Mimiwhangata Rāhui Baited Underwater Video Survey June 2024

Ceara Wallace & Vince Kerr

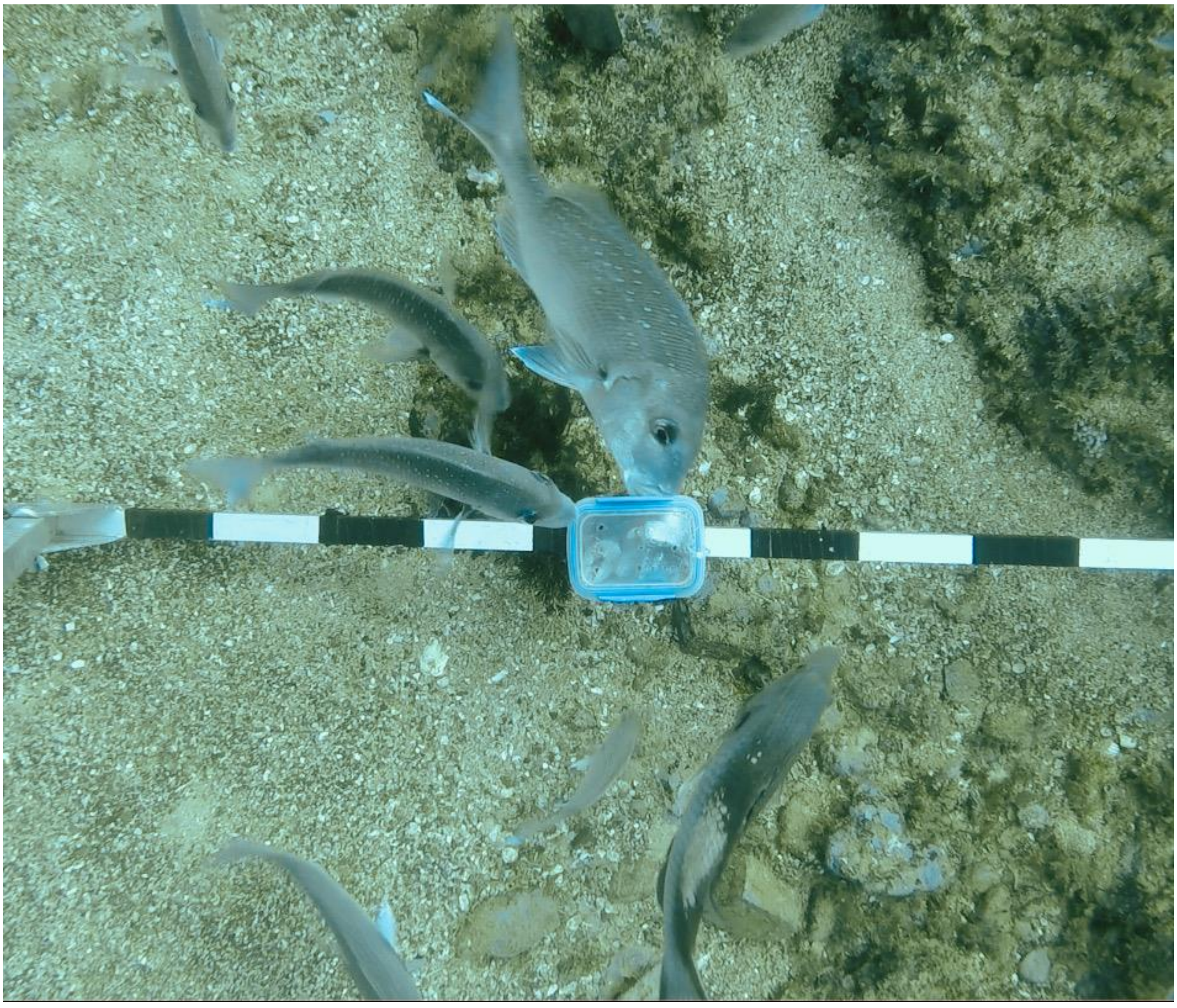

Photo: Snapper (Pagrus auratus) and a red pigfish (Bodianus unimaculatus) interested in the bait cage of the baited underwater video (BUV) apparatus during a survey at Mimiwhangata.

Client Brief

In April 2024, Kerr & Associates, in collaboration with Te Uri O Hikihiki Rahui Roopu, proposed to NRC to complete a preliminary baseline fish survey at Mimiwhangata in the first year of the rāhui tapu. It was agreed by all parties that a Baited Underwater Video survey would be the most effective and time-efficient option. This work is designed to become part of a planned monitoring program for 2025 and is consistent with the previous survey methodology. Kerr & Associates would conduct the on-water sampling, analyse the raw data, and produce a report summarizing the methodology.

Summary

A rāhui tapu was placed around the Mimiwhangata peninsula in 2023. In April 2024, we completed a preliminary survey to determine baseline data on the abundance of predatory fish species in the area at the commencement of the no-take rāhui tapu. A standard monitoring method used throughout New Zealand called Baited Underwater Video (BUV), was used for this monitoring project. BUV surveys provide a cost-effective and simple method for estimating the relative density of predatory reef fish. This monitoring project is historically significant as there is a large body of existing data from the same area, including BUV survey, starting from 2002[1] and 2003[2]. This means the data obtained from the current sampling can be compared to historical data and tracked over time to follow recovery, as was done at Leigh, the Poor Knight Islands and Maitai Bay after they became fully no-take marine protected areas (MPA's)[3]. Evidence of such trends is crucial to showing the ecological value of having the rāhui tapu in place at Mimiwhangata.

The fieldwork was completed by Ceara Wallace and Vince Kerr from Kerr & Associates onboard Dive Northland's vessel using one of their skippers. The work was done in collaboration with Te Uri O Hikihiki via its Komiti Chair, Holly Heteraka. This work is expected to become part of the larger monitoring programme proposed to start next summer.

Results from this year's sampling were similar to those from previous BUV surveys done at Mimiwhangata in 2009 and prior and are comparable to those from fished sites along the North East coast. With the rāhui tapu closure now in place, future data is expected to show

[1] Denny, C.M., Babcock, R. C. (2002). Fish survey of the Mimiwhangata Marine Park, Northland. A report to the Department of Conservation, Northland Conservancy. Leigh Marine Laboratory University of Auckland.
[2] Usmar, N. R., Denny, C. M., Shears, N. T., Babcock, R. C. (2003). Mimiwhangata Marine Park monitoring report 2002-2003, Leigh Marine Laboratory, University of Auckland.
[3] Kerr, V.C., Rutene, W., Bone, O. (2019). Maitai Bay Rāhui Monitoring Report, Cape Karikari. A report prepared for Te Whānau Moana me te Rorohuri, Maitai Bay, Cape Karikari, Northland and the Mountains to Sea Conservation Trust

similar trends of increasing biodiversity and fish abundance as observed in MPA's within Northern New Zealand, where habitat restoration has occurred due to fishery closures.

Baited Underwater Video Survey

The BUV methodology, statistical analysis, and advantages are explained in detail in Willis and Babcock (2000)[4]. This method produces a fish diversity measure of predator fish and sizes. It is a simple method for relative abundance as the number for each species translates to an abundance figure, a biomass measure and an age class structure relative to each site. BUV has the distinct advantage of not being affected by diver bias, either negative or positive, towards fish behaviour. It is also useful for comparing changes over time and to allow comparisons between different locations or management regimes. In this case, the location of the BUV survey sites allows us to compare snapper abundance trends within the rāhui tapu to adjacent sites open to fishing or other protected areas.

The BUV apparatus (*see Fig. 1 & 2*) consists of an aluminium frame welded into two sides of a triangle. The horizontal bar sits on the bottom, has a bait cage secured in the centre, and is marked at 100mm intervals for recording fish sizes. A GoPro camera is mounted at the top of the frame angled down at the bait cage. The frame is attached to floats and a rope. Sampling involves dropping the apparatus overboard so that it sits on the bottom, left to film for 30 minutes, and retrieved. The bait cage is filled with fresh pilchard before each new deployment. This process is repeated at each survey site.

Site selection for the BUV surveying is achieved by creating a series of randomly selected points near reef edges or on the reef in a depth range of 7 - 35m. The sites around Mimiwhangata were first designed and established in 2002 in collaboration between V. Kerr (DOC) and the Auckland University research program[5]. For this study we surveyed 30 sites, covering the rāhui tapu and control areas north and south of the Mimiwhangata Peninsula (*see Fig. 3*).

[4] Willis, T. J. & Babcock, R. C. (2000). A baited underwater video system for the determination of relative density of carnivorous reef fish. *Marine and Freshwater Research* 51. 755-763.
[5] Denny, C.M., Babcock, R. C. (2002). Fish survey of the Mimiwhangata Marine Park, Northland. A report to the Department of Conservation, Northland Conservancy. Leigh Marine Laboratory University of Auckland.

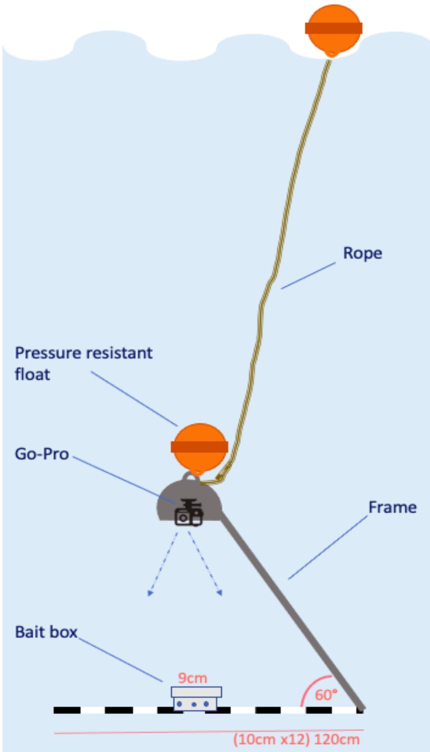

Figure 1 & 2. Left: Diagram of deployed BUV apparatus. Right: shows the BUV apparatus in situ about to be deployed overboard during 2024 Mimiwhangata BUV survey.

On-Water Data Collection

Favourable conditions and crew capabilities meant sampling was completed in 2 days on the water. The BUV drops were done on the 23rd and 24th of April, between 0800h and 1500h each day. Video data collection was conducted within this time window as it allowed for the best levels of light for recording underwater due to sunset being around 1850h on these days. High tide was at 0645h on the first day on the water, and 0731h on the second. Low tide was at 1312h and then 1350h for each day. The full moon fell over these two days and there was about 1.7m difference between high and low water.

The vessel and all crew departed from Wharf Road Whangaruru on both days and travelled south to the survey sites. The swell was Easterly between 0.5-1m on the first day, and the wind was variable 5kts, so we focussed on the Western and more sheltered sites in the morning, which were also the closest to the start point. By the afternoon, the swell and wind had picked up to 10kts SE, making the exposed sites around the top of the peninsula difficult to survey, but it was possible to do a few more drops on the southern side of the peninsula before turning back. On the second day, it was calmest in the morning so the outer sites were surveyed first before methodically moving south and surveying all the remaining sites. Wind on the second day was variable less than 5kts in the morning with a 1m swell.

Video processing & Data analysis

The video footage was thoroughly analysed to determine the total fish diversity, maximum snapper count, and maximum snapper biomass using snapper lengths for each of the 30 sample sites. The maximum snapper count refers to the maximum number of snapper observed in a single frame during the 30-minute footage. The maximum snapper biomass is the total estimated maximum weight of snapper measured in a single frame. This is determined by converting snapper length estimates to biomass using the equation[6]:

$$W = aL^b$$

W is the weight (g), L is the length (mm), a is 7.194×10^{-5} *and b is 2.793*.

In some instances, the frame with the maximum snapper count was not the same frame as the one with the maximum snapper biomass. This is because large snapper individuals have an exponentially greater biomass than smaller snapper. Individual snapper lengths were measured in still frames of the video sequence and great care was taken to measure fish lengths as accurately as possible when the fish were at the same level as the bottom bar. These individuals' lengths were then used to determine biomass. These values were combined to determine the mean total snapper biomass per site. Calculating biomass enables us to follow any trends in biomass that occur over time.

Hapu Involvement

Holly Heteraka joined the team on the water on the second day of data collection. He assisted with some of the work and witnessed what was involved with the practical component of the survey. The goal is that Te Uri o Hikihiki can eventually put forward a team or individual who can help with the monitoring of their rāhui tapu in the future. Post-video processing, a highlight video was made of the BUV process and the different species captured in the footage. This was shared, along with a short presentation about the new rāhui tapu, with Whangaruru School on the 28th of May. The intention was to educate, inform and inspire as the majority of the children and staff at the school are from the hapu. Holly Heteraka and Roxanne Pene were also present. Roxanne is another member of Te Uri o Hikihiki, works for the group *Experiencing Marine Reserves*, and shows valuable potential in being able to assist with future monitoring of the Mimiwhangata rāhui tapu.

[6] Taylor, B.T., Willis T.J. (1998). Relationships amongst length, weight and growth of north-eastern New Zealand reef fishes. Marine & Freshwater Research 49:255–260

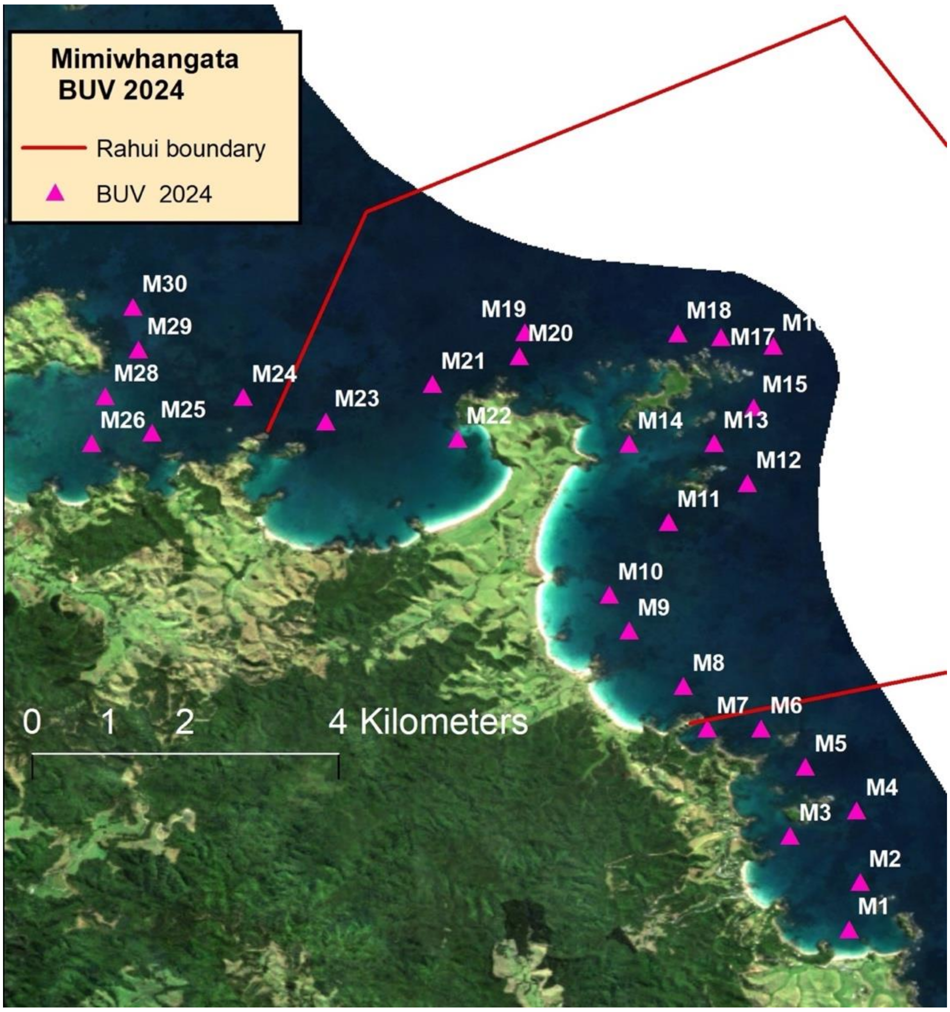

Figure 3. Map of the 30 BUV sites surveyed in 2024 around the Mimiwhangata Peninsula

Results

Wpt	Longitude	Latitude	Drop Date	Drop time	Drop depth
M1	174 27.7860874 E	35 29.2674488 S	24/04/24	13:22	9.4
M2	174 27.8640877 E	35 28.9314488 S	24/04/24	13:02	14.4
M3	174 27.3720876 E	35 28.6074492 S	24/04/24	12:44	12.4
M4	174 27.8400882 E	35 28.4274492 S	24/04/24	12:19	18.7
M5	174 27.4800880 E	35 28.1214490 S	24/04/24	12:07	14
M6	174 27.1680883 E	35 27.8514493 S	24/04/24	11:40	12.9
M7	174 26.7900877 E	35 27.8514491 S	24/04/24	11:31	8.7
M8	174 26.6220880 E	35 27.5514493 S	24/04/24	11:04	12.3
M9	174 26.2380885 E	35 27.1614489 S	24/04/24	10:54	11
M10	174 26.1000883 E	35 26.9094492 S	24/04/24	10:26	11.5
M11	174 26.5140892 E	35 26.3994495 S	24/04/24	10:16	17.5
M12	174 27.0720897 E	35 26.1234497 S	24/04/24	09:44	24.2
M13	174 26.8380896 E	35 25.8414499 S	23/04/24	14:41	15
M14	174 26.2380899 E	35 25.8474498 S	23/04/24	13:59	8.4
M15	174 27.1140899 E	35 25.5894498 S	24/04/24	09:37	22.7
M16	174 27.2520906 E	35 25.1574502 S	24/04/24	08:58	31.1
M17	174 26.8860908 E	35 25.0974501 S	24/04/24	08:43	28.5
M18	174 26.5800907 E	35 25.0674499 S	23/04/24	13:35	27
M19	174 25.5060899 E	35 25.0614494 S	23/04/24	13:20	25.1
M20	174 25.4640903 E	35 25.2294496 S	23/04/24	12:45	18.2
M21	174 24.8520896 E	35 25.4274495 S	23/04/24	12:55	19.2
M22	174 25.0320896 E	35 25.8114493 S	23/04/24	11:07	4.4
M23	174 24.1020890 E	35 25.6914493 S	23/04/24	10:53	17.2
M24	174 23.5200890 E	35 25.5174490 S	23/04/24	10:28	21.8
M25	174 22.8780887 E	35 25.7694489 S	23/04/24	09:09	12
M26	174 22.4520883 E	35 25.8414488 S	23/04/24	10:16	8
M27	*174 26.0720897 E*	*35 26.1234497 S*	23/04/24	14:16	7.2
M28	174 22.5480885 E	35 25.5114491 S	23/04/24	09:51	11.6
M29	174 22.7820893 E	35 25.1814489 S	23/04/24	09:40	16.5
M30	174 22.7460895 E	35 24.8814493 S	23/04/24	09:05	15.4

Table 1. A record of the corresponding BUV site coordinates, drop date, time and depth for each of the 30 surveyed sites of the Mimiwhangata rāhui tapu and surrounding area.

In 2024, 30 BUV sites were surveyed around the Mimiwhangata Peninsula. A record of the drop location, date, time and depth were recorded for each site, as seen above in *Table 1*. Of the 30 sites surveyed, 28 of these drops successfully obtained 30 minutes of continuous and uncompromised footage that could be analysed. Site M5 had significant kelp interference, and at site M25, the bottom bar of the BUV frame landed underneath a ledge and had kelp interference; therefore, the total count and lengths of snapper could not be accurately determined for either site. The footage in both cases was still carefully analysed and the closest estimate was recorded, as seen in *Table 2*.

Analysis of Snapper

	In / Out Rāhui	Maximum Snapper Count	Maximum Length	Mean Length (cm)	Mean biomass (kg)	Total biomass (kg)
M1	**Out**	1	20	20.0	0.19	0.2
M2	**Out**	6	30	22.50	0.30	1.78
M3	**Out**	16	30	22.73	0.29	3.24
M4	**Out**	6	30	18.33	0.19	1.13
M5	**Out**	9	25	17.78	0.15	1.37
M6	**Out**	1	15	15.00	0.09	0.09
M7	**Out**	2	5	5.00	0.00	0.01
M8	**Out**	9	35	31.67	0.70	6.33
M9	**Out**	19	30	23.68	0.32	6.12
M10	**In**	16	35	26.56	0.45	7.15
M11	**In**	23	40	28.26	0.56	12.96
M12	**In**	13	35	25.00	0.39	5.09
M13	**In**	7	30	24.29	0.36	2.49
M14	**In**	1	20	20.00	0.19	0.19
M15	**In**	6	25	21.67	0.25	1.49
M16	**In**	14	30	23.21	0.33	4.58
M17	**In**	11	40	20.00	0.28	3.11
M18	**In**	6	30	25.00	0.37	2.22
M19	**In**	6	30	22.50	0.31	1.84
M20	**In**	3	25	20.00	0.21	0.64
M21	**In**	20	30	21.25	0.27	5.35
M22	**In**	7	40	29.29	0.61	4.28
M23	**Out**	7	30	26.43	0.43	2.99
M24	**Out**	2	35	32.50	0.76	1.51
M25	**Out**	1	15	15.00	0.09	0.09
M26	**Out**	0	0	0.00	0.00	0.00
M27	**Out**	2	30	27.50	0.48	0.95
M28	**Out**	4	35	28.75	0.56	2.23
M29	**Out**	5	50	26.25	0.74	2.95
M30	**Out**	2	15	15.00	0.09	0.17
TOTAL		**225**	-	-	-	**82.55**
MEAN		7.5	**28**	-	-	**2.8**

Table 2. Summary of BUV snapper data from the 30 surveyed sites at Mimiwhangata and the surrounding area completed in 2024. Data was obtained for each site from the respective video frame with the maximum snapper count. Cells highlighted in blue refer to data taken from the frame during video analysis with the greatest snapper biomass rather than a frame with maximum snapper count. Cells highlighted in red indicate data was compromised due to kelp interference and could not be as accurately obtained.

A summary of the maximum snapper counts, lengths and estimated biomass for the 30 surveyed sites is presented in *Table 2*. The table indicates whether sites fall inside or outside the rāhui tapu boundary. Sites M11 and M21, within the rāhui area, had the greatest maximum snapper number recorded, with 23 and 20 snapper, respectively. The mean snapper count across all sites was 7.5 snapper. M11 had the greatest total snapper biomass recorded for a site, with an estimated 12.9kg, while the mean biomass across all 30 sites was 2.8kg. No snapper were recorded at site M26 which is outside the rāhui boundary.

The maximum snapper length in this survey was 50cm, recorded at site M29. This was the largest and only individual recorded for that length. The average across all 30 sites was 28cm. Snapper length is taken into account as each size class plays an important ecological role, which changes as the fish grows. Snapper can be a long-lived species that can grow up to ~100cm in length, making them an ecologically significant predator on the reef and a useful indicator species. Only the large snapper are physically able to crush big kina with their jaws, small snapper are unable to do this. Thus, having bigger individuals in the population is valuable to keep the balance between predator and prey species on the reef and is critical to the restoration process.

Location	Maximum Snapper Count	Mean Maximum Snapper Count	Total Biomass (kg)	Mean Biomass (kg)
Inside Rahui (*n = 13*)	133	10.23	51.39	3.95
Outside Rahui (*n = 17*)	92	5.4	31.2	1.2

Table 3. Summary BUV data showing maximum and mean snapper counts and biomass inside and outside the rāhui tapu area of Mimiwhangata.

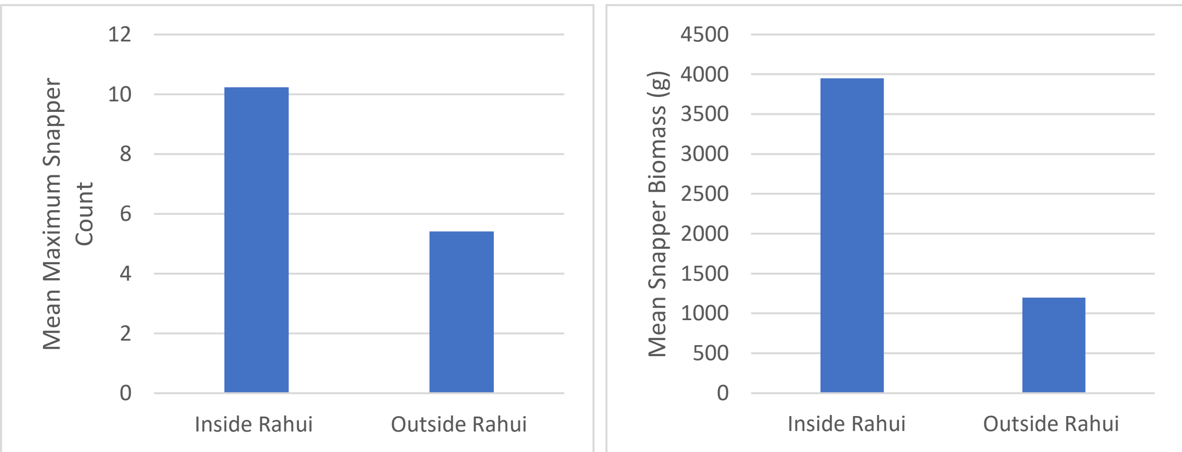

Figure 4a & 4b. The mean maximum snapper count and mean snapper biomass as a combined value of all sites inside and outside the Mimiwhangata rāhui tapu area.

In *Table 3*, the maximum snapper counts and biomass were compared across sites inside and outside the rāhui. 13 of the BUV sites are included within the Mimiwhangata rāhui tapu area and the other 17 sites fall outside, distributed either to the Northwest or the South of the boundary. The mean maximum snapper count and mean snapper biomass were slightly greater across the rāhui tapu sites compared to sites outside it (*see Fig 4a & 4b*). It is important to note that *Table 2* does not compare site habitat or variables like whether they are sheltered or exposed. Visually, the difference in habitat is described in *Figure 6*. The rāhui tapu area encompasses the most diverse and ecologically significant habitat compared to the surrounding areas. As restoration within the rāhui progresses, the distinction between values inside and outside should become increasingly significant. Previous studies following recovery within MPA's indicate that we can expect to see these values significantly increase within the protected area over the next 10 years[7][8].

Comparison between Mimiwhangata and similar sites in Northern New Zealand

In *Table 4*, the 2024 Mimiwhangata BUV results for snapper are compared to BUV results from other Northeast coast surveys. As the rāhui tapu has just been put in place, the 2024 results as expected, are comparable to fished sites like Cape Brett and Mokohinau Islands, and are consistent with previous surveys at Mimiwhangata. It is evident that the two Marine Reserves (Leigh and Poor Knight's Islands) have the highest values across all measures and that the values have increased for Maitai Bay, which has been protected under traditional rāhui since 2017.

Area	Sampling Year	Typical mean snapper count	Typical mean total snapper biomass per BUV site (kgs)	Typical mean snapper length (cm)
Maitai Bay Rahui	2019	9	2	21
Maitai Bay Rahui	2024	11	4	23
Cape Brett	2001-2009	7	3	21
Cape Brett	2016	10	4	23
Leigh Marine Reserve	1997-99	14	17	30
Poor Knights Marine Reserve	2001-2009	17	24	35
Mokohinau Islands	2001-2009	6	3	21
Mimiwhangata	2002-2009	4-7	3	25
Mimiwhangata	**2024**	**7.5**	**2.8**	**22**

Table 4. BUV results from various Northeast coast locations showing the comparison between sites protected from fishing as marine reserves or rāhui and fished locations. Reference to this table and values comes from Kerr et al. 2019.

[7] Cole, R.G., Ayling, T.M., Creese R.G. (1990). Effects of marine reserve protection at Goat Island, northern New Zealand. New Zealand Journal of Marine and Freshwater Research, 24:2, 197-210, DOI: 10.1080/00288330.1990.9516415

[8] Shears N.T., Babcock R.C. (2002). Marine reserves demonstrate top-down control of community structure on temperate reefs. Oecologia 132: 131142.

In 2009, Paul Buisson did a fish monitoring study at the Poor Knights Island Marine Reserve and Mimiwhangata Marine Park using the same BUV methodology[9]. The resulting values for the mean maximum number of snapper within the marine park (6.88) and the mean maximum number of snapper outside the marine park (5.42) were very similar to the 2024 data.

In *Figure 5* we compare current snapper results from Mimiwhangata to results from the BUV surveys at the Leigh Marine Reserve, taken after twenty years of no fishing, and Maitai Bay rāhui after 7 years of full protection through rāhui. In the case of the Leigh MR, there has been nearly full habitat restoration of kelp forests from extensive urchin barren. At Maitai Bay there is no clear habitat recovery occurring yet. However, there is evidence of larger snapper returning to the area. It is predicted that Mimiwhangata should follow the same trend. In all three measures of maximum snapper count, length and biomass, the results are significantly better for Leigh. While it looks as if there is only a small increase in mean maximum snapper count per BUV drop, there is also a large jump in snapper length and biomass. This indicates that the individual snapper being counted in Leigh are bigger fish, resulting in the increased mean length and significantly higher biomass. At Mimiwhangata, the snapper population was predominantly made up of small fish, so the mean biomass per BUV drop was 2.8kg compared to 17kg in the Leigh Marine Reserve.

Data from long-term no-take marine reserves is valuable as it shows the significant effect full protection has on restoring fish abundance to more natural levels and provides the best example of what natural reef populations should look like. Comparing this data to our current results allows us to accurately follow the progress of a restoration project, like the Maitai Bay and Mimiwhangata Rāhui.

[9] Buisson, P. R. D. (2009). Poor Knights island Marine Reserve and Mimiwhangata Marine Park Fish Monitoring Report 2009. The Department of Conservation

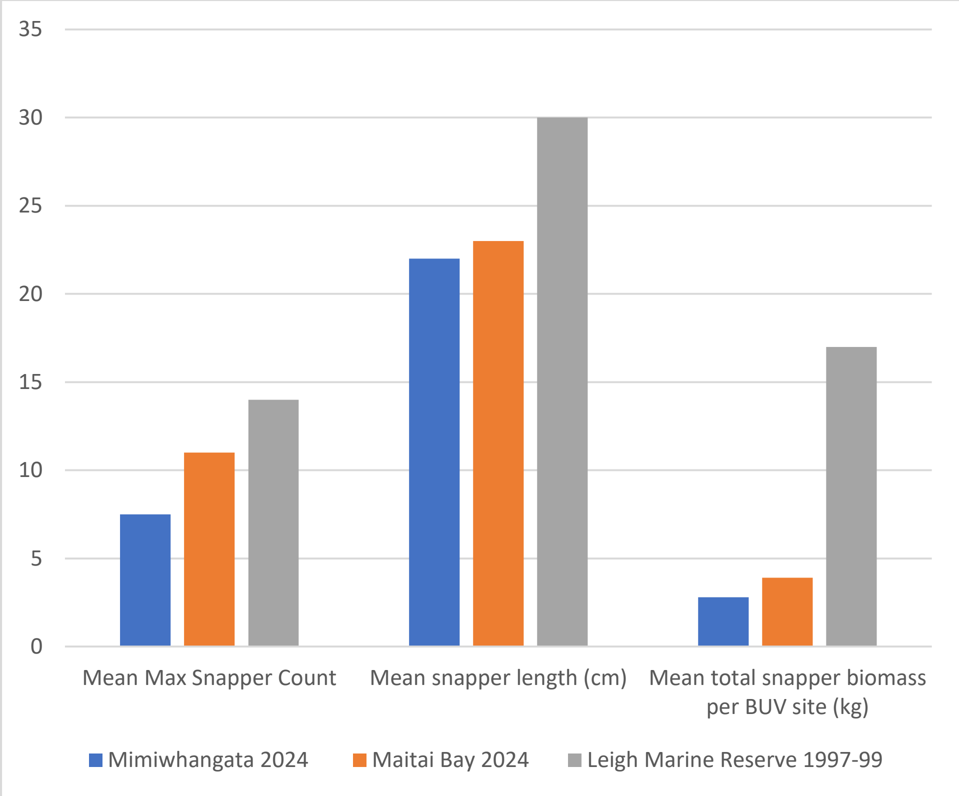

Figure 5. Comparison of mean BUV results from Mimiwhangata rāhui tapu 2024, Maitai Bay rāhui 2024[10] *and Leigh Marine Reserve 1997-1999*[11].

Fish biodiversity

A total of 20 fish species were captured across all 30 BUV sites surveyed (*see Table 5*). Snapper were the most predominant predator species across all sites. As snapper were the main target species for the survey, this is to be expected. Other notable predator species included kingfish, kahawai, eagle rays and a hammerhead shark. Sites on rocky reef habitats generally had higher biodiversity with more reef fish species present, compared to sites with sandy substrate, which generally had only snapper and other predator species present. This can be visualised by comparing data from *Table 5* with correlating sites and habitats in *Figure 6*. As habitat restoration occurs and fish communities return and grow, the number of species observed is expected to rise. Incorporating other complementary surveys, such as Fish Diversity or Timed Swim Surveys, into the monitoring program becomes valuable as they provide a way to follow species recovery more effectively.

[10] *Unpublished*: Wallace, C. I., Kerr, V (2024). Maitai Bay Rāhui Monitoring Report 2024

[11] Willis, T.J., Millar R.B., Babcock, R.C. (2003). Protection of exploited fish in temperate regions: high density and biomass of snapper *Pagrus auratus* (Sparidae) in northern New Zealand. Journal of Applied Ecology, 40, 214-217.

Species	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30
Big eye																							4							3
Blue Maomao		1																												
Dwarf Scorpion Fish																			1											
Eagle Ray														1														1		
Goatfish																			1				4							
Hammerhead Shark														1																
John Dory												1																		
Kahawai			2																											
Kingfish												1																		
Leather Jacket				1											1															1
Pigfish		1		2	1							1	2		3	3	3	1	2	1									1	1
Porae																			1		1									
Red Moki																2	2						2		1					
Scarlet Wrasse																									1					
Snapper	1	6	16	6	9	1	2	9	19	16	23	13	7	1	6	14	11	6	6	3	20	7	7	2	1	0	2	4	5	2
Spotty																														1
Sweep																			10				1		10					20
Trevally			1																			4							1	
Two-spot Demoiselle				2	1										50				6	100										
Yellow Moray					1												1								2					1
TOTAL Biodiversity	**1**	**3**	**3**	**4**	**4**	**1**	**1**	**1**	**1**	**1**	**1**	**4**	**2**	**3**	**4**	**3**	**4**	**2**	**7**	**3**	**2**	**2**	**5**	**1**	**5**	**1**	**1**	**2**	**3**	**7**
TOTAL Fish counted	1	8	19	11	12	1	2	9	19	16	23	16	9	3	60	19	17	7	27	104	21	11	18	2	15	0	2	5	7	29

Table 5. Summary of the total biodiversity of fishes captured on video during the BUV survey at Mimiwhangata in 2024.

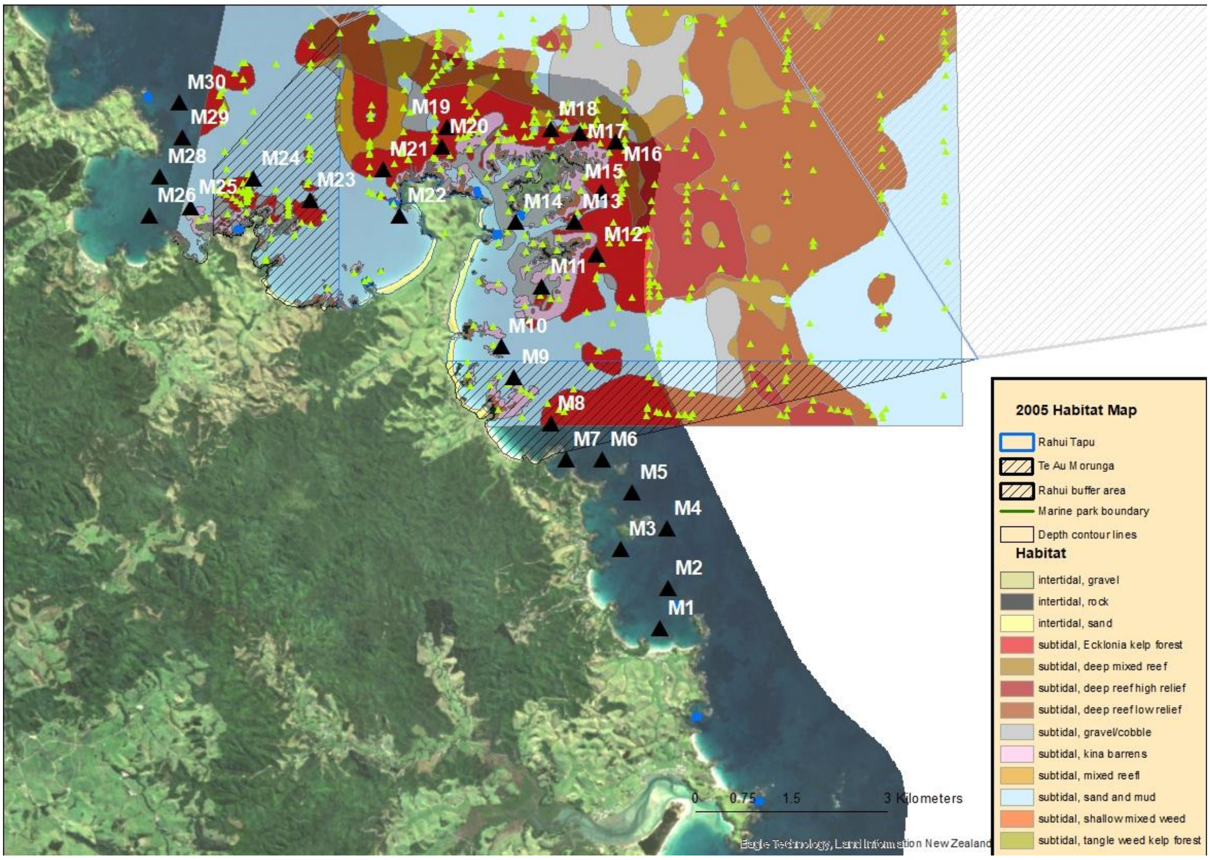

Figure 6. Habitat map of Mimiwhangata rāhui tapu and the surrounding area with the 30 BUV survey sites labelled. The small light green triangles are locations where habitat mapping and descriptive data was collected for the 2005 mapping project[12]. The blue triangles are where the long-term permanent crayfish transects are located[13].

[12]Grace, R.V., Kerr, V.C. (2005) Intertidal and subtidal habitats of Doubtless Bay, Northland, N.Z. Contract report for the Department of Conservation, Northland Conservancy, Whangarei.

[13] Grace, R.V., Kerr, V.C., 2006. Mimiwhangata Marine Monitoring Program, Summer & Autumn Sampling. Report to the Department of Conservation, Northland Conservancy.

Compliance Observations

Note, while surveying on the water there were several compliance encounters with other vessels. In each instance, the skipper of our vessel would professionally approach the other vessel and ask if they were aware of the new rāhui tapu and its boundaries. In most cases, the other vessel did and thanked us for engaging. On the two occasions we found vessels fishing within the no-take area, the individuals seemed genuinely apologetic, reeled in their gear, and moved on promptly. As a recommendation, it could be suggested more signage be put up around surrounding boat ramps and a greater presence of hapu or council members at sea education and speaking to boaties in the early stage of the rāhui tapu.

Acknowledgments

We would like to acknowledge Te Uri o Hikihiki, tangata whenua of Mimiwhangata and Holly Heteraka in particular for their contribution to this work. A big thank you to Shane and Julia from Northland Dive for their expertise and assistance on the water. We are also grateful to Northern Regional Council for funding this work and their efforts to guide and support the establishment of the rāhui.

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