Interactions by New Zealand Sea Lion pups with terrain traps at Campbell Island:

A report for the New Zealand Department of Conservation

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Introduction

Pre-weaning mortality of pups is an important contributor to the overall population trajectory of New Zealand sea lions (DOC/MPI 2017). A major component of this mortality, at both the Auckland Islands and Campbell Island is the entrapment of young pups in terrain traps such as mud wallows and bogs, at the breeding sites.

The reduction of terrain trap induced mortality of pups is therefore a key part of the direct mitigation planning in the New Zealand Sea Lion Threat Management Plan (DOC/MPI 2017). As part of investigating potential mitigation strategies, a preliminary study was conducted to assess the vulnerability of pups at Campbell Island to entrapment in terrain traps during the breeding season.

The overall objectives of the study were:

1. To assess how pups are using the colony terrain at the two key breeding sites, Davis and Paradise Points, in relation to the location of wallows/ and bogs; and
2. To spatially quantify the risk that wallows and bogs pose to pups during the breeding season at Davis and Paradise Points.

Methods

Study site. There are two main breeding colonies on Campbell Island located at Davis (52°33’46.6’’S 169°14’13.4’’E) and Paradise Point in Perseverance Harbour, with Davis Point being the largest colony on the island to date. Davis Point has two sub-areas with different characteristics – a rock platform and a mud bog area. The rock platform and mud bog area are separated by a steep cliff (~ 5 m height) which slopes down at the top of the cliff from the mud bog area to the rock platform. The rock platform is mostly solid rock substrate and has several small to large rock pools. Some of the rock pools have steep sides and pups may struggle to climb out of them once inside. The mud bog area is mainly soft peat bog substrate. The main harem areas are usually on a flat open area which easily turns into a quagmire after periods of rain. Behind the flat open area are several bogs and wallows, which may interconnect to form a larger, muddy channel. There is much more vegetation (mainly tussocks) growing around the bogs and wallows in this area. Bogs and wallows may have steep ridges, which become slippery when wet, and pups may struggle to climb out of the wallows if they fall in. Although the main harem is on the flat open area, adult sea lions and especially the pups are usually found at the boundary between the flat open area and where the wallow area begins.

The breeding colony at Paradise Point is comprised of two sub-colonies – Paradise East and West. Paradise Point West is approximately two thirds of the breeding harems at Paradise Point, and its location is quite dynamic in nature. Previously (2014/15), Paradise Point West was separated from Paradise Point East by approximately 500 m, however, during this study’s fieldwork, Paradise Point West had shifted and was about 2 km west from Paradise Point East. Paradise Point West was essentially at Shoal Point in 2017/18. The breeding area at the Shoal Point colony is elevated from the beach and gently slopes up a hill. The terrain is highly vegetated (ferns and tussocks) in a grid-like fashion, and the substrate is soft but drains well, hence it stays relatively dry even when wet. The layout of Paradise Point East is similar

to that of Shoal Point, however it has poorer drainage and deep bogs and wallows are found at the eastern edge of the main breeding area.

There were two components to the study. The first included an assessment of how many pups interacted with wallows and the way in which they became entrapped. The second was an assessment of individual pup movements around the colony, and how often individual pups potentially came into contact with wallows and bogs.

Pup interactions with wallows. Here we attempted to quantify the number of pups within and outside of wallows, to estimate the overall likelihood of pups entering a wallow, the mechanism by which they enter wallow and how they escape. This was done by placing camera traps at several of the major wallows (see Figure 1).

We used Outdoor Swift 3C cameras (Outdoor Cameras Australia, Unit 11, 189 Anzac Avenue, Toowoomba Queensland, Australia) with a 50 degree field of view (FOV) for this by placing traps at five wallows or bogs where pups have been found dead or trapped. The cameras were repositioned regularly according to pup movements to ensure optimal coverage. The cameras were programmed to photograph the wallow every 10 minutes, and were downloaded after approximately two weeks. To help identify pups in the images we glued blue, circular patches (10 cm radius) on the rumps of 100 pups (standard Department of Conservation marking procedure).

We recorded the number of pups within and outside (~ 2 m from the edge) wallows from each of the images taken by the camera-traps, only counting pups that could clearly be identified as pups (e.g. from their size and/or with a blue cap). From these data, the total number pups inside and outside each wallow/bog was calculated, excluding photos with no pups, and the probability of a pup entering a terrain trap (P) was thus calculated as:

$$P = \frac{total\ number\ of\ pups\ inside\ the\ terrain\ bog}{total\ number\ of\ pups\ inside + outside\ the\ terrain\ bog}$$

Individual pup movements. This component of the study was intended to quantify the time pups spent near or in wallows and to identify the core areas used by the young pups during the breeding season. We deployed 20 GPS trackers (±5 m resolution, Catlog S, Catnip Technologies, Hong Kong), which recorded a position every 10 min. The tags were glued to a small neoprene patch (4.5 x 3.5 cm), secured by zip ties, then a thin coating of glue (quick-setting epoxy, Selleys Araldite 5 Minute) was applied to attach the packages to the mid-back region of the pups. The pups were captured by hand, manually restrained, and weighed **(±** 500 g), measured (length and girth (cm)) and sexed. The GPS tags were recovered after a maximum of 15 days on the pup (mean = 12 days; n = 20).

Results

An early visit to Paradise Point established that the colony had moved away from areas with dangerous wallows and since Paradise Point East had the smallest population among all the sub-colonies, the team only visited Paradise Point East on two occasions, and did not do any behavioural study there. Hence, the work reported here is all from the Davis Point colony exclusively. There were several wallows and mud channels within that colony that were dangerous for the pups (Figure 1), none of which were in the "rock colony". The principal features were the "giant bog", the "small bog" and mud channels 1 & 2 (see Table 1).

Figure 1. *Map of the pricipal wallows and mud channels in the Davis Point colony. The yellow boundary encloses the sub-colony "bog colony".*

Table 1. Names, abbreviations and locations of the primary terrain traps at Davis Point, Campbell Island in December 2017/January 2018.

Terrain trap name	Abbreviation	Longitude	Latitude	n days	n photos
Far east of giant bog	FEoGB	169.236871°	-52.562614°	1	168
East of giant bog	EoGB	169.236788°	-52.562563°	10	1926
Giant Bog	GB	169.236667°	-52.562500°	15	4004
West cliff	WC	169.236111°	-52.562222°	2	233
Upper west boggy slide	UWBS	169.236214°	-52.562229°	3	591
Upper west wallows	UWW	169.236389°	-52.562222°	0.25	43
Small bog	SB1	169.236535°	-52.562442°	6	1084
Small bog 2	SB2	169.236543°	-52.562265°	5	1113
Mud channel start	MC	169.236667°	-52.562500°		
Mud channel end	MC	169.236457°	-52.562391°		
West open bog	WOB	169.236431°	-52.562423°	11	1670
Mud channel 2 start	MC2	169.236543°	-52.562265°	6	1597
Mud channel 2 end	MC2	169.236382°	-52.562340°		
Open boggy area	OBA	169.236805°	-52.562731°	14	2675

Number of pups in and out of wallows. Overall, a total of 11022 pup sightings were recorded in the 15104 recorded camera trap images (0.73 pups per image). Of those images including pups, 14% (n=1555) showed pups in terrain traps (wallows and bogs) and 86% (n=9467) showed pups to be outside terrain traps. In other words, the overall probability of sighting a pup in a terrain trap (from our camera view points) was 14%. Importantly this varied considerably among the wallows, with some having a much higher likelihood of pups being sighted in them, than others (Figure 2). For example, “West Cliff”, “Far east of Giant Bog”, “Small Bog 2” (Figure 3), and “Mud Channel 2” (Figure 4) had some of the highest probabilities (above 60%). “Small Bogs” and “Mud Channel 2” in particular, were the most problematic as they were deep, steep-sided and full of water. In contrast, “Giant Bog” and the “Open Boggy Area” exhibited relatively low probability of sighting a pup in the wallow (<15%). Although the images of “Upper West Wallows” did not capture any pups inside the terrain trap, pups were found inside the wallow before the camera trap was set up. “Upper West Wallows” and “West Cliff” became terrain traps towards the end of the fieldwork which meant the images from their camera-traps only covered a short period of time. Similarly, images from “Far east of Giant Bog” camera-trap also only covered a short period of time as although it was identified as a terrain trap early in the field season, due to the changes in the environment and pup movement, it became less boggy and less visited by pups and thus the camera trap was moved to a different location.

Effectiveness of existing ramps as pup escape mechanisms. In 2014/15, a number of the terrain traps were equipped with ramps intended to provide pups that fell into the bogs with an escape route. The ramp in the “Giant Bog” was very effective and most pups were able to self-rescue via the ramp. However, in some cases, pups were not able to find the escape route, wandering instead into deeper parts of the bog/channel and becoming stuck. In 2017/18, “Small Bog 1” was fitted with a ramp, which was also effective in allowing pups to

self-rescue. Additionally, “Small Bog 2" was modified by opening them up with a short trench to allow them to drain, after which the pups could self-rescue.

Factors affecting how pups enter wallows. We noted that overall there was a higher chance of pups falling into wallows when conditions were wet because of their steep sides, the slippery nature of the wet soil and the lack of vegetation. Pups would also accidentally fall into bogs if they were sleeping on tussocks next to bogs, which was a quite a common behavior. Also, the pups are social, and will move towards other pups already in a wallow, and others may walk in to join the first one. Finally, on some occasions, adults accidentally pushed pups into wallows if it was crowded around the outer edge of the wallow.

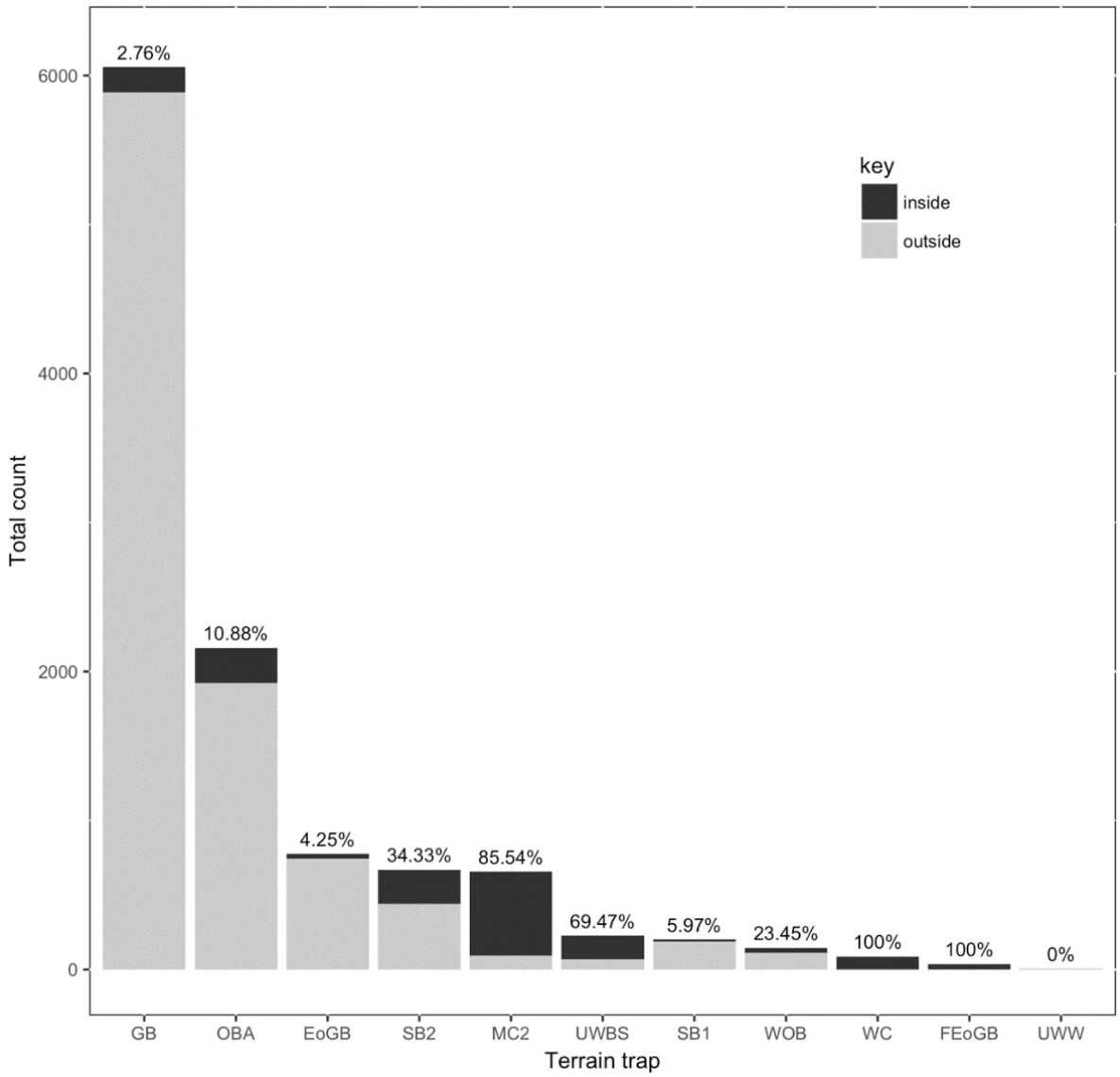

Figure 2. *The total number of pups in the camera-trap photos that were either inside (black), or outside (light grey) each of the potentially dangerous terrain traps at Davis Point. The proportion of pups counted inside each of the terrain trap is indicated above each bar. See Table 1 for full terrain trap names.*

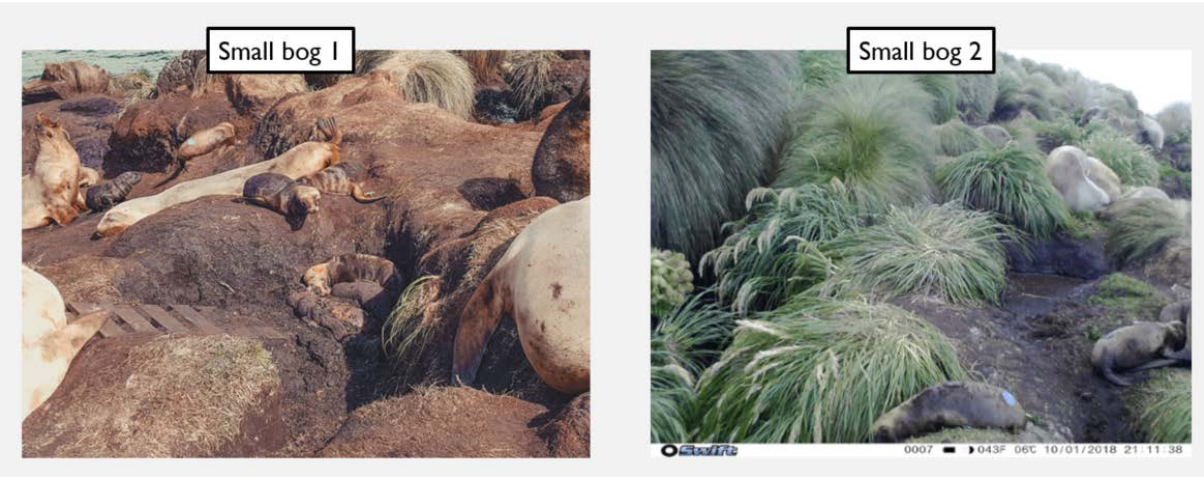

Figure 3. *The two small terrain traps (small bogs 1 & 2). "Small bog 2" was one of the deadliest bogs, being deep with steep sides and full of water.*

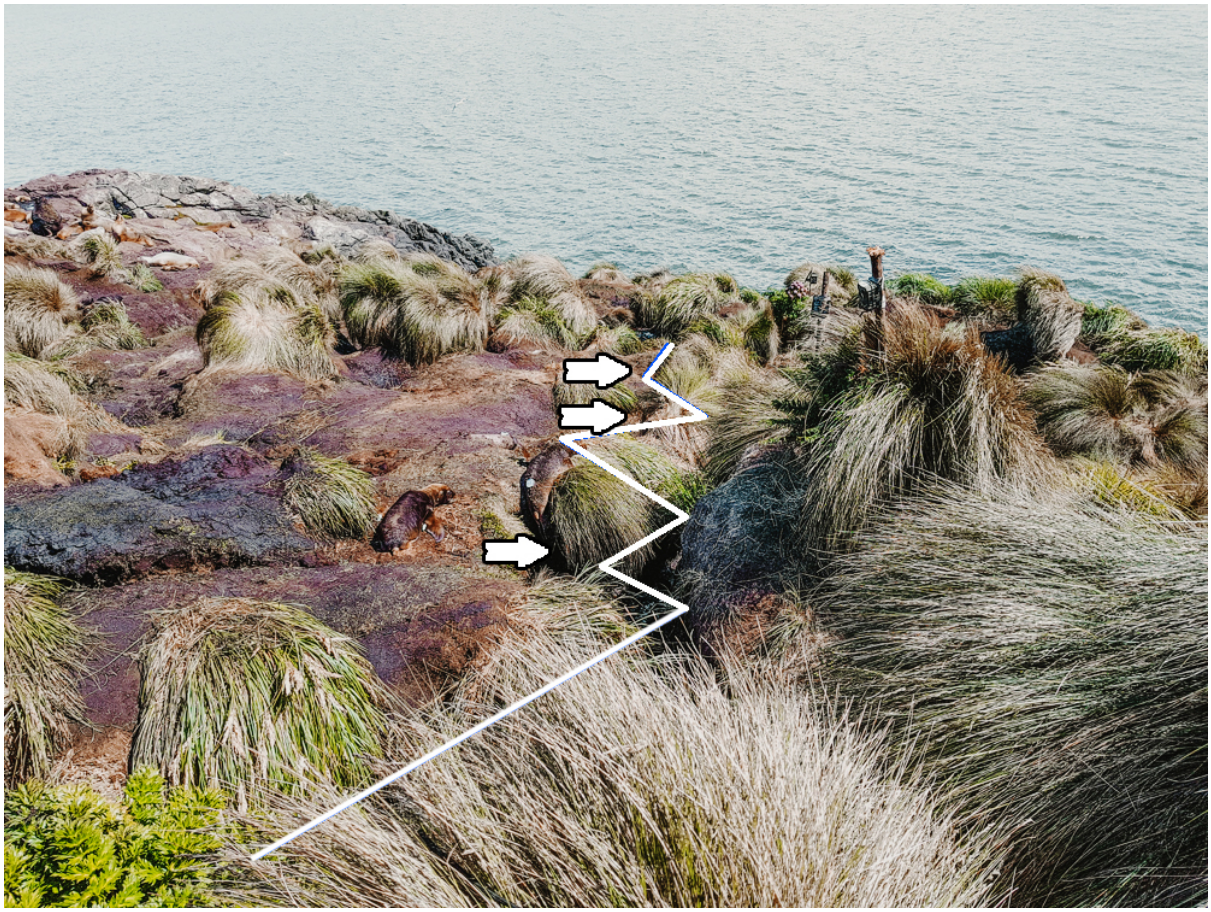

Figure 4. *Mud channel 2, another potentially deadly terrain trap. The white line indicates the approximate position of the channel under the tussock, and the white arrows show where pups would try, unsuccessfully to climb out. The only exit point was at the seaward end of the channel, and not all pups were able to find this easily.*

Individual pup movements. Twenty pups were tracked with GPS tags between 30 Dec 2017 and 13 Jan 2018, a total of 15 days. Only 18 GPS tags were recovered as two fell off and were lost. Two tags failed, leaving 16 tracks ranging in duration from 1.9 to 14.8 days (9.9d ± 3.7). Each tag provided over a thousand locations, which after a simple speed filter was applied (locations requiring pups to travel at over 10 km per hour were excluded), there were 22283 locations in total (mean per pup =1310 ± 520). As the location accuracy of the tags was ±5m we established a 5 m buffer around each of the major wallows (Figure 5a); we regraded a pup as being close enough to a wallow to fall in if its location was within this buffer. There was considerable movement of the pups within the main colony (Figure 5b), including within the 5m buffer zone (i.e. possibly in or at the edge of a wallow). All of the pups spent some time within the buffer (Figure 6a), and the area of overall core usage by the pups also overlapped with the buffer zone (Figure 6b). This indicates that not only were all pups at risk of entering a wallow, the wallows were also in the part of the colony in which the pups spent most of their time.

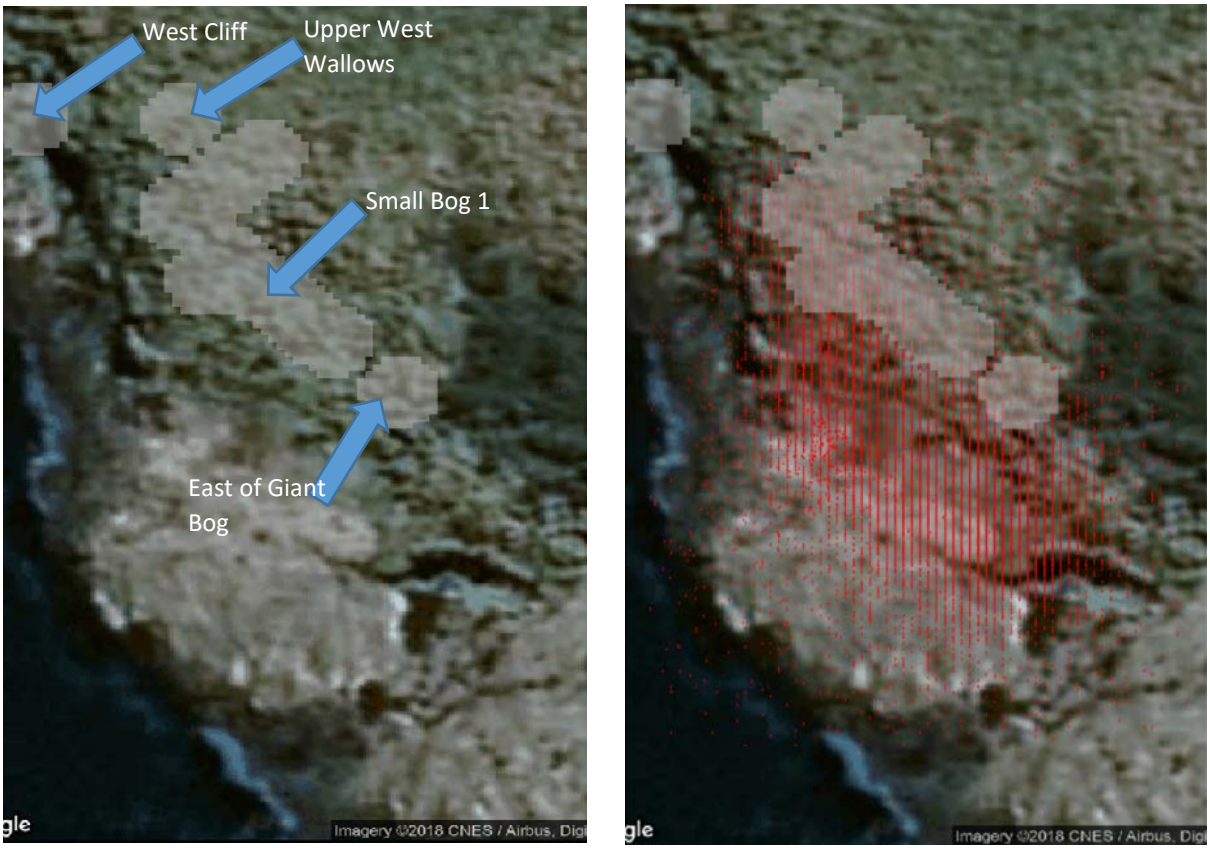

Figure 5a. *A map of the main colony indicating the 5m buffer (pale grey) around the identified terrain traps. Some of the terrain traps are indicated with a blue arrow.* ***5b.*** *A map of all GPS locations (red, n= 22283) from the GPS tagged pups (n=16) in the main colony at Davis Point, Campbell Island.*

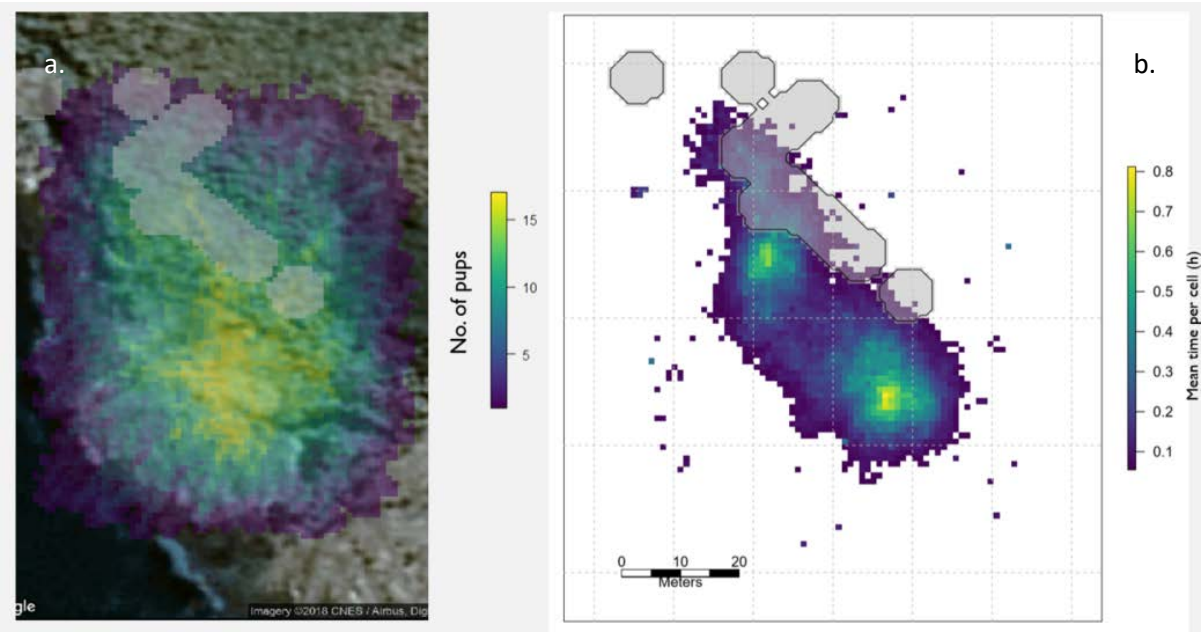

Figure 6. *Spatial use of the main colony by 16 GPS tracked New Zealand Sea Lion pups.* ***a.*** *the number of pups that used each 1x1 m grid cell and* ***b.*** *the mean time spent by the pups in each grid cell. Here we show the upper quartile of time spent as an indication of the area of core usage. The 5m buffer zones around the major wallows are indicated as grey polygons.*

There was however considerable individual variation in the way the pups used the main colony (Figure 7). Although the region of core usage (the upper quartile of time spent) for all pups over-lapped with the wallow buffer to some extent, this ranged from less than 10% of their total time (pup 650) to more than 40% (pup 561). Overall, the pups spent an average of 11.5 ± 11.3% of their time in the in the buffer.

Temporal changes in core usage. There was clear shift in the location of the overall core usage area in the latter half of January (Figure 8), with pups moving northwards and closer to the wallows. This was accompanied by a change in the percentage time that individual pups spent within the wallow buffer. During late December and early January (*early*), individuals spent 5.3 ± 15.7% of their time in the wallow buffers. This increased three-fold between mid to late January (*late*) to an average of 18.7 ± 17.0%.

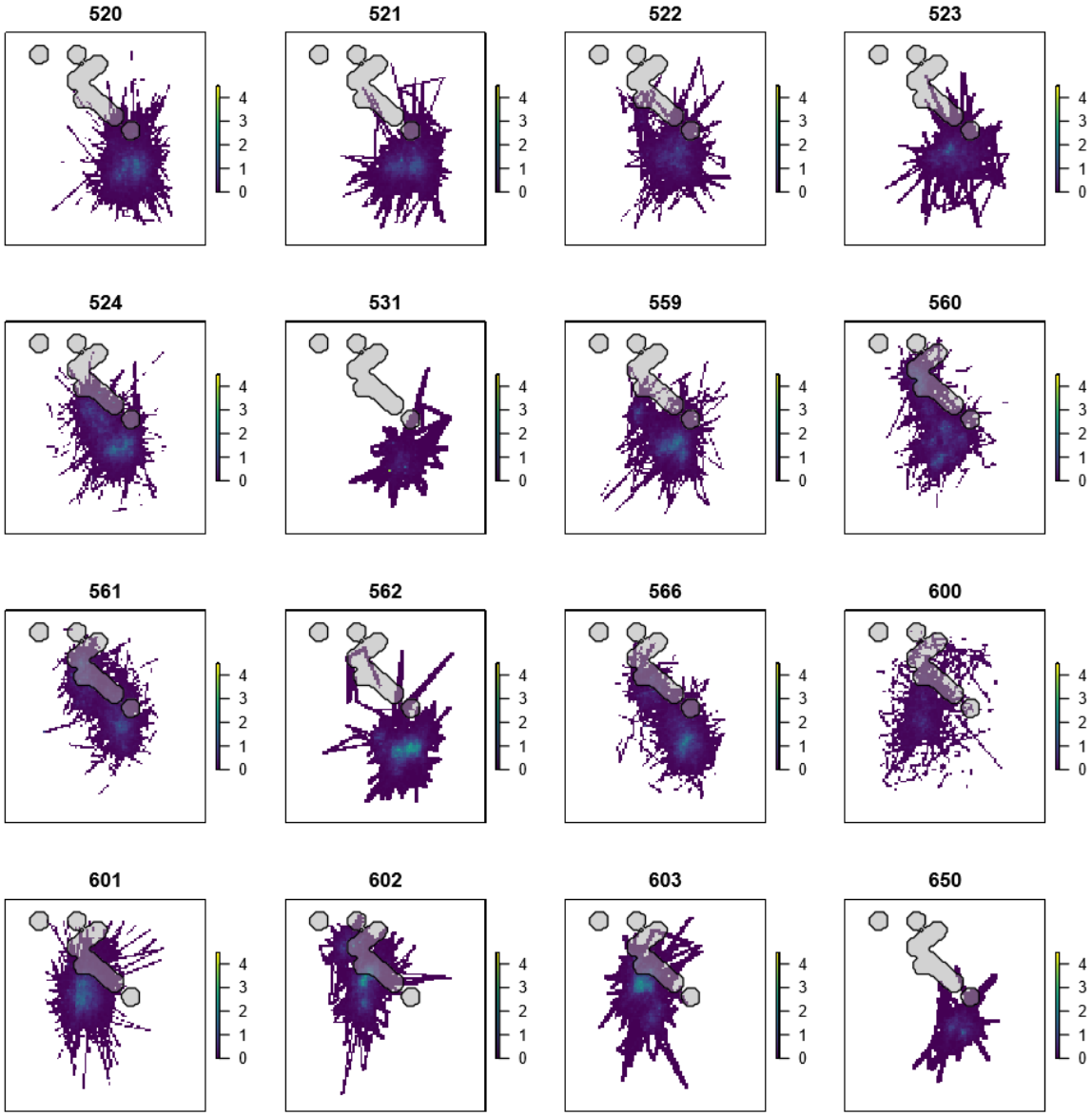

Figure 7. *Usage plots for the 16 GPS tracked pups. In each case the top quartile of time spent per 1 x 1 m cell are shown as a way of indicating core usage. The 5 m buffer zone around the major terrain traps are indicated as grey polygons.*

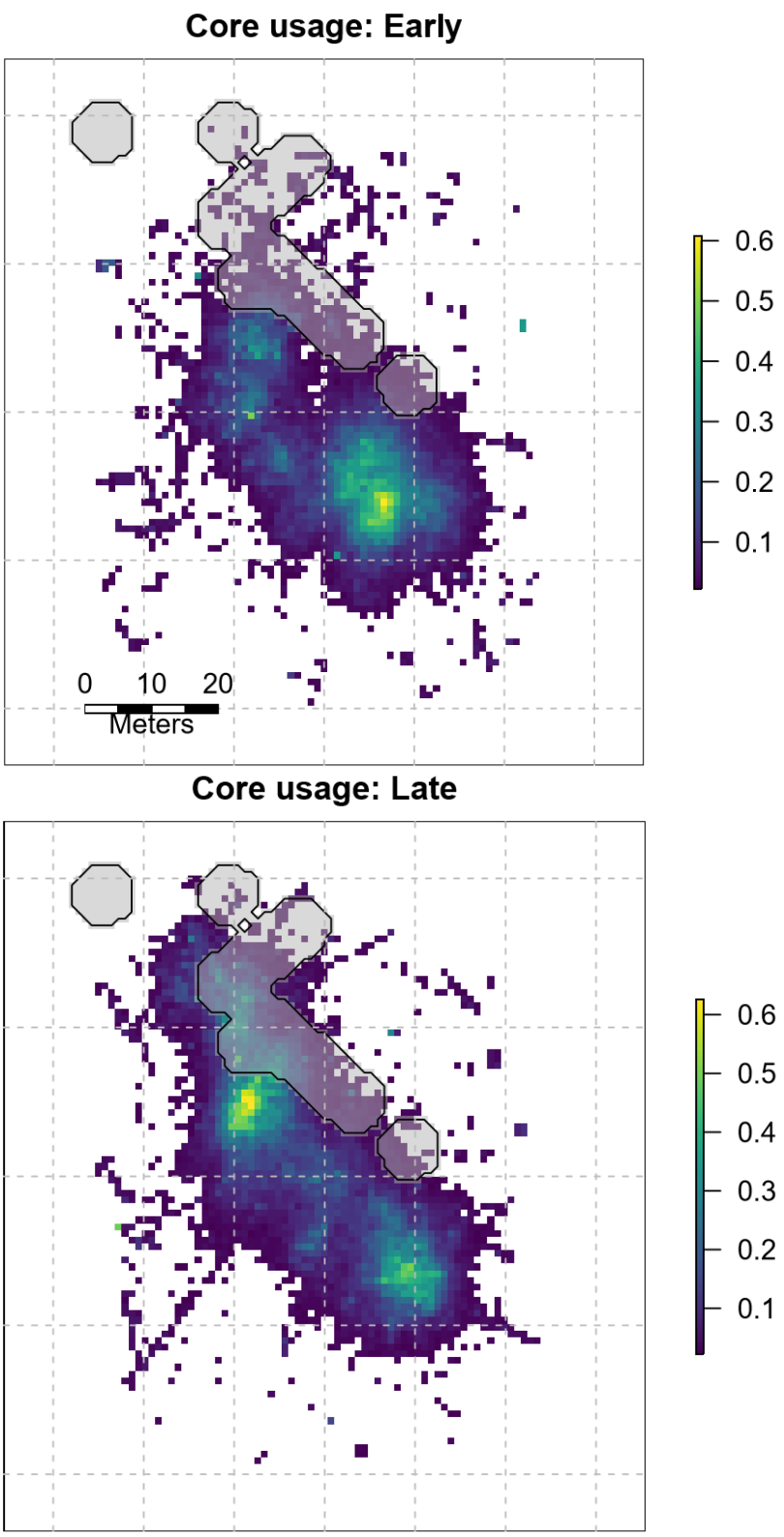

Figure 8. *Change in spatial use of the main colony over time. Combined core usage (top quartile of time spent in a cell) for the 16 GPS track New Zealand sea lion pups at Davis Point separated in to early (30 Dec. 2017 to 6 Jan. 2018) and late (7 Jan. 2018 to 13 Jan. 2018) season.*

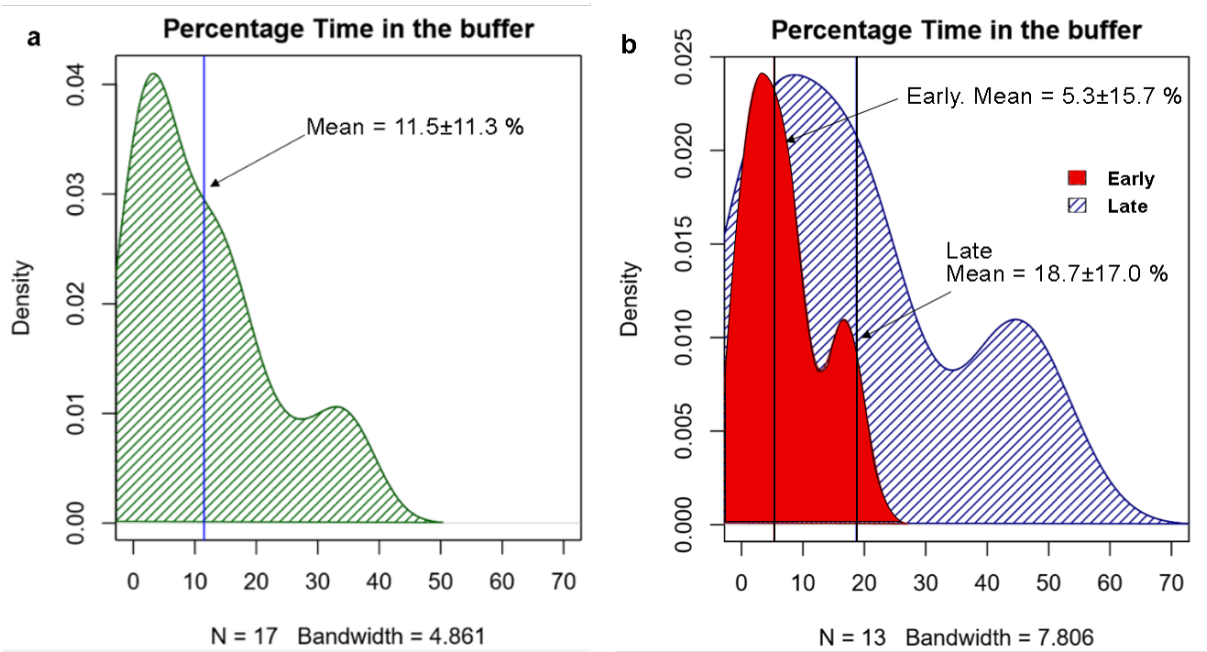

Figure 9. *Density plots of the percentage time that pups spent within the 5m buffer zone around the major wallows.* ***a.*** *overall and* ***b.*** *data separated into early and late, the vertical line represent the mean time that the 16 pups spent within the buffer.*

Figure 10. *Comparison of wallows in the main colony at Davis Point in two years, 2014/15 and 2017/18. The black arrows indicate the same tussock in consecutive images, the red arrows indicate dead pups, and the white arrows show a wallow that was present in 2014 but not in 2017.*

Differences in wallow characteristics between years. There were pronounced differences in the condition at the main colony at Davis Point between two breeding season (2014/15 and 2017/18) (Figure 10). 2017/18 was had less rain, which resulted in a drier substrate overall and fewer deep wallows. This seems to have contributed to a lower mortality rate for that year, although the high level of active intervention (rescuing pups from wallows) in both years makes this difficult to quantify. However, there were approximately eight deaths in wallows over a two-week period in 2017/18, with an additional 29 pups rescued. This contrasts with more than 60 rescues in 2014/15. Several wallows responsible for mortalities in 2014/15 were no longer present in 2017/18 (Figure 10).

Conclusions

The New Zealand sea lion pups at Davis Point moved a lot during December and January. All individuals that were tracked traversed the entire colony and all got to within 5m of a problem wallow. The overall percentage time that individuals spent in proximity to problem wallow was 11%. Results of the camera trap study suggest that once near a wallow there was on average a 14% likelihood of a pup entering it.

The pups nonetheless had areas (core usage regions) that they used more than others. These core regions changed over time increasing the likelihood that pups would encounter a problem wallow as the season progressed. In early January, pups spent an average of only 5% of their time near problem wallows. This increased to 18% two weeks later. This indicates that the most effective period of direct intervention is later in the season. mortality changes in both the short (within a year) and long term (between years). Drier years have fewer wallows, but even within a year some problem wallows can be transient. There are nonetheless some wallows, which are present every year and remain for the entire season. These are the ones that would benefit from permanent structural intervention (such as ramps and ladders).

Key management implications of the study are:

- All pups are at risk
- Ramps and digging trenches are effective and proven solutions but require maintenance. Some wallows can have semi-permanent structures but others need to be installed on a case by case basis depending on local conditions
- Human intervention (rescuing pups) is also effective but requires long-term presence at the colony.

Acknowledgements

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References

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