Subject:	Tuatua Baseline Survey December 2020 – Puwheke Beach
Attention:	John Sturgess, Director, Lucklaw Farms Limited
From:	Dr Gareth Taylor
Date	25 January 2021

1 Introduction

Puwheke Beach is located on the northern face of Karikari Peninsula, Northland. The beach extends between the headland at Motutara Bay (west) and Mt. Puwheke (east) and is approximately 3.2km in length (**Figure 1**). Public access to the beach is obtained via Puwheke Road, which terminates at the eastern end of Puwheke Beach.

A small waterway discharges to the Coastal Marine Area (CMA), approximately midway between the headland and Mt. Puwheke and appears to be fed from the surrounding land and Lake Rotokawau.

***Figure 1**: Aerial photo of Puwheke Beach (Headland at Motutara Bay shown west and Mt. Puwheke shown east) Source: Northland Regional Council Local Maps Viewer.*

Tuatua[1] (*Paphies subtriangulata*) are known to be present on Puwheke Beach which is popular for recreational and customary gathering. There is no minimum size for tuatua gathering; however,

[1] Species referred to as tuatua are of two species, *Paphies donacina and Paphies subtriangulata*, species found on Puwheke Beach are *P. subtriangulata.*

preference tends to be for adult sizes (i.e. 50mm +) which are found in the swash zone to approximately 4m depth subtidal and up to 150 are able to be collected per day.

***Figure 2**: Looking east from the Headland towards Mt Puwheke. Site Visit Photo taken 11 December 2020.*

Tuatua are from the family Mesodesmatidae which are a group of moderate to large surf clams. Tuatua are an important part of the ecosystem as a prey species for fish, birds and crustaceans as well as filtering water, which lowers turbidity and can help to facilitate other species (Taylor, 2013).

Tuatua are broadcast spawners, which is when eggs and sperm are released into the water column. Two main spawning periods are documented in north-eastern species, being February to April and September to November (Grant and Creese, 1995). Once fertilised, the planktonic larvae then settle in the intertidal zones of fine sand beaches. It is thought that tuatua reach a length of 40-70mm within 3 years and over that time move towards the lower shore (MPI). Tuatua are unable to actively move, but are able to emerge from the sediment and 'swash ride' to redistribute and individuals will then rapidly rebury. Due to this, tuatua can have variable distribution patterns across a beach, but are normally able to found in distinct bands within the intertidal zone at juvenile sizes, then subtidal zones for adult sizes.

As tuatua bury shallowly in the sediments (within 10mm of the surface) they are known to be adversely affected by human users of the beach; particularly vehicles (Taylor, 2013).

Lucklaw Farms Limited have engaged Collaborations to undertake a baseline study of the tuatua populations present at Puwheke Beach, Karikari Peninsula in Northland.

1.1 Pupose of this memo

The purpose of this memo is to present the results of the initial baseline survey of Tuatua populations within the intertidal zone at Puwheke Beach, Karikari Penisula.

2 Methodology

2.1 Sampling

As this is a baseline report and tuatua can be variably distributed, the methodology has been developed to be replicated temporally should further studies be undertaken. A spaced transect method has been implemented along the length of Puwheke beach. Seven sites were selected for the purpose of sampling to examine spatial trends in shellfish size and distribution.

Sampling of tuatua populations at Puwheke Beach was undertaken during the morning low tide period over 11th – 12th December 2020. These seven sites were spaced approximately 500m apart to cover the length of Puwheke Beach. The locations of these sites were recorded using GPS and are shown in **Appendix A**.

Paired transect lines with quadrat sampling was used. A total of seven transect lines were sampled; one at each of the seven sites. Transect lines 1 to 4 were sampled on 10 December 2020 and Transect lines 5 to 7 were sampled on 11 December 2020.

A 31.7cm x 31.7cm (0.1m^2) quadrat was spaced at 10m intervals along the transect line. The first quadrat was taken at the last high tide mark and the final at the swash zone. The length of the transect line ranged between 40m to 60m across the seven sites.

Sediment within the quadrat was removed carefully using a flat spade to a depth of 15 cm. The sediment was sieved through a 5 mm sieve. Shellfish that were caught in the sieve were recorded for numbers and the shell length of individuals. The number of shellfish per quadrat was multiplied by ten (10) to give the density of shellfish per m².

In addition to transect sampling, the surface sediment was scraped by running a flat spade over the top 10-20mm of sediment from the high tide to the swash zone to identify where the band of shellfish are located.

A search of the swash zone was also undertaken to get an understanding of adult tuatua present. This was done by searching within the swash zone for the hydroids of the tuatua and with the aim of collecting up to 25 individuals for recording.

All work was undertaken in accordance with Collaborations Special Permit (SP752) issued by the Director General of the Ministry for Primary Industries (MPI) pursuant to Section 97(1) of the Fisheries Act 1996.

2.1.1 Data and Statistical Analysis

All tuatua were recorded for location, size and number. All data was recorded in Microsoft Excel spreadsheets and plotted where data sets allowed.

2.2 Site Descriptions

The locations of the seven transect sites are shown in **Appendix A**. As outlined above, Sites 1 to 7 span west to east along the length of Puwheke Beach and are spaced every 500 m along the high tide line.

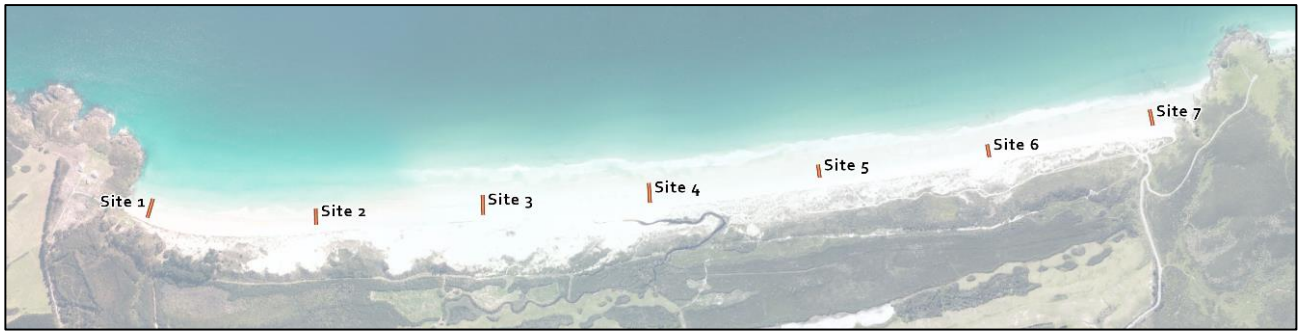

***Figure 3**: Locations of the seven sites along the length of Puwheke Beach. Excerpt from Appendix A.*

2.2.1 Site 1

This site is situated at the western end of Puwheke Beach, adjacent to the headland of Motutara Bay. The sediment in this area are fine sands and the intertidal zone is at a relatively low grade. The intertidal area during the low tide was observed to be approximately 60m wide. The upper shore in this area consisted of sand dunes within approximately 3-4m of the high water line.

***Site Photo 1**: Looking east from Site 1 towards Mt Puwheke. Photo taken 10 December 2020.*

***Site Photo 2**: Looking north from Site 1 towards the sea. Photo taken 10 December 2020.*

2.2.2 Site 2

This site consisted of fine sands. The intertidal area was at a moderate grade due to the presence of a berm in the upper intertidal zone. The observed width of the intertidal zone was approximately 50m. It was also noted that a deeper 'gutter' was present approximately 10m out into the subtidal zone.

***Site Photo 3**: Looking north from Site 2 towards the sea. Photo taken 10 December 2020.*

2.2.3 Site 3

Site 3 is located west of the point where the unnamed waterway discharges to the CMA. The site is comprised of fine sand sediment types. The intertidal zone was at a low grade and observed to be approximately 60m wide. During sampling, a distinct shell layer was encountered around the 40m transect line, approximately 50mm below the surface. A deep 'gutter' was observed in the subtidal zone.

***Site Photo 4**: Looking north from Site 3 towards the sea. Photo taken 10 December 2020.*

***Site Photo 5**: Distinct shell layer encountered around the 40m transect line, approximately 50mm below the surface. Photo taken 10 December 2020.*

2.2.4 Site 4

This site is located to the east of the point where the unnamed waterway discharges to the CMA. The sediments comprised of fine sands. The intertidal zone was at a low-moderate grade and was observed to be approximately 60m wide.

***Site Photo 6**: Looking east from Site 4 towards Mt. Puwheke. Photo taken 10 December 2020.*

2.2.5 Site 5

This site comprised of fine sands and had a moderate grade intertidal zone. The observed width was approximately 40m. At the time of the survey, the area had been driven over by a number of vehicles leaving deep tyre tracks on the intertidal zone. This site also had a shallow shell layer towards the swash zone. Immediately upshore of the high tide line was sand dunes.

***Site Photo 7**: Looking east from Site 5 towards Mt. Puwheke. Photo taken 11 December 2020.*

***Site Photo 8**: Looking north from Site 5 towards the sea. Photo taken 11 December 2020.*

2.2.6 Site 6

Site 6 comprised of fine sand and was observed to contain a shell layer within 20mm to 50mm of the surface. The intertidal zone was of moderate grade and observed to be approximately 40m wide.

***Site Photo 9**: Distinct shell layer encountered approximately 20mm to 50mm below the surface. Photo taken 11 December 2020.*

2.2.7 Site 7

Site 7 is located at the eastern end of the beach and was the closest site to the public vehicle entrance from Puwheke Road. The sediment comprised of fine sands and the intertidal zone is at a low grade. The width of the intertidal zone was observed to be approximately 50m wide. At the time of the survey, a number of vehicle tracks were observed in the intertidal zone.

***Site Photo 10**: Looking north-east from site 7; base of Mt.Puwheke to right. Photo taken 11 December 2020.*

3 Results

3.1 Tuatua Densities and Sizes

3.1.1 Intertidal

Over the survey sites, a single tuatua was found at Site 5 at the 50m quadrat and was 16mm in length (juvenile is <30mm).

3.1.2 Subtidal/Swash

The total number of tuatua collected at each of the seven transect sites ranged from 3 to 23 individuals. The tuatua collected by hand in the swash zone ranged in length from 33mm to 63mm with a mean of 50.7mm.

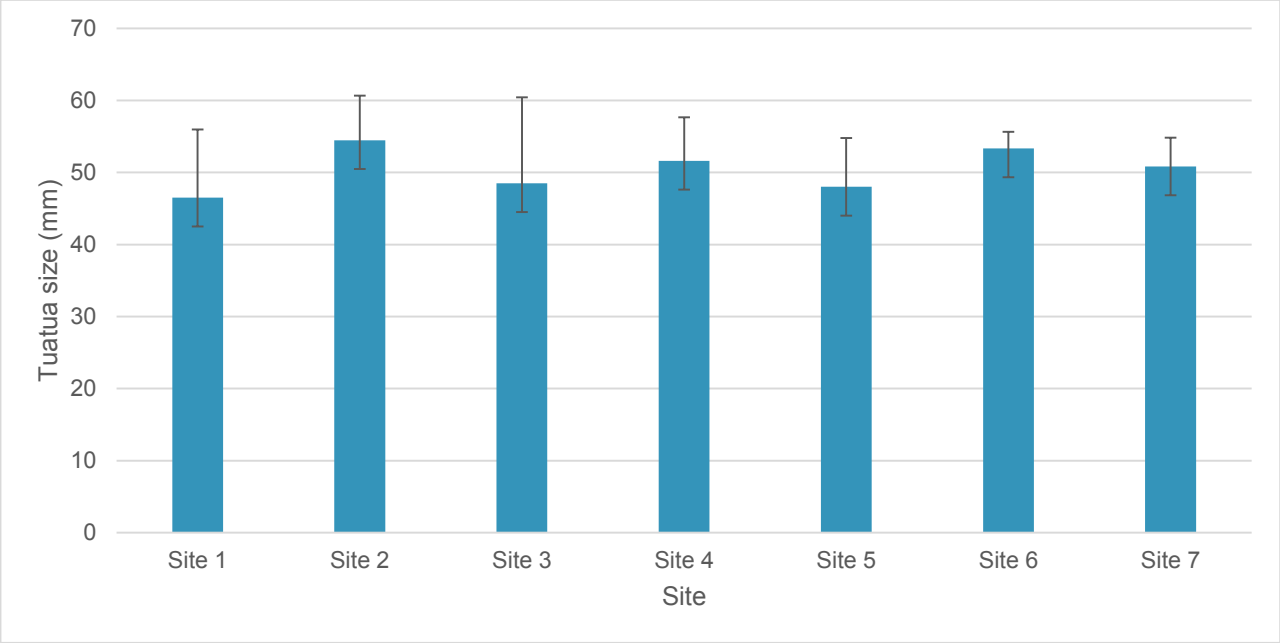

***Figure 4**: Average tuatua size and standard deviations at each subtidal site.*

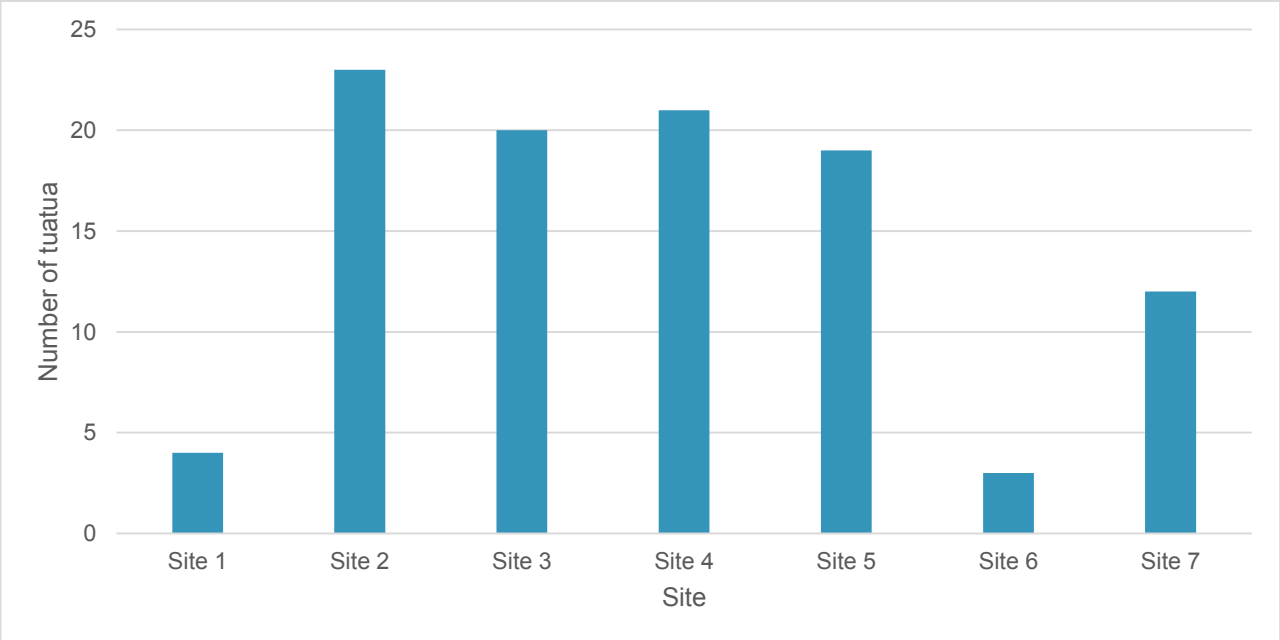

***Figure 5**: Number of individual tuatua across the seven sites.*

4 Discussion

A key finding of this study at Puwheke Beach was that only one juvenile tuatua (<30mm) was found. As tuatua are known to spawn twice a year, it would be expected that the smaller size classes would be present throughout the year. In addition, the author's observations on other beaches (e.g. 90 mile, Takao Bay) in Northland have found very high abundances of tuatua in the intertidal zone. As this was not observed, further understanding of the physical environment, population dynamics, and stressors is required.

4.1 Investigation into ecosystem dynamics

Further investigation into population dynamics for tuatua at Puwheke Beach would be required to determine if the absence of a juvenile population is of concern. The focus of this would be to determine if the natural environment is suitable for juvenile shellfish to be present.

Within ecological systems are source-sink dynamics; whereby a source population is self-supporting and leads to a surplus, whilst a sink population is within a habitat of lower quality which would lead to a deficit in population growth. If the source population is connected to the sink population this will maintain sink the population.

Understanding such dynamics for tuatua at Puwheke Beach is important to determine why individuals were found at larger size ranges only; for example, whether these individuals were relocated within ocean currents of neighbouring beaches. This is important from a conservation perspective, in order to identify where efforts are best focused and a common area of uncertainty (i.e. in establishing marine reserves).

The following matters are considered to require further investigation to help determine if the population at Puwheke Beach is self-supporting:

- Seasonal observations of larval settlement: As no smaller size classes were found and the sampling was undertaken soon after a spawning period, it may be possible that recruitment does occur but may not succeed (i.e. juveniles do not survive to adult stages).
- Seasonal monitoring: This will identify if recruitment is successful or if events are leading to unsuccessful recruitment of juveniles into the adult population.
- Survey of beaches up and down current of Puwheke Beach: This would establish if other tuatua populations are present and establish the demographics within those populations.
- Determine ocean nearshore currents: Determining the current patterns within the near and far shore is important to allow inference into dispersal patterns and identify where source populations may be present.
- Monitoring of anthropogenic effects: activities undertaken by humans can have detrimental effects on shellfish populations. Understanding these activities through observations to establish how these are occurring will help to identify possible effects and specific investigations.

4.2 Investigation of possible stressors

There are a number of stressors that can cause tuatua abundance to decline. These include over-harvesting, predation, desiccation, temperature change and chemical stressors.

Over-harvesting for tuatua would primarily relate to adult individuals so would not be expected to directly affect the juvenile population. Commercial harvesting is managed under the Quota Management

System (QMS). The Fisheries New Zealand Infosite for Tuatua East Northland (TUA1A), which includes Puwheke Beach, does not show any reported catch nor quota allocated. The recreational harvesting limit is 150 shellfish per day per person so consideration of this limit is important at popular locations.

With regard to chemical stressors, the inland area adjacent to Puwheke beach is predominantly rural grazed land, native forest and wetland. It is not expected this would have an impact on tuatua; however, some baseline water quality monitoring would help to confirm this.

Turning to anthropogenic effects, a number of studies in New Zealand have demonstrated that vehicles on beaches can adversely affect surf clams (see Taylor, 2013; Moller et al., 2014). Vehicle use within the intertidal zone was observed on Puwheke Beach and pictured within Site Photos 7 and 10 above.

Each of these studies seeks to identify the approximate proportion of juvenile shellfish population that are fatally injured, but acknowledge determining this is difficult due to population dynamics and the variability of human use. However, there are examples within these studies that demonstrate vehicle use causes direct mortality. For example, Moller et al. 2014 found that intertidal toheroa (*P. ventricosa*) on Oreti Beach had 4% morality when driven over by a vehicle or motorbike. Similar levels of mortality were found in Taylor 2013 for *P. donacina* on Pegasus Bay, Canterbury. Taylor, 2013 also identified that mortality rates reduced if vehicles followed existing tracks and that tracks spread across a beach surface would increase mortality.

Very busy periods on the beach can be very detrimental to populations if timed when juveniles are most vulnerable. For example, Moller et al. 2013 undertook a study following the Burt Munro Beach races and estimated a minimum mortality of 72% but up to 90% within the race track.

4.3 Other observations

Whilst undertaking the study, observations were recorded to understand the ecosystem that is present on the beach.

Sand dunes

The sand dunes at Puwheke Beach comprise of Pīngao (*Fincinia*) which is an important species for dune ecosystems in sand binding and stability. Native stands like this are in rapid decline as species such as marram grass have outcompeted on many beaches, but additionally vehicle traffic can be a problem. During the survey it was observed that vehicles would also enter the dune area and this evidenced within the satellite images near the vehicle entrance (see Figure 6)

Figure 6: Western end of Puwheke Beach showing vehicle tracks within the sand dunes.

Birds observed

Two pairs of northern New Zealand dotterels (At Risk – Recovering) were identified near to site 4 (outside the river mouth). These birds are known to be very vulnerable to vehicle impacts and predation due to nesting within the debris on sand beaches. Consideration of protection measures in the form of fencing off areas of beach or seasonal closures is suggested to protect the breeding pairs.

A single little blue penguin was also found on the beach towards the vehicle entrance to Puwheke Beach from Puwheke Road. This species conservation status is At Risk – Declining so protection measures are important. As little blue penguins may come ashore they can be vulnerable to vehicle traffic and human disturbance.

In addition, oyster catchers (*Haematopus unicolor*) which are Endemic, recovering, Southern black-backed gull (*Larus dominicanus*) which are Not Threatened and red-billed gulls (*Larus novaehollandiae*) which are Declining were observed.

5 Summary

The present study found a single juvenile tuatua on Puwheke Beach, Northland. Adult populations were found in the swash zone, though had patchy distribution. Further investigation is required to determine if this is due to the population dynamics of this population or if potential stressors are leading to a decline in the population. It was reported by Lucklaw Farms that a very high amount of gathering and traffic occurred on Puwheke Beach during the COVID19 lockdown which may have lead to a decline over this spawning season, but further observation and investigation would be required to definitively identify if this was a contributing factor. Other observations made also indicate that birds and the Pīngao dune system may be at risk of beach users without further consideration of management measures to control human use of Puwheke Beach.

6 References

Fisheries New Zealand. (2021). Fisheries Infosite; Tuatua East Northland (TUA1A). Retrieved from https://fs.fish.govt.nz/Doc/5670/TUA_07.pdf.ashx.

Grant, C.M. and Creese, R.G. (1995). The reproductive cycle of the tuatua-*Paphies subtriangulata* (Wood, 1828), in New Zealand. Journal of Shellfish Research, Vol 14(2). Pp 287-292.

Moller JA, Garden C, Moller SI, Beentjes M, Skerrett M, Scott D, Stirling FF, Moller JS, Moller H (2014). Impact of vehicles on recruitment of toheroa on Oreti Beach. Ecosystems Consultants Report 2014/2. [Online at: http://www.ecosystemsconsultants.co.nz/project/conserving-a-taonga-speciesand-recreation]

Taylor, G.F. (2013) Management of sand beaches for the protection of shellfish resources. PhD Thesis, University of Canterbury. 258p.

7 Limitations

This report has been prepared based on the scope agreed between Lucklaw Farms Limited and Taylor Collaborations Limited. Taylor Collaborations Limited take no liability for the use of this report by a third party.

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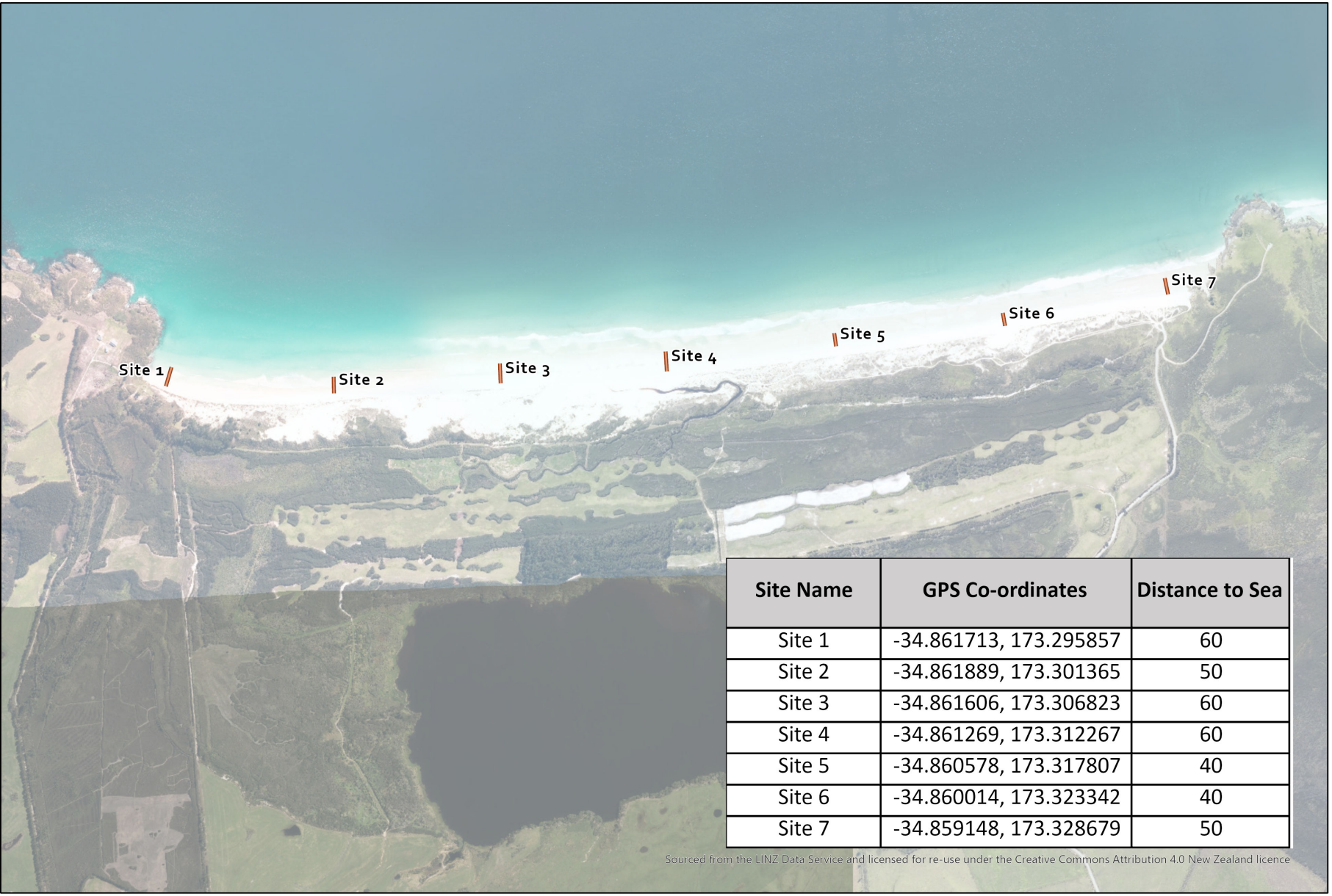
Appendix A – Map of Transect Locations



Site Name	GPS Co-ordinates	Distance to Sea
Site 1	-34.861713, 173.295857	60
Site 2	-34.861889, 173.301365	50
Site 3	-34.861606, 173.306823	60
Site 4	-34.861269, 173.312267	60
Site 5	-34.860578, 173.317807	40
Site 6	-34.860014, 173.323342	40
Site 7	-34.859148, 173.328679	50

Legend

Transect Site Locations

N

0 300 600 Metres

Puheke Beach Tuatua Survey

Transect site locations

Project:	Tuatua	Author	TN
Client:	Lucklaw	Date	Jan 2021
Ref:	001	Size	A3

Collaborations