

Muriwai Beach to Te Henga (Bethells) 2016 grey-faced petrel and little penguin survey

Todd J Landers

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Executive summary

Seabirds are the world's most threatened group of birds, primarily a result of deadly encounters 'at sea' with fisheries and 'on land' with invasive pest mammals. Additionally, the struggles to find available, suitable habitats compound the threat faced by seabirds.

The Auckland region is renowned as a seabird hotspot, with 27 breeding species in the greater Hauraki Gulf in particular. Most of these are 'threatened' or 'at risk' of extinction. Auckland Council, through provisions in the Auckland Plan and Indigenous Biodiversity Strategy, is implementing seabird management practices to improve their regional conservation status. Critical steps to implementing these practices are to establish a stocktake of where seabirds are in the region, an understanding of what their breeding success is, and what threats exist at breeding sites.

This report details the first comprehensive survey of grey-faced petrel, or ōi, *Pterodroma macroptera gouldi* (GFP) and little penguin, or kororā, *Eudyptula minor iredalei* (LP) on Auckland's west coast, the seabirds which are most likely to be breeding over the winter on Auckland's mainland. The survey was undertaken on the Constable Road local parkland (also known as the Muriwai Marginal Strip) and surrounding areas between Muriwai Beach and Te Henga (Bethells Beach). This area was chosen because of specific interest by Auckland Council's Biodiversity group to identify biodiversity values in this area to help identify and prioritise management actions, and also as there have been anecdotal observations of GFP and LP in this area.

Ground searches were conducted by seabird experts during daylight hours between April and November 2016 (12 days in total) when GFP and LP come ashore to breed. Five of these survey days used a trained seabird detection dog. All nests and seabird 'signs' (feathers, faeces, footprints, diggings, smells, strong dog response) encountered were noted, including any indication of pest animals and any other wildlife found.

A total of 97 GFP nest burrows were located: 17 confirmed with birds (14 were chicks), 51 with some activity (i.e. there was at least one seabird 'sign' such as feathers or diggings), and 29 burrows that were not active. The total GFP population in the survey area was observed to be at least 14 confirmed breeding pairs and up to 54 more breeding pairs which did not produce chicks.

Only 14 LP nests were found (0 chicks): six with adult birds, seven with some activity, and one with no activity. The population of LP is therefore likely to only be up to 14

breeding pairs (although further LP surveying is required for assessing additional areas as well as nest success).

Some pest animal (cat, possum, rabbit, rat) signs were found, as well as a variety of wildlife including seals, a heron, and six sightings of groups or single seabirds/shorebirds.

The survey identified several important GFP colonies, mostly situated at the northern (Muriwai) and southern (Te Henga) extremes of the survey area, with only some LP activity. Management recommendations are detailed within this report. Broadly, these include:

- Development of a long-term pest animal management programme at the three key seabird areas identified in the survey (Muriwai and southern bays, Kirikiri Bay and Te Henga);
- Establishment of productivity monitoring of all active nests found;
- Further surveying for LP using acoustic and night techniques along seashore, future surveying of other key seabird areas in the Waitākere Ranges (namely to the south of the study site);
- Supporting restoration activities in study area; and
- Running engagement and education campaigns for community and iwi members about seabirds in their areas and actions they can take to help improve the birds' conservation statuses.

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1.0 Introduction

Seabirds have the unfortunate title of being the world's most threatened group of birds (Croxall et al., 2012), highlighting their conservation importance and need for monitoring and management. New Zealand is internationally referred to as the 'seabird capital of the world' with almost a quarter of all seabirds breeding here (Gaskin and Rayner, 2013, Brooke, 2004). The Auckland region itself is well known as a seabird hotspot, with 27 species breeding in the greater Hauraki Gulf, the majority which are 'threatened' or 'at risk' species (Gaskin and Rayner, 2013). Most of Auckland's coastal areas are designated as 'Important Bird Areas', which are internationally recognised sites that are home to key species and are important for conservation (Forest & Bird, 2014).

Factors that are threatening seabirds' survival can be grouped into two major categories, those that occur 'at sea' while they forage or migrate over their nonbreeding season, and those 'on land' when they come ashore to breed (Croxall et al., 2012). They may be killed 'at sea' from interactions with fisheries; such as if they get hooked and drowned or if they crash into fishing gear ('gear strike') (Phillips et al., 2016). There are also other potential 'at sea' threats to seabirds, such as from ingesting marine pollution or from reductions in available prey to forage on (Wilcox et al., 2015). On land, seabirds are challenged by the loss of available nesting habitat, namely from coastal development, as well as the threat of being killed by invasive mammals (Moors and Atkinson, 1984). Our understanding of how these threats affect seabird population structures and breeding success is poor, which is a likely result of the challenge of studying these birds with their elusive life histories and often difficult to reach breeding colonies due to their terrains. It is fair to say that the most threatened bird group is possibly the least monitored compared to other bird groups.

Auckland Council's 30-year Auckland Plan Strategic Direction 7 states: "*Ensure no regional extinctions of indigenous species and a reduction in the number of 'threatened' or 'at risk' species from 2010 levels by 50% by 2040*" (Auckland Council, 2012b). Seabirds, with their low conservation status (i.e. threatened) in Auckland, are an important component of achieving this Direction, and of which a number of species have been prioritised for management as part of the Indigenous Biodiversity Strategy (Auckland Council, 2012a). One of Auckland Council's first seabird management goals, identified in this strategy, is to assess the status of their breeding populations in Auckland to identify where they are breeding, how successfully, and what threats exist at these sites.

The majority of known seabird breeding areas in Auckland are confined to invasive predator-free (e.g. cats, stoats, rats) islands in the Hauraki Gulf; however, the larger seabirds, such as grey-faced petrel *Pterodroma macroptera gouldi* (GFP) and little penguin *Eudyptula minor iredalei* (LP), are known to breed at several mainland areas on Auckland's coast (Gaskin and Rayner, 2013). In general, there have been very few recent seabird surveys conducted in the Auckland region, and less so on the mainland, where cryptic colonies may exist.

The Waitākere Ranges area is of particular interest for seabirds with its large intact coastal forest potentially providing favourable seabird breeding habitat. This area has a number of both historical and recent observations of GFP and LP breeding in this area, such as at Cornwallis, Whatipu, Piha, and Karekare (J. Russell, pers. comm., Greene et al., 2015, Cameron et al., 1995). Another key area is at Te Henga, a stronghold for GFP, with two colonies on adjacent islands Ihumoana (130 breeding pairs) and Kauwahaia (330 breeding pairs) (G. Taylor, pers. comm.). Recruitment to these populations from returning birds for their first breeding attempt could serve as a source for other GFP breeding areas along this coast. A number of areas to the south of Muriwai Beach have had a few active GFP burrows discovered in the last few years (M. Young and S. Borrelle, pers. comm.), as well as sporadic sightings of LP along this coast.

To my knowledge, no comprehensive seabird survey of the coastline between Muriwai and Te Henga beaches has been conducted, and hence this study set out to ascertain the presence/absence of the winter breeding seabirds, GFP and LP, in this area with a focus on the Constable Road local parkland (also known as the Muriwai Marginal Strip). In addition to the reasons above, this area was chosen because of specific interest by Auckland Council's Biodiversity group to identify biodiversity values in this area and any resulting management actions. All wildlife and pest animal signs encountered were also noted during the survey. This report describes the results of this survey, and includes recommendations for future management of seabirds in this area so as to help protect and enhance any populations located, and thus contribute to Auckland Council's strategic direction to improve the status of our indigenous biodiversity.

2.0 Methods

2.1 Study species

Grey-faced petrels are a medium-sized seabird (~550 g). These birds nest in burrows that tend to be found on headlands and peninsulas near the sea, in areas where there is malleable soil to allow them to dig their burrows (Taylor, 2013) (Figure 1). They are only found on land when breeding, which starts from as early as late March when they establish or re-establish their nest burrow (Taylor, 2013). They go to sea from mid-May for ~50 days (pre-laying exodus) after which they return to lay a single egg in late June or July, with their chick leaving the nest ('fledging') between December and January (Imber, 1976). Although GFP are not currently nationally 'threatened' or 'at risk', they are believed to be recovering in Auckland from past threats and pressures and thus are at some risk. Their major threats on land are from mammalian predators, namely cats (*Felis catus*), rats (*Rattus* spp.), and dogs (*Canis lupus*), and possibly mustelids (*Mustela* sp.) and feral pigs (*Sus scrofa*) (Taylor, 2000b).

Little penguin are the world's smallest penguin species (~1 kg), coming to shore to breed from as early as late April, and then laying one or two eggs any time from July until November, with the last chicks fledging by February (Flemming, 2013) (Figure 1). They are found on land along coastlines in dug out burrows (similar to GFP), in rock crevices, under fallen logs, under vegetation such as harakeke (*Phormium tenax*), or also under artificial structures such as stacks of timber, other building materials, or even under the structures themselves. They'll also breed in artificial nest boxes (Note: 26 boxes were installed in the Muriwai area of the survey in late 2015). They are a declining 'at risk' species with their major threats on land from predation by introduced predators such as cats, dogs and mustelids (namely ferrets – *Mustela putorius*), and potentially feral pigs and livestock (Taylor, 2000b, Dann, 1994).



Figure 1: Study species for survey: a) grey-faced petrel in nest burrow; b) grey-faced adult; c) little penguin adult in nest; d) little penguin adult with two chicks.

2.2 Study area

The study area included coastal areas from the southern end of Muriwai Beach south to the northern end of Te Henga (Bethells Beach) just east of Ihumoana Island, totalling approximately 12km of coastline (Figure 2). This included the coastal side of the Constable Road local parkland which encompassed about a 70ha narrow strip, where the popular Te Henga Walkway crosses. Areas which were accessible by foot and deemed safe were surveyed, which generally equated to most sites at Otakamiro Point, Maukatia (Māori) Bay, Collins Bay, Pillow Lava Bay, Tirikohua Point, Kirikiri Bay, Raetahinga Point, and O'Neill Bay.

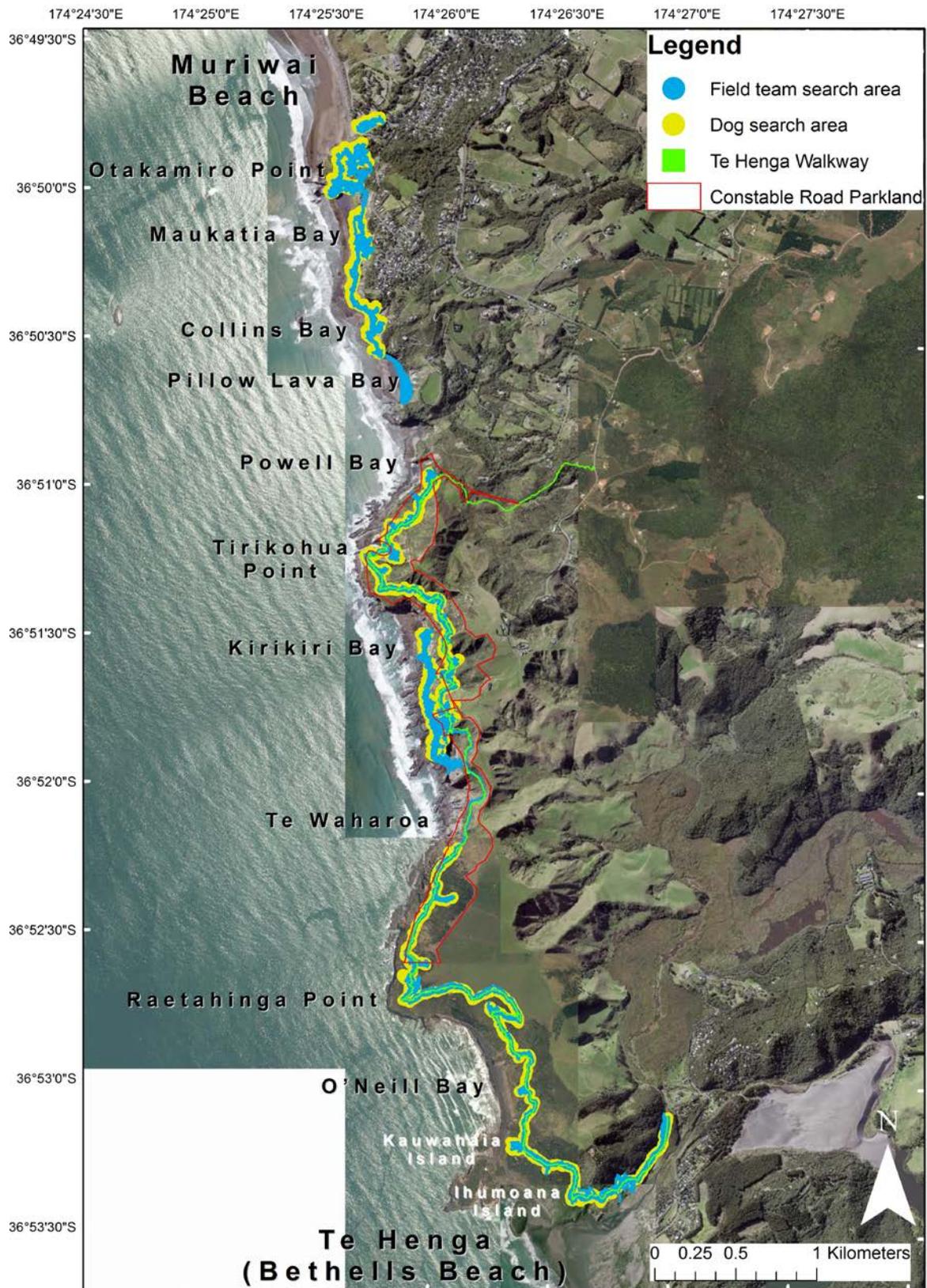


Figure 2: Study area along the coast between Muriwai Beach and Te Henga (Bethells Beach), showing areas searched with field teams and seabird detection dog.

The area surveyed contains a variety of land types (assessed through aerials and previous vegetation surveys): along the shoreline are sandy and rocky beaches where LP may choose to roost or nest; further inland are coastal cliffs, with a variety of vegetation types dominated by harakeke, mānuka (*Leptospermum scoparium*, kahikatoa), coastal toetoe (*Cortaderia splendens*), with some cabbage trees (*Cordyline australis*, tī kōuka), hangehange (*Geniostoma ligustrifolium*), and kawakawa (*Piper excelsum*), which may provide habitat for GFP and LP; there are a few older forest patches dominated by pohutukawa which are promising GFP habitat; large parts of the terrestrial coastal margin are dominated by dense gorse and rank grassland, however these are unlikely to contain many seabirds (Taylor, 2013, Flemming, 2013) (Figure 3).



Figure 3: Example habitat types in study area – a and b are high quality habitat for penguins and grey-faced petrel, whereas c is lower quality: a) sandy and rocky beaches leading up to coastal cliffs containing a variety of vegetation types dominated by harakeke, manuka, coastal toetoe, with some cabbage trees, hangehange and kawakawa; b) older forest patches dominated by pohutukawa; c) gorse and rank grassland.

2.3 Survey method

Ground searches were conducted along the study site during daylight hours at several times over the GFP and LP breeding seasons in 2016 (Table 1), with a focus on two general time periods: April to mid-May when GFP and LP return to land to establish nests, and August to early September when GFP are on eggs or have young chicks, and LP are laying eggs. A total of 12 survey days were completed, most with a minimum of two experienced seabird biologists present. A pre-survey was conducted on the first day (6 April 2016) along the full Te Henga track to identify all potential seabird habitats. Once identified, it was where the future survey work was then prioritised.

With the large area and difficult terrain to traverse, a trained seabird detection dog, Rua – handled by Joanna Sim (DabChickNZ) (Figure 4), was used for five of the survey days to increase the chance of locating seabird areas (Figure 2). Rua not only increased the range of detection with his highly sensitive trained nose, but also was able to access more areas which were deemed not safe for people to access.

All ‘signs’ of GFP and LP were noted, which included the presence of GFP and LP feathers, faeces (LP tend to have lots of faeces at their nest entrances compared to GFP), footprints, diggings at a burrow entrance, seabird odours (GFP tend to have a musky smell whereas LP have a much stronger unpleasant smell), and Rua gave a strong response which the dog handler would validate (Figure 5). All nests encountered were classified as ‘active’ if a bird was confirmed as present (either physically sighted, movement detected using a stick to search nest, or vocalisations heard), ‘some activity’ if at least one of the above ‘signs’ were found, or ‘non-active’ if no ‘signs’ were detected. It was also noted when seabird ‘signs’ were found at locations where a nest was not detected (e.g. roost site), as well as the presence of other wildlife and pest animal ‘signs’.

Table 1: Details of seabird survey dates, seabird expertise present, days seabird detection dog used and the areas surveyed.

Date	Number of seabird experts	Seabird dog survey	Area surveyed
6/04/16	2	No	Habitat survey of areas surrounding Te Henga walkway
25/04/16	4	Yes	Southern Te Henga walkway (O'Neill Bay north to Te Waharoa)
26/04/16	5	Yes	Northern Te Henga walkway (Powell Bay south to Kirikiri Bay)
3/05/16	3	No	Southern Muriwai Beach south Powell Bay
8/05/16	2	No	Kirikiri Bay, Te Waharoa
10/05/16	1	No	Otakamiro Point and surrounding areas
14/05/16	2	No	Southern Muriwai Beach (toilet block dune)
17/08/16	3	No	Northern Te Henga, O'Neill Bay
8/09/16	2	Yes	Otakamiro Point, southern Muriwai Beach (toilet block dune)
9/09/16	2	Yes	Kirikiri Bay, Te Waharoa, Maukatia Bay
10/09/16	2	Yes	Maukatia Bay, Collins Bay, Pillow Lava Bay
1/11/16	1	No	Otakamiro Point and surrounding areas



Figure 4: Trained seabird detection dog Rua used for five days of the survey.



Figure 5: Examples of seabird 'signs' of grey-faced petrel and little penguin which were noted during the survey: a) feathers, b) faeces, c) footprints, d) diggings.

3.0 Results

3.1 Seabirds

3.1.1 Grey-faced petrel

A total of 97 GFP nest burrows were located in the study area, with the majority found on Otakamiro Point at Muriwai Beach (Figure 6, Figure 7, Figure 8 and Table 2). Of all the GFP burrows found, 17 were classified as 'active', 51 as 'some activity', and 29 as 'non-active'. We were able to confirm that 14 of the 17 'active' burrows had chicks in them. There were also two other locations between Kirikiri Bay and Te Waharoa which had GFP 'signs' (Figure 5) but no burrow was located.

Between southern Muriwai Beach south to Collins Bay there were 73 burrows located, nine which were 'active' of which seven had 'chicks' in them, another 38 which were classified as having 'some activity', and 26 which were 'non-active'. Between Kirikiri Bay and northern Te Waharoa there was one burrow located with a chick in it and two sites which showed 'petrel signs'. In the Te Henga area there were 22 burrows located, six which had chicks in them, another 12 which were classified as having 'some activity', and three which were 'non-active'.

Burrows were located in a variety of substrate types including hard-packed soil away from vegetation, soft sand, under tree trunks and roots (usually pohutukawa), and dry, rocky soils (Figure 9). There were also a number of areas found which had no burrows or 'signs', or which were too dangerous to access, but which contained potential GFP habitat (blue 'Xs' in Figure 6, Figure 7 and Figure 8).

3.1.2 Little penguin

Fourteen LP nests were found in the study area, of which six were classified as 'active', seven as 'some activity', and one as 'non-active' (Figure 6, Figure 7 and Figure 8). No LP chicks were found during the survey. There were also six locations which had LP 'signs' (Figure 5) but no nests were located.

The majority of nests were found under harakeke or under rocks along the shoreline (Figure 9). There were a number of areas along the shoreline and surrounding coastal hills and cliffs which we were unable to find LP nests or 'signs', or which were too dangerous to access, but which contained potential penguin habitat (blue 'Xs' in Figure 6, Figure 7 and Figure 8).

Table 2: Results summary of seabird burrows/nests and signs (i.e. feathers, faeces, footprints, diggings, odour) encountered during the survey.

	Area	# burrows/nests	# chicks/ # active burrows	# with some activity	# non-active burrows/nests		Seabird signs
Grey-faced petrel	North	73	7/9	38	26		0
	Central	2	1/1	1	0		2
	South	22	6/7	12	3		0
	TOTAL:	97	14/17	51	29		2
Little penguin	North	10	0/5	4	1		2
	Central	4	0/1	3	0		3
	South	0	0/0	0	0		1
	TOTAL:	14	0/6	7	1		6

3.2 Pest animals

Sixteen pest animal signs were found during the survey which included cat tracks, three possum (*Trichosurus vulpecula*) signs (faeces, tracks and a live possum), five areas with rabbit faeces (two at burrow entrances), and five rat signs (four with faeces and one live rat) (Figure 6, Figure 7 and Figure 8).

3.3 Other wildlife

A variety of coastal wildlife was encountered during the surveys, including New Zealand fur seal (*Arctocephalus forsteri*, kekeno), pied shag (*Phalacrocorax varius*, kāruhiruhi), southern black-backed gull (*Larus dominicanus*, karoro), red-billed gull (*Larus novaehollandiae*, tarāpunga), variable oystercatcher (*Haematopus unicolor*, tōrea pango), white-faced heron (*Egretta novaehollandiae*, matuku moana), caspian tern (*Hydroprogne caspia*), and pied stilt (*Haematopus unicolor*, poaka) (Figure 6, Figure 7, Figure 8, Figure 10 and Table 3). There are also two well-known seabird colonies within the study area on Otakamiro Point: Australasian gannet (*Morus serrator*, tākapu), white-fronted tern (*Sterna striata*, tara).

Table 3: Details of wildlife encountered during study.

Date	Species	Location	Observation
3/05/16	pieb shag	Collins Bay	18 pieb shags roosting on beach
3/05/16	pieb shag	Pillow Lava Bay	12 pieb shags
3/05/16	shorebirds	Pillow Lava Bay	1 caspian tern, 12 pieb shags, 15 pieb stilts
8/05/16	shorebirds	Kirikiri Bay	5 pieb shags, 1 variable oystercatcher pair, 2 white-faced herons, 2 southern black-backed gulls
8/05/16	pieb shag	Kirikiri Bay	10 pieb shags roosting on sand and rocks
9/09/16	variable oystercatcher	Kirikiri Bay	4 variable oystercatchers
9/09/16	shorebirds	Kirikiri Bay	1 southern black backed gull, 2 red-billed gulls, 2 variable oystercatchers
9/09/16	New Zealand fur seal	Kirikiri Bay	1 New Zealand fur seal under rocks
10/09/16	shorebirds	Collins Bay	2 variable oystercatchers, 2 southern black-backed gulls, 1 pieb shag
10/09/16	New Zealand fur seal	Collins Bay	1 New Zealand fur seal on rocks
10/05/16	pieb shag	Otakamiro Point	pieb shag roost

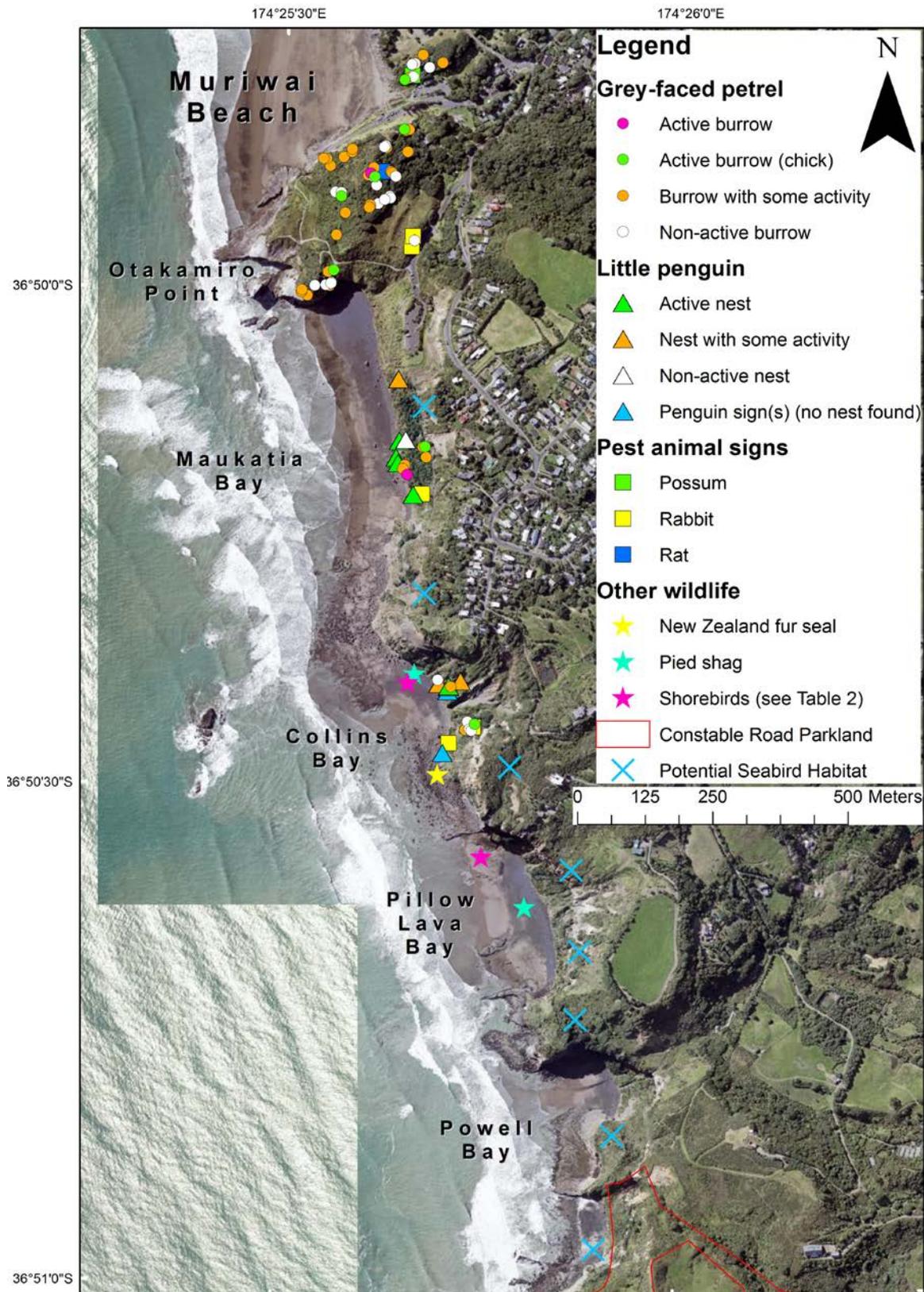


Figure 6: Northern third of survey area showing location of all grey-faced petrel and little penguin 'signs' of activity (Figure 5), pest animal 'signs', and other wildlife encountered (Table 3). 'Potential seabird habitat' are promising areas which need further searching (seabird detection dog/acoustic/night surveys).

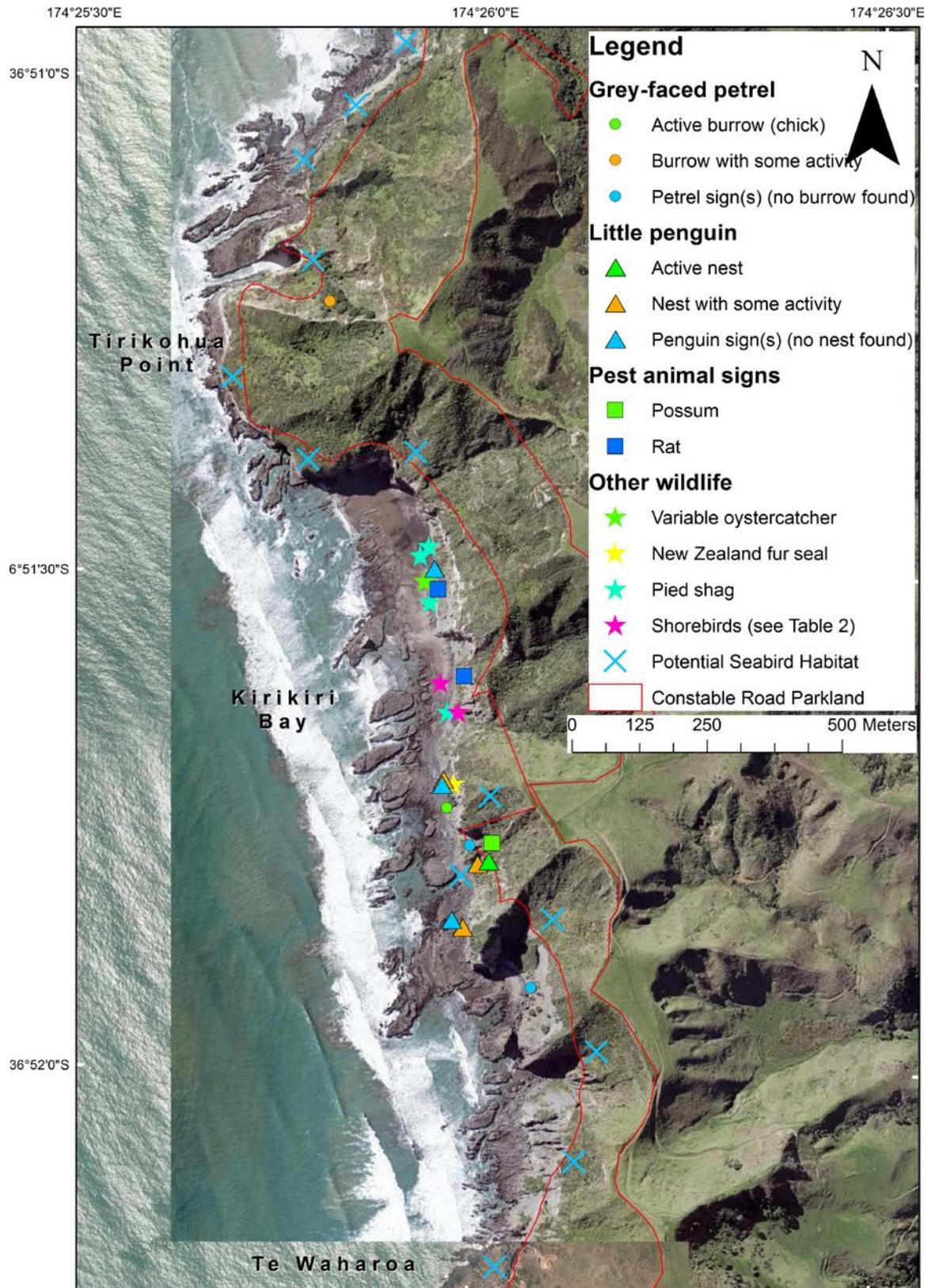


Figure 7: Central third of survey area showing location of all grey-faced petrel and little penguin 'signs' of activity (Figure 5), pest animal 'signs', and other wildlife encountered (Table 3). 'Potential seabird habitat' are promising areas which need further searching (seabird detection dog/acoustic/night surveys).

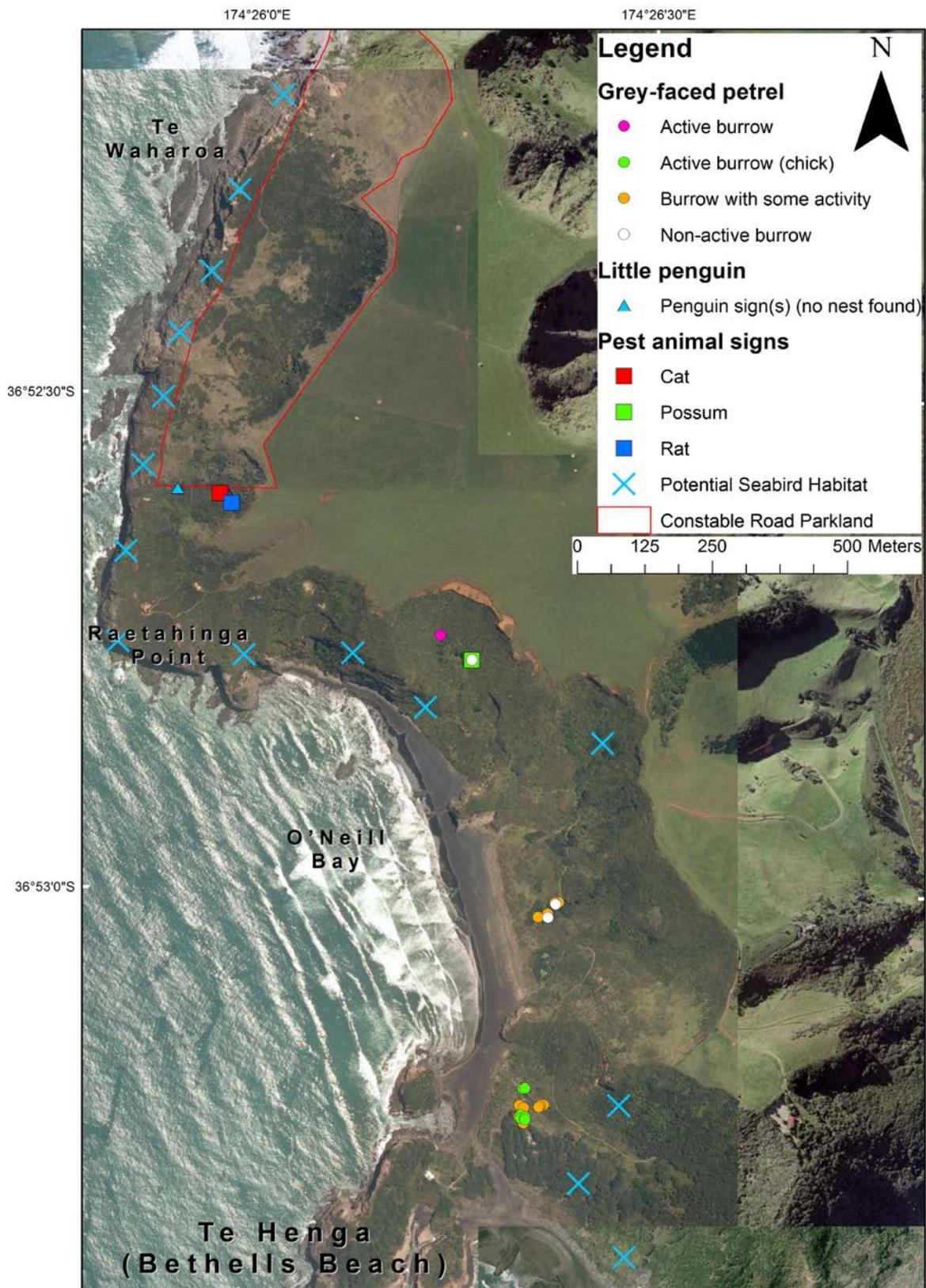


Figure 8: Southern third of survey area showing location of all grey-faced petrel and little penguin 'signs' of activity (Figure 5), pest animal 'signs', and other wildlife encountered (Table 3). 'Potential seabird habitat' are promising areas which need further searching (seabird detection dog/acoustic/night surveys).



Figure 9: Example nest types located in survey. Grey-faced petrel: a) hard-packed soil, b) soft sand (usually with pohutukawa tree roots), c) under pohutukawa trunk or roots, d) dry, rocky soil (rare). Little penguin: e) under harakeke, f) rock crevice.



Figure 10: Other wildlife found during survey: a) New Zealand fur seal (kekeno; *Arctocephalus forsteri*), b) Pied shags (kāruhiruhi, *Phalacrocorax varius*), c) Pied stilts (poaka, *Himantopus himantopus*), d) Variable oystercatcher (tōrea pango, *Haematopus unicolor*).

4.0 Discussion

4.1 Grey-faced petrel

The majority of the 97 GFP burrows found were in two general locations at the latitudinal extremes of the study area: Otakamiro Point and O'Neil Bay. The distribution of burrows may represent the historical presence of GFP on this stretch of coast; however, there are no published historical records to confirm this. These two areas have the largest forest fragments remaining in the survey area, which provide suitable soil that the birds can easily dig burrows into. There has also been some pest animal management occurring in these areas by community groups (over the last few years) and Auckland Council at Otakamiro Point (for over 10 years) which would likely have been helping to protect these colonies.

The majority of the 97 GFP burrows showed 'some activity' which indicates that birds are prospecting and visiting these locations, but do not appear to be successfully breeding as only 14 burrows were confirmed to have chicks in them. This low breeding productivity is most likely the result of high pest animal incursions taking place at nest sites (see 'Pest animals' below), either causing birds to abandon their nest or birds failing to breed from pests killing the offspring and/or parent birds. In the northern area of the survey, seven out of the 73 burrows located (9%) had chicks in comparison to the southern area at O'Neill Bay which had six chicks in the 22 burrows located (32%). This may reflect the different pest animal densities, with the Muriwai area likely to have a lot more domestic cats with its larger and closer residential housing network.

Another factor that may affect these results is the nest chamber of the northern burrows tended to be more difficult to access, making it difficult for the surveyors to confirm the presence of chicks (even when using a burrow scope). Northern burrows were often under Pohutukawa trees with deep and challenging burrow tunnel angles in contrast to the O'Neil Bay colony which were in more sandy soil and tunnels were less complex.

Burrow locations varied across the study area, both in terms of general location characteristics as well as specifics of the substrate (Figure 9). There was a general trend of GFP burrows being associated with pohutukawa forested areas with canopy cover. Burrow entrances tended to go beneath pohutukawa roots. This is likely to be because the forest and associated tree roots provide stability for burrowing in the dune system, which characteristically have relatively fragile/erodible soils. Why a seabird selects a particular place for its nest has not been the focus of much research, however this is currently being investigated in a GFP habitat modelling

study in the Waitākere Ranges (University of Auckland/Auckland Council) analysing features of burrows (e.g. slope, elevation, vegetation) to help predict which areas may be favoured by GFP and thus prioritise future areas to search for GFP burrows. In particular, forest canopy cover appears to be a likely predictor of burrow location, albeit not in all cases as shown in the O'Neill Bay colony where burrows are in more open, sandy soils.

Compared to other land uses, there is relatively a high abundance of retired coastal farmland in the study area, particularly in the southern half. This appears to be unfavourable GFP habitat based on our lack of finding burrows in the rank grass areas in this study. We can infer that before the coastal forest was cleared for farming that GFP would likely have had a greater presence all along this coast. There are a number of sites with small stands of forest or scrub remaining which we identified as potential seabird habitat which are worth reinvestigating in future surveys (blue 'Xs' in Figure 6, Figure 7 and Figure 8), however there were only two fragments in the central and southern coast sections which had GFP burrows with 'some activity'.

This study has identified that only three small populations of GFP exist in the study area: Northern area at Muriwai (7 chicks/breeding pairs + up to another 40 breeding pairs), Central area at Kirikiri Bay (1 chick/breeding pair), and Southern area at Te Henga (6 chicks/breeding pairs + up to another 13 breeding pairs). This equates to a total GFP population in the survey area of at least 14 confirmed breeding pairs with up to 54 more breeding pairs (all which failed to produce chicks). Although this is a relatively small number of GFP, this area stands as an opportunity for conservation management to protect and enhance these 3 GFP colonies. It is likely to be easier to attract birds to natural colonies in contrast to trying to re-establish a new colony from scratch as calling birds from their nest burrows may attract prospecting birds flying along this coast.

4.2 Little penguin

There were relatively few LP nests (14) and 'signs' (six) encountered in this study. There was no apparent locational bias in these sightings, except perhaps that only one LP observation was found in the southern third of the study area. With the small sample size of LP encountered in this study it is challenging to make robust inferences about the distribution of LP in the study area, except that it appears that there is a small LP population of up to 14 breeding pairs; however, as this survey was conducted well before the end of the LP breeding season (up to February), it

was not possible to confirm breeding status for these 14 nests. Follow up monitoring is necessary to assess an accurate number of breeding pairs in the survey area.

The small population size of LP found in this survey is somewhat supported by the initial data from the 26 penguin nest boxes installed in the northern part of the study area, with no LP taking up residence in 2016 (M. Fitchett, pers. comm.). These boxes were only in their first full season, and hence it may be too early to use these data to infer any LP population insights. Note also that there are several areas along the shore (Te Waharoa south, Pillow Lava and Powell Bays) we were unable to survey with the seabird detection dog due to difficulty accessing (e.g. boat required) which could be productive LP areas, and hence these should be surveyed in the future.

If indications of the survey are correct and LP are in low numbers between Te Henga and Muriwai Beach, this may be a result of the likely high number of pest animals in these areas, namely cats and potentially dogs (see 'Pest animals' below). A useful survey technique to get a rough estimate of penguin numbers is by undertaking dusk observations at beach areas to count how many birds come ashore (Dann, 1991, Giling et al., 2008, Cannell et al., 2011). We were unable to undertake this survey methodology in this study due to resource constraints and potential health and safety challenges. Night camera traps could also be used in the future to gather penguin visitation data. These surveys would help identify the quantity of LP that are prospecting in a particular area, and thus aid in elucidating what may be restricting their establishment on this coast. More penguin nest boxes may be worth installing along this coast, particularly in the difficult to reach areas, as they are a useful survey tool and also provide shelter for the penguins.

4.3 Pest animals

Although this study was not designed to survey pest animals, we did encounter a number of invasive mammal sightings which included a cat, possums, rats and rabbits. Given the location next to residential homes as well as rural land, there are likely to be a high presence of pest animals in the study area, and hence our observations are most certainly an under representation of the pest situation. With the exception of possums (which do potentially affect breeding habitat indirectly with their removal of forest), the pest animal sightings we encountered are all known to affect seabirds (Taylor, 2000b, Taylor, 2000a).

Only one cat was detected just north of O'Neill Bay, but others have also been detected at the northern end of the survey by local community group MEACT (Muriwai Environmental Action Community Trust) which have monitored some GFP

burrows with camera traps. Feral cats, and potentially domestic cats, are a serious threat for GFP, as they are known to kill both adults and chicks when they leave their nest burrows (Taylor 2000a, 2013, G. Taylor, pers. comm.). Little penguin may also be affected by cats, however dogs are more likely to be an issue (Flemming, 2013). Dogs are currently prohibited at the southern end of Muriwai Beach, Otakamiro Point, Maukatia Bay, and along the Te Henga track. Personal observations suggest that despite the ban, dogs are known to enter these areas. There are also areas where GFP burrows are situated that are close to recreational facilities where dogs frequent.

Rats and possum signs were detected in the three main areas of the study area as depicted in Figure 6, Figure 7 and Figure 8. Rats are a serious threat for many seabirds, including GFP as they may prey on eggs (July/August) or kill young chicks (August/September) (Imber et al., 2000, Imber, 1976). Once the chicks reach a large enough stage at about six weeks they are most likely able to defend themselves from rat incursions (Imber, 1976).

Rabbit signs were detected only in the northern third of the study site from Collins Bay to Otakamiro Point (Figure 6). There have been a number of reports from Muriwai community members that rabbit numbers have been very high recently (A. Brockie, pers. comm.), and hence Auckland Council has recently been instigating rabbit control in the northern third of the study area. Rabbits have been reported to compete for habitat with other seabird species (Imber et al., 2000, Brodier et al., 2011), and hence it is feasible that rabbits are affecting GFP, and possibly LP.

Although not detected in this study, mustelids are a problem for a number of seabirds, and in particular ferrets are known to affect LP breeding success (Taylor, 2000b, Taylor, 2000a). Grey-faced petrel may very well also be affected by ferrets, and possibly stoats; however, this is an area needing more study.

4.4 Other wildlife

All wildlife sightings encountered over the study were New Zealand native species, including four 'threatened' or 'at risk' birds. Wildlife sightings were all in the northern two thirds of the study area from Kirikiri Bay to Maukatia Bay. At Kirikiri Bay a New Zealand fur seal was resting under rocks (Figure 10a), and as well there were a number of shorebirds found mostly on the northern end of this Bay, including a group of a dozen pied shag. The northern area of the study site is another productive wildlife location with eight different shorebirds species encountered as well as

another New Zealand fur seal (Table 3). This stretch of coast appears to be an important area for coastal wildlife.

4.5 Recommendations

4.5.1 Pest animal management

1. Develop and maintain long-term pest animal management programme based on the timings presented in Table 4 (in consultation with Auckland Council's Biosecurity, Parks and RIMU departments, and current community led pest management work – Note: a useful guide to help develop a pest framework is DOC's Operational Planning for Animal Pest Operations (Department of Conservation, 2016)), and which includes:
 - Outcome monitoring, along active seabird areas at northern and southern ends of the study area;
 - A focus on cats, rats, mustelids, rabbits, and dogs;
 - Kirikiri Bay pest management. Although only one burrow was found at Kirikiri Bay, a difficult location to reach, it is recommended that pest management also be explored in this area.

Table 4: Recommended pest management and timing for grey-faced petrel (GFP) and little penguin (LP).

Timing	Seabird event	Rats	Cats	Mustelids	Rabbit	Dogs
late Mar-Apr	GFP return		X		X	
May	GFP pre-laying exodus, LP return		X	X		X
Jun-Jul	GFP eggs, LP return	X	X	X	X	X
Aug-Sep	GFP chicks, LP eggs	X	X	X	X	X
Oct	GFP chicks, LP eggs		X	X	X	X
Nov	GFP chicks, LP eggs		X	X	X	X
Dec-Jan	GFP fledge		X	X		X
Jan-Feb	LP fledge		X	X		X

2. Continue and further support studies improving our understanding of pest animal interactions with GFP and LP (Note: GFP pest animal interactions

camera monitoring study currently occurring at Muriwai Beach – University of Auckland/Auckland Council).

3. Investigate (in partnership with Auckland Council Parks) the effectiveness of dog bans at Muriwai Beach and along the Te Henga track. Dog bans should include the northern most area of this survey (to north of Muriwai Beach toilet block).

4.5.2 Future seabird surveying and monitoring

1. Monitor all active (and any new) GFP and LP nests each year to establish productivity rates for the survey area (Note: Auckland Council/University of Auckland/DOC currently establishing productivity monitoring of these burrows);
2. Survey with seabird detection dog areas missed at Pillow Lava, Powell Bay and Te Waharoa south;
3. Trial seabird acoustic monitoring at sites within this survey area which were too difficult to reach (e.g. coastal cliffs south of Kirikiri Bay);
4. Conduct visual and 'camera trap' night surveys along accessible coast to ascertain the level of LP visiting this coast;
5. Replicate this study within five years (post pest management implementation as recommended above);
6. Establish future studies in greater Waitākere Ranges, focussing on areas south of this study (i.e. near Ihumoana Island GFP source), areas identified as suitable seabird habitat (Note: current GFP habitat modelling study occurring which will identify priority areas – University of Auckland/Auckland Council), and other areas known (including anecdotal observations) to have GFP or LP visiting (e.g. Piha).

4.5.3 Seabird restoration and enhancement

1. Support community groups (namely those at Te Henga and MEACT) and Auckland Council (i.e. Parks) who are actively restoring and managing areas in the study area.

Ultimately if management is reducing pest numbers to negligible levels and seabird habitat is being restored via removal of weeds with supplemental planting

of key native species to re-establish closed canopy forest, seabirds should continue to thrive and expand their mainland populations.

2. Do not establish active seabird enhancement (e.g. acoustic seabird calling systems, translocations) until pest numbers are negligible.

Active seabird enhancement will become a more viable option in the near future when programmes such as Pest Free Auckland and MEACT's Pest Free Muriwai have shown a strong record over several years of negligible pest animals in this area, at which time active enhancement could be explored (e.g. acoustic attraction systems, artificial burrows).

4.5.4 Public seabird education

1. Establish public campaign to engage with and educate local community and iwi about the seabirds in their neighbourhood and surrounding areas, including:
 - The above threats discussed;
 - How community members can help reduce these (e.g. pest control, dog control, habitat restoration).

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