Marine Reserve Summary Report

Tapuae Marine Reserve

Monitoring of habitats, climate change and key species, 2000 - 2024

Department of Conservation
Te Papa Atawhai

Cover: Waikaranga/ Seal Rock and Taranaki Maunga *Photo: Emily Roberts*

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Foreword

Marine reserves, established under the Marine Reserves Act 1971, are Aotearoa New Zealand's highest level of marine protection. They protect all natural features within their boundaries, helping to conserve biodiversity and allow marine areas to return to a more natural state. The Department of Conservation (DOC) is responsible for the implementation, management and monitoring of Aotearoa New Zealand's marine reserves.

Biodiversity monitoring is the collection and analysis of observations or measurements to evaluate changes in the condition of biodiversity and measure progress towards meeting management objectives. Monitoring helps inform effective marine reserve management, planning and policy development, which in turn improves accountability, confidence and support for marine conservation management. Long-term monitoring can also lead to better understanding of impacts such as climate change and other long-term environmental changes. It is also important to note that monitoring has value beyond the data it generates, it also builds capacity and fosters advocacy for wider environmental concerns.

Inform, educate and involve people – Information from marine reserve monitoring is used to inform and educate people and communities about the marine environment, which can benefit and unite communities through education, shared responsibilities, connecting people to their 'big blue backyard', and tourism opportunities.

Assess existing reserves – Monitoring has improved our fundamental understanding of Aotearoa New Zealand's marine ecology and demonstrated the benefits of marine reserve protection.

Support the establishment of an effective network of MPAs – Evidence from marine reserve monitoring allows us to advance the goal of having an ecologically representative, well-connected and effective network of MPAs around Aotearoa New Zealand.

Meet domestic and international reporting requirements – Knowledge from marine reserve monitoring allows Aotearoa New Zealand to report against its national and international marine protection targets.

Make informed management decisions – Knowledge and understanding of marine species and ecosystems provided by long-term monitoring supports the development of strategies for conserving marine biodiversity and assessing the effectiveness of those strategies.

Understanding the state of marine reserves is important for several reasons

No monitoring programme can answer all questions, detect all possible impacts or highlight all problems. Additionally, not all marine reserves can be monitored in the same way, or at all, because of differing practical constraints. Accessibility / remoteness, depth, water visibility, weather, and sea conditions all influence what and how much monitoring is practicable. DOC must therefore prioritise available resources to determine what, where and when marine reserve monitoring is undertaken.

DOC's marine reserve monitoring is informed by the Marine Monitoring and Reporting Framework (MMRF), which uses examples of best practice from around the world to guide how monitoring plans are developed for marine reserves. The goal of the MMRF is to monitor whole ecosystems, as opposed to focussing on key species, so that we can see more of what's there, assess what condition it is in, and how it is changing. The monitoring framework is built around 10 themes, each with their own specific objectives. The themes monitored at place depend on the local environment and the aspirations of mana whenua and local communities.

Theme	Purpose
Habitat representation	To determine if a range of marine ecosystems are protected nationally.
Habitat composition and condition	To determine if habitats in protected areas change with time
Climate change	To track climate change indicators, such as ocean acidity and sea surface temperature.
Key species	To determine how the populations of key or taonga (treasured) species, such as crayfish/kōura, change over time.
Compliance	To understand how many people are following the rules in marine reserves.
Water quality	To understand if water quality, such as clarity and pollutants, has improved in reserves.
Human uses	To determine how much people are using reserves, such as for recreation or study.
Non-indigenous species (invasive species)	To determine if invasive species are increasing or decreasing or showing up in areas they were not found previously.
Extreme events	To understand how extreme events, such as floods or oil spills, may affect marine ecosystems.
Marine pollution	To assess the impact of beach litter on marine reserves.

This summary report is designed to provide an overview of the monitoring results presented in companion with future marine reserve technical report(s). It gives an indication of the status of the marine reserve, the pressures upon it, and the key species likely to be found there. Links and references to associated research studies are provided within this summary report for those who want more detailed information.

1. Introduction

Tapuae Marine Reserve was established in 2008 under the Marine Reserves Act 1971 (Figure 1). Its creation was the culmination of many years of advocacy, research and community education by the local community group Ngā Motu Marine Reserve Society, with support from local tangata whenua Ngā Mahanga a Tairi. The objectives for the reserve, as stated in the original marine reserve application, were:

- To establish a network of marine reserves in the Taranaki region.
- To ensure that marine life and other natural resources within the region are protected.
- To encourage the scientific study of marine life on the Taranaki coast.
- To foster community awareness of the coastal environment by education.

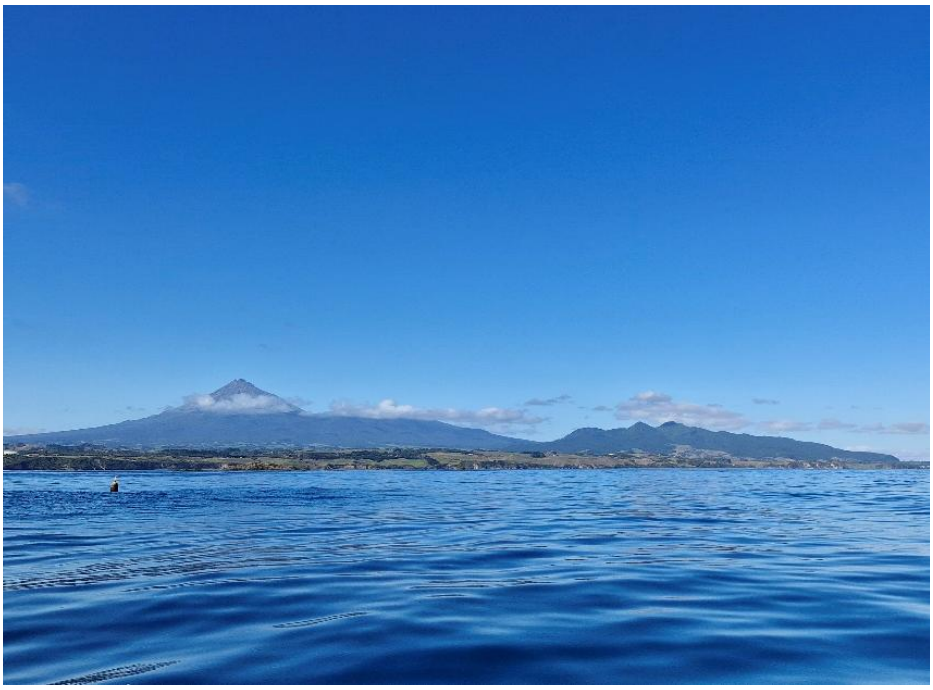


Figure 1. Taranaki Maunga behind Tapuae Marine Reserve.
Photo: Emily Roberts/Wild for Taranaki.

Tapuae Marine Reserve is home to incredible and diverse marine life

Tapuae Marine Reserve covers 1,404 ha (14 km^2) of the Taranaki coastline, from the Tapuae Stream, north of Oākura, to the Herekawe Stream, New Plymouth (Figure 2). When Tapuae Marine Reserve was implemented, it superseded approximately one-third of the pre-existing Ngā Motu/Sugar Loaf Islands Marine Protected Area, known as SLIMPA. Tapuae Marine Reserve encompasses the rocky island features of Waikaranga (Seal Rocks) and Tokatapu (Castle Rock). A diverse range of habitats are found within the reserve, such as caves, canyons, crevices and overhangs, pinnacles, boulder reefs, volcanic rocky outcrops, mud and sand, which supports an incredible variety of marine life. More than 400 different species have been found in the area of Tapuae Marine Reserve including approximately 80 species of fish, 50 seaweeds, 136 molluscs, 65 sponges, 24 echinoderms, 14 crabs and shrimps, 11 chitons, 13 cnidarians, 8 ascidians, and 6 barnacles. The reserve waters are home to a large variety of fish species, invertebrate and algal species, as well as a breeding population of kekeno / New Zealand fur seal. Rarer species seen within the reserve include orca, humpback whales, and ocean sunfish, while the nearby Ngā motu / Sugar Loaf Islands are an important nesting site for many species of seabird, such as the toanui / flesh-footed shearwater and matuku moana / pacific reef heron.

Figure 2. Map of Tapuae Marine Reserve and Ngā Motu/Sugar Loaf Islands Marine Protected Area. Coordinates available on the DOC website.

Tapuae Marine Reserve borders the Ngā Motu / Sugar Loaf Islands Marine Protected Area

1.1 Pre-reserve monitoring

Before the establishment of Tapuae Marine Reserve (Type I Marine Protected Area, or MPA) large efforts were made in conducting biological monitoring of the wider area, which will be discussed in more detail in later sections. While some of this was conducted with the establishment of the marine reserve in mind, much of it was conducted to monitor the impact of the implementation of SLIMPA (Figure 3). SLIMPA is a partially-protected marine area (Type II MPA) which was established in 1986, in which commercial fishing was banned (except trolling for kingfish and kahawai) and recreational fishing methods were restricted. Within SLIMPA, a Conservation Area (CA) was also established, encircling 500 m around Waikaranga / Seal Rock. Within the CA, all types of fishing were banned except trolling or spearfishing for kingfish and kahawai. The preexisting CA regulations have now been superseded by the Tapuae Marine Reserve.

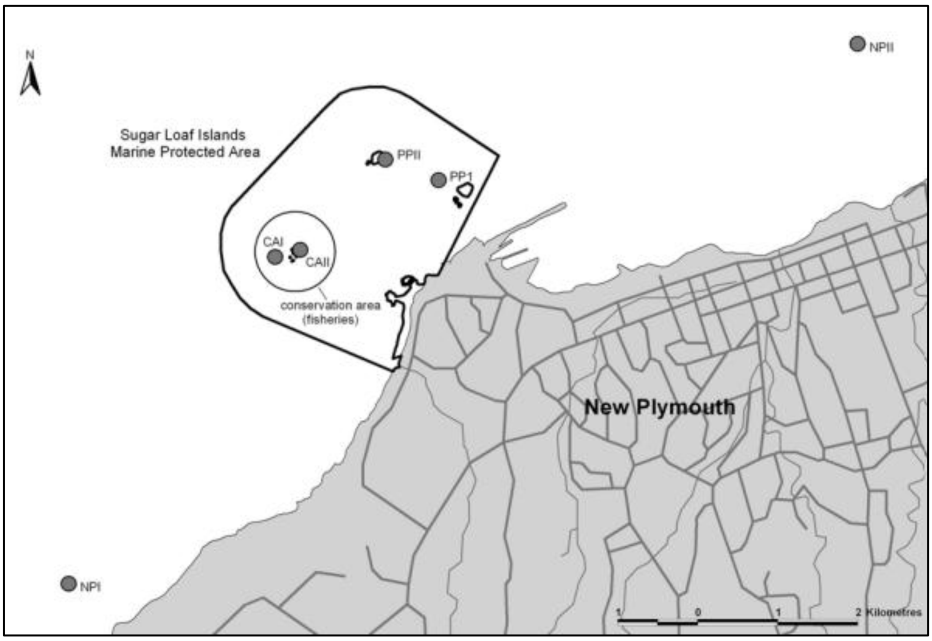


Figure 3. Historical map of the Ngā Motu / Sugar Loaf Islands Marine Protected Area (SLIMPA), the fisheries Conservation Area and biological monitoring sites used prior to the establishment of Tapuae Marine Reserve.
Acronyms represent protection level: Conservation Area (CAI and CAII); partial protection (PPI and PPII) and no protection (NPI and NPII).

Monitoring carried out prior to the reserve provides historical data of the wider area

1.2 Post-reserve monitoring

Since the establishment of Tapuae Marine Reserve in 2008, biological monitoring work has primarily focused on reef fish populations, with five Baited Underwater Video (BUV) surveys completed, as well as a fish and kōura / rock lobster dive survey (MMRF Theme 4) conducted in 2009 (Table 1). Since 2021, monthly water samples have been collected as part of the New Zealand Ocean Acidification Observation Network (MMRF Theme 3).

Additionally, in 2021 a high detail bathymetric survey was conducted, producing detailed maps of the seafloor of both Tapuae Marine Reserve and SLIMPA (MMRF Theme 2).

Table 1. Surveys conducted at Tapuae Marine Reserve per year (2000 – 2024). Sampling methods are indicated as: Q – quadrat surveys; UVC – Underwater Visual Census; BUV – Baited Underwater Video; S – side-scan mapping; M- multi-beam mapping; W – monthly water samples. Red box encompasses the Tapuae Marine Reserve establishment year.

	Year (20xx)																			
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16 - 20	21	22	23	24
Kina/ Invertebrates	Q	Q	Q																	
Rock lobster	UVC	UVC	UVC																	
Intertidal community	Q																			
Reef fish	UVC	UVC	UVC		UVC	UVC	UVC	UVC	UVC		BUV		BUV		BUV			BUV		BUV
Habitat Mapping		UVC		S													M			
Climate Change																	W	W	W	W

2. Habitat composition and condition

In 2021 a high-resolution bathymetric survey of Tapuae Marine Reserve and SLIMPA was conducted as a partnership between DOC and Land Information New Zealand (LINZ), who were mapping approaches to Port Taranaki to update the navigational charts. Figure 4 below shows bathymetric map and marks areas of interest:

A. The Southern boulder fields.
B. A defined ridge between different sediment types located northeast of Saddleback Island (Motumahanga).
C. A ridge extending from Saddleback Island (Motumahanga) to Barret Reef (Tokomapuna).
D. Muddy sand waves south of Moturoa Island.
E. An unconfirmed seep field east of Seal Rock (Waikaranga).
F. Areas of isolated sand waves.

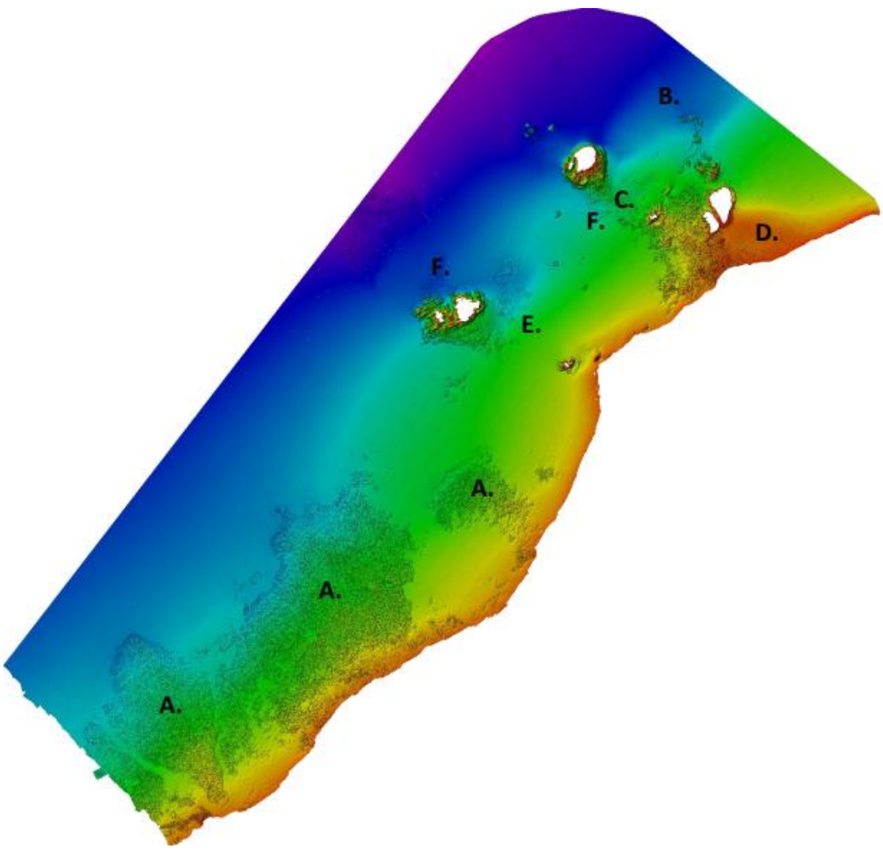


Figure 4. Bathymetric imagery within Tapuae Marine Reserve and the Ngā Motu / Sugar Loaf Island Marine Protected Area.

Seafloor mapping has shown the diverse habitats found in the marine reserve and protected area

As part of the bathymetric survey, acoustic backscatter was also recorded in 2021 using multi-beam echosounders, and 17 seabed sediment sample grabs were collected. The map created from backscatter data gives an indication of seabed material with less reflective materials such as mud showing up as darker areas and more reflective materials such as rock and coarse sand showing up as lighter tones (Figure 5). The sediment samples aligned closely with the expected material indicated by the multi-beam echosounder backscatter mosaic.

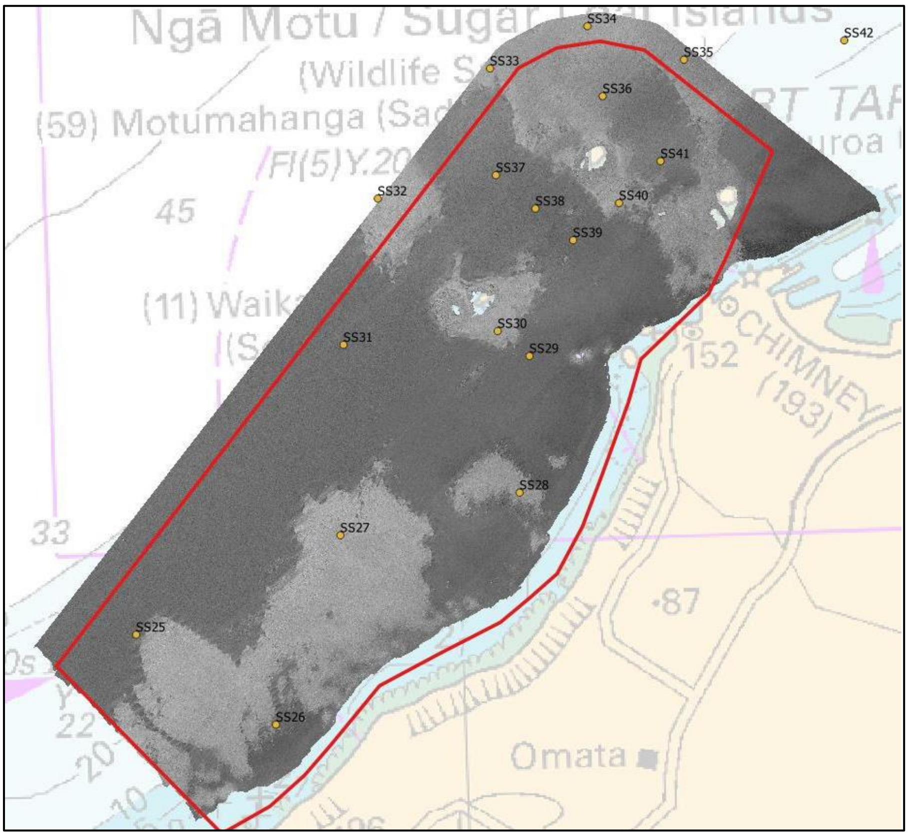


Figure 5. Sediment sampling sites over backscatter surface throughout the Tapuae Marine Reserve and Ngā Motu / Sugar Loaf Island Marine Protected Area (combined extent outlined in red).

Habitat been assessed using sediment samples and multi-beam mapping

Ground-truthing of the bathymetric and backscatter data will be conducted in the future through further sediment sample collection and drop-camera work, to create a map of habitat types and extents across the surveyed area. This will allow for any future shifts in habitat extents and structures to be monitored.

3. Climate change

Much of the carbon dioxide from burning fossil fuels is absorbed by the oceans, causing acidification that harms marine life, especially shell-building animals like crabs and shellfish. It also affects plankton, coralline algae, and entire marine ecosystems, impacting coastal economies. We monitor ocean acidification in marine reserves to understand these effects on species and habitats.

3.1 Ocean acidification

Since November 2020, monthly water samples have been taken from the Tapuae Marine Reserve as part of the New Zealand Ocean Acidification Observing Network (NZOA-ON). NZOA-ON is a programme jointly run by Earth Sciences New Zealand and the University of Otago. This programme established coastal sites around the country to collect monthly measurements at a range of urban and remote locations, to identify any effects that the local environment may have on ocean pH and sea surface. Additional sampling sites have been added offshore from the marine reserve (Figure 6). Changes in and sea surface temperature pH take years to detect; so far, very little variation in either has been observed inside the marine reserve (Figure 7).

Figure 6. Water sampling sites in and offshore from Tapuae Marine Reserve.

pH and temperature have been monitored at sampling sites in and around the reserve

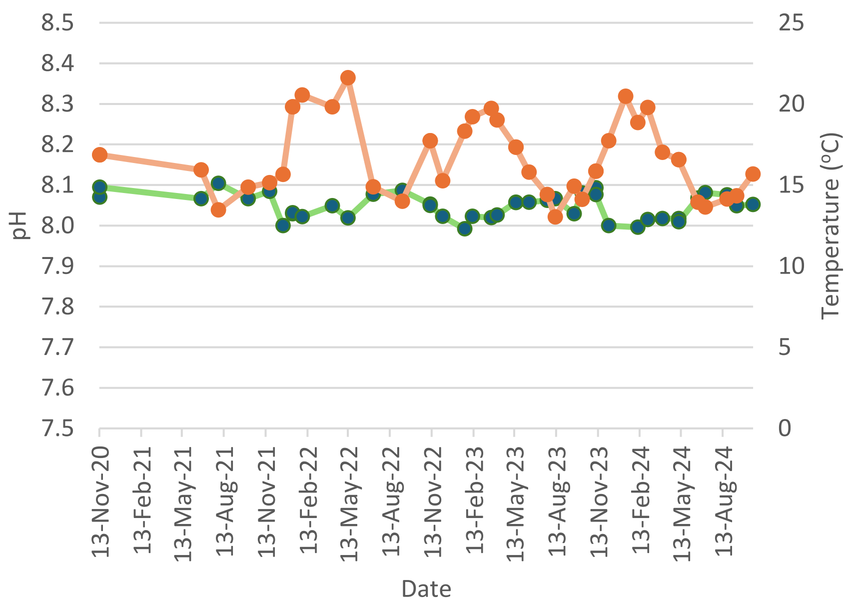


Figure 7. Monitoring of pH levels (green) and temperature (orange) measured inside the Tapuae Marine Reserve. Normal pH is typically reported as 8.1.

pH and temperature have been relatively consistent in the reserve since 2021

4. Key species

4.1 Benthic species

From 2001 – 2003, surveys were conducted assessing the make-up of benthic/sea floor communities, across the different levels of protection. Results showed variability both between sites and across years at the same sites. This variability and the relatively low number of sites studied limit the conclusions that can be drawn. However, it was found that there were higher kina (*Evechinus chloroticus*) densities, and larger kina, within the CA than at other sites. The study also found a consistent negative relationship between higher kina densities and kelp cover (Miller et al., 2013).

4.2 Intertidal species

In 2001, an intertidal survey was conducted between Paritutu and Tapuae Stream, identifying 109 species (Hayward & Morley, 2001). The rocky shores around Ngāmotu / New Plymouth (Kawaroa Reef and Back Beach), which are partially sheltered by Paritutu and the Ngā Motu / Sugar Loaf Islands, were found to contain the richest and most diverse intertidal biota of the Taranaki coast (Hayward & Morley, 2001).

4.3 Kōura / rock lobster

Underwater Visual Census (UVC) dive surveys were conducted at sites within SLIMPA, the CA and at non-protected control sites in 2001, 2002 and 2003 (Figure 8). Kōura / rock lobster (*Jasus edwardsii*) were consistently more abundant within the CA compared to other sites. Results also showed that average kōura size (carapace length) was larger in the CA compared to other sites. This suggests that the protection provided within the CA positively impacted kōura abundance and size in 2001-2003, though differences in habitat suitability between sites may also have impacted results (Miller et al., 2013).

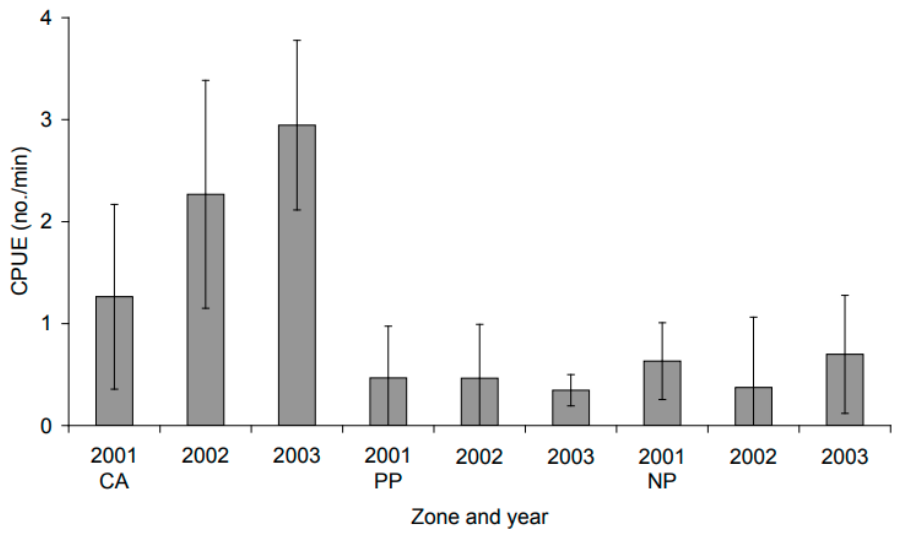


Figure 8. Kōura / rock lobster catch-per-unit-effort (CPUE ± 95 CI) per year (2001-2003).
CPUE is shown per protection level: Fisheries Conservation Area (CA), partial protection within SLIMPA (PP) and no protection (NP).
Source: Miller et al. (2013).

Kōura density was highest in the conservation area between 2001 - 2003

Since the establishment of Tapuae Marine Reserve, a single UVC survey for kōura has been undertaken, in 2009. However, the survey included a limited selection of sites. Only one control site was surveyed, where one koura was found, with three sites inside the reserve surveyed where 77 kōura were found. This limits the conclusions that can be drawn from the data in terms of impacts of the marine reserve. However, the data from sites within the reserve on the size and sex of kōura observed will be of use as baseline data when these sites are resurveyed as part of future kōura surveys.

4.4 Reef fish

Reef fish were surveyed in UVC dive surveys across SLIMPA, the CA, non-protected control sites, annually from 2001 – 2003 and again from 2005 – 2009. Surveys that occurred after the establishment of Tapuae Marine Reserve included sites within the reserve.

Miller et al. (2005) reported on the surveys from 2001 – 2003, but due to the low number of sites surveyed and the habitat variation across sites, they noted difficulty in drawing conclusions of the impact of protection levels on reef fish populations. However, prior to the reserve implementation, rawaru / blue cod (*Parapercis colias*) were consistently more abundant within the CA compared to other sites (Figure 9). The highest density of blue cod across all surveys was observed in Tapuae Marine Reserve in 2009. While habitat variability is recognised as an important factor in species density, the consistently high mean densities of blue cod within areas with stronger protection suggest that the protection offered by the CA and Tapuae Marine Reserve increased local blue cod abundance.

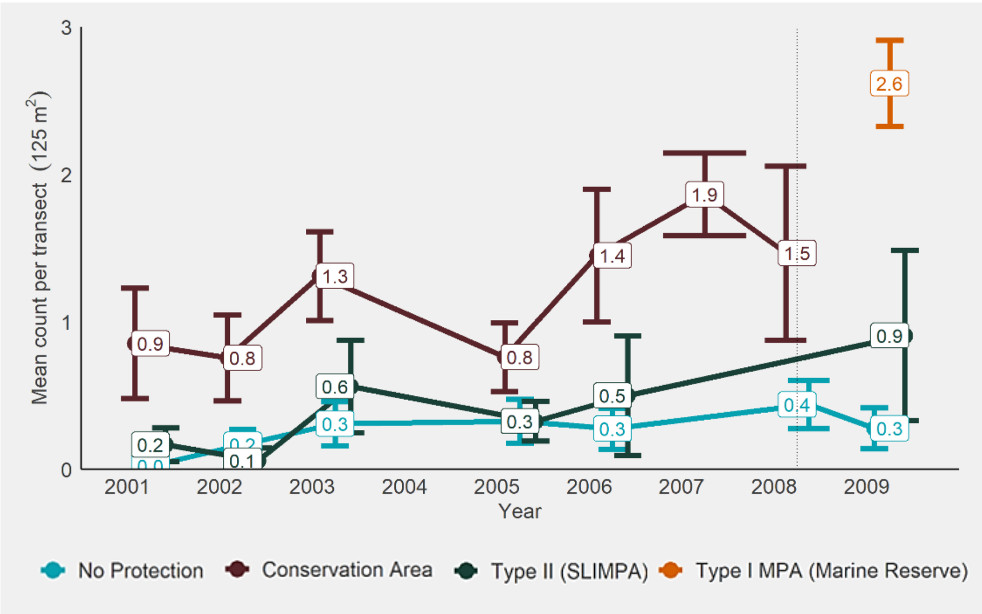


Figure 9. Density of blue cod (mean ± SE) in Underwater Visual Census surveys per year (2001-2009).
Density is shown per protection level: No Protection, the fisheries Conservation Area, the Type II MPA SLIMPA, and the Type I MPA Tapuae Marine Reserve.
The dotted line indicates the date of establishment of Tapuae Marine Reserve.

Blue cod density was highest in the marine reserve between 2001-2009

Tāmure / snapper (*Chrysophrys auratus*) numbers were also more abundant within the CA, but snapper were seen in relatively low numbers across all surveys from 2001-2009. The vast majority of snapper recorded were seen within stronger protected areas, with almost no snapper recorded outside the CA and Tapuae Marine Reserve (Figure 10). However, the low overall numbers make it challenging to discern how protection status may have impacted snapper density, as differences between sites may also be due to differences in habitat between sites, or natural variability between populations.

Ngutere / red moki (*Cheilodactylus spectabilis*) and pūkaiwhakarua / scarlet wrasse (*Pseudolabrus miles*) were the most abundant species across all UVC surveys (Appendix 1 & 2), except for all species of Blennidae (Appendix 3).

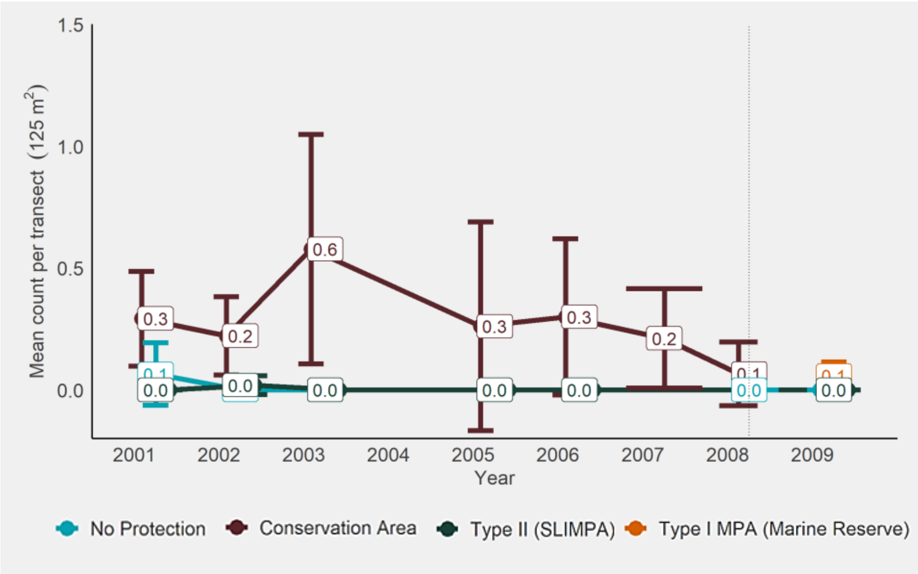


Figure 10. Density of snapper (mean ± SE) in Underwater Visual Census surveys per year (2001-2009).
Density is shown per protection level: No Protection, the fisheries Conservation Area, the Type II MPA SLIMPA, and the Type I MPA Tapuae Marine Reserve. The dotted line indicates the date of establishment of Tapuae Marine Reserve.

Snapper density was highest in the conservation area between 2001-2009

Since 2011, reef fish populations in the reserve have been monitored through Baited Underwater Video (BUV) surveys. This is an observational, non-destructive survey method intended to minimise disturbance on reef fish species, particularly for carnivorous species which often avoid divers. This sampling method has been extensively used in New Zealand (e.g., Morrison & Gregor, 2012; Roux de Buisson, 2009; Shears & Usmar, 2006; Zintzen et al., 2017). The method involves lowering a metal frame mounted with a video camera and a baited box, recording 30 minutes of survey footage from each site, before bringing the frame and camera back up for later analysis.

Five Baited Underwater Video (BUV) surveys of carnivorous reef fish have been conducted since the establishment of the reserve, in 2011, 2013, 2015, 2022, and 2024. Data across the 2011, 2013, 2015 BUV surveys found that both blue cod and snapper were consistently more abundant within the marine reserve compared to non-protected control sites (Figure 11). In the 2022 and 2024 surveys, BUV sites were spread across Tapuae Marine Reserve, SLIMPA, and non-protected control sites. These recent surveys further demonstrate the positive impacts of stronger protection on blue cod and snapper populations, as higher abundances of each were observed at sites with stronger protections in place.

It was also found that blue cod were larger within the marine reserve compared to control sites. Similarly, snapper were larger within the marine reserve, although the low number of snapper outside the reserve meant this could not be proven statistically (Green et al., 2017). While other factors, such as habitat variability, may influence differences in abundance, these findings suggest that the main driver of these differences is the protection offered by Tapuae Marine Reserve.

Across the five completed BUV surveys, blue cod abundance has declined across all levels of protection (Figure 11). It is difficult to determine whether this relates directly to a decline in local populations, or if this pattern reflects the change in the design of BUV sites between 2015 and 2022. However, blue cod maximum counts were consistently higher within the marine reserve compared to other areas, indicating that the Tapuae Marine Reserve is aiding in protecting this key species.

Occurrence and mean maximum counts of snapper have risen considerably across all protection levels from earlier surveys (Figure 11), suggesting a healthy local snapper population. When compared to other species, BUV surveys show a shift toward snapper being the dominant species in many areas (Figure 12 & Appendix 4).

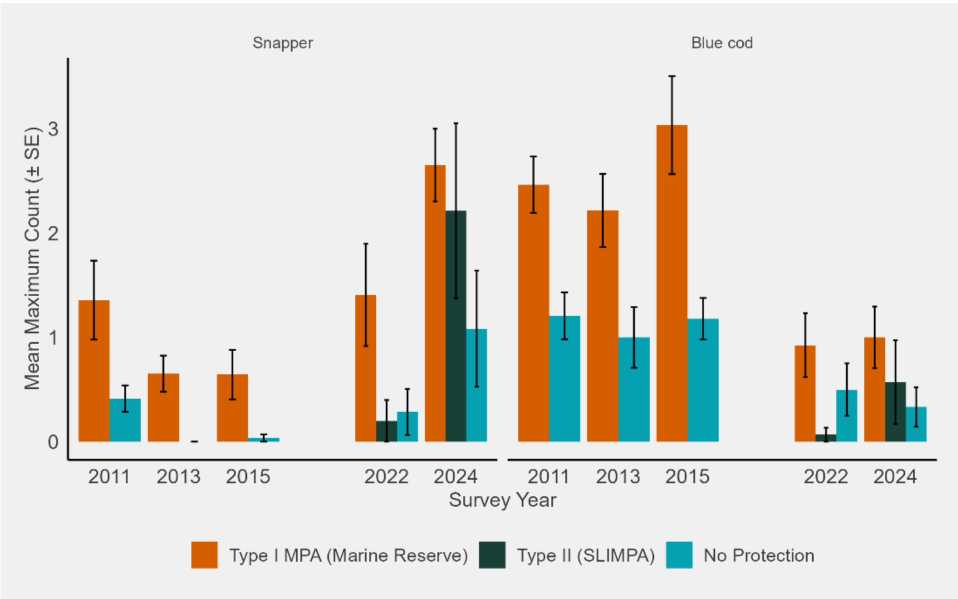


Figure 11. Maximum count (mean ± SE) of snapper (left) and blue cod (right) observed in surveys from 2011 to 2024.
Count is shown per protection level: the Type I MPA Tapuae Marine Reserve, the Type II MPA SLIMPA, and No Protection.

From 2011-2024, snapper and blue cod were most abundant within the marine reserve

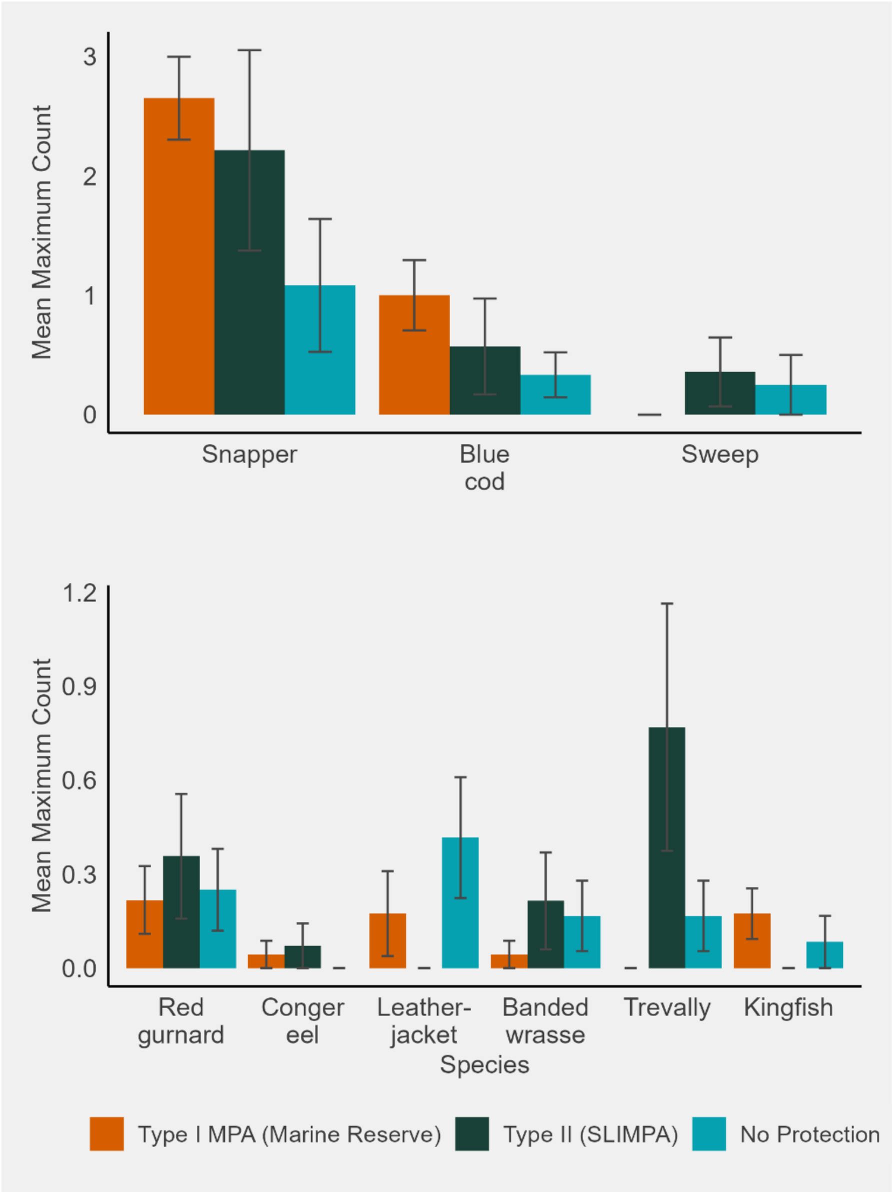


Figure 12. Maximum count (mean ± SE) of fished species observed in the 2024 video survey.
Count is shown per protection level: the Type I MPA Tapuae Marine Reserve, the Type II MPA SLIMPA, and No Protection.

Snapper and blue cod were most abundant fish of those analysed in the 2024 BUV survey, and were more abundant in stronger protected sites

Across 13 years of surveys, BUV data consistently highlights the positive impacts of the Tapuae Marine Reserve for key reef fish species such as blue cod and snapper. These species have been consistently observed more often and in higher numbers within the Tapuae Marine Reserve compared to other areas. Given the key ecological roles these reef fish play, as well as their cultural and economic importance, this data emphasises the positive impact and value of Tapuae Marine Reserve.

5. Conclusions

Tapuae Marine Reserve has now been in place for 17 years and has become an integral part of the Taranaki coastal ecosystem. This report provides insights as to the status and trends of habitat composition and condition, key species and climate change impacts within and around Tapuae Marine Reserve. Significant biological monitoring has been undertaken to understand the health of the marine reserve, and the impact of the protection it offers to the local species and ecosystem. Alongside key species monitoring, the seafloor bathymetry has been mapped in detail, and monthly water samples are taken to track ocean acidification and sea surface temperature.

Tapuae Marine Reserve has been proven effective in protecting previously exploited, keystone species such as rawaru / blue cod and tāmure / snapper, with the reserve holding more and larger fish than surrounding waters. While it has not been directly investigated, the spillover effects to local fisheries of both adult fish and larvae is likely significant. Continuing the biannual reef fish BUV surveys will strengthen the data set and reveal any trends over time. Important work has been completed in mapping the benthic seafloor structure of the reserve and instigating long-term ocean acidification monitoring.

Monitoring programs in the coming years will work towards filling the current information gaps regarding kōura / rock lobster, sessile benthic invertebrates (kina and pāua), habitat mapping, and intertidal communities. In the years since the establishment of the marine reserve, logistical and financial constraints, alongside shifting prioritisation, have limited the monitoring work undertaken in these areas. In coming years, alongside maintaining the biannual BUV surveys, the following are recommended as areas of focus within the monitoring program:

- Improving the understanding of kōura population demographics in and around the reserve. Kōura are recognised as a keystone species, and understanding their recovery in the localised Taranaki context is of upmost importance.
- Build the understanding of the intertidal community within the reserve, focusing on assessing and monitoring community level biodiversity, ensuring comparability with the method developed for local conditions by Taranaki Regional Council (TRC). Using this standardised methodology will enable marine reserve data to be directly compared to the long running TRC Rocky Shore Monitoring dataset for sites around the region.
- Develop localised methods to monitor intertidal populations of pāua in and around the marine reserve. This is complicated by the smaller size and cryptic nature of pāua in Taranaki. The exposed nature of this section of coast also makes

such monitoring work challenging. However, in the context high public interest in local pāua stocks and the ongoing Section 186A fisheries closure across south Taranaki, it is especially important to improve understanding of pāua populations in the reserve.

- Assess the need and best method for monitoring kina populations in the reserve. In the context of increasing concern around urchin barrens, particularly in northeastern New Zealand, there is increasing need to monitor for changes in their population and distribution.
- Complete the drop-camera ground truthing of the 2021 multibeam bathymetry data, to create a detailed habitat map of the reserve and SLIMPA. With marine ecosystems facing threats from multiple sources (climate change, ocean acidification, fishing pressure, invasive species), a detailed habitat map is needed as a baseline against which future changes can be measured.

Much remains undetermined as to how Tapuae Marine Reserve is benefitting marine ecosystems. While continued monitoring efforts will strengthen our understanding of trends in the reserve, we can continue to optimise our efforts by reflecting on monitoring effort gaps and drawbacks, as well as drawing on new monitoring technologies and research insights.

The Taranaki marine environment is home to incredible marine diversity of deep significance to many. Marine reserves provide a unique window for understanding marine ecosystems and human influences. Understanding how marine reserves impact marine ecosystems at place ensures we are equipped with information on how to protect marine biodiversity through changing ocean conditions into the future.

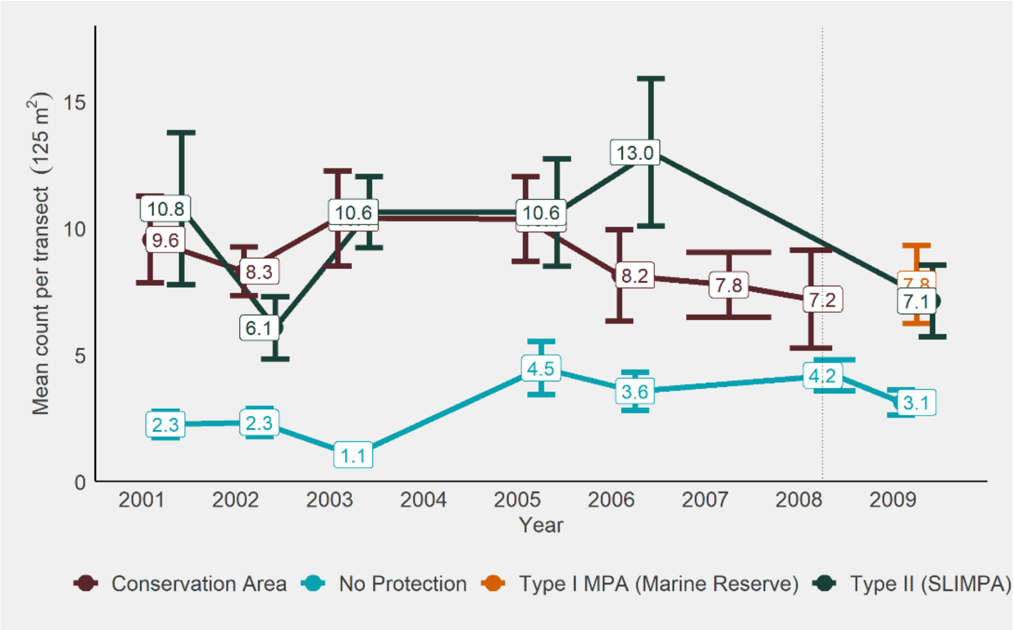
6. Acknowledgements

Thanks to the many people who contributed to the various studies referenced in this report, and to Nicole Boniface and Jesu Valdes for their work summarising the various scientific reports related to Tapuae Marine Reserve.

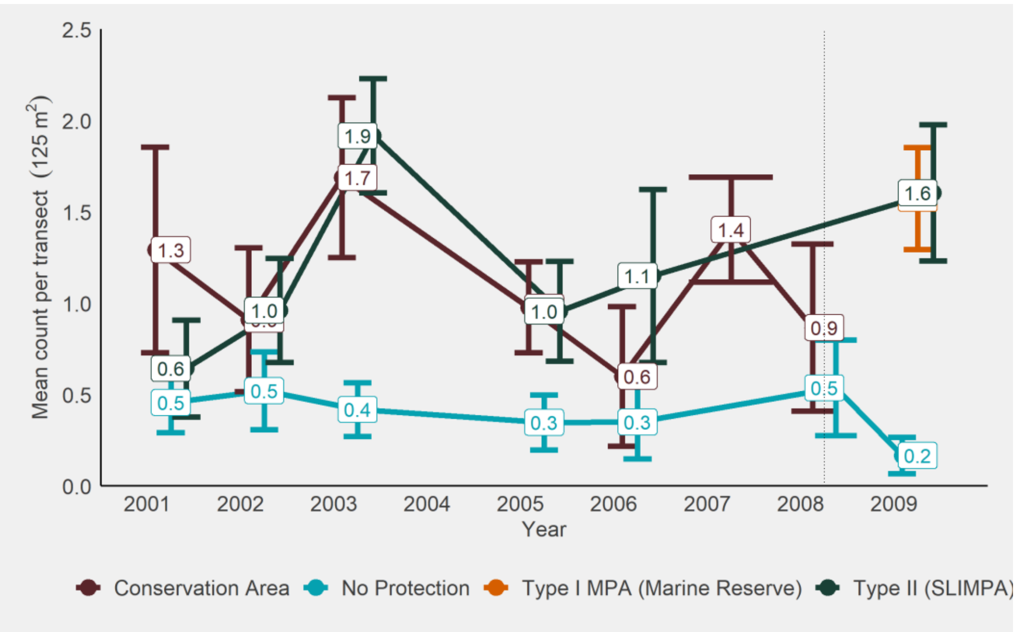
This summary report includes information sourced from a range of studies and reports referenced in the body of the report. All authors are thanked for their important scientific contributions on the ecology of Tapuae Marine Reserve and the wider Taranaki marine environment.

7. Appendix

Appendix 1. Density of scarlet wrasse (mean ± SE) across annual UVC surveys from 2001-2009. Density is shown per protection level: No Protection, the fisheries Conservation Area, the Type II MPA SLIMPA, and the Type I MPA Tapuae Marine Reserve. The dotted line indicates the date of establishment of Tapuae Marine Reserve.



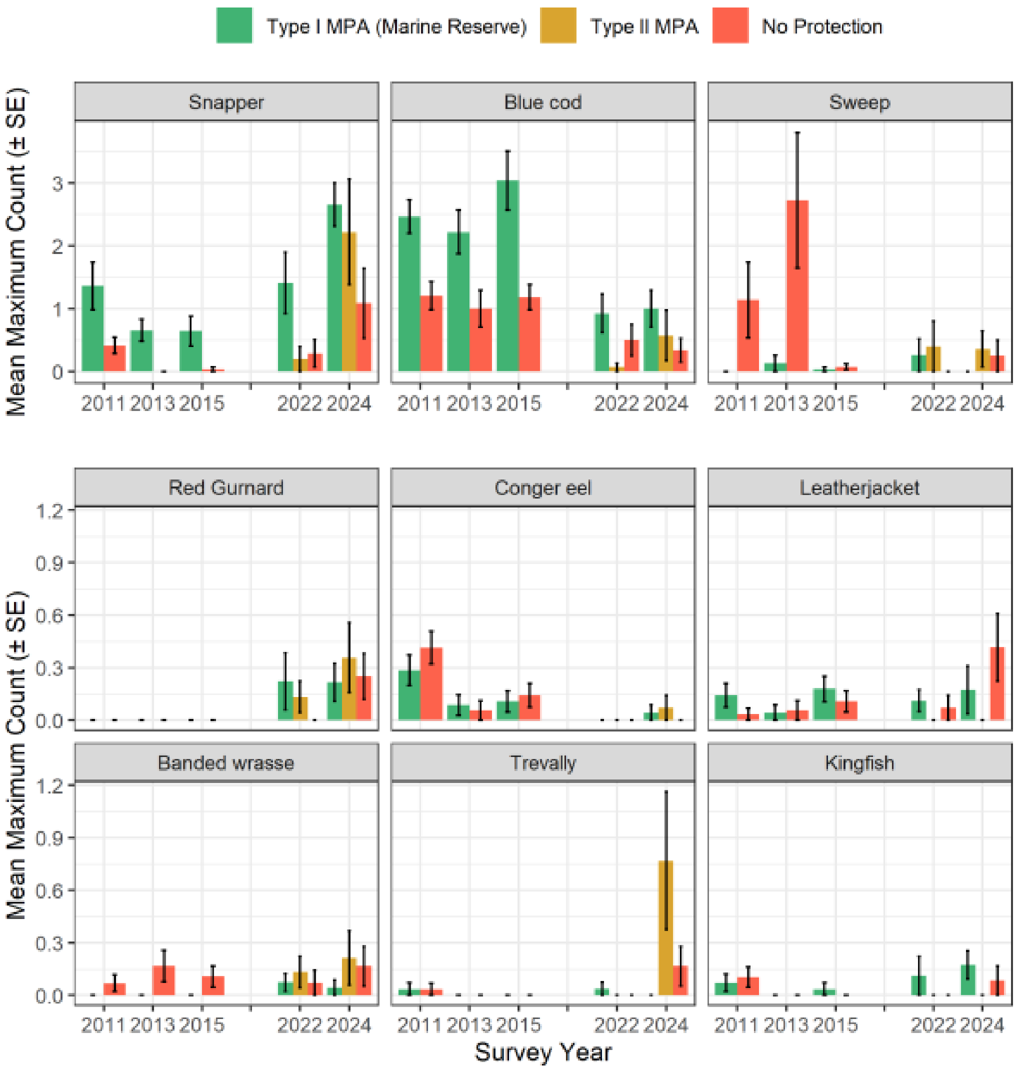
Appendix 2. Density of red moki (mean ± SE) across annual UVC surveys from 2001-2009. Density is shown per protection level: No Protection, the fisheries Conservation Area, the Type II MPA SLIMPA, and the Type I MPA Tapuae Marine Reserve. The dotted line indicates the date of establishment of Tapuae Marine Reserve.



Appendix 3. Reef fish counts (N) per lowest taxonomic grouping observed in Underwater Visual Census dive surveys, compiled from surveys across the Ngā Motu / Sugar Loaf Island Marine Protected Area, the fisheries Conservation Area and non-protected control sites. Surveys were conducted annually from 2001 – 2003 and again from 2005 – 2009.

Lowest taxonomic grouping	N
Blennioidei	857
Pseudolabrus miles	837
Cheilodactylus spectabilis	534
Parapercis colias	435
Scorpis lineolata	225
Notolabrus celidotus	224
Notolabrus fucicola	216
Caesioperca lepidoptera	214
Aplodactylus arctidens	166
Meuschenia scaber	106
Trachurus novaezelandiae	64
Forsterygion maryannae	63
Chromis dispilus	59
Scorpaena	48
Chrysophrys auratus	46
Optivus elongatus	38
Odax pullus	27
Arripis trutta	23
Lotella rhacina	13
Latridopsis ciliaris	12
Myliobatis tenuicaudatus	10
Octopoda	10
Nemadactylus macropterus	8
Latridopsis forsteri	6
Seriola lalandi	5
Conger	4
Kyphosus sydneyanus	4
Upeneichthys lineatus	4
Pempheris adspersa	3

Appendix 4. Maximum count (mean ± SE) of reef fish species observed in surveys from 2011 to 2024. Protection status indicates sites within: Tapuae Marine Reserve (Type I MPA), Ngā Motu / Sugar Loaf Islands Marine Protected Area (Type II MPA), and no protection.



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