MONITORING OF INDIGENOUS LIZARDS ON OTAGO PENINSULA IN DECEMBER 2018

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Cryptic skink at Pilots Beach on ice plant

Pitfall trap at Te Rauone Beach containing 18 southern grass skinks

MONITORING OF INDIGENOUS LIZARDS ON OTAGO PENINSULA IN DECEMBER 2018

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1. INTRODUCTION

The Otago Peninsula Biodiversity Group (OPBG) was formed by members of the Otago Peninsula community to facilitate the removal of pest animals from the Peninsula (9,500 hectares) in order to protect biodiversity values, lifestyles, and economic values. The initial target for the OPBG was the removal or low-level suppression of possums (*Trichosurus vulpecula*) across the Otago Peninsula, and possum numbers across the Peninsula have been heavily reduced since control began in 2011. The OPBG have also shown a keen interest in monitoring the potential effects of their pest control on the indigenous plants and fauna, and this includes monitoring of indigenous lizards.

The OPBG arranged for installation of nine lizard monitoring transects on Otago Peninsula in 2016 and recorded a baseline of lizard species and numbers along these transects (Knox 2016). This monitoring was repeated two years later in December 2018 in order to obtain more data on lizard populations and potentially identify any population trends, as described in this report.

The OPBG are also interested to know whether or not a manageable population of the green skink (*Oligosoma chloronoton*) can be located on Otago Peninsula, and thus, a secondary aim of this monitoring work was to try and identify such a population.

2. METHODS

2.1 Target species

Nine monitoring sites were examined in 2016 (Knox 2016). The lizard species encountered during the 2016 monitoring were the southern grass skink (*Oligosoma polychroma*; Clade 5 - all sites), korero gecko (*Woodworthia* "Otago-large" - three sites), and the cryptic skink (*Oligosoma inconspicuum* - two sites). Jewelled geckos (*Naultinus gemmeus*) were not targeted by the monitoring regime, as they require different monitoring methods, but are known to be widespread on Otago Peninsula. There is potential for another species, the Otago green skink (*Oligosoma* aff. *chloronoton*), to be present on the Otago Peninsula and possibly at one or more of the monitoring sites. Historically, Otago green skinks were present on Otago Peninsula, and there are confirmed reports of green skink from at least three sites (most recently in 2007), as well as on Wharekakahu Island off the Cape Saunders coastline. Green skinks have shown severe declines across Otago (T. Jewell, pers. comm.; C. Knox pers. obs.) and Southland and these declines are of conservation concern. The OPBG are particularly interested in locating Otago green skinks on Otago Peninsula and potentially managing them in order to protect them from introduced predators and other threats.

2.2 Monitoring sites

In 2016, lizard monitoring transects were installed at nine sites on Otago Peninsula, covering a range of different habitats used by lizards. Secure land tenure and accessibility were taken into account when selecting sites, as well as the locations of the OPBG rodent monitoring tracking tunnel lines in order to enable comparison of lizard monitoring data with rodent tracking tunnel data. In 2018, the OPBG expanded the lizard monitoring to ten sites. Seven of these sites are sites that were also monitored in 2016, two sites were dropped (due to small numbers or low diversity of lizards), and three new sites have been added following discussions with OPBG in an attempt to cover a greater range of habitats and also target detection of Otago green skinks (Table 1; Figure 1).

Table 1: Sites selected for monitoring of indigenous lizards on Otago Peninsula in 2018.

Site	Target species	Reason for inclusion
Harbour Cone	Southern grass skink, korero gecko	Good population of korero gecko
Te Rauone Beach	Southern grass skink	Most abundant southern grass skink population from the 2016 monitoring.
Okia - Large Pyramid	Cryptic skink, southern grass skink, korero gecko, Otago green skink	Good populations of three lizard species. Possibility of Otago green skink.
Sandymount	Southern grass skink, korero gecko	Good population of southern grass skink. Small numbers of korero gecko.
Grassy Point	Southern grass skink	Southern grass skinks present. Multi-species predator control in place.
Bushkin Track	Southern grass skink	Southern grass skinks present. Rodent line.
Pilots beach upper	Cryptic skink, southern grass skink, Otago green skink	Good population of cryptic skinks. Possibility of Otago green skinks (old report).
Pilots beach lower	As above	As above.
Cape Saunders	Cryptic skink, southern grass skink, korero gecko, Otago green skink	Good populations of three lizard species. Possibility of Otago green skink.
Dickson's Hill	Cryptic skink, southern grass skink, korero gecko, Otago green skink	Good populations of three lizard species. Most recent (2007) record of an Otago green skink from Otago Peninsula.

Figure 1: Sites selected for monitoring of indigenous lizards on Otago Peninsula.

2.3 Monitoring set-up phase

At each of the ten sites a lizard monitoring transect comprising ten lizard stations was installed in August 2018. Each station was set out 10 metres apart along a 100 metre transect. Each station had its position recorded using a hand-held GPS unit and was flagged to ensure it could be easily found during subsequent monitoring in November. These 'stations' targeted both skinks and geckos by comprising a pitfall trap (targeting skinks) and a three-layered Onduline Artificial Cover Object (hereafter ACO; targeting both skinks and geckos).

Each ACO dimension was 40 × 50 centimetres and consisted of a stack of three sheets of Onduline with 1-2 centimetre spacing between each layer (Plate 1). Onduline ACOs create a thermally stable retreat for lizards that mimics the conditions of rock crevices, which form natural retreats for lizards (Lettink & Cree 2007). 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 (Plate 1).


Plate 1: Left: 3-layered Onduline ACO. Right: pitfall trap containing skinks.

Pitfall traps were closed when not in use (they have a plastic lid) and checked every day to ensure that skinks are not enclosed within traps for long periods. Pitfall traps had a cover (Onduline) to provide shelter and prevent desiccation of skinks which fall into the trap. In this study, the Onduline ACO would function both as an attractive refuge for lizards, a basking spot, and a lid for the pitfall trap. Extra-large deep-sided pitfall traps were used at sites where Otago green skinks were considered a possibility (i.e. Cape Saunders, Dickson's Hill, and both Pilots Beach sites), as green skinks are much larger than the other skink species and smaller pitfall traps will not always contain them between checks.

2.4 Monitoring protocol for skinks

During each monitoring day for seven continuous days from 6-12 December 2018 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 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 lizard it was noted whether the animal was on the Onduline, in the Onduline (between the layers), 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 every lizard that was 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 millimetres). Recording 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. 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 1, the pitfall trap was baited with two cubes of canned pear and the traps were rebaited with fresh pear on Day 4. 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 recording the information described above. Pitfall traps were closed on the last day of monitoring and the gear packed up and brought back to storage.

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).

2.5 Monitoring protocol for geckos

Geckos were captured from within the layers of Onduline, under the Onduline, or rarely, in the pitfall traps (geckos can generally 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 that they were captured (dorsal surface from straight above), as the patterns allow for individuals to be identified between monitoring days and years (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 individual geckos twice).

2.6 Gear pack-up and storage

It is standard practice to deploy artificial retreats three-four months before the first check in order to give lizards sufficient time to find the retreats, become accustomed to their presence, and begin habitually using them. In this study, artificial retreats were deployed in August and the monitoring took place in December. It was initially aimed to undertake the monitoring in early November (as was done in 2016); however, the weather was too poor, so monitoring was delayed until December 2018.

The gear (Onduline and pitfall traps) were removed once the monitoring was complete in and put into storage. 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. Monitoring equipment should be reinstalled in the late winter of any subsequent monitoring years. This also reduces wear and the chances of sheets becoming lost or damaged. The location of each station (or every second station) was marked with a wooden stake in 2016 so that pitfall traps and Onduline ACOs could be put back in the same places in each subsequent monitoring year.

2.7 Statistical analysis of gecko data

Abundance of korero geckos (*Woodworthia* "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 were 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 were trialled and the Akaike's Information Criterion corrected for small sample size (AICc, 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 selected as the most reliable population estimate.

2.8 Statistical analysis of skink data

Mark-recapture was not attempted for skinks, because it was not possible to effectively distinguish between individuals in a population based on natural markings, and because temporary marks tend 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 meaning that many captures cannot be marked. 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, numbers of skinks caught at each site, sex ratios, and average size of individuals were compared between 2016 and 2018.

3. SURVEY RESULTS AND DATA ANALYSIS

3.1 Overview

Seven days of consecutive pitfall trapping and Onduline retreat checks were completed at all ten sites on the Otago Peninsula between 6-12 December 2018. In total, 1,060 lizard captures or sightings were made across the 100 lizard stations. This consisted of 777 detections of southern grass skinks, 111 cryptic skinks, and 172 korero geckos. Otago green skink were not located. Southern grass skinks were recorded at all sites, but were easily most numerous at Te Rauone Beach (571 of the 777 total captures for this species). Cryptic skinks were found in reasonable numbers at Pilots Beach and The Pyramids, and were also recorded at Cape Saunders. Korero geckos were most numerous at the Pyramids (104 detections out of a total 172). There were also reasonable numbers on Harbour Cone (n = 37) and Dickson's Hill (n = 26). Korero gecko were also present in low numbers at Sandymount and Cape Saunders. The Pyramids and Cape Saunders had the greatest diversity of lizard species, as they were the only site where all three species were recorded at the monitoring stations.

Lizard captures per day are shown in Table 2, while lizard captures per site are compared to 2016 captures in Table 3. The weather was good for the first six days of the monitoring (generally warm, sunny or partly cloudy days), but poor on the last day when it rained. This resulted in substantial numbers (i.e. $\geq$140) of lizards being recorded on all of the monitoring days, except for the last rainy day when < 50 lizards were recorded.

Table 2: Detections per day from monitoring of indigenous lizards on Otago Peninsula in December 2018.

Day	Southern Grass Skink	Cryptic Skink	Korero Gecko	Total Lizards
1	79	13	55	147
2	123	23	33	179
3	126	23	26	177
4	144	14	21	180
5	152	26	17	192
6	110	10	17	137
7	43	2	3	48
TOTAL	**777**	**111**	**172**	**1060**

Table 3: Detections per site from monitoring of indigenous lizards on Otago Peninsula in December 2018 along with a comparison with the 2016 data. N/A means the site was not examined.

Site	Southern Grass Skink		Cryptic Skink		Korero Gecko		Total Lizards	
	2016	2018	2016	2018	2016	2018	2016	2018
Harbour Cone	19	10			27	37	46	47
Te Rauone Beach	458	571					458	571
The Pyramids	23	22	25	28	105	104	153	154
Sandymount	55	22			2	1	57	23
Grassy Point	55	34					55	34
Buskin track	35	14					35	14
Pilots Beach upper	44	14	23	41			67	55
Pilots Beach lower	N/A	17	N/A	33	N/A		N/A	50
Cape Saunders	N/A	2	N/A		N/A	4	N/A	15

Site	Southern Grass Skink		Cryptic Skink		Korero Gecko		Total Lizards	
	2016	2018	2016	2018	2016	2018	2016	2018
Dickson's Hill	N/A	71	N/A		N/A	26	N/A	97
Leith Track	29	N/A		N/A		N/A	29	N/A
Paradise Track	34	N/A		N/A		N/A	34	N/A
TOTALS	752	777	48	111	134	172	934	1060

As was the case in 2016, Te Rauone Beach had by far the greatest number of lizards, due to a high-density population of southern grass skink being present. Skink detections at Te Rauone Beach from the ten monitoring stations per day ranged from 38-106. The maximum number of southern grass skinks recorded at a Te Rauone Beach station on a single check was 27, with a maximum of 18 recorded in a pitfall trap and 25 in an Onduline retreat. The most korero geckos recorded in an Onduline retreat was eight at the Pyramids. Lizard detections were highest on Day 5 (192 lizards) and lowest on Day 7 (48 lizards). Skink detections remained reasonably similar across the seven consecutive days of checks, except for the last day (Table 2). In contrast gecko detections gradually dropped over the course of the monitoring, as expected due to repeat interference with the Onduline retreats.

Lizards can be difficult to catch in the Onduline retreats during hot weather, and as such, many escaped before they could be captured, sexed, and measured. Nonetheless, all sighted lizards were counted as this was important for the repeat count analyses. Overall, 565 lizards (417 southern grass skinks, 69 cryptic skinks, and 79 korero geckos) were captured, sexed, and measured out of the 1060 lizards recorded total (53%).

The proportion of individuals caught or detected by the trap or retreat varied for each lizard species (Figure 2). More than half of southern grass skink captures/sightings were within the Onduline retreat (between the Onduline sheets). Approximately one-quarter were in the pitfall trap with the remainder being either under, or on top of, the Onduline retreat. For cryptic skinks, nearly half were caught in the pitfall traps, with the remainder split fairly evenly between in, under, or on top of the Onduline retreats (Figure 2). For korero geckos the vast majority of captures/sightings (158 out of 172) were made between the Onduline sheets, with 10 under the Onduline, and only two caught in pitfall traps. This was expected, as unlike skinks, geckos can climb out of pitfall traps.

For all 565 lizards that were captured Snout-Vent Length (SVL) was measured and sex determined for mature lizards (≥52 millimetres 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 (Figure 3; Table 4). 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; Figure 3). This may indicate that females are more inclined to use the lizard stations, rather than an uneven sex ratio occurring in the wider population. For cryptic skinks, however, the number of males and females recorded was similar. The average size (SVL) of all three species was slightly larger in December 2018 than was what recorded in November 2016 (Table 4). This may partly be because a higher proportion of juveniles were recorded in 2016 (Figure 3).

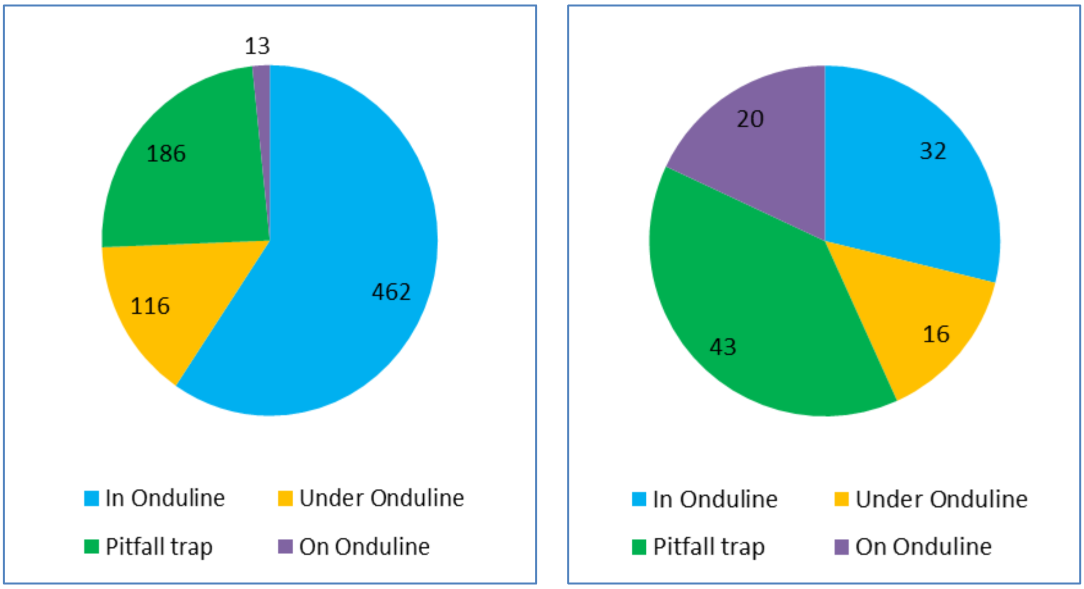

Figure 2: Detection locations of southern grass skinks (left) and cryptic skinks (right) during the 2018 monitoring.

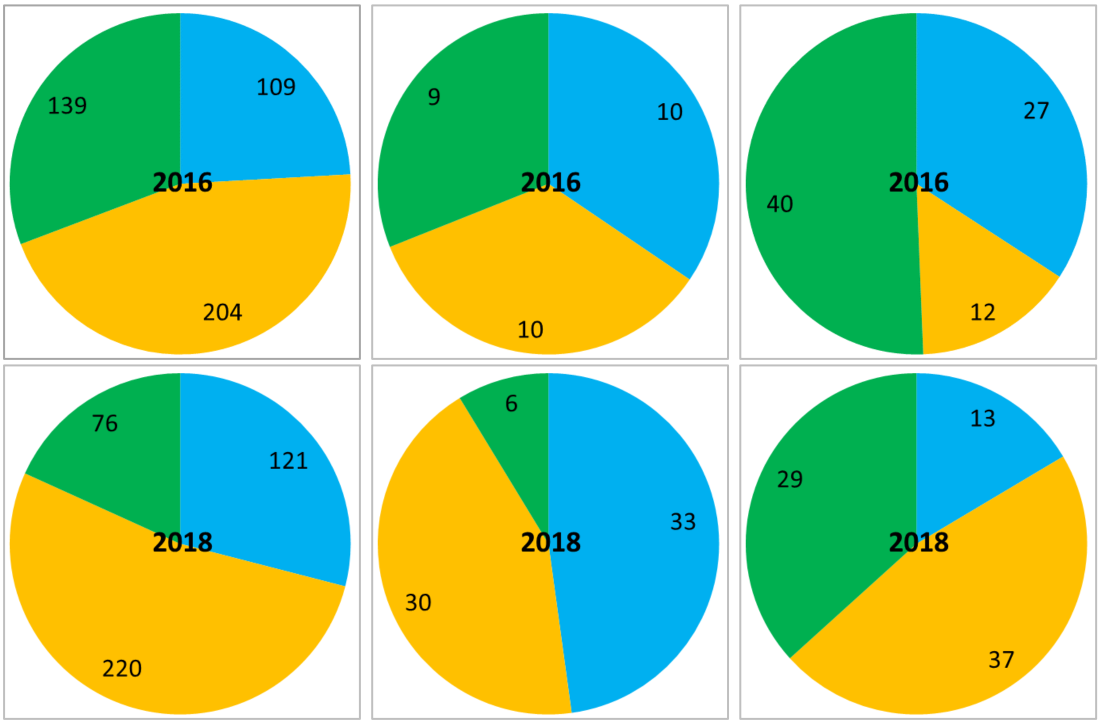

Figure 3: Ratio of adult males (blue), adult females (orange), and juveniles (green ≤51 mm SVL) southern grass skinks (left), cryptic skinks (center), and korero geckos (right) detected during monitoring of indigenous lizards on Otago Peninsula in December 2018 (below) and November 2016 (above). Sample sizes and the year of monitoring are depicted on the graphs.

Table 4: Average SVL (Snout-Vent-Length) ± SE of lizards detected from monitoring of indigenous lizards on Otago Peninsula in December 2018 and November 2016.

	Southern Grass Skink		Cryptic Skink		Korero Gecko	
	2016	**2018**	**2016**	**2018**	**2016**	**2018**
Males	59.5 ± 0.3	58.8 ± 0.3	66.4 ± 1.7	65.7 ± 0.9	65.1 ± 1.8	70.8 ± 1.7
Females	63.9 ± 0.4	63.5 ± 0.3	65.9 ± 1.2	70.8 ± 0.7	62.7 ± 1.1	63.2 ± 1.2
Juveniles	46.0 ± 0.6	45.3 ± 0.5	46.0 ± 1.0	47.0 ± 1.9	43.7 ± 1.1	44.1 ± 1.2
Total	57.3 ± 0.4	58.8 ± 0.4	59.9 ± 2.0	66.3 ± 1.0	53.5 ± 1.3	57.4 ± 1.4
Range	32 - 78	35 - 75	41 - 77	40 - 78	31 - 80	34 - 83

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 trailled 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. This may have been due to repeated disturbance of the Onduline retreats effecting catchability and varying weather conditions influencing gecko movements and behaviour. Number of gecko captures, number of individual geckos recorded, and number recorded on the first day is given for all five sites where korero geckos were recorded below (Table 5). A population estimate and comparisons with the 2016 data at the Pyramids is also given in Table 5.

Table 5: Number of geckos sighted and other statistics given for all five sites where korero geckos were recorded. A comparison with the 2016 data collected at the Pyramids is given.

	The Pyramids 2018	The Pyramids 2016	Harbour Cone	Dickson's Hill	Cape Saunder s	Sandymount
Total gecko sightings	104	105	37	26	4	1
Total gecko captures	85	94	31	25	3	1
No. of captured individuals	43	59	17	17	3	1
No. on first day sighted	30	40	15	7	2	0
Recaptures from 2016	5		3	N/A	N/A	0
Population estimate with SE and 95 % CI	59 ± 9 (43-80)	97 ± 14 (72-132)				

4. DISCUSSION

The combination of an Onduline retreat and a 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 nearly half of the cryptic skinks were recorded in pitfall traps. In other studies pitfall traps have 'out-caught' the Onduline retreats and pitfall traps also have the benefit of containing 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 working in 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, compared to using one or the other method on its own.

Monitoring undertaken for this project 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).

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. There are only three known cryptic skink populations on Otago Peninsula and two of these sites are quite small: Cape Saunders and Pilots Beach. The cryptic skink population at Okia Reserve and surrounds is much larger, 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.

Korero geckos were only abundant at the Pyramids; although reasonable numbers were also present at Harbour Cone and Dickson's Hill. 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 in kānuka scrub (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.

Plate 2: Korero gecko (*Woodworthia* "Otago-large"),
recorded during the 2018 lizard monitoring on Otago Peninsula.

Otago green skink 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, Boulder Beach, The Pyramids, Victory Beach, Taiaroa Bush, Pilots Beach, and Harbour Cone). There remains a chance that an Otago green skink population still exists somewhere on the peninsula but has not yet been identified. If a population of this threatened species is found on Otago Peninsula, suitable conservation measures can then be considered and implemented. Otago green skinks were also recorded on Wharekakahu Island in the 1990s and this island should be resurveyed in order to determine whether this population still exists and what can be done to ensure its continued survival.

It is suggested that if lizard monitoring is to be continued by the OPBG than it should be undertaken using exactly the same methods at the same time of 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 methods worked well and major changes to them should be avoided. It is critical to have personnel experienced with handling lizards undertake this work (and/or appropriately trained personnel). After a few more years of collection of lizard monitoring data, it may be insightful to compare lizard numbers with mammalian pest numbers as collected by OPBG, as well as with bird and invertebrate count data and any observed vegetation changes. This may yield important insights into the effects of possum removal and other pest control initiatives instigated by OPBG on the natural ecosystems of the Otago Peninsula.

5. CONCLUSIONS

Seven consecutive day of checking pitfall traps and Onduline retreats were undertaken at 10 sites on the Otago Peninsula between 6 and 12 December 2018. Overall, the weather conditions were very good for the monitoring. The weather was generally mild to warm and some sunshine occurred every day, except for Day 7 which was wet. In total, 1,060 lizard captures or sightings were made at the lizard stations. This consisted of 777 detections of southern grass skinks, 111 cryptic skinks, and 172 korero geckos. Otago green skink were not located. Skink captures remained reasonably similar across the first six consecutive days. In contrast, gecko captures dropped quickly over the first few days (as predicted) and then remained much lower until the end of monitoring.

At this stage, it is difficult to say whether the lizard populations on Otago Peninsula have responded to the near-eradication of possums. Detection of southern grass skink was higher at Te Rauone in 2018 than in 2016, but lower at several of the smaller sites i.e. Sandymount, Harbour Cone, Grassy Point, Buskin Track, and Pilots Beach; Table 3. Cryptic skink detection was higher at Pilots Beach and similar at the Pyramids. Korero gecko detection was higher at Harbour Cone, but slightly lower at the Pyramids, where the estimated population size also dropped (Table 3; Table 5). Average size of all three species was higher in 2018 than it was in 2016, perhaps indicating more larger/older individuals in each or some of the populations. If lizard numbers are responding to pest management by OPBG, trends may become more apparent from the next monitoring round onwards (i.e. December 2020).

The following further work should be undertaken:

- Continue lizard monitoring on a biennial basis. Future monitoring rounds will enable a more thorough examination of population trends, as comparisons between years will be able to be made across a greater number of sites, and most sites will have three or more years of monitoring data.

- Undertake a survey of Wharekakahu Island for Otago green skink. If a healthy population of Otago green skinks was found on this island, it could be a potential source of individuals for a translocation back to the Otago Peninsula mainland, should a suitably protected site be available.

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