Data report for mahinga kai monitoring within the Waitutu Mātaitai

Fieldwork Date
January 24 - 30 2016
Report Date
May 31 2018

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Te Rūnanga o NGĀI TAHU

Te Tiaki Mahinga Kai
tātai kōrero ka ngaro, tātai kōrero ka rangona

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Acknowledgements

We would like to acknowledge the Waitutu Mātaitai Tangata Tiaki/Kaitiaki for their guidance and support of this work. We would also like to recognise specifically the mahi of Tiny Metzger who was instrumental in enabling the initial baseline survey in 2010 and the establishment of the Waitutu Mātaitai in 2014. Thanks also to the Waitutu Incorporation for the wonderful accommodation at the Waitutu Lodge. A special mention needs to be made for the hospitality of Rose and Pete Baldwin who went beyond expectations to make our stay as easy as possible. Thanks to Dale Green (High Country Helicopters) and Johan and Joyce Groters (Wairaurahiri Jet) for providing the exhilarating transport into this amazing place. Special thanks also go to the team of dedicated divers and scribes: Matthew Desmond, Brenton Twist, Gretchen Brownstein, Tiffany Stephens and Eugene Leahy. This work could not have been completed without your hard work.

The baseline mahinga kai survey and preparation of this data report was undertaken by the Te Rūnanga o Ngāi Tahu Mahinga Kai Monitoring and Enhancement team and the University of Otago Department of Marine Science as part the Te Tiaki Mahinga Kai partnership programme. Funding for this work was provided by Te Rūnanga o Ngāi Tahu, University of Otago and the Ministry of Business Innovation and Employment (MBIE), Pūnaha Hihiko Vision Mātauranga Capability Fund (UOOX1408 and MRGRO1301).

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Introduction and Background

The purpose of this data report is to provide details of the methods used during the survey and present a summary and analysis of the data collected. The Te Tiaki Mahinga Kai team remain available to conduct further analyses if required by the Waitutu Mātaitai Tangata Tiaki / Kaitiaki.

In December of 2010, at the request of Tangata Tiaki / Kaitiaki, a baseline stock assessment within the (at that time) proposed Waitutu Mātaitai was conducted to provide robust information on the abundance, size and distribution of key mahinga kai species in this area (Hepburn and Richards 2012). The initial area proposed for the Waitutu Mātaitai was from Long Point (in the west) to the mouth of the Wairaurahiri River. However, the final area incorporated into the mātaitai in 2014 was from approximately 150 meters east of the Crombie Stream to the mouth of the Wairaurahiri River (Figure 1), but slightly further out to sea. The Waitutu Mātaitai was gazetted in July 2014, and on September 2015 a bylaw prohibiting pāua fishing was implemented (Department of Internal Affairs 2014, Department of Internal Affairs 2015). An unintended consequence of this boundary adjustment has led to one of the original three survey areas (Crombie) now positioned outside of the mātaitai. This enables a monitoring design that includes replicate control (outside the mātaitai) and treatment (inside the mātaitai) sites and provides an opportunity to trace the success (or otherwise) of any management interventions.

<u>Objectives</u>

The purpose of this study was to resurvey the 2010 baseline survey sites for key mahinga kai species and habitat structure within the Waitutu survey area. The intention is that the information collected will support the management objectives of the Waitutu Mātaitai committee and local Tangata Tiaki / Kaitiaki. The purpose of this report is to:

1. Detail the methods used to resurvey the original 2010 sites to assess the abundance and distributions of mahinga kai species, with particular emphasis on pāua (*Haliotis iris*), within the Waitutu Mātaitai and an adjacent 'control' site.

2. Make comparisons, where possible, between the 2010 and 2016 surveys.

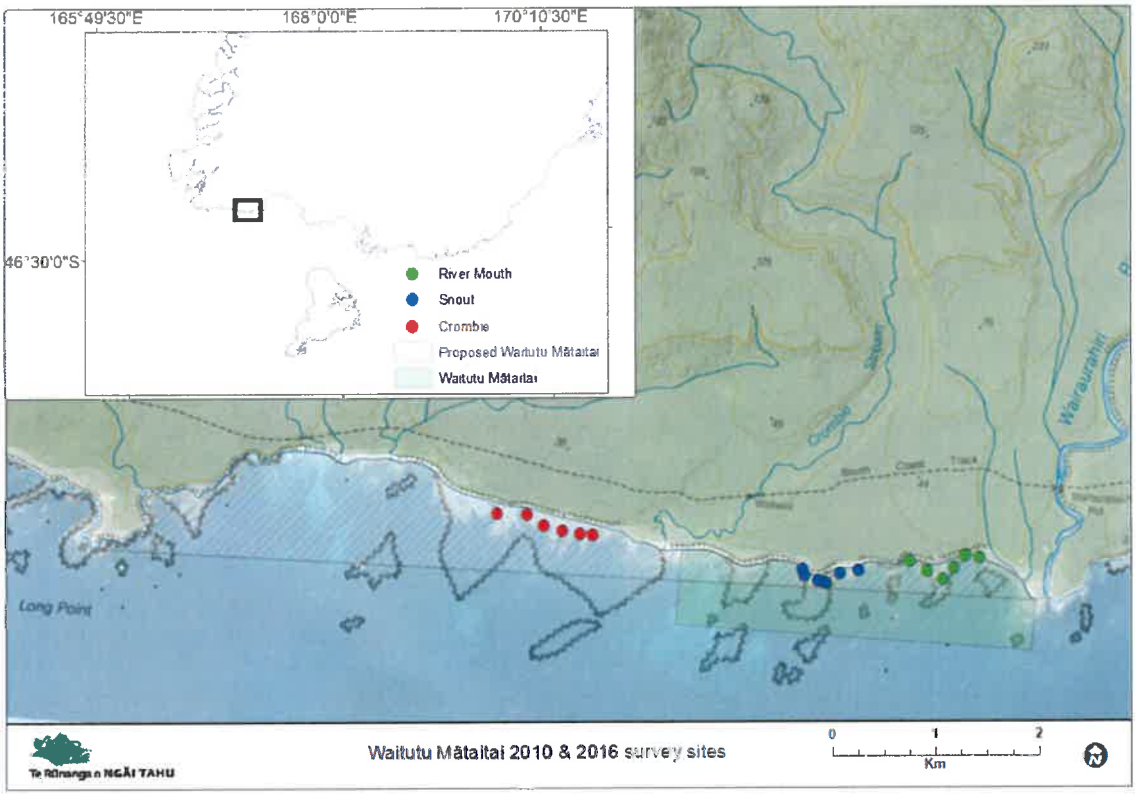

Figure 1: Location of survey sites along the Waitutu coast at three survey locations, River Mouth (Green circles), Snout (Blue circles) and Crombie (Red circles), with the proposed Waitutu Mātaitai area (grey shaded area) and the final gazetted mātaitai (green area).

Methods

The 2016 survey was designed to follow as closely as possible the methods from 2010. For completeness and as the basis of future surveys, these methods are described here but for detailed information on the 2010 initial survey methods see Hepburn and Richards (2012).

Site Identification and Characterisation

The 2016 survey used the sites established in 2010. The 2010 survey areas were initially established by conducting scoping surveys (via snorkelling) on reef habitat within the proposed mātaitai. Initial observations indicated very low abundances of blackfoot pāua in general. Pāua were found to be less common as depth increased and were not observed below a depth of three meters. Based on these scoping surveys, three survey locations inside the proposed mātaitai were chosen (River Mouth, Snout and Crombie). Each location consisted of approximately one kilometre of shoreline (Figure 1).

Mahinga Kai Surveys (2016)

Within each of the locations, six 50 m transects were placed parallel to the shore above the low tide mark (Figure 1). Ten 1 x 4 m rectangle quadrats (see Figure 2) were placed at random non-overlapping positions along the 50 m transects. The 4 m^2 sized quadrats were selected, as they are the largest sized quadrat that can be managed without difficulty in wave-exposed habitats, are more likely to provide a better estimate of the pāua population due to their extreme patchiness at this location (Kingsford and Battershill 1998) and are the same size as those used in

2010. All strata were surveyed via snorkelling. The start and end of the transect at the 0 m strata was marked with a GPS with an accuracy of ±3 m. The recording of the location using GPS allows for monitoring to be carried out in the future at the same site and ensures accurate comparisons over time.

The presence of crustose coralline algae (CCA) was used as a biological indicator of mean low water zone (Morton and Miller 1973, Morton and Hayward 2004) and nominal survey depths were adjusted for tidal height at the time of the survey. Within each 50 m transect, three depth strata were sampled:

(i) at the low tide mark (this depth was set as a reference depth of zero metres for all other depths); 0 m nominal depth,

(ii) approximately twenty metres offshore from the low tide zone (0.1 – 2 m below the 0 m mark); 1 m nominal depth,

(iii) approximately fifty metres out from the low tide zone (0.5 – 4 m below the 0 m mark); 2.5 m nominal depth.

These three depth strata covered the depth range that pāua were observed during scoping dives.

Due to adverse conditions (low visibility and swell), not all of the original 2010 sites or depths were completed (Table 1). Where visibility and swell allowed, surveys were conducted within the same locations as the 2010 survey; two inside the mātaitai (River Mouth and Snout) and one outside the mātaitai (Crombie).

Table 1: Transects that were unable to be completed during the 2016 survey

Site (Transect Number)	Nominal Depth Zone
River Mouth (5)	2.5 m and half of the 1 m
River Mouth (6)	2.5 m
Snout (2)	2.5 m
Snout (6)	2.5 m
Crombie (1)	2.5 m
Crombie (2)	2.5 m

Figure 2: Example of the 1 x 4 m quadrat laying alongside the 50 m transect line.

Within each quadrat all blackfoot pāua (*Haliotis iris*), yellow foot pāua (*Haliotis australis*), kina (*Evechinus chloroticus*) and Cookia (*Cookia sulcata* / Cook's turban) were counted and measured. For koura (*Jasus edwardsii*), only the number of individuals were recorded. Measurements were made to the nearest millimetre using Vernier callipers. When possible, pāua and kina were measured without removing them from the substrate. When this was not practical, the individuals were carefully removed, measured and placed back in the same spot. When neither of these options was possible, length was estimated and was recorded as such. Measurements taken were: greatest shell length of blackfoot pāua and yellow foot pāua; greatest width of Cookia and test diameter of kina (Figure 3). Unlike the 2010 surveys, cryptic blackfoot pāua underneath moveable boulders were not measured. Typically these cryptic pāua were juveniles (i.e. < 80 mm, McShane and Naylor 1995, Subritzky 2013).

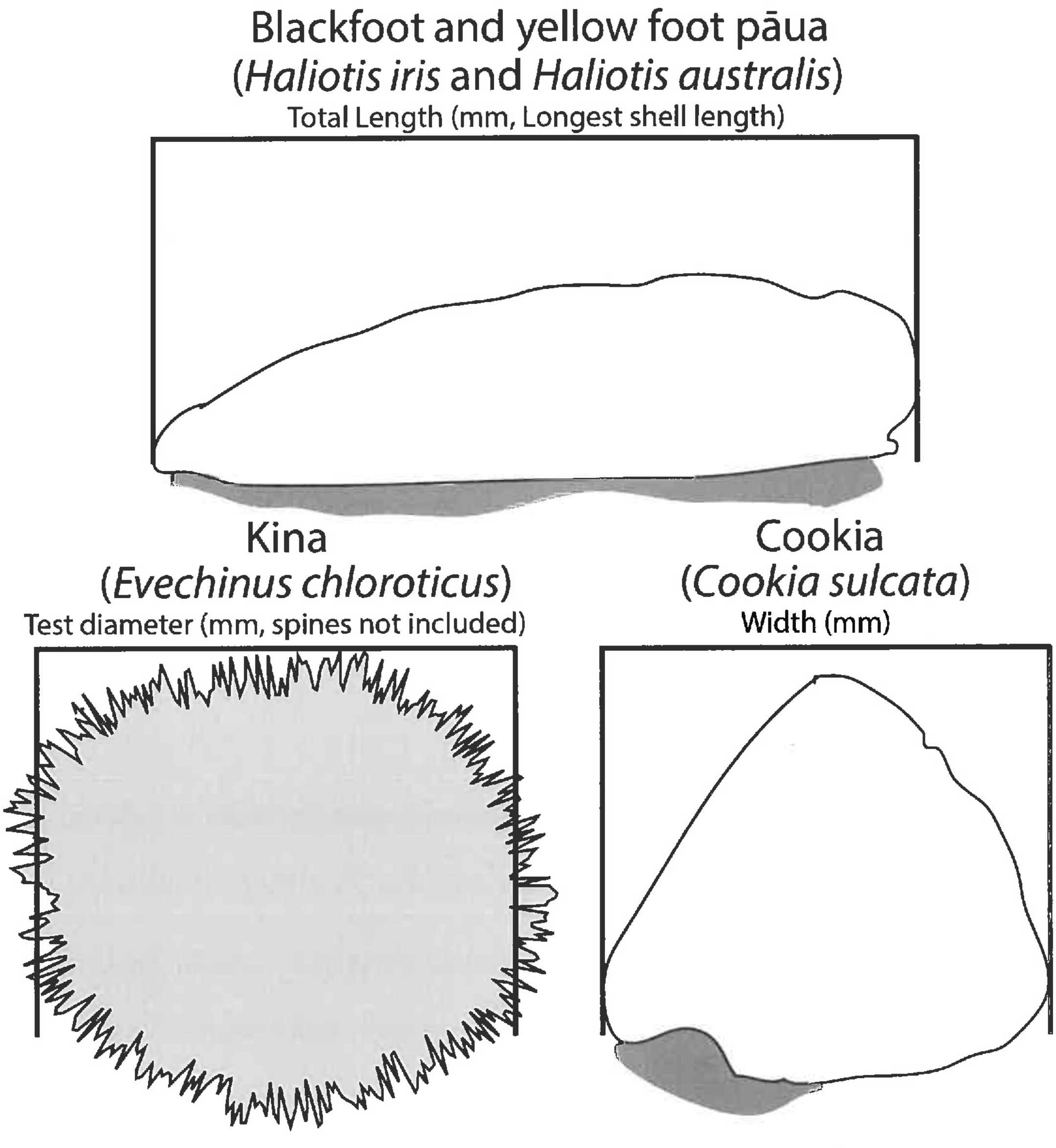

Figure 3: Measurements recorded for key grazer species.

Within each quadrat percentage cover of substrate[1] and macroalgae[2] (seaweed) was estimated. Where turf forming macroalgae was found and could not be readily identified to species level, they were classified as 'Turf'[3]. A further category of 'Low Turf'[4] species was also established. Species in the 'Turf' and 'Low Turf' categories were recorded at a higher taxonomic resolution (to species level where possible, see Appendix 1), however, these categories are retained for this report to enable meaningful comparisons between the 2010 and 2016 surveys.

Statistical Analysis / Data Management

Data recorded in the field were transferred into standardised Microsoft Excel spreadsheets. All subsequent data validation and analysis was conducted with the R statistical software (version 3.3.2, R Core Team 2016) using open-source reproducible workflows established within the Te Tiaki Mahinga Kai research programme. Primary data validation was conducted as the data read into R, using the takiwaR package (v1.0, https://github.com/dpritchard/takiwaR). Site information (GPS location, name etc.) was managed within a QGIS project and stored in an ESRI shapefile format.

To ensure results from the 2016 survey are comparable to those presented in the 2010 report, the mean of the 50 m transects (not the 1 x 4 m quadrat) was used to

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[1] Reef (>4096 mm), boulder (4096 mm - 256 mm), cobble (3256 mm - 64 mm), gravel (64 mm - 2 mm), sand (2 - 0.06 mm), based on Wentworth 1922

[2] Macroalgal species recorded were: *Caulerpa brownii*, crustouse coralline algae (CCA), *Cystophora retroflexa, Cystophora scalaria, Cystophora torulosa.*

[3] The category of turf forming assemblages is comprised of articulated coralline algae (ACA), *Codium fragile*, *Colpomenia* spp., *Halopteris* spp., *Hormosia banksii*, *Ulva* spp. and all red algae species.

[4] The category of low forming assemblages is comprised of *Codium convolutum*, *Codium dimorphum* and *Zonaria* spp.

create figures and conduct statistics (i.e. the transect was the experimental unit). However, unlike 2010, density information is presented per 1 m^2 (not per 4 m^2) for ease of comparisons to other survey locations within the Ngāi Tahu takiwā.

Where possible, changes in density and mean size of key māhinga kai species were compared between survey location, depth and time (2010 vs 2016) using linear models and analysis of variance (ANOVA) with multiple comparisons between combinations of these factors conducted using a Tukey's HSD post hoc test. Overall differences in percentage cover of substrate and primary producing species between survey location, depth and time were analysed using a unified multiple-model approach for multivariate data (Wang et al. 2012). Individual (univariate) tests were used to assess the effect of location, depth and time on the individual components of this multivariate dataset, with p-values adjusted to account for multiple testing (Wang et al. 2012).

Results

Overview

During the 2016 survey a total of 475 quadrats[5] were sampled within the three survey locations (155 at the River Mouth and 160 at both the Snout and Crombie, respectively). Survey effort in the three depth zones was unequal, with 180, 175 and 120 quadrats place in the 0 m, 1 m and 2.5 m zones, respectively (Table 1). In total, 17 blackfoot pāua, 14 yellow foot pāua, 64 kina and 30 Cookia were counted and measured. In addition, two kōura were counted. In the following sections comparisons with the 2010 survey will be made where possible[6].

Mahinga Kai Species

Blackfoot Pāua

Within the survey area, density of blackfoot pāua declined by 82% between 2010 and 2016 (from 0.050 m^{-2} to 0.008 m^{-2}, Figure 5). This decline was predominantly driven by statistically significant reduction in blackfoot pāua density at the Snout (a decline of 0.08 pāua m^{-2} between surveys, $p = 0.009$), although density decreased across all sites (a statistically non-significant decline of 0.03 and 0.02 pāua m^{-2} at Rivermouth and Crombie respectively, Figure 4 and 6). Blackfoot pāua were only found within the mid and deep zones during the 2016 survey, whereas pāua were found across all locations and depths in 2010 (Figure 5). Overall, in 2016 blackfoot pāua were less common at the River mouth site, with similar densities observed at

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[5] For comparison the 2010 survey had 540 quadrats in total (180 at each site).

[6] In the process of preparing this report data from 2010 was transferred into the current TMK data archive format. In doing so, discrepancies in the density and size information were identified. The authors of this report have used their best judgement when assesing which comparions can be made (see dataset README files for further information).

the Snout and Crombie (Figure 5). The average size of blackfoot pāua in 2016 was 128 ± 3 mm, compared to 96 ± 3 mm in 2010, with 65% at or above the minimum legal size limit of 125 mm in 2016 compared to 23% in 2010 (Figure 6). The average size of blackfoot pāua was greater in the deep zone compared to the mid (132 ± 5 mm and 126 ± 5 mm respectively), with no blackfoot pāua found within the 0 m zone. The low number of blackfoot pāua found during the 2016 survey makes formal statistical comparisons of pāua size problematic.

Yellow foot pāua

Between the 2010 and 2016 surveys, yellow foot pāua density declined by approximately 73% (from 0.027 to 0.007 pāua m^{-2}). As with blackfoot pāua, this was driven by a reduction in the density of yellow foot pāua within sites at the Snout (a reduction of 0.05 pāua m^{-2}, $p = 0.017$, Figure 4 and 6). Average density of yellow foot pāua in 2016 was 0.01 ± 0.01 m^{-2} with most found within the mid depth zone (0.02 ± 0.01 m^{-2}), followed by the deep zone (0.01 ± 0.01 m^{-2}). No yellow foot pāua were found within the 0 m zone, or at the River Mouth site (Figure 5). The mean size of yellow foot pāua in 2016 was 78 ± 3 mm with 57% were at or above the minimum legal size limit of 80 mm. This was comparable to 2010, where the mean size was 77 mm and 53% were of legal harvestable size. In 2016, the average size of yellow foot pāua was greater in the deep compared to the mid zone (87 ± 2 mm and 76 ± 3 mm, respectively). Again, the low number of yellow foot pāua encountered during the survey makes formal statistical comparisons of the size structure of this species difficult.

Kina

Overall in 2016, average density of kina was 0.033 ± 0.01 m^{-2} (Figure 4). There was no statistically significant change in the density of kina between 2010 (0.034 ± 0.01 m^{-2}) and 2016 (ANOVA $F_{1,84}$ = 0.03, p = 0.87, Figure 4). The highest density of kina was observed within the mid zone at the Crombie (0.13 ± 0.07 m^{-2}, Figure 5). In 2016, kina were more abundant at the Crombie (0.07 ± 0.03 m^{-2}) and the Snout (0.03 ± 0.008 m^{-2}) when compared with the River Mouth (0.003 ± 0.002 m^{-2}, TukeysHSD, p < 0.001, Figure 4). There was no significant difference in kina size between 2016 (111 ± 2.0 mm) and 2010 (115 ± 2.3 mm, ANOVA $F_{1,137}$ = 0.02, p = 0.88). In 2016, an overall pattern of increasing size with depth was observed ($F_{2,137}$ = 5.23, p = 0.006), with the average size of kina increasing from 94 ± 5.2 mm in the 0 m zone to 122 ± 3.7 mm in the deep zone.

Cookia

In 2016, average Cookia density was 0.015 ± 0.007 m^{-2}. Although this was an order of magnitude higher than in the 2010 survey, high uncertainty in this estimate (i.e. a very patchy distribution, with high numbers at the Crombie) meant that this difference was not statistically significant (one-way ANOVA, $F_{1,100}$ = 3.75, p = 0.055, Figure 4 and 6). Cookia were also more abundant within the mid and deep zones when compared to the 0 m zone (Figure 5). Overall, the average size of Cookia was 74.5 ± 3.1 mm across all locations. The mean size of Cookia increased with survey depth from 47 mm (one individual) to 78.6 ± 5.2 mm. These sizes and trends were similar to that observed in 2010, but low numbers of Cookia at some sites / depths make formal statistical comparisons difficult.