Otago Peninsula Lizard Monitoring Report 2016

Prepared for the Otago Peninsula Biodiversity Group (OPBG)

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Cryptic skink (*Oligosoma inconspicuum*) in *Helichrysum lanceolotum*

Left: An onduline retreat. Right: A pitfall trap with Southern grass skinks inside

Introduction

The Otago Peninsula Biodiversity Group (OPBG) and Carey Knox (Herpetologist, Knox Ecology) installed nine lizard monitoring lines on Otago Peninsula. A baseline of current lizard numbers at the sites was estimated through field work completed in spring 2016. In subsequent years, the aim is to identify any significant changes in lizard population numbers. This data can then be added to bird count, vegetation, and invertebrate monitoring data, in order to get an idea of how the native biodiversity of Otago Peninsula may be responding to the effects of possum removal and any other future pest control initiatives undertaken by the OPBG. The lizard species encountered in the monitoring equipment were the Southern grass skink (*Oligosoma polychroma*, Clade 5), korero gecko (*Woodworthia* sp. 'Otago-large'), and the cryptic skink (*Oligosoma inconspicuum*).

Methods

Lizard monitoring lines were installed at nine sites on Otago Peninsula which cover a range of sites of interest and different habitats used by lizards. Secure land tenure and accessibility was also taken into account when selecting sites, as well as the location of the OPBG rodent monitoring tracking tunnel lines. The monitoring sites are shown below (Fig. 1.).

Fig. 1. The nine sites on Otago Peninsula incorporated into a lizard monitoring programme

Monitoring equipment

At each of the nine sites a lizard monitoring line consisting of 10 lizard stations was installed. Each station was set out 10 m apart along a 100 m transect line. These 'stations' target both skinks and geckos by consisting of a pitfall trap (targeting skinks) and a 3-layered onduline Artificial Cover Object (hereafter ACO; targeting both skinks and geckos). Each ACO dimension was 40 x 50 cm and consisted of a stack of three sheets with 1-2 cm spacing between each layer (Fig. 2). Onduline ACOs create a thermally stable retreat for lizards that mimics the conditions of a rock crevice, which form natural retreats for lizards (Lettink & Cree 2007). When utilizing an appropriate study design and statistical method, this technique has been shown to be effective for monitoring of skink and geckos species (Lettink & Seddon 2007; Lettink & Cree 2007; Lettink *et al*. 2011). Pitfall traps consist of a plastic pottle dug into the ground (typically baited with pear to attract lizards which may subsequently fall into the trap and be unable to exit; Fig 2). Pitfall traps should be closed when not in use (they have a plastic lid) and checked every day to ensure that skinks are not constrained within traps for long periods. Pitfall traps should have a cover to provide shelter and prevent desiccation of skinks which fall into the trap. In this study, the onduline ACO functions both as an attractive refuge for lizards (skinks and geckos), a basking spot for skinks, and a lid for the pitfall trap.

Fig. 2. Left: 3-layered onduline ACO. Right: pitfall trap containing Southern grass skinks.

Monitoring protocol: Skinks (all sites)

During each monitoring day for seven continuous days all stations at all sites were visited and checked (onduline retreats were checked seven times and pitfall traps were baited on the first day and then checked six times). Once arriving at a site, the first lizard station was slowly approached and any skinks basking on top of the onduline ACO were noted. Then the rocks on top of the onduline retreats were carefully removed, without putting any weight on top of the onduline retreat (in case lizards were inside). Each layer of the onduline was then carefully checked by lifting one layer at a time. All lizards were identified (to species) and the number of each species counted. For each individual lizard it was noted whether the animal was ON the onduline, IN the onduline, UNDER the onduline, or in the pitfall trap.

As many lizards as possible were captured and their SVL (Snout to Vent Length) was measured (note: lizards move very quickly during warm weather, so it was not always possible to catch all lizards that were in an onduline retreat). The SVL measure excludes the tail of the lizard (because this can sometimes be absent or shortened, often due to predation), and is a standardised measure of the size of the lizard relative to other individuals. Sex was also noted on mature lizards (SVL greater than 54 mm). Taking the SVL measurements over multiple years, as well as the sex of mature lizards, potentially allows for any significant changes in the age structure or demography of a population to be identified. For example, pest control may allow the lizards in a population to live longer and achieve a greater size (on average), and as such, a significant increase in the average size of lizards in a population may suggest a benefit of pest control (Newman 1994; Towns 1991, 1994, 1996; Brown 1997; Rufaut & Clearwater 1997). Likewise, males and females may differ in their vulnerability to predation; therefore pest control could affect the sexes differently.

After checking and collecting data from the lizards, onduline ACOs were set up again by putting the layers back together and the rocks back on top. Once this was completed and the ACO was stable, lizards were released back into the onduline ACO. On day one, the pitfall trap was baited with two cubes of canned pear and traps were rebaited with fresh pear on day four. On days 2-7 the pitfall traps were checked and all skinks released into habitat within 1 m of the trap (but not back into the trap), after noting down the data mentioned above. Pitfall traps were closed on the last day of monitoring.

At all stations the following was recorded: site, weather, time of day, station number (1-10), what lizards were caught/sighted in both the pitfall trap and onduline retreat (on top, inside, or under), the size (SVL) of each lizard, the sex of mature lizards, and photo numbers for each capture (if photos were taken). For example: Paradise track: Station 1: Southern grass skink, juvenile, SVL = 45, UNDER onduline, Southern grass skink, ♀, SVL = 68, basking on top of onduline. Station 2: nothing. Station 3: Korero gecko ♀, SVL = 66, (photos: 2345-46)

IN onduline, Southern grass skink, ♂, SVL = 72, pitfall etc. The time of day each site was visited was rotated so that sites were checked at different times each day (to help account for any influence that time of day may have on the number of lizards caught or sighted).

Monitoring protocol: Geckos

Geckos were captured from within the layers of onduline, under the onduline, or in the pitfall traps (rarely – as geckos can climb out of pitfall traps). All geckos were given consecutive ID numbers (in order of capture for each site) and these were written on the belly of the gecko using a non-toxic marker pen. All geckos were sexed, measured (SVL – as per skinks) and photographed the first time they were captured (dorsal surface from straight above), as the patterns allow us to identify and keep track of individual geckos between monitoring days and years (Fig. 3; e.g. Gamble *et al*. 2008; Knox *et al*. 2013). For recaptured geckos between days, the ID number (written on the belly) was noted down and then the gecko released (there was no need to photograph or measure individuals more than once).

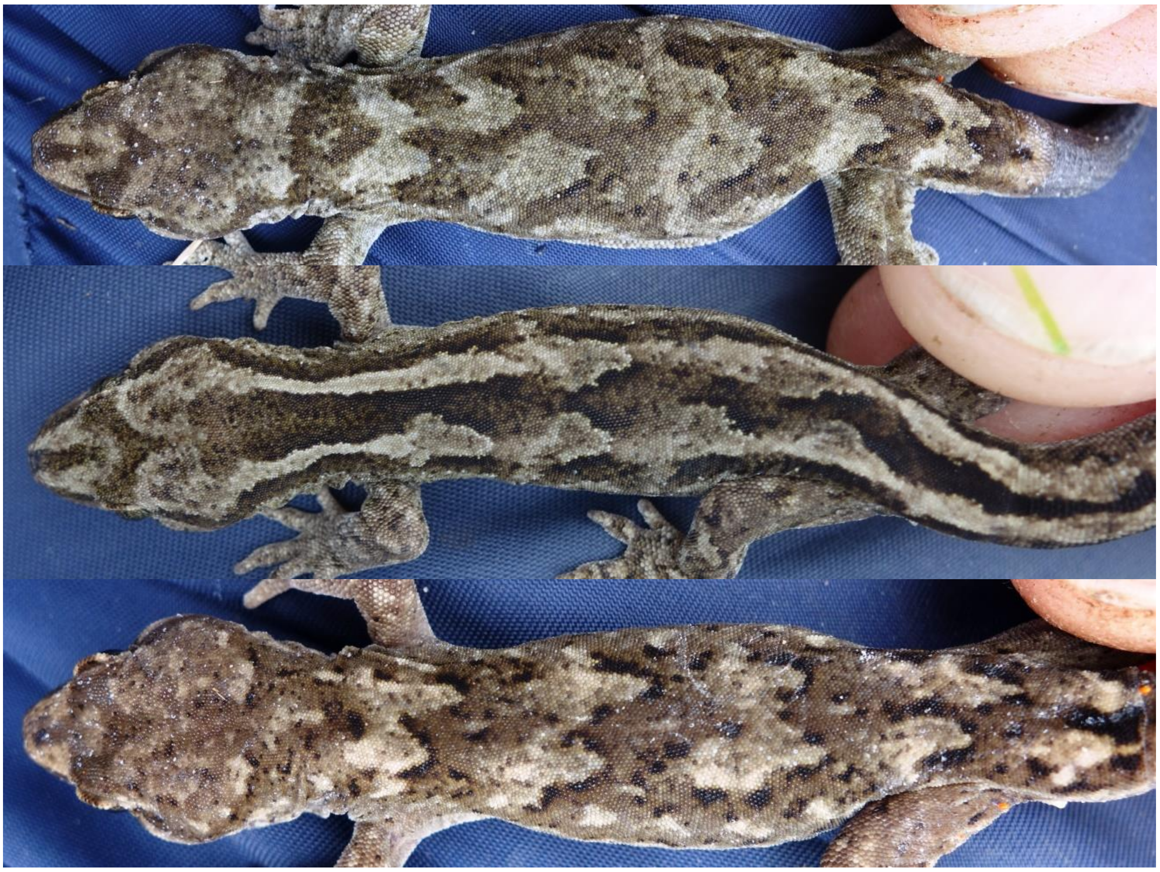


Fig. 3. Variation in the dorsal patterns of korero geckos (*Woodworthia* sp.) can be used to identify individuals within populations, assisting monitoring.

It was expected that the highest number of geckos would be recorded the first time the onduline retreats were checked, and thereafter numbers would drop with each subsequent retreat check. Successive daily checks can induce a negative 'trap response' (i.e. reduce the number of animals present over time; Lettink 2007; Wilson *et al*. 2007). In other words, repeated disturbance and handling may make geckos slow to return to retreats. This problem can be minimised by checking onduline ACOs every third day rather than on consecutive days (Lettink 2007). Nonetheless, in our study the onduline needed to be checked for seven consecutive days (rather than every third day), due to the schedule required for pitfall trapping and because the pitfall traps were under the onduline retreats. To get around this problem it was decided prior to the monitoring that if gecko numbers in the onduline dropped off too much over the seven days, then the data from days with poor gecko captures (defined as less than 25% of the initial number caught on day 1) would be excluded from the analyses and extra monitoring sessions (spaced at least three days apart - to allow for more time between disturbances) would be scheduled after the end of the pitfall trap monitoring in order to gain sufficient data to estimate population size. For example, say the number of geckos caught at the Pyramids over the first seven days are as follows: 20, 18, 14, 4, 3, 7, and 4. The data from days 1,2,3, and 6 would count (all over 25% of the day one catch, or over 5), but not the other days, meaning that an additional 3 checks would be required after the pitfall trapping is completed spaced 3 days apart (to bring the total number of checks to 7).

<u>Gear pack-up and storage</u>

Artificial retreats should be deployed at least three months before their first check, excluding winter - where there is little or no lizard activity. For monitoring, permanent placement is generally not recommended, unless it can be shown that it does not alter population parameters. For example, a population may be stable but the number of lizards using the retreats may increase over time - simply because more lizards find the retreats. This could be mistaken for an increase in population size. For long-term monitoring, sampling should be conducted at the same time each year following a standardised placement period, after which the artificial retreats are removed and replaced before the next sampling session (e.g. Lettink et al. 2011). For this project it is recommended to remove the gear once monitoring is complete in November, put the onduline into storage, and reinstall the gear in April (each year when monitoring is to take place). This also reduces wear and the chances of sheets becoming lost or damaged. Pitfall traps should be closed and left in place with a rock on top and filled with dirt (in case the lid comes off). Marking the location of each station (or every second station) with a wooden stake is recommended so that pitfall traps can be easily found and onduline ACOs put back in the same place as initially installed in subsequent years.

Statistical analysis: skinks

Skink abundance was estimated at all sites where sufficient numbers allowed for statistical analysis. Mark-recapture was not attempted for skinks, because it was not deemed possible to effectively distinguish between individuals in a population based on natural markings (Knox *et al*. 2013), and because temporary marks appear to rub off their smooth skin (regardless of the type of pen used) and are therefore not reliable (C. Knox *pers. obs.*). In addition, it is often impossible to catch every skink on top of, under, or inside an ACO. Mark-recapture only works well if all (or most) of the individuals found can be captured or tagged in some way. This often works well for New Zealand geckos, but is more difficult for skinks. Instead of mark-recapture, repeat count data was used in the programme PRESENCE. The counts for each station from the pitfall trap and onduline was combined. Royle (2004) N-mixture models for repeated count data were used. The variation in these point-counts provides information about the distribution of site-specific population size (N). Input data for this model are the counts of the number of individuals observed at each survey at each sample site. Note that the population estimates provided in this report do not represent total population sizes in the areas concerned, but simply reflect a sub-sample of each population (i.e. the proportion of each population that comes into contact with the ten monitoring stations). The area covered by the monitoring stations is approximately 100 m x 20 m. Nonetheless, they provide a reference point for future comparison to get an indication as to whether lizard populations are stable, increasing, or decreasing, at each site.

Statistical analysis: geckos

Abundance of korero geckos (*Woodworthia* sp. 'Otago-large') was estimated (at sites with sufficient data) using photo–mark–recapture (mark–recapture based on photographic recognition) and the POPAN formulation (a modification of the Jolly-Seber method; see Lebreton *et al*. 1992; Schwarz & Arnason 1996; Schtickzelle *et al*. 2003) in program MARK. Variation in the patterning of korero geckos is sufficient for this to potentially be effective, and as in other species where natural markings are permanent, population size can, thus, be estimated using photographs and mark–recapture methods (e.g. Gamble *et al*. 2008; Knox *et al*. 2013). Mark-recapture analyses will be performed in Program MARK version 6.2 (White 2013) using the POPAN formulation of the Jolly-Seber approach (Lebreton *et al*. 1992;

Schwarz & Arnanson 1996; Schtickzelle *et al*. 2003). POPAN estimates three primary parameters; residence (probability of staying in a population, *phi*), catchability (*p*), and probability of entering the population (births plus immigration, *pent*). Derived parameters are; daily number of births (Bi), daily population size (Ni) and total population size (Ns). Model notation follows Lebreton *et al*. (1992). A range of models will be trialled and the Akaike's Information Criterion corrected for small sample size (AIC_c, Burnham & Anderson 2002) used to rank models by parsimony. The best fitting POPAN model (the model with the lowest AIC-value relative to all competing models) was chosen as the population estimate.

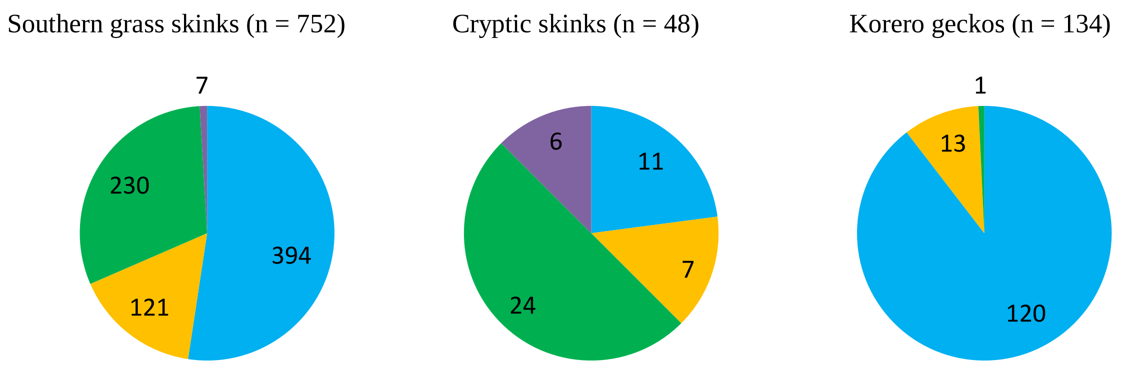
Results

Seven days of consecutive pitfall trapping and onduline retreat checks were completed at all nine sites on the Otago Peninsula between the 30th of October and 5th November. In addition, a further day of gecko monitoring (an onduline check) was undertaken at 'The Pyramids' on the 9th of November (Table 1; the only site where sufficient gecko captures were made to enable a population estimate to be calculated using mark-recapture). In total, 934 lizard captures or sightings were made at the lizard stations. This consisted of 752 captures / sightings of Southern grass skinks, 48 cryptic skinks, and 134 korero geckos. Lizard captures per day are shown below (Table 1). Lizard captures were highest on day 1 (211 lizards) and lowest on day 6 (91 lizards). Skink captures remained reasonably similar across the seven consecutive days of checks. In contrast gecko captures dropped quickly over the first few days (as predicted) and remained much lower from there until the end of monitoring.

Table 1: Lizard captures during seven consecutive days of pitfall trapping and onduline retreat checks on Otago Peninsula. An additional onduline check 4 days after the cessation of pitfall trapping is included (far right).

Species	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Total	Day 11
Southern grass skink	145	116	127	91	114	72	87	752	-
Cryptic skink	3	9	6	2	11	10	7	48	-
Korero gecko	61	32	13	3	4	9	10	134	10
Total	209	157	146	96	129	91	104	934	10

Lizards can be difficult to catch in the onduline retreats during hot weather, and as such, some escaped before they could be captured, sexed, and measured. Nonetheless, all sighted lizards were counted as this was important for the repeat count analyses. Skinks were generally much harder to catch within the onduline than geckos, because skinks move faster (only 42% of skinks sighted on, within, or under the onduline retreats were captured, compared with 86% of geckos). The maximum number of individuals in one onduline retreat on one occasion was 17 for skinks (Te Rauone) and 16 for geckos (The Pyramids). The number of lizard captures over the seven consecutive days for each species and how each lizard was caught (or where each lizard was sighted before evading capture) varied for each species (Fig. 4). More than half of Southern grass skink captures / sightings were within the onduline retreat (between the onduline sheets). Approximately one-third were under the onduline retreat (on the ground) and one quarter of Southern grass skinks were caught in the pitfall traps (Fig. 4). For cryptic skinks, half were caught in the pitfall traps, with the remainder split fairly evenly between in, under, or on top of the onduline retreats (Fig. 4). For korero geckos the vast majority of captures / sightings were made between the onduline sheets, a few under the onduline, and only one in a pitfall trap. This was expected as, unlike skinks, geckos can climb out of pitfall traps.



Key: green = pitfall trap, orange = under the onduline, blue = in the onduline, purple = on the onduline

Fig. 4. Method of capture or sighting for three lizard species encountered during lizard monitoring on Otago Peninsula. The species common name is above each graph. The key outlines what each segment represents.

Total lizard captures for each species at each site are given below (Table 2). Southern grass skinks were recorded at all sites, but were easily most numerous at Te Rauone (458 of the 752 total captures). Cryptic skink were found in reasonable numbers at Pilots Beach and The Pyramids, but were not recorded at any of the other sites. Korero geckos were most numerous at the Pyramids (105 captures), which was the only site were sufficient numbers were present to allow for mark-recapture. Nonetheless, there appeared to be a reasonable number on

Harbour Cone (25 captures) and there may be a population living amongst the old macrocarpas at Sandymount, as two geckos were recorded here in onduline retreats close to the macrocarpa plantation. The Pyramids has the greatest diversity of lizard species, as it was the only site where all three species were recorded at the monitoring stations.

Table 2: Lizard captures at each site during lizard monitoring on Otago Peninsula in spring 2016. Lizards were recorded in pitfall traps and onduline retreats (10 of each per site spaced 10 m apart).

Species	Pilots Beach	Te Rauone	The Pyramids	Grassy Point	Leith track	Harbour Cone	Sandy mount	Paradise Track	Buskin Track
Southern grass skink	44	458	23	55	29	19	55	34	35
Cryptic skink	23		25						
Korero gecko			105			25	2		
Total	67	458	153	55	29	44	57	34	35

For all lizards captured Snout-Vent Length (SVL) was measured and sex determined for mature lizards (over 54 mm SVL). The proportion of males, females, and juveniles, is shown below for each species across all the sites as well as the average and range of SVLs (Fig. 5; Table 3). For both Southern grass skinks and korero geckos, there were a far greater number of females caught as opposed to males (roughly twice as many; Fig. 5). This may indicate that females are more inclined to use the Onduline, rather than an uneven sex ratio in the wider population.

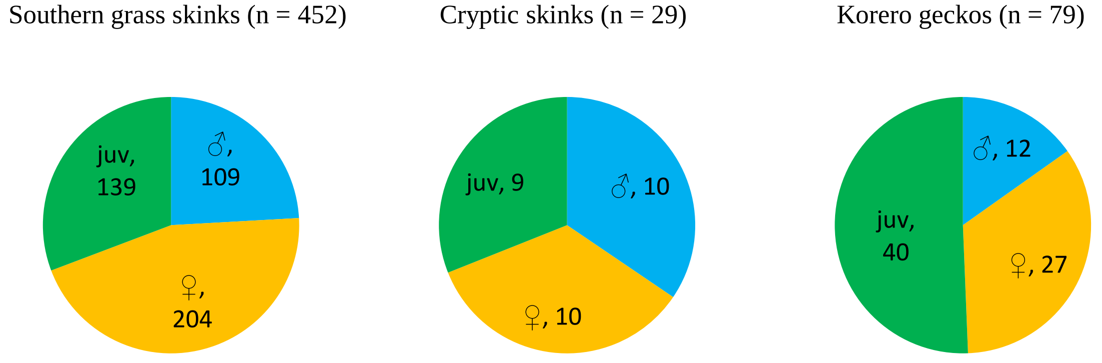


Fig. 5. The proportion of females, males, and juveniles, for three lizard species encountered during lizard monitoring on Otago Peninsula. The species common name is above each graph. Sample sizes are displayed.

Table 3: Snout-Vent Length (SVL) of lizard captures during monitoring on Otago Peninsula in spring 2016. For each species (and males, females, and juveniles separately) ranges and means with standard errors are displayed.

Species	SVL ♂	SVL ♀	SVL juvs	SVL total	SVL range
Southern grass skink	59.49 ± 0.29	63.85 ± 0.36	46.00 ± 0.59	57.31 ± 0.44	32-78
Cryptic skink	66.40 ± 1.67	65.90 ± 1.15	46.00 ± 1.03	59.90 ± 1.95	41-77
Korero gecko	65.08 ± 1.82	62.70 ± 1.08	43.73 ± 1.14	53.46 ± 1.34	31-80

Abundance of Southern grass skink and cryptic skink (where found) was estimated using repeat count data and N-mixture models (Royle 2004) in PRESENCE (Table 4). For each estimate, several models were ran including models that assumed constant detectability between sampling days, varying detectability between sampling days, and models that included weather and/or time of the day as co-variates (and combinations between all the aforementioned models). Akaike's Information Criterion corrected for small sample size (AIC_c) was used to find the best supported model for each estimate and the model that had a ΔAIC_c of zero was reported (Burnham & Anderson 2002; Table 4). For Southern grass skinks total abundance across all the sites was 503 ± 202 individuals (from 752 captures; some animals would have been caught more than once). At 345, Te Rauone clearly had the largest population of Southern grass skinks (or highest population density; 69% of the summed population estimates and 60% of the Southern grass skink captures). At the other sites the population estimates ranged from 10 ± 3 (Paradise Track) to 31 ± 8 (Grassy Point).

Table 4. The estimated abundance of: a) Southern grass skinks and b) cryptic skinks - at nine different monitoring sites on the Otago Peninsula calculated using Royles (2004) N-mixture models in PRESENCE. Count indices are also reported.

a) Southern grass skinks

Statistic	Pilots Beach	Te Rauone	The Pyramids	Grassy Point	Leith track	Harbour Cone	Sandy mount	Paradise Track	Buskin Track	All sites (summed)
Abundance (Royles) ± SE	30 ± 10	345 ± 149	11 ± 4	31 ± 8	18 ± 8	13 ± 6	28 ± 9	10 ± 3	17 ± 5	503 ± 202
Mean captures / day ± SE	6.3 ± 2.4	65.4 ± 24.7	3.3 ± 1.2	7.9 ± 3.0	4.1 ± 1.6	2.7 ± 1.0	8.0 ± 3.0	4.9 ± 1.8	5.0 ± 1.9	102.6 ± 38.8
Total captures	44	458	23	55	29	19	55	34	35	752
Max. per day	13	94	5	22	7	6	18	10	11	145
Day of max	Day 3	Day 5	Day 7	Day 3	Day 4	Day 2	Day 2	Day 2	Day 2	Day 1

b) Cryptic skink

Statistic	Pilots Beach	The Pyramids	All sites (summed)
Abundance (Royles) with SE	43 ± 43	33 ± 24	76 ± 67
Mean captures with SE	3.3 ± 1.2	3.6 ± 1.3	6.9 ± 2.6
Total captures	23	25	48
Maximum per day	9	6	11
Day maximum recorded	Day 5	Days 2 & 6	Day 5

Abundance of korero geckos was estimated at the Pyramids using mark-recapture (the only site with sufficient captures for population analysis). The POPAN formulation (a modification of the Jolly-Seber method; see Lebreton et al., 1992; Schwarz and Arnason, 1996; Schtickzelle et al., 2003) was used in program MARK. Several models were traillled and the best fitting POPAN model (the model with the lowest AIC-value relative to all competing models), was chosen as the population estimate. The best supported model had constant survival (or residence) across the monitoring period (probability of staying in population, *phi*), varying catchability between days (*p*), and varying probability of entering the population (in this case immigration only, *pent*) per day. Population size, number of gecko captures, number of individual geckos recorded, and number recorded on the first day is given for all three sites where korero geckos were recorded (where possible) below (Table 5). Note that for all three sites korero gecko numbers were highest on the first day and then dropped off sharply (Table 1).

Table 5. Population size estimated using the POPAN formulation in program MARK (where possible), number of gecko captures, number of individual geckos recorded, and number recorded on the first day is given for all three sites where korero geckos were recorded during lizard monitoring on the Otago Peninsula in spring 2016.

	The Pyramids	Harbour Cone	Sandymount
Population estimate with SE and 95 % CI	97 ± 14 (72-132)	N/A	N/A
Total geckos sighted	105	25	2
Total gecko captures	94	22	2
No. of captured individuals	60	17	2
No. on first day sighted	40	19	2
No. on first day captured	30	16	2

Discussion

Seven days of consecutive pitfall trapping and onduline retreat checks were completed at all nine sites on the Otago Peninsula between the 30th of October and 5th November. In addition, a further day of gecko monitoring (an onduline check) was undertaken at 'The Pyramids' on the 9th of November. Overall the weather conditions were very good for the monitoring. The weather was generally mild to warm and some sunshine occurred every day. There were a few brief spells of rain, but no days were completely rained out (during consistent rain or cold weather lizard captures may drop to near-zero). In total, 934 lizard captures or sightings were made at the lizard stations. Skink captures remained reasonably similar across the seven consecutive days of checks. In contrast gecko captures dropped quickly over the first few days (as predicted) and remained much lower from there until the end of monitoring.

The combination of the onduline retreat and the pitfall trap at each monitoring station worked well to maximise lizard captures at each sampling point. The onduline retreats caught more lizards overall than the pitfall traps; however one-quarter of Southern grass skinks and half of the cryptic skinks were recorded in pitfalls. In other studies pitfall traps have 'out-caught' the onduline retreats and pitfall traps also have the benefit of constraining the lizards within enabling easy capture and data collection. Which monitoring tool works better will depend on a number of factors, including the target species, habitat, and weather conditions. For example, pitfall traps only work well when the weather is mild, warm or hot, allowing for lizard activity; whereas, onduline retreats will work to some degree in cold weather (as they offer shelter) as well as warm weather. However, if the onduline retreats become too hot, lizards will leave them. So generally speaking the onduline retreats will out-compete pitfalls in cold weather, in mild or warm weather both methods work well. And in hot weather pitfall traps will out-compete onduline. These observations add weight to the argument that using the two monitoring tools combined will generally allow for better numbers of captures to be made over multiple days, as opposed to using one or the other method on its own.

The monitoring indicates that Southern grass skinks are widespread on Otago Peninsula, very abundant at some sites (e.g. Te Rauone), and inhabit a wide range of environments (e.g. road-sides, grasslands, shrublands, sand-dunes, farmland, forest edges or clearings, and rocky hill-tops). Some reasons for this abundance may be a generalist and adaptable habitat use, an ability to evade predation better than other lizard species, and their high reproductive capacity relative to other New Zealand lizards (e.g. Southern grass skinks 2-10 young per year, cryptic skinks 2-6 young per year, korero gecko 1-2 young per year; Jewell 2008).

Photograph illustrating the differences in appearance between Southern grass skinks and cryptic skinks at Pilots beach. The cryptic skink is less 'striped' and more 'flecked' with black

In contrast to Southern grass skinks, cryptic skinks are more selective of habitat and seem to only persist in a narrow range of circumstances on the Otago Peninsula. They require damp habitat. The discovery of a small population of cryptic skinks at Pilots Beach was significant as they are currently only known from two other sites on Otago Peninsula. There is a small population at Cape Saunders and a large population in the Okia Reserve and surrounds. Survey work over the last year indicates that cryptic skinks are quite widespread in Okia Reserve, ranging from the edge of Tairoa Bush, to the Pyramids, to Victory Beach. However, they are likely to still be patchy, favouring damper areas with sufficient cover. At Okia the cryptic skinks are found in rocky areas, swamp edges (with flax), damp bracken fern-land, forest edges (generally found under rocks or pieces of rotting wood), and in the sand dunes along victory beach. On the pyramids they are often seen basking in dense low growing *Helichrysum lanceolotum*. The Cape Saunders site is similar to parts of Okia. The Pilots Beach site is very different to the other sites where cryptic skinks have been recorded. The population appears to be restricted to a slope covered almost entirely in the introduced South African ice plant (*Carpobrotus edulis*). The ice plant here seems to hold a great deal of moisture underneath which is likely to have enabled the cryptic skinks to persist at the site. Cryptic skinks were rarely sighted in surrounding areas of marram grass. The existence of cryptic skink populations in this introduced pest plant may provide a conundrum for conservation management. However, plantings of snowberry (*Gaultheria macrostigma* – a favoured habitat of cryptic skinks at Macraes Flat) and *Helichrysum lanceolotum* could provide suitable native alternatives for habitat restoration, in cases where removal or reduction of the ice plant cover is desired.

Cryptic skink on an ice plant flower

Part of the ice plant slope inhabited by cryptic skinks at Pilots Beach

Korero geckos were only abundant at the Pyramids; although reasonable numbers are also present at Harbour Cone. Korero geckos on Otago Peninsula are largely restricted to rocky areas, such as hill tops, where sufficient refuge from predators can be obtained. Korero geckos are nonetheless also able to persist at forest or shrubland sites with mature trees (which provide suitable retreats under bark or in holes or cracks). They have also turned up in clay banks (Leith track) and kanuka shrubland (e.g. around Portobello and Hooper's Inlet), but are generally absent, sparse, or low in number at sites without suitable rocky retreats. The sites where korero geckos have been recorded in abundance all have an abundance of rock e.g. Dickson's Hill, The Pyramids, Harbour Cone, and parts of Cape Saunders.

The green skink (*Oligosoma chloronoton*) was not recorded during the monitoring. These large skinks (SVL up to 110 mm) are more vulnerable to predation than the smaller skink species and may be extinct, or close to extinction, on Otago Peninsula. The last known sighting occurred in 2007 and searches of several sites (with potential habitat for this species) by the author have yielded no results (sites searched include: Dickson's Hill, Cape Saunders, Okia Reserve, The Pyramids, Tairoa Bush, Pilots Beach, and Harbour Cone). There remains a chance that a population still exists somewhere on the peninsula but has not yet been identified. Searches will continue. If a population of this threatened species is found on Otago Peninsula, suitable conservation measures can then be considered and implemented.

Korero gecko at 'The Pyramids' site

Jewelled geckos (*Naultinus gemmeus*) are also widespread on Otago Peninsula and abundant at some sites, but will not be discussed in detail in this report, as they were not targeted by the monitoring regime. Jewelled geckos are arboreal shrub or tree-dwelling lizards, and do not appear to use either onduline retreats or pitfall traps. Jewelled geckos were not recorded in the monitoring programme. They require specialist skills and methods to monitor. Monitoring of jewelled geckos on Otago Peninsula is taking place under a separate arrangement.

Jewelled gecko (*Naultinus gemmeus*)

The abundance estimates of all lizard species at all sites provide a useful baseline for future comparisons. The estimates varied in their degree of precision, which can be seen by looking at the standard errors (Table 4 & 5). Where estimates lack precision, the count indices (such as the number recorded on the first day (especially for geckos), number recorded on the best day, total number of captures, and mean number of captures) still provide some information of use for future comparison. The use of repeat count modelling worked well for the Southern grass skinks in particular. For the skinks it was clear that even if they were individually recognisable (or able to be reliably marked or tagged in some way), mark-recapture would not have worked given the large number of skinks that evaded capture in the onduline retreats (only 42% of captured, compared with 86% of geckos). This justifies the use of repeat count modelling over mark-recapture. Mark-recapture worked well for the korero geckos using the combination of photographs and temporary marks. The photographs were checked for double-ups and one incidence was identified where a gecko's temporary mark had rubbed off (the gecko may have shed its skin) and the gecko had accidentally been marked twice with two ID numbers. Using the combination of the photographs and the temporary marks allows for such incidences to be identified and corrected in the data increasing the accuracy of the population estimate.

It is recommended that if lizard monitoring is to be continued by the OPBG that it takes place using the exact same methods at the exact same time of year each year. The monitoring regime could be undertaken annually or bi-annually, depending on the frequency at which OPBG thinks it best to obtain this data. The monitoring regime appeared to work well and major changes should be avoided. It is critical to have personnel experienced with handling lizards undertake this work (and/or appropriately trained personnel). After a few years of lizard monitoring data it may be interesting to compare any observed population trends with trends observed in the mammal pest monitoring data collected by OPBG, as well as bird and invertebrate count data and any observed vegetation changes. This may yield some interesting insights into the effects of possum removal on the natural ecosystems of the Otago Peninsula.

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