Density of key kaimoana species (4 x 1 m quadrat survey)

Average densities of pāua ranged between 0.02 and 0.14 per m^2 on the reefs surveyed within the proposed mātaitai during December 2010. Average pāua densities were significantly greater at the Snout when compared to the River Mouth (One Way ANOVA $F_{2,53} = 3.54$ P = 0.036), with declining densities observed at greater depths. However, densities were similar at each depth surveyed at the River Mouth and Crombie sites (Figure 5). Significantly more yellowfoot pāua were found at the Snout when compared to the Rivermouth site (One Way ANOVA $F_{2,53} = 4.40$ P = 0.017). Kina were found in greater densities in the deep sections of the reef compared to the intertidal area (One Way ANOVA $F_{2,53} = 4.67$ P = 0.014). Cookia were more abundant at greater depth when compared to the shallow and intertidal depth zones (One Way ANOVA $F_{2,53} = 4.21$ P = 0.020; Figure 5).

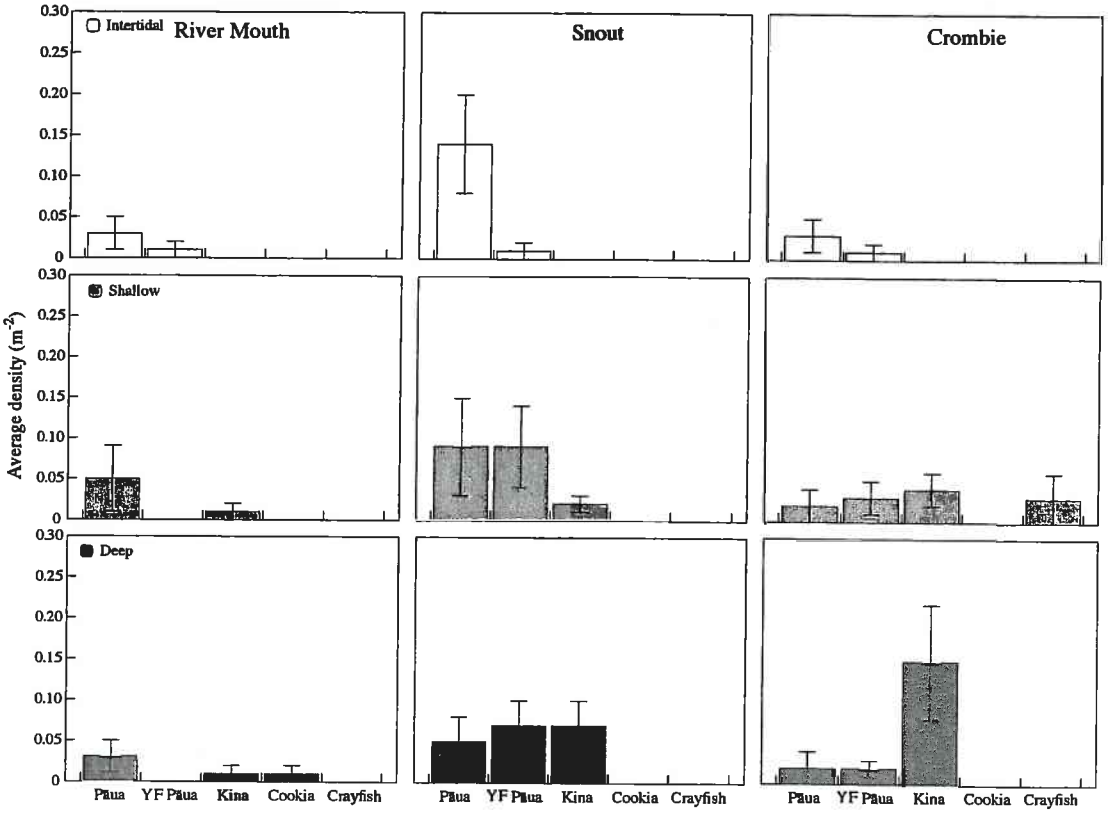

Figure 5. Density of Pāua (*Haliotis iris*), YF Pāua (*Haliotis australis*), Kina (*Evechinus chloroticus*), Cookia *Cookia sulcata* and Crayfish (koura, *Jasus edwardsii*) within three depths (Intertidal = 0 m, Shallow = 0.1 - 2 m & Deep = 0.5 - 4 m depth) at the three study locations during December 2010. Bars represent means ± standard error n = 6 at each depth.

Size frequency of pāua at each site

Each site surveyed exhibited different size structure. 62 % of pāua were longer than 125 mm minimum legal size limit at the River Mouth. The Snout exhibited more pāua within the 110-125 mm size and 53 % of pāua were longer than 125 mm. The Crombie had lower numbers of pāua throughout most size classes. A cohort of smaller pāua around 20 mm in length (found beneath rocks) was observed at the River Mouth and Crombie sites (Figure 6). The median size of pāua measured at both the Snout and River Mouth sites was 119 mm and 129 respectively, whereas the average size of pāua at the Crombie was significantly smaller at 101 mm (One Way ANOVA $F_{2,382} = 21.2$ $P < 0.0001$; Figure 6).

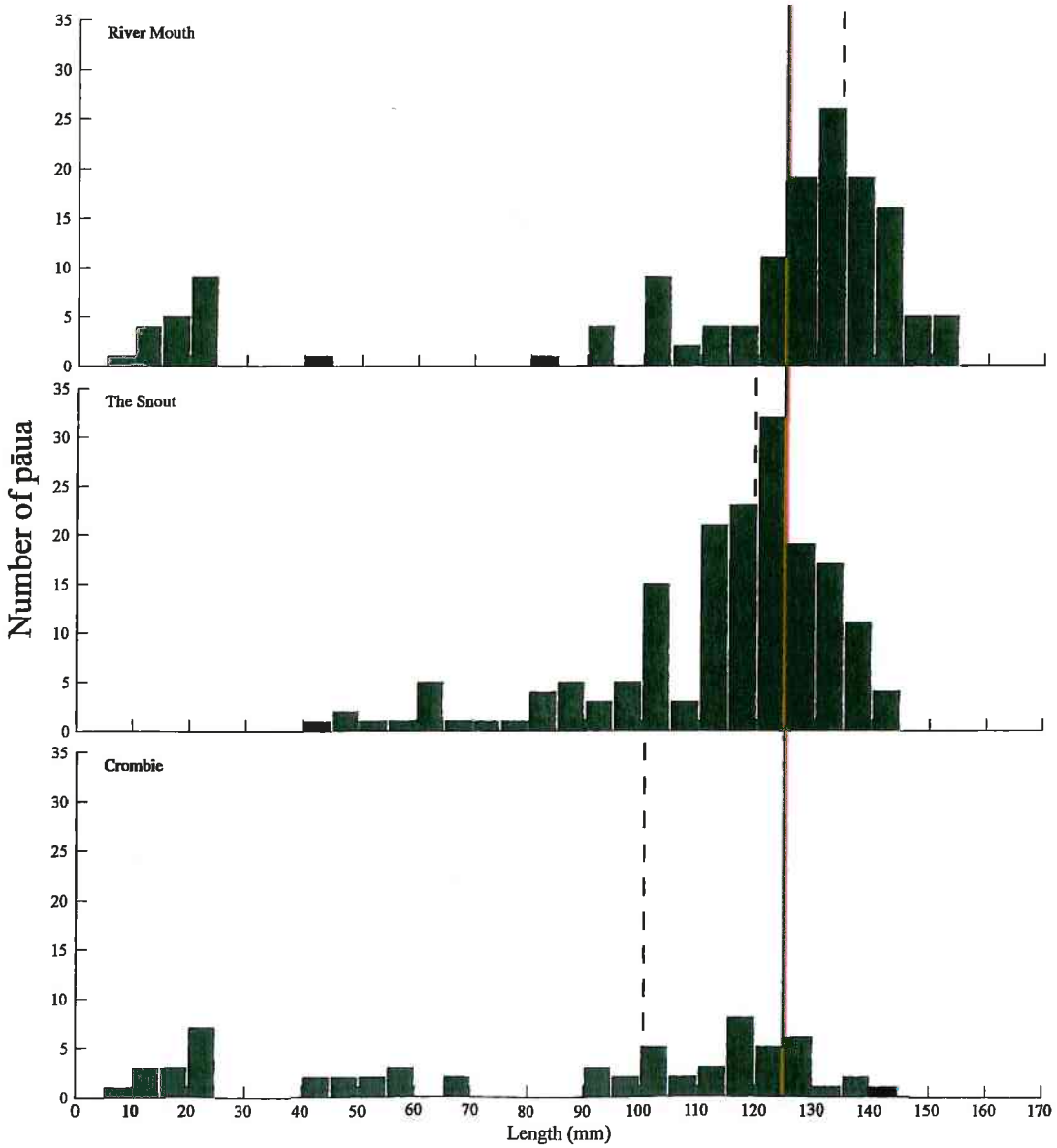

Figure 6. Size frequency of pāua in the proposed Waitutu mātaitai. Numbers measured at each site: River Mouth n=145, Snout=175, Crombie n=63. The solid red line represents the minimum legal size (MLS) of 125mm whereas the dashed line is the median size.

Discussion

Habitat characteristics of the proposed Waitutu mātaitai

Appropriate habitat for pāua within the proposed Waitutu mātaitai is limited. Flat reefs dominated by soft sedimentary rock (papa) do not appear to be favoured habitat for pāua, therefore they are limited to small areas where large boulders are present. Boulders may provide protection (for pāua) from predators (human and non-human), and in areas where there was significantly more boulder habitat there were more pāua (e.g the Snout versus the Crombie sites). These boulders may provide protection for pāua from fishers and are also likely to concentrate food (drift seaweed) into areas accessible to feeding pāua more than areas of flat reef (Saunders et al. 2009). The limited extent of habitat for pāua in the Waitutu area may have made the area within the proposed mātaitai more susceptible to depletion due to overfishing. Most pāua where observed in shallower parts of the reef and were clumped in distribution. We did not observe any significant pāua populations in deeper water that could provide a refuge from fishing.

Density of kai moana species

All kai moana densities within the proposed Waitutu mātaitai are low with the exception of koura. Average pāua densities at Waitutu are several times lower than the lowest densities observed in recent surveys of three other customary areas in the South Island (see Figure 7). The low densities found at Whareponga and Waitutu could be due to the habitat characteristics of both these areas (both have flat mudstone and sandstone reef habitats) with paua only being found in patches on and around large boulders. Such low densities may also be a result of overfishing and habitat degradation (e.g. sediment from the land) or a combination of all three factors. Irrespective of the reason, low densities and the patchiness of pāua populations along the Waitutu coast makes this fishery prone to collapse due to environmental change (e.g. slips effecting key paua reefs) or overfishing.

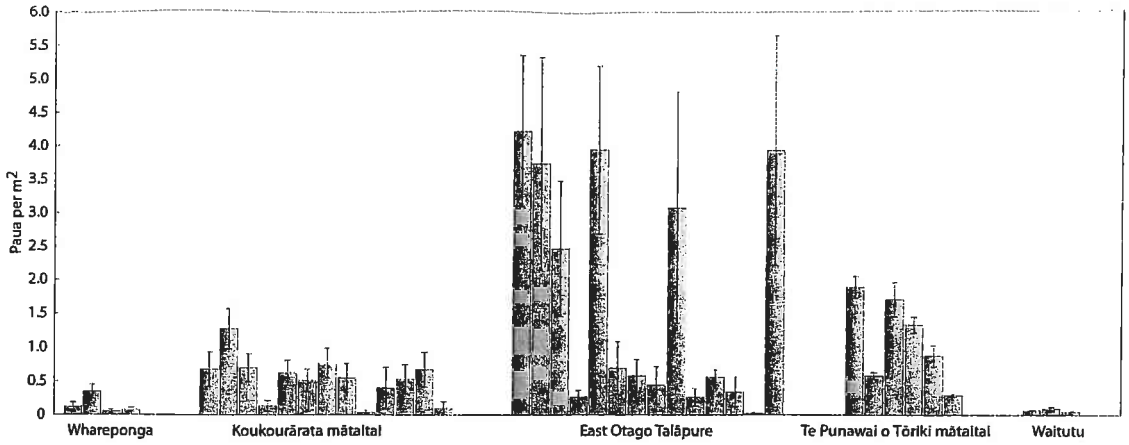

Figure 7. Pāua density (pāua per meter squared) at Whareponga, Koukourārata mātaitai on Banks Peninsula, East Otago Taiāpure just north of Dunedin City, Te Punawai o Tōriki Mātaitai in South Otago and Waitutu in southeastern Fiordland. Bars indicate average densities for individual reefs in each area ± S.E. for n= 30-60.

How much kai moana is there?

The initial survey conducted has provided densities and sizes for kai moana in a range of reefs in the eastern portion of the proposed mātaitai, however the western section (2.5km^2) is still to be surveyed (see Figure 8). Until this western area has been accurately surveyed we are unable to provide realistic estimates of how many pāua (and other important kai moana species) are within the proposed mātaitai. If we conduct further surveys in the western area the information can be used to develop estimates for how much kai is in the mātaitai once detailed habitat maps are produced (e.g. how far out the reef extends). As far as we can tell (within the eastern section), the amount of pāua within the proposed mātaitai is well below a quantity needed to make commercial fishing in this area practical. As such the implementation of the mātaitai in Waitutu would have little or no effect on the commercial pāua fishers in this region (unless pāua are far more abundant in the un-surveyed western section of the proposed mātaitai). We would suggest that this is doubtful, as the habitat is likely to be similar in both sections. If however, the habitat is different and suitable for pāua (a situation that is possible around Long point) abundances could be greater. Additional surveys are required in the western section to clarify this point.

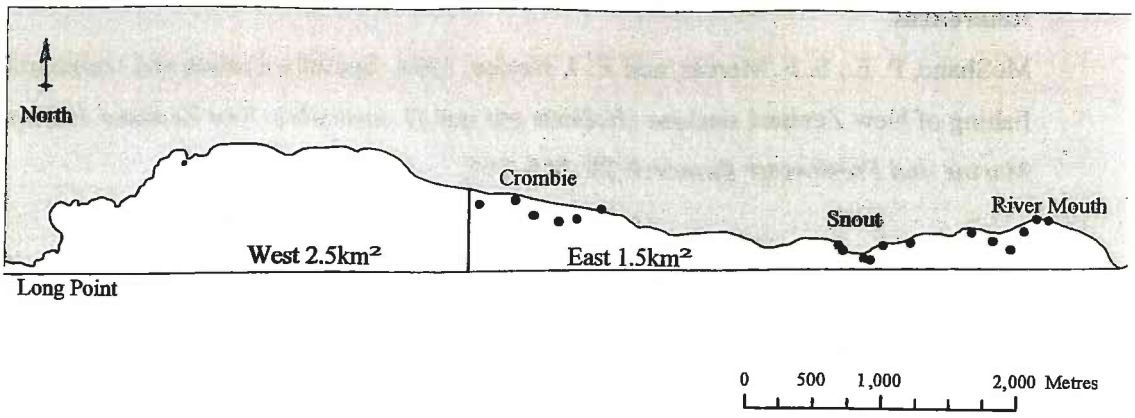

Figure 8. Size of areas surveyed (eastern section) and still to be surveyed (western section) within the proposed Waitutu māitaitai.

Conclusions

- Pāua numbers are very low in the eastern section of the proposed māitaitai.
- Poor habitat combined with overfishing and habitat degradation is potentially the reason for the low number of pāua.
- Limited habitat increases the chance of over exploitation of pāua in this area.
- Further surveys are required to address pāua numbers in the western section. This will enable us to provide a realistic estimate of the pāua population for the entire proposed māitaitai.

References

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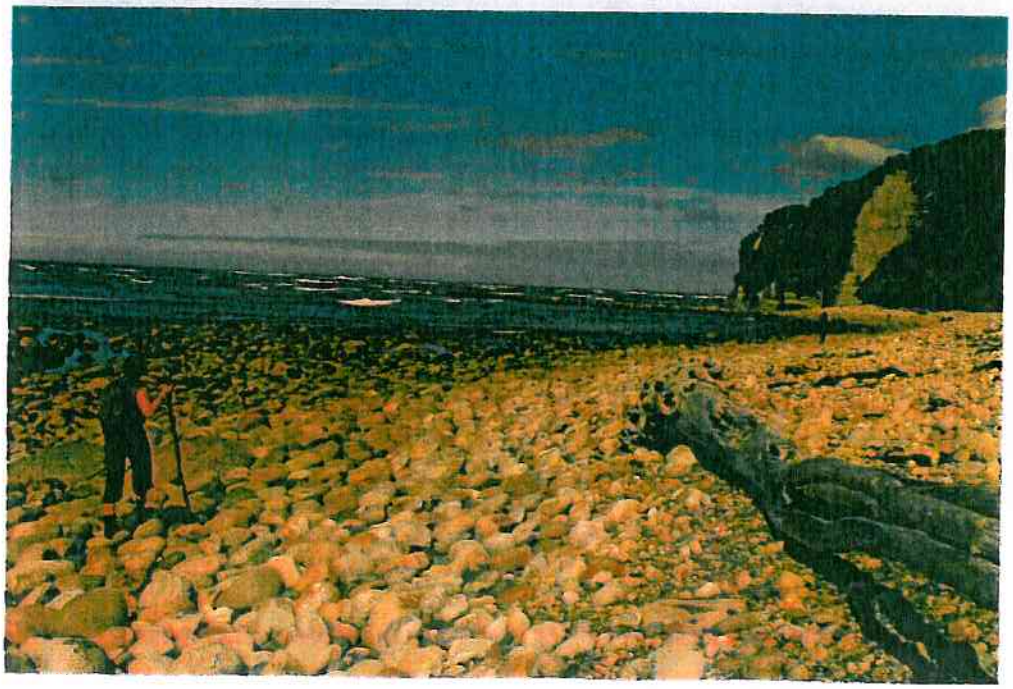
Saunders, T. M., S. D. Connell, and S. Mayfield. 2009. Differences in abalone growth and morphology between locations with high and low food availability: morphologically fixed or plastic traits? *Marine Biology* 156: 1255–1263.

Appendix

Above: The large reef to the west of the Crombie Stream (Crombie Site). Flat papa reefs with scattered large boulders surrounded points along the coast from the Wairaurahiri River mouth to the reef beyond the Crombie Steam.



Above: A series of boulder beaches extended between points from the Wairaurahiri River mouth to the Crombie Stream. Boulders typically grade into papa reef below the low tide mark.

Above: Yellow-eyed mullet and a juvenile blue moki swim over typical habitat found in shallow subtidal sections of the proposed Waitutu mātaitai. There areas are dominated by brown seaweeds particularly species of the *Cystophora* genus.

Above left: Deeper sections of reef (>2 m) are dominated by a range of small turfing red and brown seaweeds. **Above right:** The common kelp *Ecklonia radiata* appears at depths greater then 2m below the low water mark.

Above Left: A banded Wrasse swims over subtidal coralline cobble, an important habitat for juvenile pāua. **Above Right:** Very small pāua (<30mm) live under small boulders in subtidal areas within the proposed mātaitai

Above: Adult pāua are found clumped together on boulders and are usually hidden in cracks or beneath turfing seaweeds.

Above: Surveying shallower sections of the Snout Site.

Above: Turfing seaweeds below and the cliffs above the River Mouth Site