure 11 BUV snapper average biomass and MAXsnapper counts for all sites in the survey for the seven years the BUV survey has been done.

Figure 12 below shows the 2025 BUV biomass and MAXsnapper count results, divided into those inside and outside of the rāhui groups. The inside biomass average is significantly higher at 8.55 kgs than the outside value of 3.30 kgs. The MAXsnapper counts are closer in value to the outside group count at 17.67 compared to the inside counts at 14.75. There were clearly more small fish making up the results in the outside group. The increase in snapper biomass inside the rāhui is a significant result (red bar and right axis), and it is positive, indicating progress in restoring snapper, one of the two most important predator species on the shallow reefs.

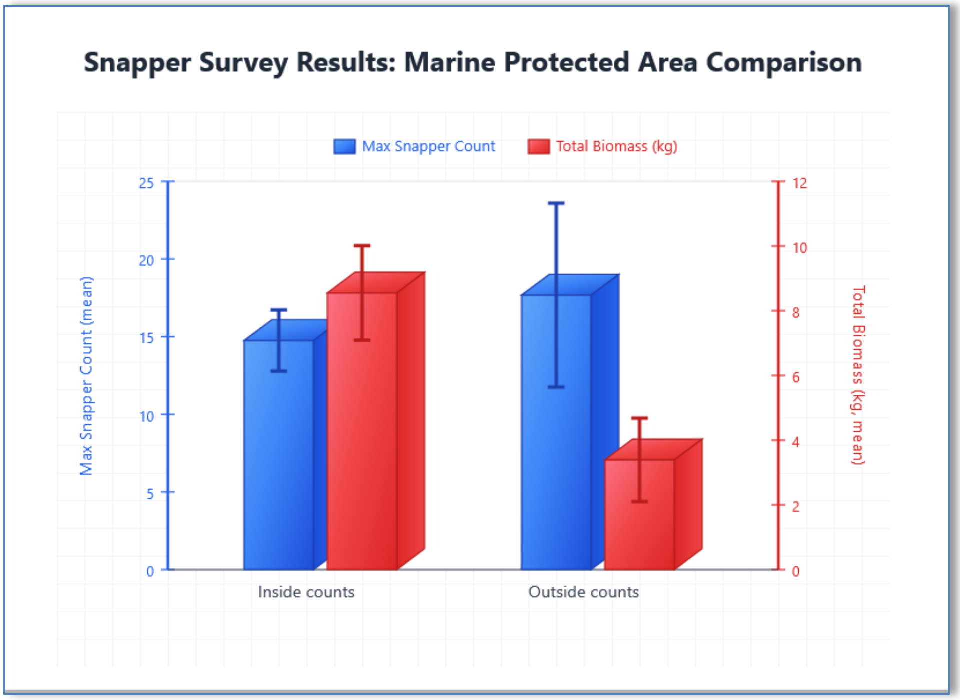

Figure 12 Average BUV snapper biomass and MAXsnapper counts split into inside and outside of the rāhui groups. There were 16 inside BUV sites and 8 outside sites. The blue bars show snapper counts (left axis), red bars show biomass in kg (right axis). The error bars represent the standard error for the calculation of the average values.

Crayfish observations

We do not yet have a formal crayfish recovery monitoring program for the rāhui. We do, however, take every opportunity to keep an eye out for crayfish when doing any of the diving work at Maitai Bay. Up until this year, we had not observed significant recruitment of young crayfish, and overall numbers remained low, with only a few individuals seen in high-quality cracks and overhanging reef structures. This year, after reports of crayfish sightings from our volunteer culling crew, we organised a scuba dive on the campground reef (M1 timed-swim transect) and did some extra free diving searches for crayfish in the M1 transect area.
Two experienced crayfish divers spent 40 minutes searching potential crayfish habitats, identifying 20-30 mainly sublegal red crayfish and a few juvenile packhorse crayfish. Free diving in the remaining area revealed another 20 mostly sublegal crayfish, with a few juvenile packhorse crayfish. Overall, there were approximately 6-8 red crayfish at or above legal size. There were no crayfish larger than 2 kg seen in the area. Notably, we observed small crayfish of 100mm in length in all the crayfish locations. These small crayfish are evidence of recent (within the last 3-5 years) recruitment to the reef, which is a promising sign. We will continue to monitor these developments.

Figure 13 A typical view of a young red crayfish taken at the Campground reef (M1 timed swim transect)

Fish Diversity

We have a reef fish diversity monitoring method introduced in the 2019 monitoring report (Kerr). This survey involves a scuba-based search of four specific areas where the diver carefully searches along a set route, recording all fish species encountered. The dive path is spread over as much of the reef depth profile as possible. This monitoring was carried out in 2019, 2020, 2022, and 2024, but not last summer. We created a running total list of fish species seen at Maitai Bay in the diversity dives, the BUV data, and the timed swims. This list of known fish diversity grows each year and now stands at 60 fish species (see Appendix 5 for details). This summer, our BUV recorded 32 species, see Appendix 4, and our timed Swim recorded 33 species, see Appendix 1.

Discussion

The rāhui has given us a glimpse of a better future

Heavy and sustaining fishing has been going on in the coastal area of Northland for so long that there is no one alive who can remember what a natural shallow kelp forest looks like. Stories handed down through generations speak of the abundance of hapuku, snapper, blue maomao, kingfish, trevally and kahawai that once were ever present in vast numbers in the coastal waters. These natural fish populations were distinctly different from today, as there were many old and large fish. Elders of the fish community were big, really big fish, and were a storehouse of learned behaviours, superior genetic stock and played vital ecological roles that affected the whole community. Kelp forests were lush, kina fat, and there were no kina barrens. Fast forward 150 years, and our shallow reefs are largely barren. After eight years of no fishing in the rāhu, the restoration is now in motion. People now step out of the water, amazed by the return of the marine life. Kids are excited and tell their parents stories of the ‘big’ snapper. The rāhui is literally educating us as the restoration proceeds. We are learning what ‘natural’ looks like again for Maitai Bay. This is perhaps our most important result: once you experience a thriving reef, it is not something you can forget. The staggering good news in this story of restoration is that we are only at the beginning of the process; there is much, much more to come.

Timed-swim strengths and weaknesses

The timed swim method on the shallow reefs appears to be working quite effectively. Snapper are currently the star of the show as they are showing the greatest recovery of all the species. The data consistently provides information on the abundance of all size classes. The method has the significant advantage that the diver can swim quietly and slowly without the loud noise associated with scuba gear, which is known to warn and scare snapper. It also works well for snapper because snapper are very mobile and mainly swim in mid-water or off the bottom, making them consistently visible to the diver. With the other species, the effectiveness of the method will vary greatly depending on how cryptic their normal swimming behaviours are, and this will change over time as the kina barrens change to a kelp forest. Counts for species like red moki, marble fish, hewihewi, and some of the wrass species may become less representative of the population as the fish are hidden down in the kelp much of the time. This will literally be different with each species. The timed-swim has one other significant benefit. The method can be repeated many times over the summer season, which improves the result and understanding we get from the data. The method is also relatively easy to learn and only requires competent snorkelling skills. Possibly the most positive aspect of this method is the sheer amount of time the divers spend observing everything on the reefs. Every year, we have learned a lot from our timed-swim work. To summarise, the method is ideal for snapper monitoring and will be less reliable for some of the other reef species as the kelp returns; however, for those species, it will still be useful as a relative population indicator of change over time. It does diminish in value and reliability when underwater visibility drops below 5 meters.

Baited underwater video strengths and weaknesses

BUV is a gold standard for tracking changes over time in predator fish abundance. The method has been used successfully in NZ for over two decades and is a commonly go-to technique overseas. The version we use (single camera) is a relatively low-cost option, but it does require some learning to carry out the on-water work. Additionally, there is equipment involved, and a training process is required to analyse the video and compile a report on the results. Overseas, higher-tech systems with two cameras are commonly used, utilising stereo software that can automatically size the fish in post-survey analysis. These systems (BRUV) come at a cost to use, but obviously have some advantages (Langlois et al, 2018). The BUV has one major advantage as a fish monitoring method. It is absolutely consistent in its execution, and there is no interference with the fish's behaviours, unlike with all diver-based methods. Our BUV has performed well and has produced data for us that shows the snapper population increasing inside the rāhui compared to outside.

Table 5: Typical results of snapper biomass at fished and no-fishing locations, on the Northeast coast. Open fishing areas are: Cape Brett, North Cape, Karikari Peninsula, and Mokihinau Islands.

Average Snapper BUV per drop biomass kgs

Long term reserves Leigh and Poor Knights Islands	**17 - 24**
Maitai Bay inside the rāhui 2025 Year 8	**8.6**
Maitai Bay inside the rāhui 2017 Year 1	**2.0**
Open fished areas	**2 - 4**
Mimiwhangata rāhui tapu 2024 Year 1	**3.9**
Mimiwhangata rāhui tapu 2025 Year 2	**6.7**

These BUV results indicate that the open-fished coast is significantly impacted by fishing and exhibits a long-term recovery pattern in the reserves, which may still not have fully recovered. Maitai Bay is now at approximately the midpoint in this process for snapper. Data sources: Leigh and Poor Knights Islands (Buisson, 2009), Maitai Bay (Kerr & Wallace), Mimiwhangata (Kerr & Wallace)

Seasonal patterns, intense storms, fish kill and the uniqueness of Maitai Bay

One of the difficulties in monitoring is that there is typically a lot of natural variation in the habitats of a given site, and wave exposure as a result of complex coastlines. Then there are seasonal differences from year to year. Maitai Bay is an extreme case of all these variations. The shallow reefs of the inner Bay are gently sloping and are limited to shallow depths of 8-12m, whereas the outer coast areas of the rāhui are steeper sloping with more rugged terrain, extending to 20m in depth, typically with deeper reefs offshore. Wave exposure equally varies greatly between inside and outside the Bay. The eastern side of the Karikari Peninsula is highly exposed with peak storm waves reaching 6-8m. In the Bay, it is tempting to describe the reefs as sheltered, but depending on the swell angles, both the north and south bays can have waves in severe storms of up to 3m high. When waves of this size strike a shallow reef, they are capable of damaging kelp forests and even killing fish, especially if those events are infrequent. In April of this year, we had a severe storm that resulted in a significant fish kill with hundreds of reef fish washed up on the beach. It is unknown how many of these fish were from inside the Bay or outside, or in the rāhui or not. It was certainly a significant event and very unusual. Figure 15 below is an image from the beach at Maitai Bay in the aftermath of the April storm. The extreme example from this year illustrates that the shallow reefs in Maitai Bay are unusual in that they are most of the time beautifully sheltered, but then occasionally subject to violent wave events. It is not really known how many reef species cope with this situation. Some in the inner reefs at Maitai Bay have no close deep reef to seek refuge on. It was noticeable in the fish kill of the April storm that virtually all the fish were small in size; possibly this was a factor, with young fish not having acquired the knowledge of avoiding harm in the storm conditions or not being strong enough to physically cope.

Figure 14 The fish kill on the beach from the April storm was evidence of how significant the storm damage can be at Maitai Bay. Image: Haina Tamehana

Recommendations

There is never a simple answer to the question of how often to monitor. One answer is the more the better, and the more you monitor, the more you can learn from the data. Some of our data is based on a once-yearly sample (BUV), and some is based on several surveys spread over the summer season (timed-swim). We know from the timed-swim data that there is much variation in the fish numbers over the course of summer and that fish numbers decrease following stormy periods. From frequently repeated monitoring, we can learn more about how the fish are moving around over the busy summer season and how they adapt to stormy periods. With one-off yearly sampling (BUV), we simply miss the detail of these seasonal ups and downs, but over a period of years, we can clearly see significant trend changes. So the answer is about being clear about what you want to know. Some monitoring programs change in sampling frequency because the questions change. For example, once a trend change of a species is established, your question may change from 'is there a change happening' to 'is the long-term status of the species stable or continuing in a steady trend upwards?' For the first question, you might want to monitor frequently to understand the response and establish that the change is happening, whereas for the second question, monitoring every other year or even over longer periods may be sufficient. The Ocean is playing a long game, whereas we humans often operate in very short time frames that are important to us. For the Maitai Bay rāhui, we have reached a significant turning point in the restoration. The process of restoration has begun with apparent increases in snapper and likely also crayfish, so it is a changing set of questions we may be interested in now.

Timed-swim options to consider

While the timed-swim method and design have proven themselves to be useful, there are some improvements to consider as the restoration process progresses.

We could look at better representing the habitats of the rāhui. There is now good coverage of the shallow reefs, but there could be more coverage of the outer coast areas. There is also no coverage of areas outside the rāhui, which prevents comparison between inside and outside the rāhui, as is available in the BUV system.

Transects, S1-S5 in southeast corner of the bay, transects S1-S5, could be monitored less often. The southeast corner of the Bay is currently not included in the rāhui and has not shown the increase in snapper as within the rāhui. We can expect that the southeast corner area will not change significantly if fishing continues there. Transect S5 in particular is problematic in its design because most of the transect is in the fished area, with one end being at Blue Mao Mao Point, a special habitat comprised of a protruding headland creating a change between sheltered and exposed habitats. Transect S5 is also divided between shallow and deeper reefs, subject to stronger currents and includes a boundary of the fishing area the rāhui. It would be better to include the Blue Maomao Point with a new transect on the exposed open coast side to the east, which is inside the rāhui. The S5 transect ideally should not include the point itself, as it is not similar to the rest of S5 or to S2–S4 transects, which are in the fished area and are shallow and semi-sheltered.

The BUV system options

The BUV system was adequately designed to measure differences between inside and outside of the rāhui; the only change suggested is to evaluate the sites that have failed in recent years by having the camera obscured in dense kelp. The solution is to move these sites to a near reef edge or barren patch to avoid them failing. In setting up the sites, we used side scan sonar to accurately locate reef edges or soft bottom patches to locate the BUV waypoints. Drop cameras or normal single-beam sonar can be used to locate good BUV spots, but side scan sonar is the best tool for this job. The number of sites outside the rāhui is minimal from a statistical aspect, so we can't afford these sites to fail. A few more exposed sites within the rāhui would enable us to analyse differences between exposed and sheltered site habitats inside the rāhui, something which we currently struggle to do with the number of sites we have.

Crayfish Monitoring

The answer here is YES. It would be ideal to have an effective crayfish monitoring program, as there are now signs that crayfish recruitment is occurring within the rāhui. Crayfish is a key predator on the reef and a crucial part of the puzzle in reaching the tipping point where kina are maintained at a low enough level, for the kelp forest to return and once again dominate the reef.

There are basically two approaches worth considering. There is the standard transect-based design setup that Auckland University uses that would work well if the crayfish numbers are not too low, and has the advantage of producing estimates of actual abundance and population data for a given reef area (Kelly, 2000). The second approach would involve locating high-quality cracks, ledges, overhangs and caves where crayfish congregate and seek shelter, especially when abundance is low and fishing pressure is high. This second approach could suit local crayfish divers who traditionally know these locations well. This method would utilise permanent sites and can effectively analyse changes over time. This traditional approach leverages local knowledge and also provides a robust 'relative' monitoring result that would track recovery from the current very low abundance levels during recovery. Tracking crayfish numbers would definitely be of great value in understanding the restoration process. Ideally, the design of the survey would include sufficient sampling sites to allow statistical analysis of the results divided into: inside rāhui sheltered/shallow, inside rāhui exposed, outside rāhui exposed. We don't have a close outside rāhui sheltered site to use as a fish reference site unless we consider a site in Doubtless Bay or on the other side of the Karikari Peninsula.

Kelp regeneration: how can we measure progress?

Local people who swim over the reefs will easily see changes happening, probably suggesting that a formal monitoring effort is not needed. However, there is a case for assisting kelp restoration by engaging in culling kina or restoration-focused harvesting. Applying traditional harvesting strategies as part of the restoration process could provide new knowledge to guide future management decisions.

There is also great scientific interest in tracking the kelp forest restoration at Maitai Bay. Many other groups will likely be interested in repeating or expanding the studies of the restoration process at Maitai Bay. Detailed information on what works well for different habitats and with culling or harvesting kina at various stages of restoration could be valuable for the entire Region. The burden of carefully collecting this information shouldn't just fall on the shoulders of the hapū; there should now be more resources made available to the hapū for these options to be explored.

The transition from kina barren to kelp forest can be tracked in a number of ways. First, the existing habitat map of what the kina barrens looked like before the rāhui was established (Kerr, 2020) can be used as a baseline. Next, new aerial photos from drones or satellites can be gathered to support an updated habitat map. Even updating just a sampling of locations would be worthwhile. Permanent photo points done as horizontal landscape shots or vertical canopy shots could be used to monitor changes as well, and are easy to set up. In addition, videos can be recorded during timed-swim transects for later analysis. Periodic sampling using drop cameras is another useful method. Each of these steps contributes valuable information for tracking habitat change.

How best to assist the restoration, options or do nothing?

Maitai Bay is a unique situation and is literally approaching a transition to a kelp forest. However, the timeline for reaching this point, whether with assistance from kina culling or through harvest strategies or no culling, remains uncertain. Our current opportunity is to test the value of culling at or around this transition time. We achieved a lot with our voluntary culling trial last summer. The options and importance of what we learned are thoroughly explored in our volunteer kina culling trial report (Kerr, 2025). New strategies are explored in the report, including targeting just active kina aggregations and feeding fronts.

The potential to harness volunteer efforts

The volunteer culling program this summer demonstrated that a lot could be done with volunteer efforts, and the interest in the community is certainly there. As these efforts grow and we develop our kaitiaki group who can lead and supervise this work, there are other possibilities like the timed-swim monitoring that could be volunteer-based once there are trained supervisors to lead and monitor projects.

Centrostephanos urchins - have we got a problem? Do we need to cull? Can they be controlled naturally by predators?

Based on the extensive diving we have done at Maitai Bay, it is clear that the *Centrostephanos* urchin has increased in numbers relatively quickly in the last five years, after being present for over fifty years on our coast at very low levels. This is a strong suggestion that either it has reached a critical mass that allows it to reproduce more efficiently, or environmental conditions, specifically sea temperature rise, are favouring this species. Both of these factors may be operating together.

What we are observing mirrors the situation at Poor Knights Island and is also similar to what is happening on the North and East coasts of Tasmania. There, *Centrostephanus* has established itself and is now the primary cause of urchin barrens (Ling et al., 2023). The University of Auckland research team is tracking the changes in *Centrostephanos* abundance and impacts at the Poor Knights Islands. Recently, they initiated a culling trial on Poor Knights Island to assess methods for controlling the spread of the *Centrosptephanos* urchin and the barrens it has begun to create (Balemi & Shears, 2003).

We are faced with the reality that sea surface temperature is warming off the Northland coast (Shears et al, 2024), and it is predicted to continue to warm. We know from research in Tasmania and NSW that this favours the *Centrostephanos* urchin. These facts suggest they are a potential serious threat to our kelp forests going forward. There remains one more vital question to answer: Can natural predators control *the Centrostephanos* urchin at levels that could be in balance with our kelp forests? The advice from Tasmanian researchers is that they can be controlled by large crayfish, but for the time being, we have few or no large crayfish on our reefs, and we don't know for sure if this natural balance will be achieved on our reefs. In summary, we should be concerned and monitor the situation closely, and at least try culling the *Centrostephanos* urchins to maintain low numbers in the whole rāhui area. This is a decision to make now, rather than waiting for the situation to worsen. The hope for the future is that in the rāhui, the large crayfish can achieve natural control of these urchins. A second hope is that we create more restoration areas to work alongside sensible fisheries management that maintains large crayfish in the population on all our reefs.

Compliance with the no-fishing rules

In all no-take reserves around the world, compliance with the no-fishing rules is probably the biggest challenge, and it can be the make-or-break of the reserve. Unfortunately, in the early stages of restoration, small amounts of fishing can significantly hinder the restoration process, making these initial stages critical. At Maitai Bay, the approach has been to educate, engage, and encourage people to support the kaupapa. There is no Government fishing regulation or other legal protection for the rāhui. While this may appear high-risk, this strategy leans into the true reason why people should respect the rules: the rāhui is urgently needed and is about turning things around after decades of over-exploitation. Support for the Maitai Bay rāhui kaupapa overall remains strong. Our observation is that the awareness of the importance of the rāhui is growing, not fading. It is also a statement of mana motuhake, which loosely translates to mean that a local cultural solution has been put in place backed by their traditional authority. In our observations and conversations with visitors, the kaupapa is gaining respect and support, and, in a sense, is growing the mana of the rāhui. While the strength of this cultural approach is obvious, there remains the challenge of supporting the local human and other resources to remain vigilant and on the job of teaching people about the rāhui.

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Vince Kerr, September 2025

A lone butterfish cruises over the reef; now only a few remain where once they were a common fish of the shallow kelp forests

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Appendix 1 Timed Swim 2025 fish counts all species

Date	Transect	banded wrass	black angelfish	blue maomao	bronze whaler	butterfish	demoiselle	eagle ray	flounder	goatfish	hewihewi	jack mackeral	juv maomao	kahawai	kingfish	koheru	leather jacket	marbelfishh	orange wrass	parore	pigfish	piper	porae	puffer	red moki	sandagger wrass	silver drummer	sawtooth surgeon	spotty	snapper	sweep	swimming blennie	tailspot goatfish	trevelly	counted No of fish	No of species
6/3	M1	1				0				2	4			320						10	1	50			1	5			11	27				27	458	12
6/3	M2	1		100		0				1	2			3						18		13			3	5	6		4	12	100			15	182	14
6/3	M3	2	1			0		1						4				1		19					3	5	4		2	32					71	11
6/3	M4		1			0														15		30			1	4			7	46				16	119	8
16/3	M1	4				0				5	3			10			2			8	1	20			7	8			13	58	60			46	241	14
16/3	M2	5				1	20			2				10			1	1			2		15		9	3	2		14	34	120			5	238	16
16/3	M3		1	6		0							100							15	1				2		7		4	31					160	9
16/3	M4		1			0														5					1	1			4	43				11	65	7
16/3	O1	1	2	2		0	16				2		250	4				1		3			1		3	3	10		3	34		30			360	16
16/3	O2	2	1	38		0	5	1			3		600					5					54		3	1	10			5	30			1	718	15
16/3	S1	1				0																			3	1			1	21					26	5
16/3	S2	2	1			0	30							7			1			3					5	1			6	22					75	10
16/3	S3	1	1			0	28			3												20	6		5	3			10	20					95	10
16/3	S4					0	40			7							2			4					4	1			6	14				20	98	9
16/3	S5		3			1	110	1		4				160			6		1				41		7	15	1		15	26	10			10	407	16
16/3	W1	1				0		2		10								1		12	2		1		10	10			10	41				100	199	12
16/3	W2	3				0	10									30		1			1		7		8	10	1		2	56	30			20	176	13
22/3	M1					0				4			35					1			1	56	10		4	15			11	36				1	174	11
22/3	M2					0																	12		5	2			8	11					38	5
22/3	M3					0	1	1					50	1						25					3	7	2			17					107	9
22/3	M4					0	1			4		10					1				1		7		1	3			10	44					82	10
22/3	O1	3	2	33		0	243					70	200						1				55		5	3	2		2	26	30			30	667	15
22/3	O2	2	2	47		1	26					120	300	50		100				10					2	2	2		3	6	20	100		55	796	18
22/3	W1	1				0				3				50	1				1	14					6	5			12	32		30			154	11
22/3	W2	6				0				2								1		8	2				8	2	5		7	24					59	10
29/3	S1	1	1			0	55			2				4	1	20				6				1	5	11			18	57				11	191	14
29/3	S2	1		3		0	105			2						1	2			10					5	7			6	39		30	1		208	13
29/3	S3					0	20			3		200								22		60			21	5		1	11	18	5				366	11
29/3	S4	1				0																	3		3				7	12	7				32	6
29/3	S5		2	43	1	0	143			7	1	310		9	12		1			28					1	22	2	1	7	23				30	597	18
24/5	M1					0			1	1	2	500		200						3		100			2	5			9	83				225	1131	12
24/5	M2	2		20		1	10				2							1		4	1				7	3	4		6	9				20	67	14
24/5	M3	1		15		0	25													60					3	1	5		4	15					113	9
24/5	M4	1				0												50					50		0	2			5	31				465	603	7
Totals		43	19	307	1	4	888	6	1	62	19	1210	1535	832	14	151	16	63	3	302	13	349	262	1	156	171	63	2	238	1005	412	190	1	1108	9073	33

Appendix 2 Timed Swim Years 1-8 records

Summary Timed Swim Results	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Number of transects surveyed	16	45	67	38	37	39	39	**34**
Hours surveying	4	11	17	10	9	10	10	**9**
Distance of shoreline reef observed (kms)	6	18	27	15	15	16	16	**14**
Total number of fish counted	2,239	15,865	21,395	29,251	17,814	15,953	21,510	**9,487**
Average number of fish counted per transects	140	353	319	770	481	409	552	**279**
Diversity: Average number of species/transect	10	10	9	13	11	12	14	**12**
Highest diversity: Number of species/transect	14	20	13	22	17	21	21	**18**
Lowest diversity number species/transect	0	4	3	5	5	6	5	**5**

Appendix 3 BUV Snapper 2025 results

Wpt	Exposure	Rāhui	MAX # Snapper	Max Length (cm)	Mean Length (cm)	Mean biomass (kg)	Total biomass (kg)	Number of species
B12	Sheltered	In	34	60	24.6	0.49	16.81	2
B13	Sheltered	In	3	20	16.7	0.12	0.36	1
B14	Sheltered	In	15	45	32.7	0.80	11.97	4
B15	Sheltered	In	14	45	22.1	0.40	5.57	2
B16	Sheltered	In	16	40	25	0.45	7.23	3
B18	Sheltered	In	18	60	31.4	0.85	15.32	2
B19	Exposed	In	19	35	23.16	0.36	6.86	8
B21	Sheltered	In	23	40	22.39	0.31	7.20	3
B26.1	Pinnacle	In	8	90	40.63	2.42	19.38	8
B26.2	Pinnacle	In	9	30	22.22	0.27	2.47	7
B4	Exposed	In	19	40	28.16	0.56	10.57	5
B5	Sheltered	In	2	35	27.5	0.55	1.11	4
B6	Sheltered	In	9	40	23.89	0.41	3.69	4
B8	Sheltered	In	8	35	21.9	0.32	2.56	6
B25	Pinnacle	In	20	80	27.25	0.82	16.34	8
B7	Sheltered	In	19	60	23.4	0.49	9.32	4
B1	Exposed	Out	4	25	20	0.21	0.8	6
B10	Sheltered	Out	31	20	10.6	0.05	1.50	6
B11	Sheltered	Out	41	35	20.7	0.25	10.17	1
B2	Exposed	Out	13	35	21.2	0.28	3.64	3
B22	Exposed	Out	8	35	22.5	0.33	2.62	5
B9	Sheltered	Out	9	25	18.3	0.18	1.58	8

Note: Cells highlighted in blue are size data taken from frames with less individual snapper but greater snapper biomass. Four sites in this survey had the BUV frame obscured with kelp and could not be reliably counted, and were excluded from the data analysis.   Appendix 4 BUV 2025 all fish species counts

Appendix 4 BUV fish diversity list 2025

Species	B1	B2	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B18	B19	B21	B22	B25	B26.1	B26.2	TOTAL
Banded Wrasse								1															1
Big eye																							0
Blue Cod																				1		1	1
Blue Maomao																	3						3
Butterfly Perch																							0
Eagle ray													1										
Goatfish					1	1	1		1										2	2	1	2	8
Golden Snapper																				12	19	24	12
Grey Moray	2		2																2				6
Gurnard																							0
Half-banded Perch																					1		
Hewihewi								2															2
John Dory															1			1					2
Kahawai																							0
Leather Jacket																							0
Mosaic Eel																							0
Orange Wrasse																							0
Pigfish	2	1	2	1		1	1						1				1		2	2	1	2	14
Pink Maomao																				1			
Porae			1																				1
Red Moki																							0
Sanddaggers Wrasse									2														2
Scarlet Wrasse																	1				2		1
Sharp-nosed Puffer																						1	
Short tailed Stingray							1																1
Snapper	4	13	19	2	9	19	8	9	32	41	34	3	15	14	16	20	19	23	8	20	8	9	345
Speckled Moray	1																						1
Spotty					1			1	1								1						4
Sweep								5									3				1		8
Trevally				3		1	1	25	3		1		4	1	1	1		3		2	1	1	46
Two-spot Demoiselle	20							15									10			2			47
Yellow Moray	1	1	1	1	1		1	3	1								2		1				13
TOTAL Biodiversity	**6**	**3**	**5**	**4**	**4**	**4**	**6**	**8**	**6**	**1**	**2**	**1**	**4**	**2**	**3**	**2**	**8**	**3**	**5**	**8**	**8**	**7**	
TOTAL Fish counted	**30**	**15**	**25**	**7**	**12**	**22**	**13**	**61**	**40**	**41**	**35**	**3**	**21**	**15**	**18**	**21**	**40**	**27**	**15**	**42**	**34**	**40**	503
Note: sites B3,B17,,B20,B23,B24 had the video obscurred by kelp and were not included in the analysis																							

Appendix 5 Years 1-8 combined fish diversity list

Family	Genus	Species	Common name	Maori name
Acanthuridae	*Acanthurus*	*dussumeiri*	Surgeon fish	
Aplodactylidae	*Aplodactylus*	*meandratus*	Marblefish	Kehe
Arripidae	*Arripis*	*trutta*	Kahawai	Kahawai
Berycidae	*Centroberyx*	*affinis*	Golden Snapper	Hauture
Carangidae	*Caranx*	*lutescens*	Trevally	Araara
Carangidae	*Decapterus*	*koheru*	Koheru	Koheru
Carangidae	*Seriola*	*lalandi*	Yellowtail Kingfish	Haku
Carangidae	*Trachurus*	*novaezelandiae*	Jack mackeral	Hauture
Carcharhinidae	*Carcharhinus*	*brachyurus*	Bornze whaler	Horopekapeka
Cheilodactylidae	*Cheilodactylus*	*douglasi*	Porae	Porae
Cheilodactylidae	*Cheilodactylus*	*ephippium*	Painted Moki	
Cheilodactylidae	*Cheilodactylus*	*spectabilis*	Red Moki	Nanua
Chironemidae	*Chironemus*	*marmoratus*	Hiwihiwi	Hiwihiwi
Clinidae	*Cristiceps*	*aurantiacus*	Crested Weedfish	
Dasyatidae	*Dasyatis*	*brevicaudata*	Shortailed Stingray	
Dasyatidae	*Dasyatis*	*thetidis*	Longtail Stingray	Whai
Diodontidae	*Allomycterus*	*jaculiferus*	Porcupine Fish	
Engraulidae	*Engraulis*	*australis*	Anchovy	Kokowhaawhaa
Hemiramphidae	*Hyporhamphus*	*ihi*	Piper	
Kyphosidae	*Girella*	*tricuspidata*	Parore	Parore
Kyphosidae	*Kyphosus*	*sydneyanus*	Silver drummer	
Kyphosidae	*Scorpis*	*violaceus*	Blue Maomao	Maomao
Labridae	*Anampses*	*elegans*	Elegant Wrasse	
Labridae	*Bodianus*	*unimaculatus*	Red Pigfish	
Labridae	*Coris*	*sandageri*	Sandaggers Wrasse	
Labridae	*Notolabrus*	*celidotus*	Spotty	Paketi, Paekirikiri
Labridae	*Notolabrus*	*fucicola*	Banded Wrasse	Tāngahangaha
Labridae	*Notolabrus*	*inscriptus*	Green Wrasse	
Labridae	*Pseudolabrus*	*luculentus*	Orange Wrasse	
Labridae	*Pseudolabrus*	*miles*	Scarlet Wrasse	

Labridae	*Suezichthys*	*aylingi*	Crimson Cleaner Fish	
Monacanthidae	*Parika*	*scaber*	Leather Jacket	Kokiri
Mullidae	*Parupeneus*	*fraterculus*	Goatfish (tropical)	Āhuruhuru
Mullidae	*Upeneichthys*	*lineatus*	Goatfish bar-tailed	Āhuruhuru
Muraenidae	*Enchlycore*	*ramosa*	Moray Mosaic	
Muraenidae	*Gymnothorax*	*nubilus*	Moray Grey	
Muraenidae	*Gymnothorax*	*obsesus*	Moray Speckled	
Muraenidae	*Gymnothorax*	*prasinus*	Moray Yellow	
Myliobatidae	*Myliobatus*	*tenuicaudatus*	Eagle Ray	Whai keo
Odacidae	*Coridodax*	*pullus*	Butterfish	Mararii
Ophichthidae	*Ophisurus*	*serpens*	Snake eel	
Pempheridae	*Pempheris*	*adspersus*	Big Eye	
Pinguipedidae	*Parapercis*	*colias*	Blue cod	Pākirkir/Rāwaru
Pleuroronectidae	*Rhomboslea*	*plebeia*	Sand Flounder	
Pomacentridae	*Chromis*	*dispilis*	Two-spot Demoiselle	
Pomacentridae	*Parma*	*alboscapularis*	Black Angelfish	
Scorpaenidae	*Scorpaena*	*papillosa*	Dwarf Scorpian Fish	
Scorpaenidae	*Scorpaena*	*cadinales*	Scorpion Fish	Matuawhāpuka
Scorpidae	*Scorpis*	*lineolatus*	Sweep	Hui
Serranidae	*Caesioperca*	*lepidoptera*	Butterfly Perch	Oia
Serranidae	*Epinephelus*	*daemelii*	Black Spotted Grouper	
Serranidae	*Hypoplectrodes*	*sp.*	Half banded perch	
Sparidae	*Pagrus*	*auratus*	Pink Snapper	Taamure
Tetraodontidae	*Canthigaster*	*callisterna*	Sharp nosed puffer	
Triglidae	*Chelidonichthys*	*kumu*	Gurnard	kumukumu
Tripterygiidae	*Forstergion*	*malcomi*	Common Triplefin	
Tripterygiidae	*Obliquichithys*	*maryannae*	Swimming Blennie	
Zeidae	*Zeus*	*japonicus*	John Dory	Kuparu