Survey of New Zealand sea lion pups at Port Pegasus, Stewart Island

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Abstract

There has been increasing interest and investment into the studying the breeding of New Zealand sea lions (sea lions) on Stewart Island/Rakiura since they were reported breeding there in 2010. A number of pups have been tagged each March since 2011 A pilot survey was undertaken in January 2016 to determine if sea lion pups could be monitored at this time of the year in order to be comparable to pup counts carried out at other breeding sites, such as at the Auckland Islands. A survey team searched a minimum of 126.3 km of coastline, and 114.3 km on land within Port Pegasus from 21 January to 1 February 2016. Three pups were found, two of which were travelling at sea with their mothers. The pilot study alongside with the results of the annual March surveys suggests that the sea lion females are moving their pups between locations or to new locations early in the breeding season. One hypothesis is that birth may occur outside the current Port Pegasus search area but then the female/pup pair move there in February and March. During the 2016 pilot survey samples were collected from faeces and soil to screen for the presence of *Klebsiella pneumoniae* in the environment. These samples will be analysed and reported on separately when results are available. The results from this pilot survey will help to inform decisions on future monitoring, research priorities, and management actions for the Stewart Island subpopulation through the New Zealand sea lion Threat Management Plan process.

Introduction

New Zealand sea lions currently breed at four known locations. Approximately 70% of breeding occurs at the Auckland Islands and around 29% on Campbell Island. The other two breeding locations support a small number of sea lions, Stewart Island (ca. 30 pups) and the Otago coast (ca. 10 pups). The need to protect and support the growth of these smaller breeding sites is considered important in order to contribute to the overall recovery of the species.

On the Auckland Islands peak sea lion pupping typically occurs in January. Annual pup counts on the Auckland Islands have been undertaken in January to coincide with this peak. Little is known about the Stewart Island breeding site aside from a series of annual pup tagging surveys which have taken place in March since 2011. These surveys demonstrated that breeding on Stewart Island is isolated (i.e. not colonial). This makes it more difficult to find and count the pups. The annual March surveys maximised the chance of finding pups as they are larger, more mobile and congregated closer to shore. However, the timing does not allow comparison with other mark recapture pup counts collected in January, and also results in a loss of information on the first two months of life, a period thought to be criticial because pup mortality is generally highest in this period.

As a reslt of these two issues a pilot study was conducted jointly by the Department of Conservation (DOC) and the Ministry for Primary Industries (MPI) to investigate the potential for monitoring the population on Stewart Island at the same time as counts on the Auckland and Campbell Islands are conducted.

An additional element of the pilot study was to test the utility of thermal imaging cameras to as an aid for finding sea lions, so improving upon survey efficacy.

Disease caused by the bacterium *Klebsiella pneumoniae* has had a considerable impact on pup mortality at other locations, primarily the Auckland Islands, where it killed at least 33% of pups during disease outbreaks in 2002 and 21% of pups in 2003 (Wilkinson et al 2006). More extensive analysis of the causes of pup mortality since 2010, have indicated that *Klebsiella*-associated mortality rates are likely higher than had previously been believed (Childerhouse et al 2014; Childerhouse et al 2015). Recently, the highly virulent strain has been found on the South Island, where it was associated with the death of an Otago-born pup in early 2013. It is unknown if this highly-virulent *Klebsiella pneumoniae* is present on Stewart Island. *Klebsiella pneumoniae* has had a significant impact on pups at the Auckland Islands, and has the potential to spread to other breeding sites. Due to its high virulance, *Klebsiella pneumoniae* sampling is being undertaken in other sea lion populations.

In January 2016 a pilot study was undertaken on Stewart Island. The objectives of this pilot were to:

1. Determine the feasibility of monitoring pup production in January, concurrent with the monitoring of other colonies;
2. Test the feasibility of using thermal technology to locate sea lion pups;
3. Screen for *Klebsiella pnuemoniae;* and
4. Determine the cause of death for Stewart Island pups.

Information from the pilot study, and from other relevant sources, will contribute to the overall New Zealand sea lion Threat Management Plan process being run jointly by DOC and MPI. This information will aid in the development of final advice being presented to Ministers in the latter half of 2016, specifically on what a monitoring programme for Stewart Island might look like, research priorities, and potential management actions.

Methods

Study area

The survey was carried out from 21 January 2016 to 1 February 2016. The yacht *Tiama* was used as a base. The *Tiama*'s rigid inflatable boat (RIB) was used to land at sites within the study area. Following safety briefings and planned radio scheduled check-ins, searching was undertaken between the hours of 0830-1900. The study area covered was the coastal forest of Port Pegasus/Pikihatiti in southeast Stewart Island/Rakiura (Figure 1). Port Pegasus is made up of numerous inlets and large bays sheltered primarily by the larger Pearl, Anchorage and Noble Islands. The region provides approximately 125 km of rocky coastline with some sandy beaches. Many of the inlets also enclose small islands. The land is part of Rakiura National Park and hunting is permitted in two blocks, North Pegasus and South Pegasus. The bush was dense and the search area included three main forest types:

1. Interior forest of Kamahi-Rimu-Rata which typically had a fairly open ground storey and thickets of *Coprosma foetidissima* and supplejack.
2. Coastal forest of twisted rata with dense ground cover of astelia, flax, and ferns.
3. Coastal scrub of Dracophyllum and leatherwood.

Some hunters' tracks exist; however, they are minimal and not always well defined.

Maps from previous March tagging trips were used to refine the overall search area. In addition, coarse records of where pups were tagged in 2011, knowledge from Otago University research trips, and reports from hunters were used to select possible sea lion hot spots. Search regions were selected each day and the coastline traversed initially by RIB with team members searching for potential haul out sites for sea lions.

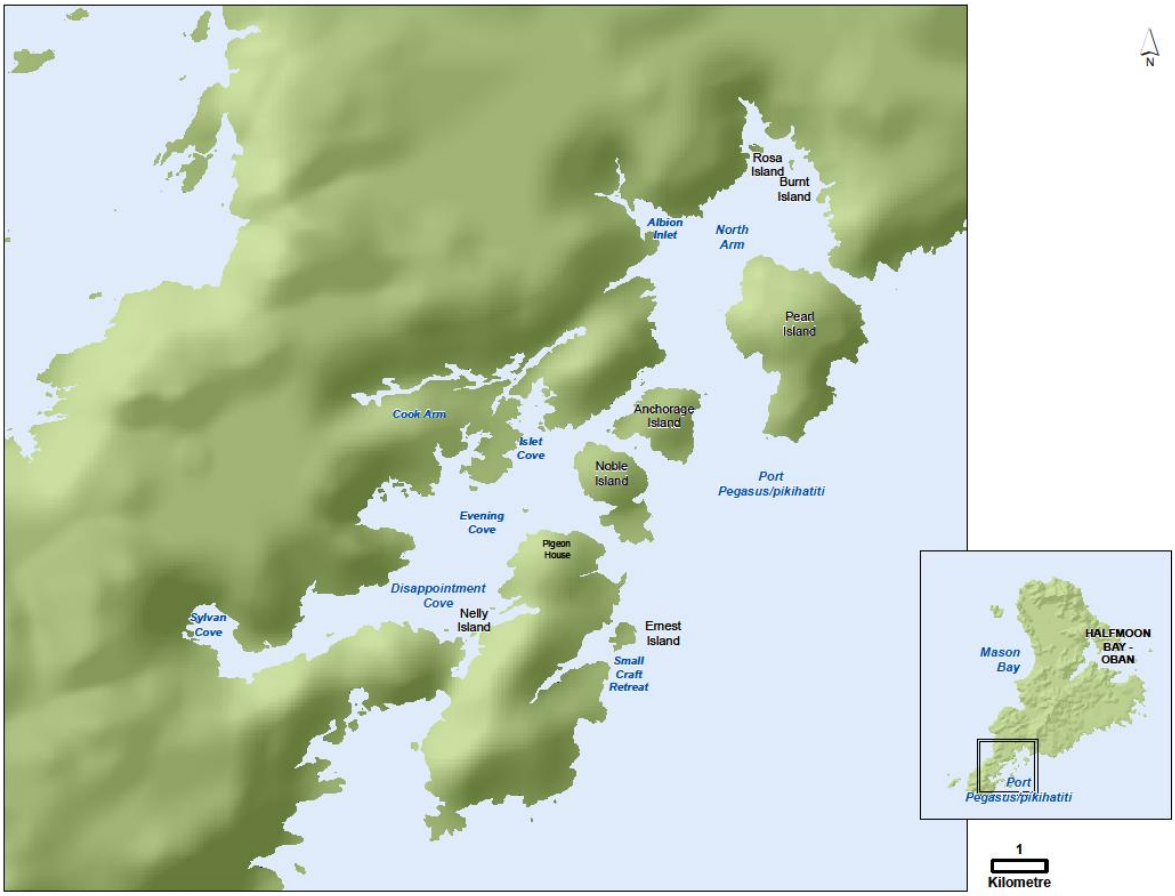

Figure 1: The coastal area of Port Pegasus/Pikihatiti in southeast Stewart Island/Rakiura.

Sites to search on land were selected based on any of the following criteria: presence of sea lions, presence of fresh sign of sea lions, sandy beaches, and sites accessible to sea lions. Sites were considered accessible to sea lions if there was access to bush that was not too steep and did not have large obstacles in the way which might prevent pups from getting from the water up into the forest. Upon landing at a suitable haul out site, either sea lion tracks were followed and/or suitable habitat was searched thoroughly by the team in a spread out linear search pattern. For the first four days, the five person

team worked together, sweeping the forest areas. For the remaining eight days, the team split into groups of two or three individuals, in order to cover a larger area.

Thermal imaging camera technology

Thermal imaging technology was tested for its potential ability to reduce the amount of search effort required to find sea lions. Two handheld cameras, a Pulsar Quantum HD19S and Pulsar Quantum XD38S, were utilised, each with slightly different specifications (http://www.acad.co.nz/index.html). These Pulsar thermal cameras have an unrestricted refresh rate (30-50 Hz) and a 384x288 pixel resolution. The Pulsar Quantum HD19 ($4086 NZD) has a human detection range of 500-700 metres and is considered suitable for large field scanning on foot or by helicopter, whereas the Pulsar Quantum HD38 ($5217 NZD) has a greater human detection range of 950-1300 metres and does not compromise distance for field of view. Each morning, when weather conditions were suitable, a pass of the coastline was made from the Tiama's RIB with at least one of the cameras scanning the coastline for potential heat signatures. Once the team was dropped off, both cameras were operated within the bush to help detect sea lions from a distance. The thermal imaging cameras had previously been tested on fur seal pups in the bush on the Kaikoura coastline and had proven useful in detecting pups that were difficult to see with the naked eye. The thermal cameras were used whenever possible, noting that there were two key times when they couldn't be used:

- In the rain the heat signature is masked, and
- In the middle of the day the ambient temperature is too high.

Tagging of pups

Once sea lions were located they were observed and information recorded about their age, sex, location and, identifying features such as tags. If a female with a pup was found, the pup would be tagged for identification. Conventional Dalton brand flipper tags would be applied to the trailing edges of the front flippers of the pup. The pup would be sexed and, where conditions allowed, measurements and additional samples (e.g. genetics) would be collected.

Collection of environmental and faecal samples

Soil and faecal samples were collected from locations where sea lions were found, for the purpose of screening for *Klebsiella pneumoniae*. Swabs were collected from fresh faecal samples, the priority being where the sea lion was observed defaecating, and in a few cases where the sample was estimated to be no more than 1-2 days old. Soil samples were not collected until the end of the survey as the primary goal was to collect them from sites where pups were found. As we didn't find sites with pups to sample, alternative soil samples were collected from sites where there were signs of sea lions resting recently. In some cases this was paired with a faecal sample. All swabs were collected via Copan Liquid Amies Elution Swab (ESwab) Collection and Transport System™. Two soil samples were collected in bijou tubes. All samples were kept chilled for between 4 and 8 days and shipped on ice to Massey University, where they were frozen pending testing.

Necropsy of any freshly dead pups found

No dead pups were found therefore no pup necropsies were performed. One moderately-autolysed dead adult female was found at Communicating Coves. A gross external and internal examination was undertaken by the qualified veterinarian on the team but no samples were collected.

Results

Search effort

In the 12 days from 21 January – 1 February 2016, the field teams were able to search each day. The amount of time spent actively searching each day depended on environmental variables but was typically between 5-10 hours.

A minimum of 126.3 km of the coastline was searched via RIB, and a minimum of 114.3 km of forest was searched on foot (Figure 2). The coastline search was greater than the total possible coastline due to searching some areas multiple times. This is noted as a minimum as not every team member carried a GPS, and in some cases when the forest was not too dense team members would spread out and sweep a broader area or follow different tracks. The locations of landings provide a rough indication of suitable landing spots for sea lions. Not all sections of the coastline were considered accessible to sea lions, and ruling out inaccessible areas could be beneficial for future monitoring. Table 1 provides an indication of the search areas of focus each day, fresh sign and sea lions were observed each day.

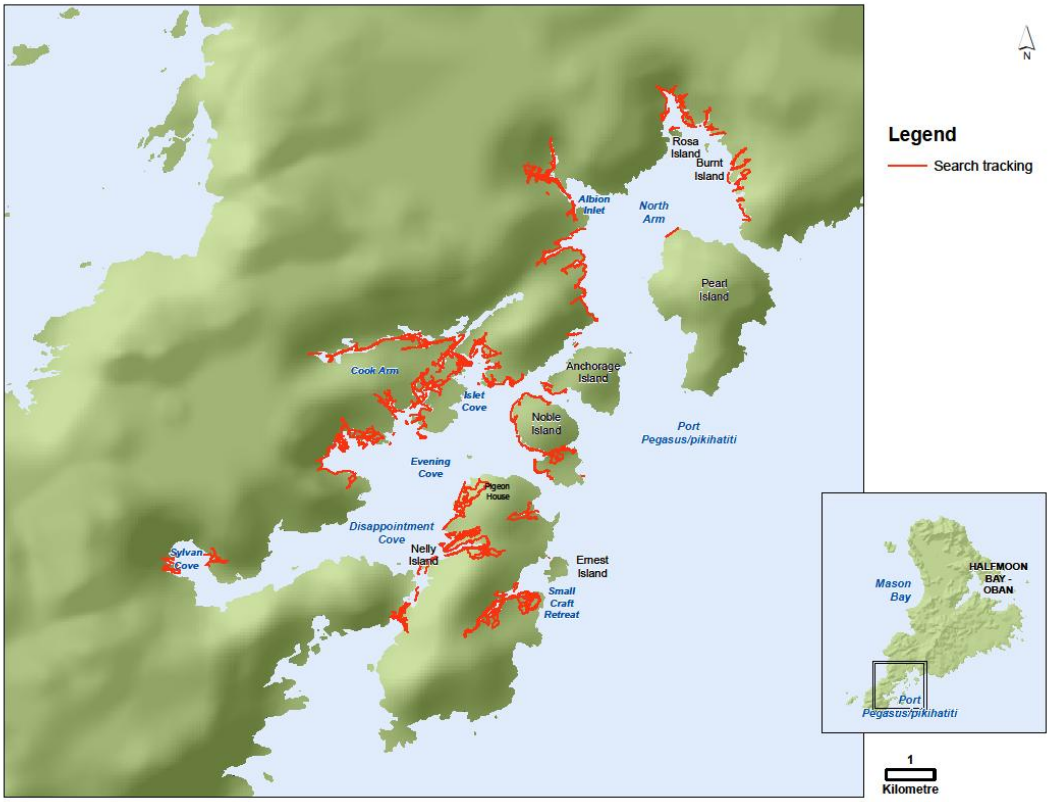

Figure 2: Tracks of area searched for sea lions on land and by dinghy, for enlargements of the area see Appendix 1.

Table 1: Activity and search area during the survey

Date	Activity	Area
21-Jan-16	Search	Pigeonhouse and Fright Cove
22-Jan-16	Search and stopped at both hunters huts	Disappointment, Communicating Coves, area between Fright Cove and Pigeonhouse
23-Jan-16	Search and stopped at both hunters huts	Islet Cove and Cooks Arm
24-Jan-16	Search	Albion Inlet, Bens Bay, Bulling Bay and Red beach
25-Jan-16	Search	Small Craft Retreat

26-Jan-16	Search and change over	Noble Island
27 Jan 2016	Search	Shipbuilders and Evening Cove
28 Jan 2016	Search	Scout, Diprose Bay, Bell Topper and Albion
29 Jan 2016	Search	Pigeonhouse, Fright Cove, Disappointment/ Communicating Cove
30 Jan 2016	Search and check in with hunters	Noble Island, Cooks Arm
31 Jan 2016	Search	Small Craft Retreat and other bay
1 Feb 2016	Search and transit to Bluff	Shipbuilders and Evening Cove, South Arm/Sylvan Cove

Sightings of sea lions and tag resights

A minimum of 41 sea lions were sighted consisting of; ten adult males, 13 adult females, seven sub adults (either sex), eight juveniles (including at least three yearlings), and three pups. Five of these were tagged individuals and details including the number, colour, shape and number of tags present, were recorded where possible to be uploaded to the Dragonfly database of sea lion resights (Table 2). Two tag sightings of interest were female GC H817 which was observed associating with the tagged yearling YC P427 at Noble Island on the 30th of January. Of further interest were three sightings of yearlings which were not tagged and did not show signs of tag scarring.

Table 2: Tag resights from Port Pegasus

Date	Location	Age / Sex	Tag #	Tag Colour /Shape	Number of tags	Year tagged
24-Jan-16	Small craft Retreat	Yearling female	V529	YC	nr	2015
27-Jan-16	Dryad Island	Juvenile female	nr - couldn't read	YC	RFFO - 1	
29-Jan-16	Fright Cove	Juvenile female	P408	YC	RFFO - 1	2014
30-Jan-16	Noble Island Sheathknife Beach	Adult female	H817	GC	LFFO - 1	2013
30-Jan-16	Noble Island Sheathknife Beach	Juvenile male	P427	YC	RFFO - 1	2014

Pups found and tagged

A total of three New Zealand sea lions pups were found. On January 24th one pup was reported by the Otago University research team swimming with its mother 300m off of Anchorage Island. On January 25th a second was sighted on the ridgeline above the sandy beach at Small Craft Retreat. Unfortunately, while the team regrouped in order to tag the pup the female moved the pup and they were not sighted again. On January 28th a third pup was observed swimming with its mother off Rosa Island near Belltopper Falls. The team that sighted this pup retrieved and tagged this male pup with red coffin tags, number M740, in both flippers (Table 3).

Table 3: Details of pup tagged off the coast of Rosa Island, in Belltopper Inlet area.

Date	Location	Age / Sex	Tag #	Tag Colour /Shape	Number of tags
28-Jan-16	Off Rosa Island	Pup/Male	M740	RC	2

Other samples collected

A total of 14 faecal swabs, two soil swabs, and two soil samples were collected during the survey to screen for the presence of *Klebsiella pneumoniae*. Details of the samples collected are in Table 4.These samples have been shipped to Massey University for further analysis and will be reported on at a later date.

Table 4: Faecal, and soil samples for *Klebsiella* screening collected from New Zealand sea lions showing date, location and where applicable the individual the sample came from.

Date collected	Sample	Location	Individual
24/01/2016	faecal swab	Albion Inlet	AM
26/01/2016	faecal swab	Noble Island South Beach	SAM
26/01/2016	faecal swab	Noble Island North Beach	AF
27/01/2016	faecal swab	Dryad Island	JF, YC RFFO
29/01/2016	faecal swab	Fright Cove	unknown
29/01/2016	faecal swab	Disappointment Cove track	yearling female
29/01/2016	faecal swab	Fright Cove	JF
29/01/2016	faecal swab	Fright Cove	unknown
31/01/2016	faecal swab	Cove SE of Pigeon House, near beach	unknown
31/01/2016	faecal swab	Cove SE of Pigeon House, near beach	unknown
31/01/2016	soil sample	SE of Pigeon House	n/a
31/01/2016	soil swab	SE of Pigeon House	n/a
1/02/2016	faecal swab	Shipbuilder's Cove	unknown
1/02/2016	faecal swab	Evening Cove	unknown
1/02/2016	faecal swab	Dryad Island	JF
1/02/2016	soil sample	Dryad Island	n/a
1/02/2016	faecal swab	Sylvan Cove	unknown

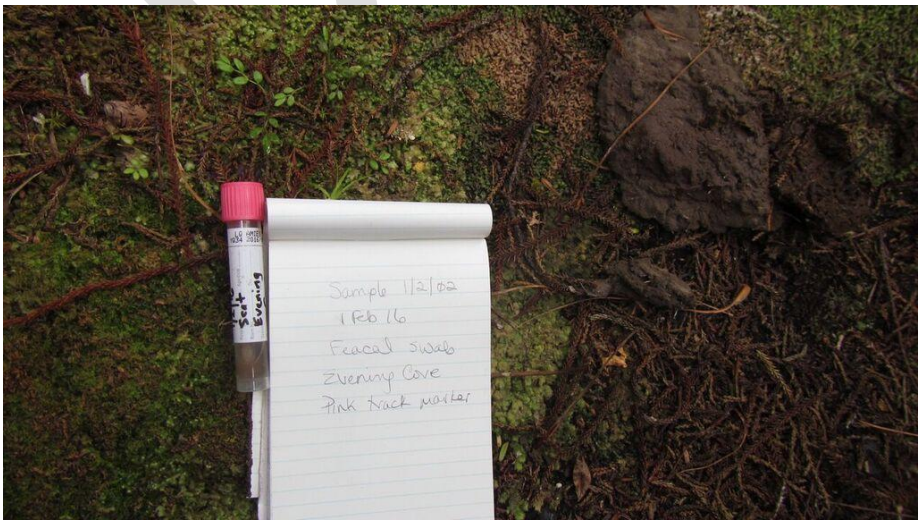

Figure 3: Example of recording faecal swab samples, image shows the collection vial and the scat which was swabbed.

At the same time as this survey, a team from Otago University was collecting hair samples from sea lions for stable isotope research at Port Pegasus. The DOC/MPI team focussed on searching for female sea lions, but when feasible, assisted Otago University by collecting hair samples from females for their research project. A total of seven hair samples were collected from juvenile and adult sea lions as detailed in Table 5.

Table 5: Hair samples collected from New Zealand sea lions for the Otago University research team showing date, location and where applicable the individual the sample came from.

Date collected	Sample	Location	Individual
27/01/2016	hair sample	Dryad Island	JF, YC RFFO
28/01/2016	hair sample	Scout Bay	AF
29/01/2016	hair sample	Disappointment Cove track	yearling female
29/01/2016	hair sample	Fright Cove	JF YC P408 RFFO
30/01/2016	hair sample	Noble Island	AF
30/01/2016	hair sample	Noble Island	JM YC P427 RFFO
30/01/2016	hair sample	Noble Island	AF GC H817 LFFO

Necropsy

On the 22nd of January 2016 a deceased adult female sea lion was observed on the beach at Communicating Coves (Figure 4). The carcass was in an advanced state of decomposition, with thousands of maggots (up to 1cm long) within the sand adjacent to a ragged skin laceration in the right flipper. Death was estimated to be greater than four days and up to one week prior. The origin of the flipper skin laceration (pre or post-mortem) was not evident due to maggot-associated maceration. The abdomen was opened and a cursory examination was performed, but no other systems were examined. Within subcutaneous ventral abdominal tissues were hundreds of blubber trematodes (higher levels than expected based on autopsies of Enderby females). Internal organs were diffusely reddened, and kidneys were bilaterally enlarged by emphysema (presumed to be post-mortem). The uterus was small, with no evidence of recent pregnancy. Collection of samples was not performed due to advanced tissue autolysis, and since the goal of the trip was to perform autopsies on pups (note: this was early in the trip and it was not yet known that few pups would be found).

Figure 4: Examining a deceased adult female sea lion found on the beach at Communicating Coves, estimated to be four to seven days since death.

Thermal imaging

Pulsar thermal cameras were effective at detecting adults and sub adults whilst walking in dense bush and open areas, in most cases before they were detected by the naked eye. Water-based RIB scans were useful for detecting sea lions hauled out in open areas such as beaches or in water, but did not detect sea lions through dense bush (note: this could be a limitation of the technology but likely also reflects the low numbers of animals in forest near the water's edge).

The thermal technology proved very effective at detecting small birds and humans in bush, which indicates it could be useful in areas with higher concentrations of sea lions (e.g. Port Pegasus during annual March surveys). The cameras were also used successfully to find fresh sea lion scat hidden in grass.

Discussion

The objectives of this pilot were to;

1. Determine the feasibility of monitoring pup production in January, concurrent with the monitoring of other colonies,
2. Test the feasibility of using thermal technology to locate sea lion pups,
3. Screen for *Klebsiella pnuemoniae*, and
4. Determine the cause of death for Stewart Island pups.

Due to low numbers of pups and absence of dead pups, it was not possible to complete objectives 2 and 4, and objective 3 relied on environmental samples rather than post-mortem samples. A number of faecal and soil samples were collected to screen for presence of *Klebsiella pneumoniae* and these will be analysed at Massey University and will be reported on at a later date.

The use of thermal cameras proved useful in the forest on dry days. The cameras improved upon researchers ability to detect sea lions in advance of seeing them with the naked eye or hearing them. For example, multiple sea lions were detected hauled

out on sandy beaches at a great distance from the boat (1000+ m) that the naked eye could not detect. However, the cameras were not effective when searching through thick forest from the RIB as scrub and bush at water level were too dense and there were too few animals within these areas.

Aerial surveys with thermal cameras might be more efficient option although again this would require testing against canopy thickness. However, this will still have constraints related to time of day and precipitation. In order to maximise effectiveness in a region that is not cold all day, one must begin searching early in the morning before the sun rises. This is when it is cooler and the temperature differential between foliage and sea lion is at its greatest, increasing detection rate (Gooday et al. 2016 unpublished). Multiple bird species were easily detectable resting on trees which were well hidden to the naked eye including oystercatchers (*Haematopus unicolor),* white fronted terns (*Sterna striata),* and multiple gull species. Also, recently or currently occupied kiwi nests were detected using the camera. Whilst not the objective of this research, both Pulsar cameras were very effective at detecting small terrestrial and sea birds, and could be more useful for detecting sea lions under a different experimental set up.

It is unclear why so few pups were observed during the survey. Historically, greater than 30 pups are observed in March, but we only observed two in January and had a verified report of a third pup by Otago University. On its own, this information leads to two potential reasons for this discrepancy:

1) pupping occurs in locations other than those that we searched;
2) 2015/16 might be a particularly poor breeding year.

In March 2016, a further survey was conducted to tag pups and found 31 pups. This discounts the second reason, and it is most likely that the mother and pup pairs were not present in the areas searched during the January survey. Prior surveys in March suggest that mothers and pups start to crèche at specific places, all of which were searched during the January survey. On the Auckland Islands, it is known that mothers and pups start swimming considerable distances when the pups are as young as one month, towards the latter half of January, for example from Dundas to Enderby Island. Two of the three pups observed during the current survey were observed swimming with their mothers. This suggests they were born elsewhere and mothers had started relocating pups by the time this survey took place.

The question still remains where the pups are born. It was initially thought that they may be further in the bush than the sites where they are normally found in March; however, several fresh sea lion tracks were followed extensively, but mothers and pups were not found. There is a huge area of forest that could potentially provide suitable habitat for sea lion mothers and pups within Port Pegasus, so it is still possible that mothers and pups were simply in areas that weren't searched, or they were incredibly well hidden. However, the considerable search effort undertaken during this survey suggests it is more likely that they are born outside the searched area and they move into the Port Pegasus area in February and March. This would be similar to behaviour observed in Otago, where sea lion pups born on the Otago coastline are commonly born on specific beaches and then mothers move them to alternate beaches when they are a couple months old.

There were yearlings found that were not tagged, therefore either the number of pups tagged in March 2015 is an underestimate of the total number born that season, or yearlings are migrating from other untagged locations. It is worth noting that one team

member present for the second week of the survey was also present on two of the previous March surveys (2014 and 2015) and was involved in the subsequent March 2016 survey. Following their experience from previous March surveys, hotspot locations were searched using the same methods and criteria for considering area suitable habitat for sea lions, yet few sightings of pups resulted.

Given the results of the March survey, the low number of sea lion pups found in January may be typical for this time of year. Therefore, to conduct a pup count in January that is comparable with the pup counts undertaken at other locations is not currently possible and future monitoring prior to March would require a different methodology or discovery of natal sites outside Port Pegasus. Surveys conducted in mid-late February could potentially be more productive in finding pups if the mothers have settled with their pups in the new areas by then. As understanding of this behaviour increases it might be possible to slowly move the surveys earlier and earlier. However, alternative methods such as trail and/or thermal imaging cameras set up early in the season at known March crèche spots would help determine when adult females start arriving, frequency of use of the area etc. Other technology such as satellite tags could be employed; however, the usefulness of this would depend on the battery life of the tags used and being able to find and catch females at the right time in order to learn where they pup vs where they move to. Additionally, mapping of potential sea lion habitat outside of the current search area of interest and search effort in these new areas would be valuable, albeit time consuming. In lieu of an extended research programme, March is accepted as the best time to survey the Port Pegasus sub-population. It is certainly possible that the sea lions use other parts of Stewart Island albeit in smaller numbers, and that areas outside of Port Pegasus are also critical for them; however, further research and monitoring will be needed to determine critical habitat where further management actions might be implemented. It is recommended that monitoring of Stewart Island sea lions is a topic for evaluation through the New Zealand sea lion Threat Management Plan process.

In summary, the field team was able to answer some of the questions they set out to answer, and currently a January pup count in Port Pegasus does not appear feasible given the current behaviour of sea lions. It has highlighted that female sea lions may well be pupping in alternative areas, suggesting that there is more critical habitat for sea lions on Stewart Island. Understanding the critical habitat for New Zealand sea lions is important for implementing conservation measures as many are spatial in nature, and managers need to know what areas to protect from specific activities. This survey was useful in highlighting this gap in our knowledge and will help inform potential future research which could be prioritised as a result of the New Zealand sea lion Threat Management Plan.

Appendix : Map enlargements of the search area to show detail of the areas searched.

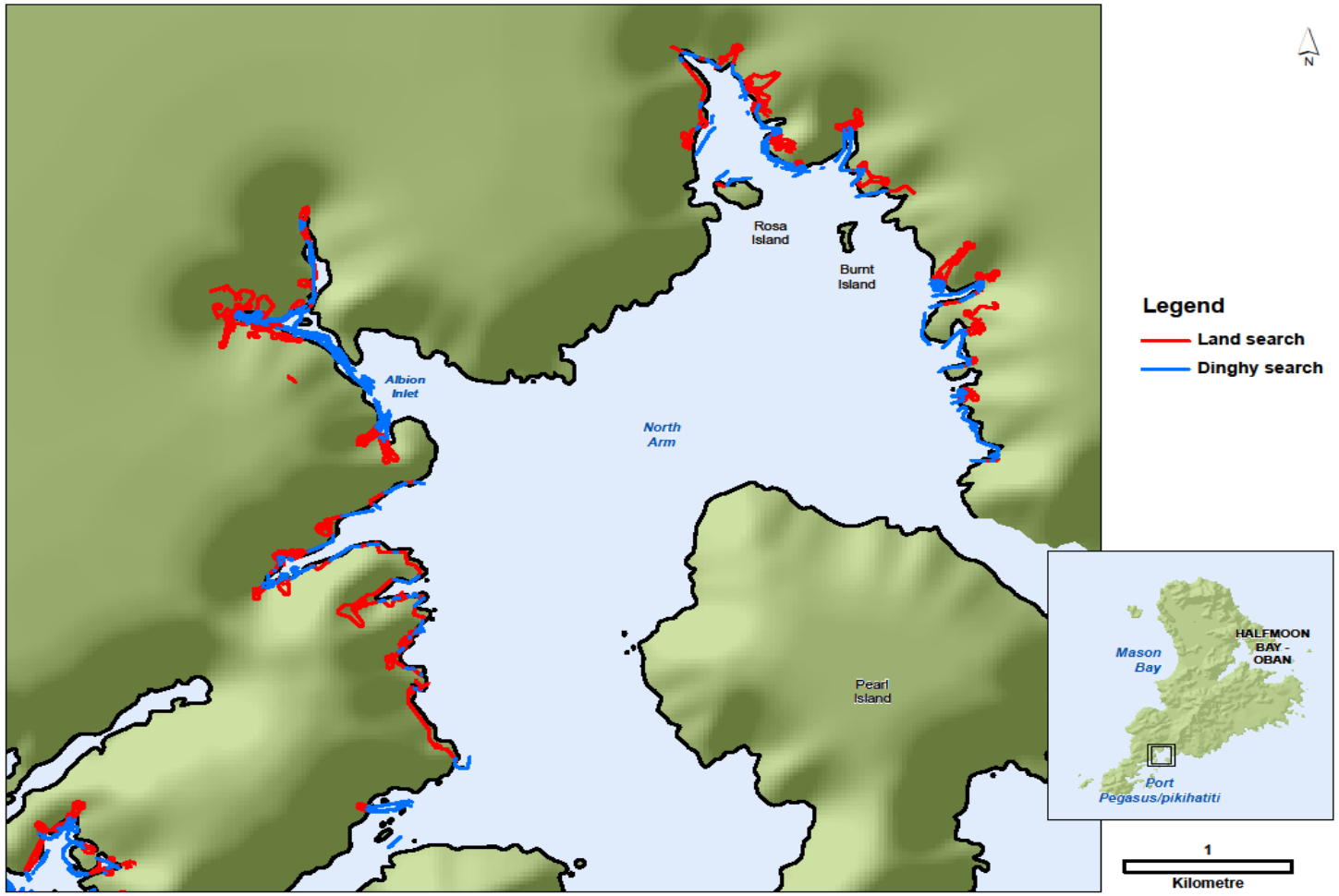

Figure 5: Enlargement of the North Arm of Port Pegasus showing a minimum of dinghy and land-based searching.

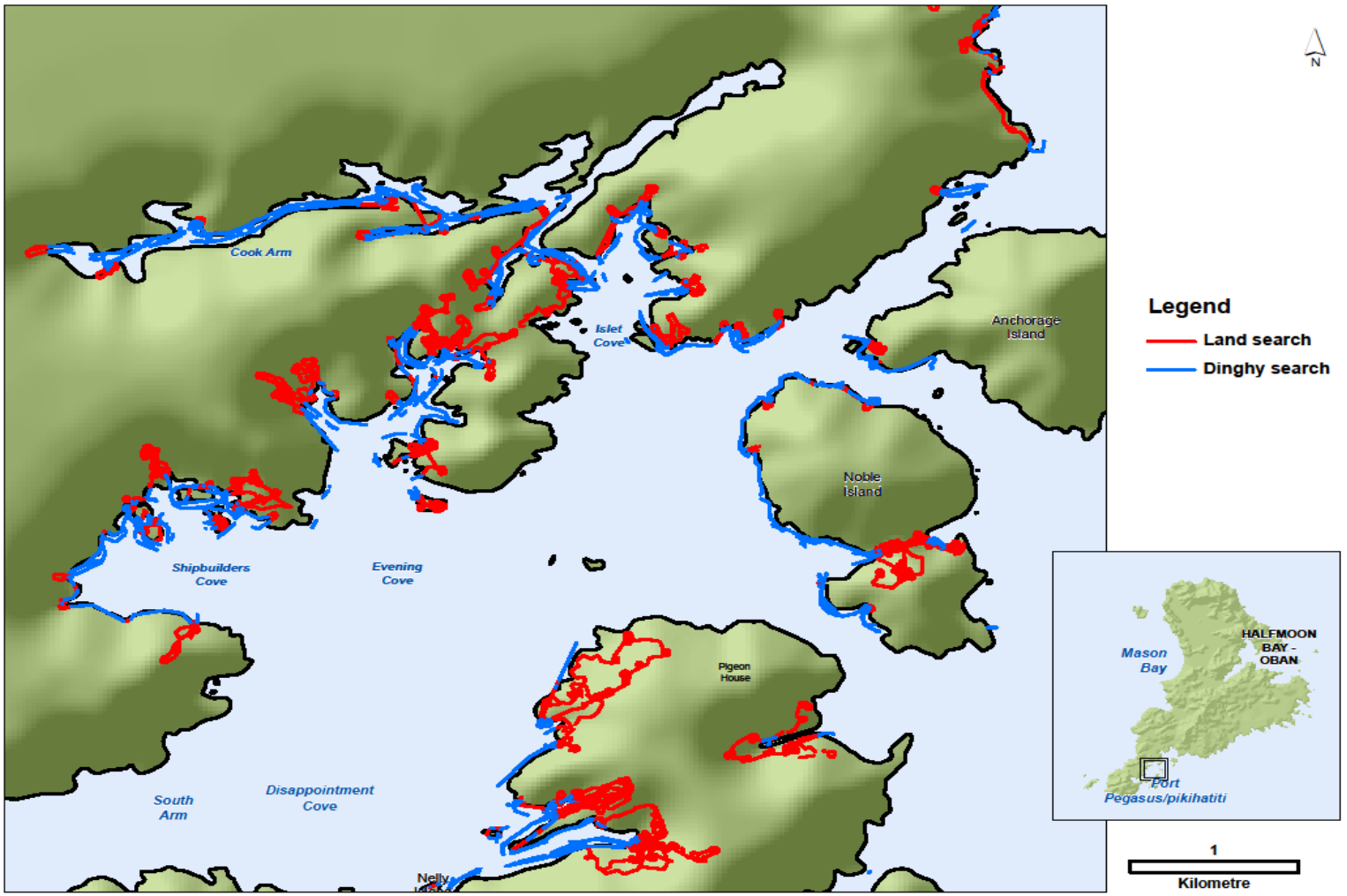

Figure 6: Enlargement of the Central part of Port Pegasus showing a minimum of dinghy and land-based searching.

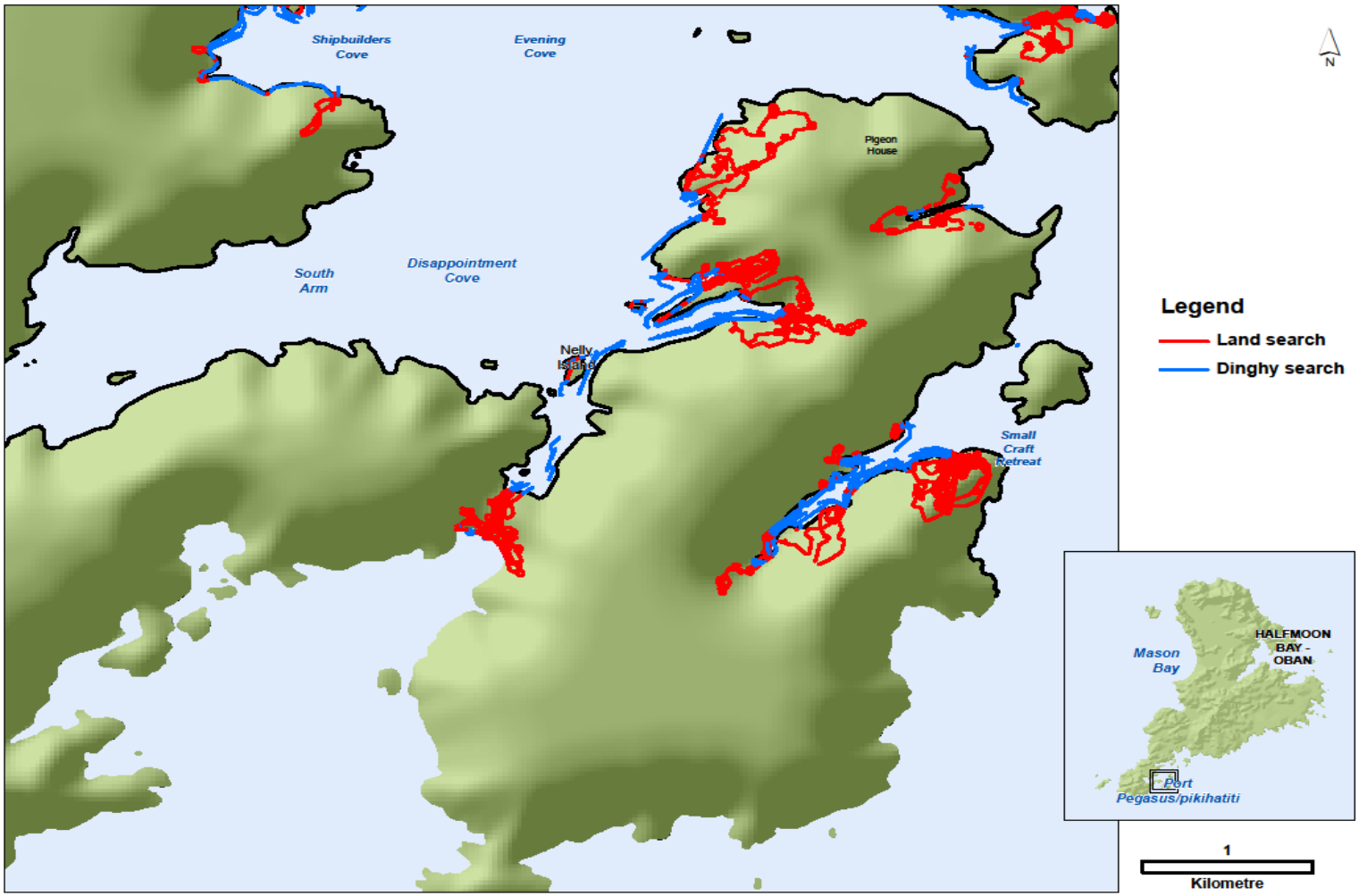

Figure 7: Enlargement of the South Arm of Port Pegasus showing a minimum of dinghy and land-based searching.