4. Discussion

Tuatua Ecology

Populations of exposed soft shore bivalves are highly variable in space and time and are influenced by factors such as variation in wave action, salinity, temperature, food supply human predation and pollution (Dame, 2009; McLachlan & Brown, 2006). Our results indicate that average tuatua size decreased on heavily impacted beaches over the sampling period (figure 9). However, with the data available it is not possible to determine whether these decreases are Rena-related, natural variation or the result of some non-Rena perturbation. The high impact sites where tuatua average size decreased are popular sites for recreational harvesting. Despite public health warnings advising the public to refrain from shellfish gathering it was observed regularly and at Waiairiki Reserve on a large scale the day prior to sampling (pers. obs.). Recreational harvesting has been noted as having effects on shellfish abundance and size in studies elsewhere (DeFeo, 1996; Grant, 1994).

Large numbers found in the 20 to 25 mm size range were almost all from Matakana Island. Thousands were found within the quadrats at the two sites sampled and many more were observed at all tidal heights, including close to the high water mark during high tide. Some literature associates large cohorts of similar size with environmental conditions, suggesting that higher density and smaller size are necessary for survival on higher energy beaches (McLachlan et al., 1995b). The absence of tuatua from Matakan Pipe line in the mid shore in summer sampling may relate to the time of day sampling occurred. During winter the mid tide site was sampled as the tide receded, during summer the low tide site was sampled then the mid tide site. A similar result was noted at the Taylors Reserve site in winter with the same sampling regime. These results may be influenced by the movement of tuatua across the tidal cycle and warrants further investigation.

Tuatua length was significantly less at heavily impacted sites across sampling events. A reduction in lipid storage and growth rates has been recorded in some marine bivalves after exposure to hydrocarbons which could be the size reduction observed post-Rena (Fukuyama et al., 2000; Ripley, 1998). Tuatua length is an important parameter determining reproductive output in marine bivalves. Reproductive maturity is often a factor of length rather than age, with number of eggs produced also proportional to an individuals size (Bayne et al., 1981; Ripley, 1998). Tuatua biomass was correlated with abundance. Biomass was greatest at the two Matakana Island sites for both winter and summer. The biomass increased a little at Matakana North despite lower overall numbers due to an increase in numbers of larger size classes. This might indicate the cohort succession from the winter sampling and in turn a population in relatively good health (Dame, 2009).

Low and mid shore height comparisons did not appear significant in evaluation of impacts at various sites and if continued studies are proposed the mid shore component may not be necessary. Significant difference between low shore sites over seasons corroborates the combined low and mid shore findings.

While no formal record of beach profile is available for the sampling periods, a changing profile and higher proportion of shell hash was noted at some sites during the summer sampling. It has been noted that such conditions can have a large influence on the population structure. Where tuatua could not be found intertidally for PAH and metals analysis, large subtidal tuatua beds were often found adjacent to the sampling area. Tuatua can be found at a depth of at least 4 m (Grant, 1994). This suggests across shore movement as a possible explanation for variation in abundance across sampling events. The Bay of Plenty Regional Council has a coastal monitoring program which has been in existence since 1990. Records show high variation in bivalve numbers at four of Bay of Plenty beaches including Pāpāmoa at Taylors Reserve (Park, 2010).
PAH profiles in kai moana

(Please also refer to Reports 1f 1–10, Wilkins et al)

Results determined by Hill Laboratories for freeze dried extracts of tuatua gathered from Waihau Bay and Whangaparaoa Bay revealed the presence of low but detectable levels of a selection of total PAHs in the range 6–17 µg/kg. Although these sites are remote (> 100 km) from the Astrolabe Reef they were impacted by debris, containers and oil after the grounding incident (see Wilkins, Project Reports, 1f). Although not directly comparable to our dry weight PAH levels, the time series graph produced by the BOPRC serves to highlight the relatively rapid depuration of hydrocarbons by the tuatua. It is also clear that PAHs are also quickly up taken during their filter feeding activity.

During the winter 2012 sampling, total PAH levels were close to baseline pre-Rena levels with the exception of two high impact beaches, Pāpāmoa Domain and Pāpāmoa Taylors Reserve. Predicting a continuation of the depuration process, it was unexpected to see total PAH levels in the summer 2012/2013 sampling period, six months later show that total PAH levels had increased across all sampled beaches with the exception of the winter’s highest reading, Pāpāmoa Taylors Reserve.

Equally unexpected was the higher than ambient levels from East Coast Waihau Bay with the second highest level in the summer period. Possible reasons for an increase in levels could be re-suspension of oils held in the sand following high seas or a second spill event prior to the sampling period confirming Rena origin (refer Tarball Report, Wilkins, 2013).

There was no unexpected pattern seen in the HRPAH levels and they generally follow the patterns seen in the total PAH series. One unusually high HRPAH was seen in the summer 2012 sampling period 15.40 µg/kg significantly greater than the second highest reading of 3.10 µg/kg, seen at Waihau Bay and the HRPAH baseline of 0.2µg/kg. Crysene (6.4µg/kg) and benzo[a] anthracene (5 µg/kg) both with 4 fused benzene rings make up the majority of this reading.

Trace metal profiles in kai moana

Quantifying ‘safe’ consumption levels of any toxin is inherently difficult. The current Australia New Zealand Food Standards Code – Standard 1.4.1 – Contaminants and natural toxicants (ANZFSC, 2013), sets out Maximum Levels (MLs) for certain toxins within certain food groups. The table to Clause 2 (which includes molluscs) is included in the Appendices and although in some cases reported levels exceed the recommended ML, it is important to remember that the results presented here are presented on dry weight basis whereas many Food Standard recommendations including that of the ANZFSC are calculated on a wet weight basis. Wet weight calculations are less reliable than dry weight as moisture content can vary between samples and varies between biota types. Tuatua have high moisture content and comparisons of metal levels to wet weight max limits cannot be reliably made.

The metals, nickel and vanadium are the highest levels naturally in crude oil and levels could be expected to increase in high impact beaches. Nickel showed a moderate increase from baseline in three beaches in the summer sampling but was approximate or below baseline in the summer sampling period indicating that depuration of nickel had taken place. Vanadium levels were below baseline at all beaches for both sampling periods, indicating no vanadium influence from residual oils in tuatua stocks.

Although the East Coast beaches are >100km remote from Astrolabe Reef, the area was impacted by both oil and debris. The chemistry section of this report shows that the Rena oil signature was detected in biota from this region and evidence of debris and whole containers washing up on the beach less than 1 km from the sampling sites testifies to the impact felt in this region.
Twelve metals showed an increase relative to ambient on the East Coast beaches during the winter sampling. This was an unexpected result as the anthropogenic influence in the region is significantly less than that of the other beaches sampled. Conversely, the levels in the summer sampling period, some six months later, showed an expected result in that levels of all metals were at their lowest concentrations on these East Coast remote beaches indicating that metal depuration within the biota had taken place.