Whataroa Bay Tubeworm Survey Monitoring July 2016

Sanford Marine Farm Site 8444

Prepared for Sanford Ltd

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Executive summary

- There has been a decline in the health of tubeworm mounds on the southern headland of Whataroa Bay between monitoring surveys from 2013 to 2016
- The tubeworm mounds are still present, but the percent of live worms per mound at the two outer sites has decreased from an average of 96.5 to 47.8 % live (Dive site 1) and 96.4 to 73.5 % live (Dive site 2).
- There is no evidence to suggest that the observed decline in mound health is related to the proximity to marine farm site 8444.
- Likely causes of the decrease in percent live may be natural mortality, seasonal variation, suspended sediment or a filamentous diatom bloom.
- Additional mapping of the mounds and establishment of permanent transects to monitor health and extent of mounds would provide greater detail on the overall condition of this biogenic reef.

1 Introduction

Sanfords mussel farm site 8444 is located north-east of the southern headland of Whataroa Bay, Port Underwood. Large tubeworm mounds of predominantly *Galeolaria hystrix* grow on a reef at the south west corner of the marine farm. Mounds of this size are regarded as having significant ecological national importance (Department of Conservation, 1995). At the time of establishment the farm boundaries were reduced to effectively position the farm backbones approximately 80 m seaward of the edge of the colonies, a distance considered unlikely to have significant impact on the continued health of the tubeworms (Davidson, 2011). The consent conditions for the farm required periodic monitoring of the tubeworm mounds.

A baseline study was conducted in September 2011 to determine health and extent of the tubeworm mounds (Page et al., 2011). The tubeworm mounds were resurveyed two years later on October 2013 (Page, 2013). There had been no change in the size or health of the tubeworms. This current study reports the results of a second monitoring study carried out on the 6th of July 2016.

2 Methods

As in the previous two surveys, a 650 kHz Tritech side-scan sonar was used to map the extent of tubeworm mounds along the shoreward side and the western boundary of the farm, along the same track as run in 2011 and 2013. Positions of reef or tubeworm habitat were noted to determine if location or size of mounds had changed.

A total of four sites were resurveyed by divers (Table 2-1). Although Site 3 dive transect was not re-surveyed in 2013 (Page 2013), we added this site into the design for the present survey to detect if there had been any recruitment adjacent to the marine farm. For each dive site, 25 m transect tapes were run parallel to the shoreline (Figure 2-1). A Go Pro camera was used to record seafloor habitat and extent of the mounds measured from the tape.

Table 2-1: Coordinates (WGS84) of dive sites in July 2016.

Site	Latitude	Longitude
1	41 19 23.716 S	174 09 03.065 E
2	41 19 24.856 S	174 09 04.505 E
3	41 19.417 S	174 09.094 E
4	41 19 23.776 S	174 09 01.205 E

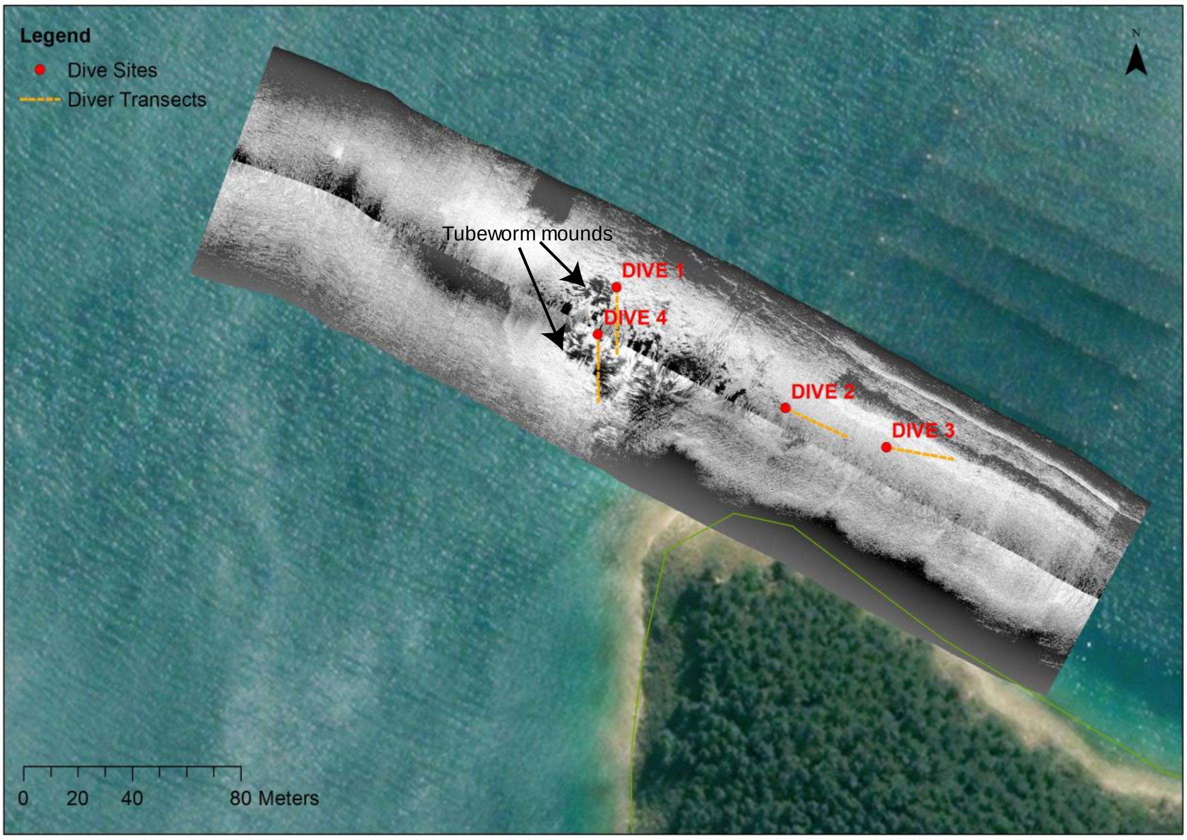

Figure 2-1: Map of the southern headland of Whataroa Bay, showing location of dive sites and tubeworm mounds.

To determine mound health at each site, five randomly placed 0.25 m^2 photoquadrats were taken using a high-definition Canon 5D camera with a 15 mm lens. The images were analysed for percent cover of worms on available substratum. Photoquadrats were further sub-sampled into five 100 mm^2 squares and the percent of live worms within each was determined. Worms were considered 'live' when the calcareous tubes were either un-fouled, or the feeding tentacles observed, or 'dead' if the tubes were fouled.

3 Results

The side-scan record shows presence of mounds at the base of the reef on the southern headland of Whataroa Bay (Figure 2-1). There was no change in the location or extent of mounds in maps between surveys in 2011, 2013 and the present survey. Mound depths ranged from 5.4 m to 9.6 m at the base of the reef.

Transects at dive sites showed mounds occurred at Dive sites 1 and 4. The size and extent of the mounds was the same as previous surveys in 2011 and 2013. Isolated patches of worms were present on small reef structures at the inner two sites (Dive sites 2 & 3).

The percent cover of tubeworms did not change significantly from previous surveys in 2011 and 2013 at sites 1, 2 and 4 (Table 3-1). However, there were new patches of tubeworms found at the inner site (Dive site 3) where no worms were found in the original 2011 baseline survey (Page et al. 2011).

Table 3-1: Mean percent cover and live tubeworms in dive photoquadrats.

Dive Site	Mean % cover			Mean % alive		
	2011	2013	2016	2011	2013	2016
1	91.8	88.8	90.8	96.7	96.5	47.8
2	40.8	30.0	21.0	97.2	98.1	90.3
3	No mounds	Not surveyed	34.4	No mounds	Not surveyed	91.1
4	79.0	85.8	100	95.0	96.2	73.5

Although there was little change in the percent cover of tubeworms, the health of mounds in the outer transects (Dive sites 1 & 4) has decreased since 2013 (Figures 3-1 & 3-2). At Dive site 1 the percent live worms per mound decreased to 47.8 ± 36.5% from 96.5 ± 3.8% and to 73.5 ± 15.4% from 96.2 ± 2.3% at Dive site 4 (± 1SD). Worms at Dive site 2 remained healthy with a high percentage of live worms per quadrat, as was the health of new patches of worms at Dive site 3 (Table 3-1). There is no apparent relationship between depth and mound health (Figure 3-3).

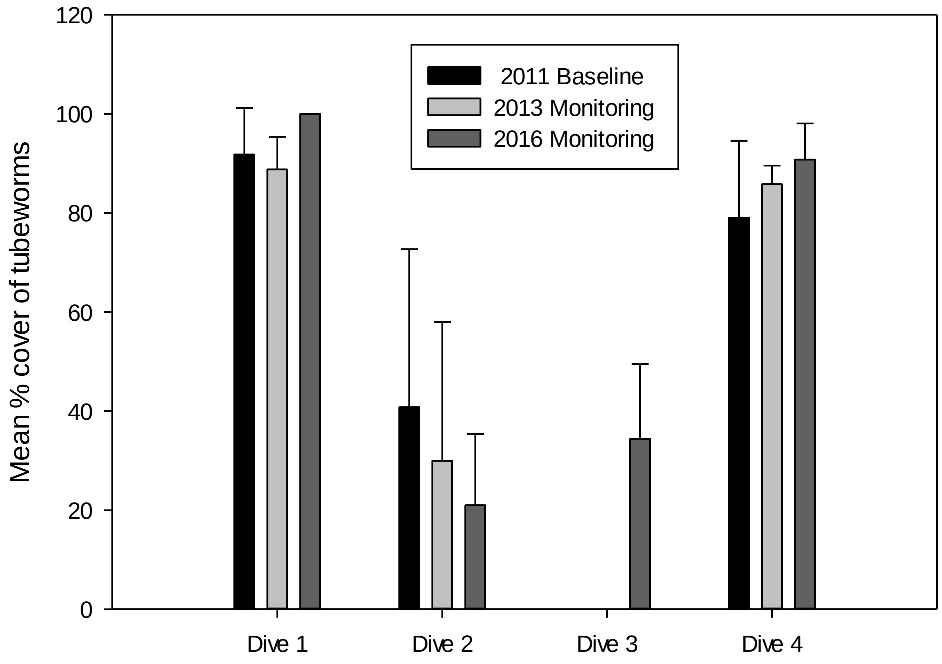

Figure 3-1: Mean percent cover of tubeworms in 0.25m^2 photoquadrats (± 1 SD).

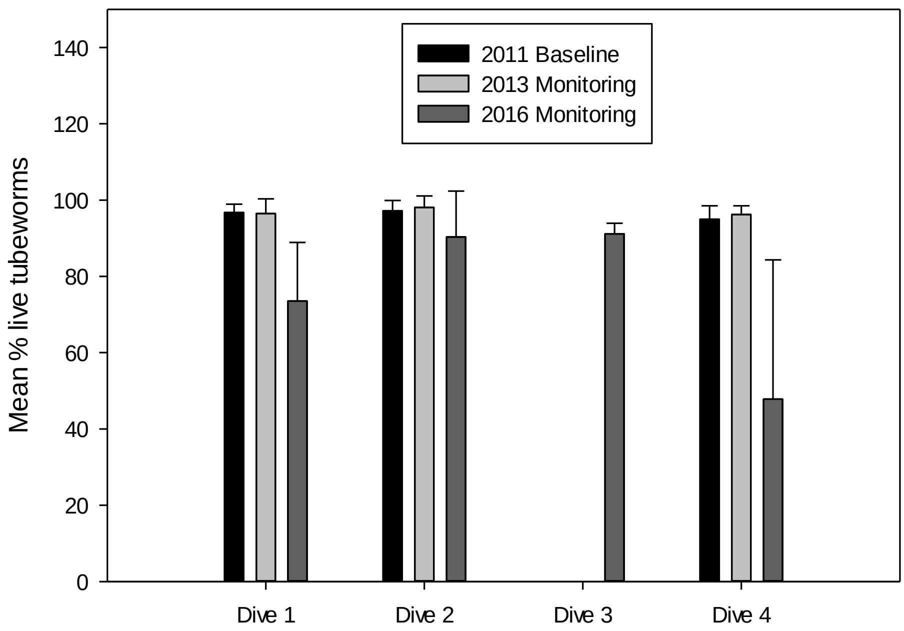

Figure 3-2: Mean percent of live worms per 0.25m^2 photoquadrats (± 1SD).

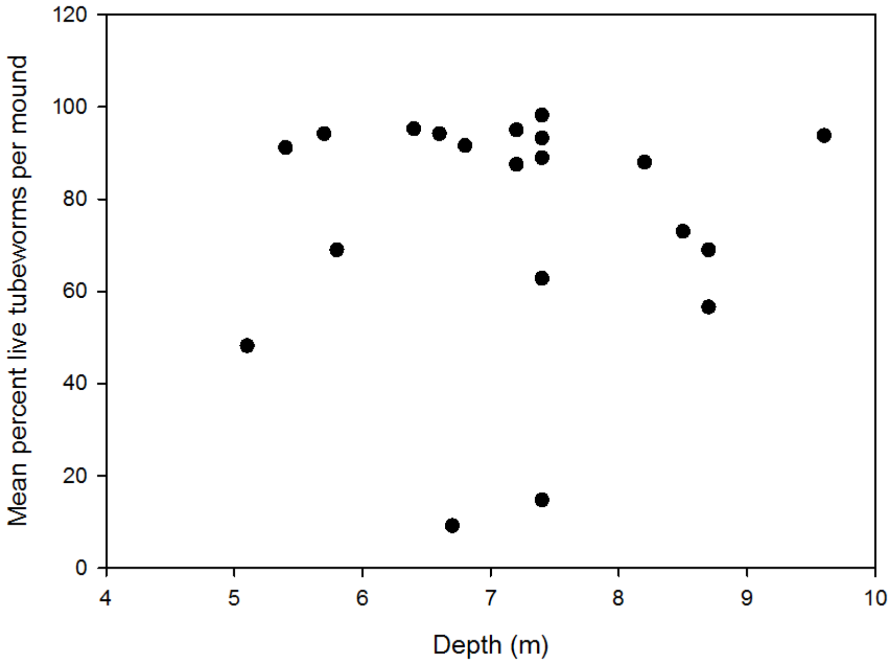

Figure 3-3: Scatterplot of depth versus mean percent live worms.

4 Discussion

The size and extent of the tubeworm mounds at the Whataroa southern headland has not changed since 2011. However, there has been a decline in the health of the mounds. The mounds are still standing, but have a high percentage of dead worms compared to the previous two surveys in 2011 and 2013, and are predominantly fouled with turfing red algae (Figure 4-1). In comparison, tubeworms at the inner two sites adjacent to the farm are healthy with new patches of worms established between 6 to 8 metres deep at Dive site 3.

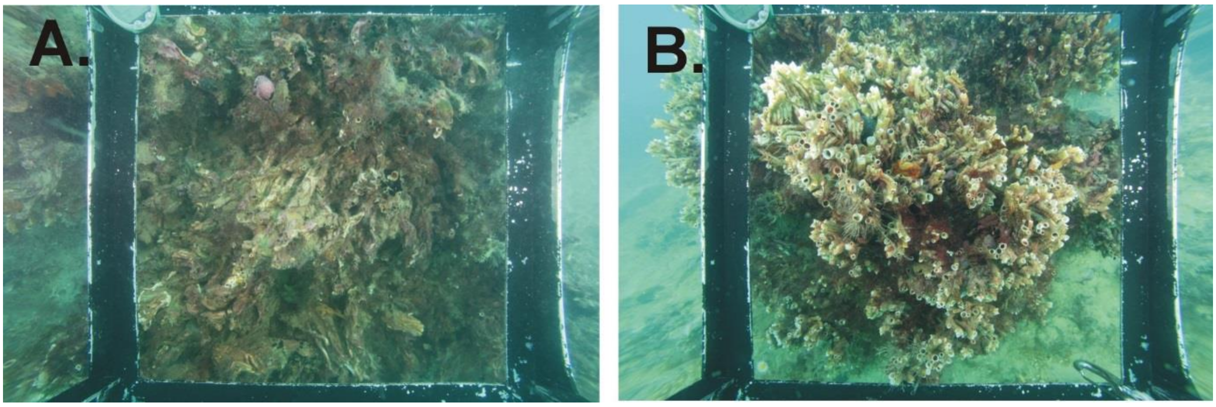

Figure 4-1: Photoquadrats; A.) 1-5 at Dive site 1 showing dead and fouled tubeworms and B), T4-4 at Dive site 4 with a healthy tubeworm mound. The deterioration in condition of the tubeworm mounds cannot

be attributed to any single factor such as proximity to the mussel farm. Mound age, seasonal variation in mortality, recruitment and growth, sedimentation and diatom blooms are potential causative factors in the observed changes.

Mound age is least likely to be the reason for increased mortality, as *Galeolaria hystrix* patch reefs can be as old as 50 years (Smith et al., 2005) and individuals worms have been estimated to live as long as 12 years (Riedi, 2012). Mounds grow by successive recruitment of worms, probably attracted to chemical released by living worms (Smith et al., 2005), although not experimentally proven for *Galeolaria*.

Seasonality should also be taken into account, as the previous two surveys were undertaken during summer after likely recruitment and growth and the current survey was conducted in winter. Growth rates have been shown to be as high as 6.7 cm/year in Otago Harbour (Riedi, 2012) and may be higher in warmer water temperatures further north in the Marlborough Sounds. Therefore, recruitment to dead mounds may occur in spring, thereby increasing the proportion of live worms per mound.

Serpulid worms are suspension feeders and susceptible to increased rates of suspended sediment which blocks feeding tentacles and can affect respiration and fecundity (Kupriyanova et al., 2001). It has been suggested that proximity to marine farms can impact *Galeolaria*. However, Smith et al (2005) found no evidence of mussel or salmon farm effects on *Galeolaria* aggregations in Big Glory Bay, Stewart Island. Furthermore, there is no evidence of marine farm influence on the mounds on the Whataroa south headland. Healthy patches of worms recorded at Dive site 2, and new patches of worms at Dive site 3, directly adjacent to the farm suggest little effect. However, we have no hydrodynamic or sediment particle tracking model for the area to determine small-scale sediment transport. Potential sources of suspended sediment in Port Underwood are unknown and outside the scope of this report.

Filamentous diatom blooms have been observed to occur in the Marlborough Sounds and are known to cause mortality by smothering benthic organisms on *Galeolaria* reefs in Tennyson Inlet, an area not influenced by marine farms (M. Page, pers. comm.). It is possible that such events occur elsewhere in the Marlborough Sounds and may cause mortality events.

In conclusion, our survey has detected a decline in health of tubeworm mounds on the southern headland of Whataroa Bay between 2013 and 2016. The cause of the decline in health of the mounds is unknown. We recommend that the reef and biogenic tubeworm mounds be surveyed in detail to further determine the extent and health of mounds. Additional permanent transects and tagging mounds to monitor through time will give us a clearer understanding of the ecology of this species.

5 Acknowledgements

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6 References

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