Council Meeting - 1 November 2017 Attachments

Monday 9th October 2017

Dr Peter Bodeker

Chief Executive
Otago Regional Council
70 Staffort Street
Dunedin 9054

Report - Environmental Enhancement Fund (Ref. A911591)

Dear Dr Bodeker,

Thank you so much for your kind support towards our ambitious goal of enhancing the Otago Peninsula's natural environment for people and indigenous wildlife. Through partnerships and community participations we aim to deliver coordinated peninsula-wide pest control to restore the resilience of ecosystems and provide a healthy quality of life for all.

With the help of more than 60 regular volunteers as well as several contractors we have now removed more than 12,500 possums from the Otago Peninsula. Parallel to our possum eradication efforts we have installed rigorous scientific monitoring programmes to document the environmental benefits of possum control (initially) with the longer-term aim to document the benefits of drastically reducing all introduced mammalian pests.

With your generous support of $27,000 we were able to:

1. **Undertake a full analysis of trends in the environmental monitoring data to date, for birds, vegetation, and rodents** (Please see attached reports 'OPBG SWTBC 2011-2017 report FINAL_compressed.pdf'; 'OPBG FBI 2011-2017 report FINAL.pdf'; 'Wilson 2017 OPBG rat tracking report LC2768.pdf');
2. **Complete a thorough base-line survey of lizard species' relative abundance and distribution on the Peninsula** (Please see attached report 'Knox, CD (2016) OPBG Lizard Monitoring Report.pdf');
3. **Contribute to the ongoing inventory of invertebrate species on the Peninsula** (Please see attached report 'Beetles from Otago Peninsula final .pdf');
4. **Trial a farming pest aversion fence as a future biosecurity tool for managing pest species reinvasions** (See pictures below).

Possums are omnivores that can not only kill trees through over-browsing but have a significant impact on bird populations both through direct competition for food and through taking eggs, young and sometimes adult birds. Furthermore, possums consume and thus contribute to the demise of many of our native invertebrate species.

We are glad to report that despite of only six years of possum control several bird species (bellbird, grey warbler and pukeko) have increased in abundance apparently benefiting from possum eradication efforts. OPBG receives many anecdotal reports of residents on increasing number of kereru and tui. For example, one landowner is excited to have tui at their place for the first time in 50 years. We expect that trends will become more significant once possums are further reduced across the entire Peninsula and we are able to begin targeting next pests.

Research in North Island forests has shown that the removal of possums may lead to an increase in ship rats due to reduced competition for food. Therefore, OPBG carefully monitored the abundance in ship rats parallel to possum removal efforts. Deb Wilson (Landcare) has recently analysed our ship rat monitoring data and fortunately was able to document that the number of ship rats has not increased in relation to possum control.

OPBG maintains vegetation monitoring plots on the Otago Peninsula. Richard Ewans (Eco-South) analysed the data and observed a significant reduction of possum use of indicator trees. Stem use has declined since 2012/13 which is likely to reflect a reduction of possum numbers. Canopy dieback is still relatively high and may reflect the lingering effects of possum use in the past.

Cary Knox (Knox Ecology) has established baseline lizard monitoring on the Otago Peninsula and provided abundance estimates of all lizard species with close to 1,000 sightings of Southern grass skinks, cryptic skinks, Korero geckos. We expect to work with him in the future to monitor lizard population trends as we move into rat and stoat control.

In conjunction with the lizard study pitfall traps for invertebrate monitoring were installed. We were glad to win the entomologist John Nunn to help with species identification. He found 233 species of beetles including the only mainland record of a species that is usually only found in the sub-Antarctic. Nunn estimates there may be around 700 species of beetles on the Otago Peninsula.

OPBG has been working hard for over six years to reduce possum numbers for the benefit of native flora and fauna. We are concerned that the peninsula will be reinvaded by possums from the urban area south of Hilton and Irvine Roads. Brendon Cross (OPBG, Roselle Farm) has installed part of a pest aversion fence at the neck of the peninsula with support from the landowner Garth Cadzow by modifying his farm fences.

As the photographs below illustrate, the modifications we are making include attaching rabbit mesh and adding a further two electric wires. The attached map shows the full length of the current fence. To determine if the fence is working as expected, we have placed trail cameras at various locations. We are looking forward to sharing with you some of the video footage of the behaviour of possums when they encounter the fence. Thank you for your kind invitation.

Thanks again for all your support!

Best regards,

Ursula Ellenberg

Project Manager, Otago Peninsula Biodiversity Group

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Appendix I: Pictures of the OPBG pest aversion fence

Appendix II: Map of the current OPBG pest aversion fence

Changes in the density and distribution of birds following possum control on Otago Peninsula:

Community based monitoring of bird fauna outcomes using the slow walk transect method between 2011-2017.

Prepared by Richard Ewans – Eco-South

For the Otago Peninsula Biodiversity Group (OPBG)

21 June 2017

Changes in the density and distribution of birds following possum control on Otago Peninsula:

Community based monitoring of bird fauna outcomes using the slow walk transect method between 2011-2017.

Prepared by:

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21 June 2017

Cover image: Bellbird on Otago Peninsula (photo: C. Hewitt, supplied by Moira Parker)

Contents

1. Introduction and Objectives

The Otago Peninsula Biodiversity Group (OPBG) is a community trust which has been carrying out intensive possum control on the Otago Peninsula since 2011. The aim of the trust is to enhance the biodiversity of the Otago Peninsula by removing possums as a first step towards a long-term goal of making the peninsula pest-free. As of March 2017, over 11,000 possums had been removed from the 9,500 hectare (ha) operational area.

The OPBG has implemented a range of biodiversity monitoring programmes to inform progress towards this goal, including monitoring of bird abundance. The primary purpose of the bird monitoring is to measure changes in the density and distribution of birds resulting from pest control operations.

Possums may impact on bird populations by both competing for resources and direct predation. Possums are generalist and opportunistic feeders and although often primarily herbivorous, will consume invertebrates and birds when available. Frugivorous, herbivorous, insectivorous and nectivorous birds, such as kokako, kereru, tui or bellbird, may increase after control of omnivorous ship rats and brushtail possums due to reduced predation, or increased food, or both (Innes et al, 2010).

Possums usually focus their herbivory on a small set of "key species", and often only target particular individuals of those species at a site which can cause the progressive reduction and elimination of preferred food species (Sweetapple et al. 2004; Nugent et al., 2010, Duncan et al., 2011, Gormley et al., 2012) and even lead or contribute to the collapse of forest canopies over large areas. Possums can also consume large quantities of flowers and fruit.

Possums are significant predators of the eggs, nestlings and sometimes adults of a number of native bird species including species present on Otago Peninsula such as harrier hawk, fantail and kereru/New Zealand pigeon, as well species present elsewhere such as brown kiwi, kokako and saddleback (Innes, 1994). It is highly likely a range of other bird species are also subject to possum predation.

The slow walk transect bird count method (Greene, 2012) can help guide management by measuring changes in bird density and distribution. The method uses repeated counts of birds on pre-determined transect routes to determine trends (an increase or decrease) in the relative abundance of birds and their distribution in the landscape. Combined with result monitoring data (i.e. indices of possum and other pest abundance) outcome monitoring data can answer questions about the effectiveness of management.

The OPBG began establishment of slow walk transect bird count monitoring in 2010 with 20 transects regularly measured since 2012. This report presents the results from the first 7 years of bird monitoring and aims to answer the following question:

'Has a reduction in possum densities coincided with an increase in bird abundance and distribution?'

2. Methodology

2.1 Study area

Otago Peninsula lies to the east of the Dunedin City urban area and is approximately 9,500ha in size. The landform is the eroded flank of an extinct volcano ranging in altitude from sea level to 408m. Originally mostly forested in the recent pre-human era, the current vegetation is a mosaic of pasture with native/exotic shrubland or scrub, remnant native forest patches, small pine plantations and hedgerows, and other vegetation types such as those on wetlands and/or coastal dunes. Pastureland is currently the predominant landcover type.

Map 1. Otago Peninsula landscape.

Approximately 5% of the land area on Otago Peninsula currently supports native forest or scrub. The forest is remnant and regenerating podocarp-broadleaved forest with scattered podocarps, primarily Hall's totara (*Podocarpus laetus*) and matai (*Prumnopitys taxifolia*). Other trees characteristic of the forested areas include broadleaf (*Griselinia littoralis*), ngaio (*Myoporum laetum*), kohuhu (*Pittosporum tenuifolium*), lemonwood (*Pittosporum eugenioides*), narrow-leaved lacebark (*Hoheria angustifolia*), lowland ribbonwood (*Plagianthus regius*), mahoe (*Melicytus ramiflorus*), tree fuchsia (*Fuchsia excorticata*) and kowhai (*Sophora microphylla*) (Johnson, 2004).

Otago Peninsula contains a diversity of habitats and is well known for the range of bird species (particularly seabirds and waders) able to be viewed within a relatively small area.

Slow walk bird count transects are located variously in a range of habitat types throughout the peninsula and locations are shown in Map 2 below.

Map 2. Location of slow walk bird count monitoring transects on Otago Peninsula (blue arrows). Yellow diamonds show non-operational transect locations.

2.2 Slow walk bird count transect monitoring

A total of 25 slow walk transects have been established since 2010. Of these; two transects were quickly abandoned (6 & 15), one has been rarely measured (1) and another has never been measured (13). These four transects are not included in this report.

A total of 21 transects are operational, although one is measured relatively infrequently (22) but still included here. Of these; four are in bush habitat, nine in mixed bush and pasture habitat, four in pasture habitat, two in wetland habitat and two in suburban areas.

Transects are planned to be monitored eight times per year (weeks 2 and 3 in September, October and November, and week 4 of April and week 1 of May), however this is rarely the case and different transects are monitored with varying frequencies in each year. Until 2013, transects were planned to be monitored for a minimum of six times per year during between October and early December, and late April/early May. Transects on farmland are not counted in September, due to restricted access during the lambing season.

Transects are generally monitored between one hour after sunrise and 11am. Observers, who are volunteer residents of Otago Peninsula, walk slowly recording all birds seen/heard of 10 main species up to 100m away from the transect. The 10 main species monitored are bellbird, fantail, fernbird, grey warbler, kereru/New Zealand pigeon, magpie, paradise duck, skylark, tomtit and tui. All observers can confidently identify these species.

All other bird species are recorded although there is likely to be some inconsistency around observer expertise for some other species. Each observer is affiliated with a particular transect, although different observers occasionally fill in for regular observers when required. There are 12 observers who have consistently measured their transects since the start of the monitoring. The same volunteer has also coordinated the bird monitoring programme since its inception. New observers are given training on their specific transect, and additional bird identification training and resources.

Leith walk transect/Transect 11 (photo supplied by Moira Parker).

2.3 Data analysis

For each year the number of birds of each species recorded on each transect was averaged across seasonal observations to produce an annual figure. The annual number for each species on each transect was then averaged across the site and plotted with 95% confidence intervals. Results are mapped for common native forest birds and threatened or at risk species for each transect and each year.

A number of bird species recorded are not presented here as observations were either very few, clumped, highly variable, and/or restricted to one or two transects. Species not included here are little owl, Canada goose, rock pigeon, shoveler, black swan, little shag, white-faced heron and pied stilt.

Descriptive statistics were calculated in Microsoft Excel. Graphics work undertaken used the R statistical computing environment (version 3.3.3; R Development Core Team, 2017). Mapping was done using QGIS. Satellite imagery in Map 1 is derived from Google Earth.

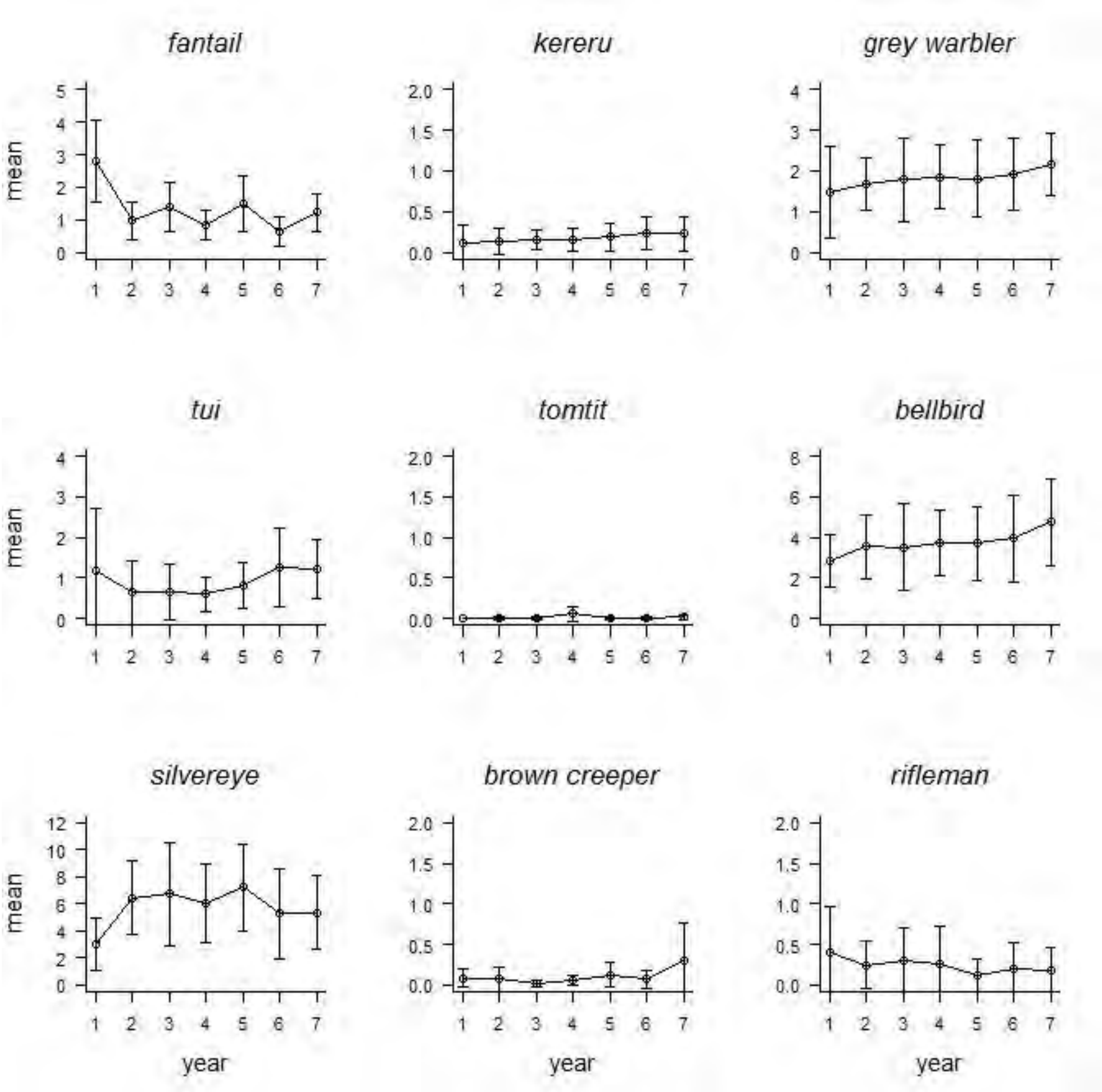
3. Results

3.1 Overall bird abundance

A total of 46 bird species were recorded on transects during the survey period. Of these, 30 species were native or endemic to New Zealand with 16 species introduced and naturalised. A total of 10,121 observations were made of 52,580 birds

Results are presented below in line graphs with the average count per transect for each year. Error bars are 95% confidence intervals and y-axis scales differ between species. Year 1 = 1 July 2010 – 30 June 2011, Year 2 = 1 July 2011 – 30 June 2012, Year 3 = 1 July 2012 – 30 June 2013, Year 4 = 1 July 2013 – 30 June 2014, Year 5 = 1 July 2014 – 30 June 2015, Year 6 = 1 July 2015 – 30 June 2016, Year 7 = 1 July 2016 – 30 June 2017. * denotes introduced bird species.

Figure 1. Mean counts per transect of 9 native forest birds on Otago Peninsula 2010-2017.



Several species of native bird (see Figures 1 & 3) appear to have increased over time e.g. bellbird (mean of 2.8 birds per transect in Year 1 to 4.7 birds per transect in Year 7), grey warbler (mean of 1.4 birds per transect in Year 1 to 2.1 birds per transect in Year 7) and pukeko (mean of 0.6 birds per transect in Year 1 to 1.2 birds per transect in Year 7). Introduced birds (see Figure 2) such as blackbird (mean of 2.8 birds per transect in Year 1 to 4.7 birds per transect in Year 7) and dunnock (mean of 1.6 birds per transect in Year 1 to 3.4 birds per transect in Year 7) also appear to have increased during the survey period.

Species that appear to show a decrease include native species such as spur-winged plover (mean of 1.3 birds per transect in Year 1 to 0.4 birds per transect in Year 7, see Figure 3) and introduced species such as redpoll (mean of 2.7 birds per transect in Year 1 to 1.4 birds per transect in Year 7, see Figure 2) and magpie (mean of 1.3 birds per transect in Year 1 to 0.7 birds per transect in Year 7).

Figure 2. Mean counts per transect of 9 introduced birds on Otago Peninsula 2010-2017.

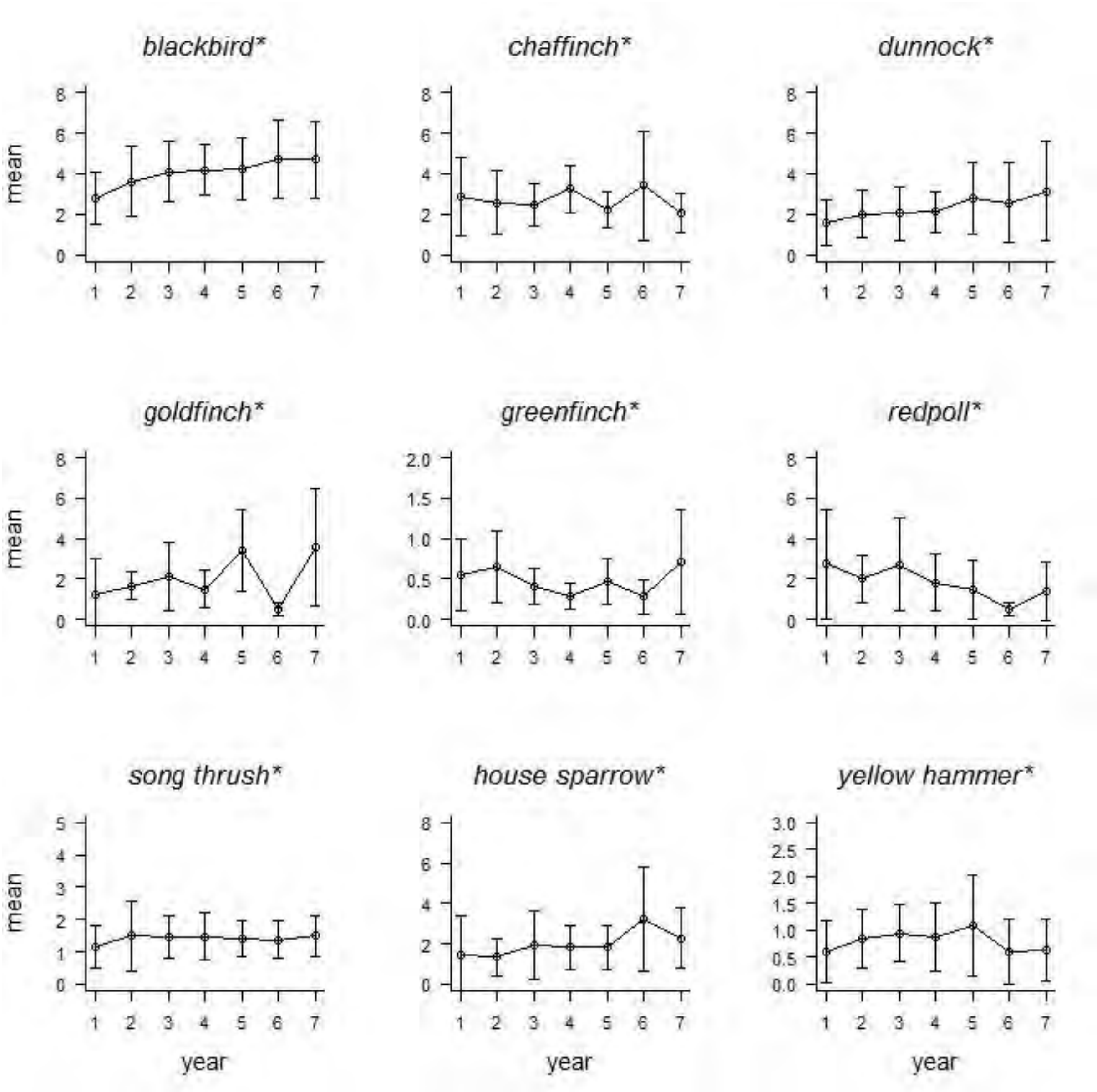


Figure 3. Mean counts per transect of 6 larger birds on Otago Peninsula 2010-2017.

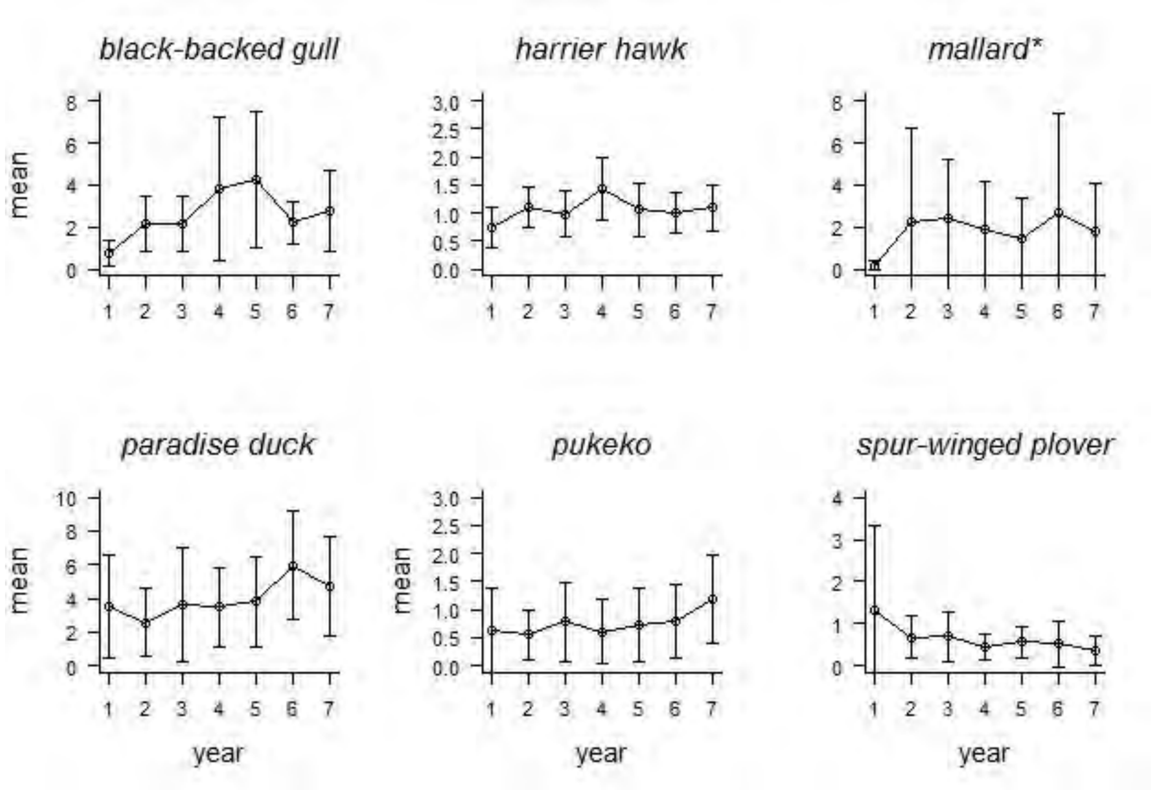
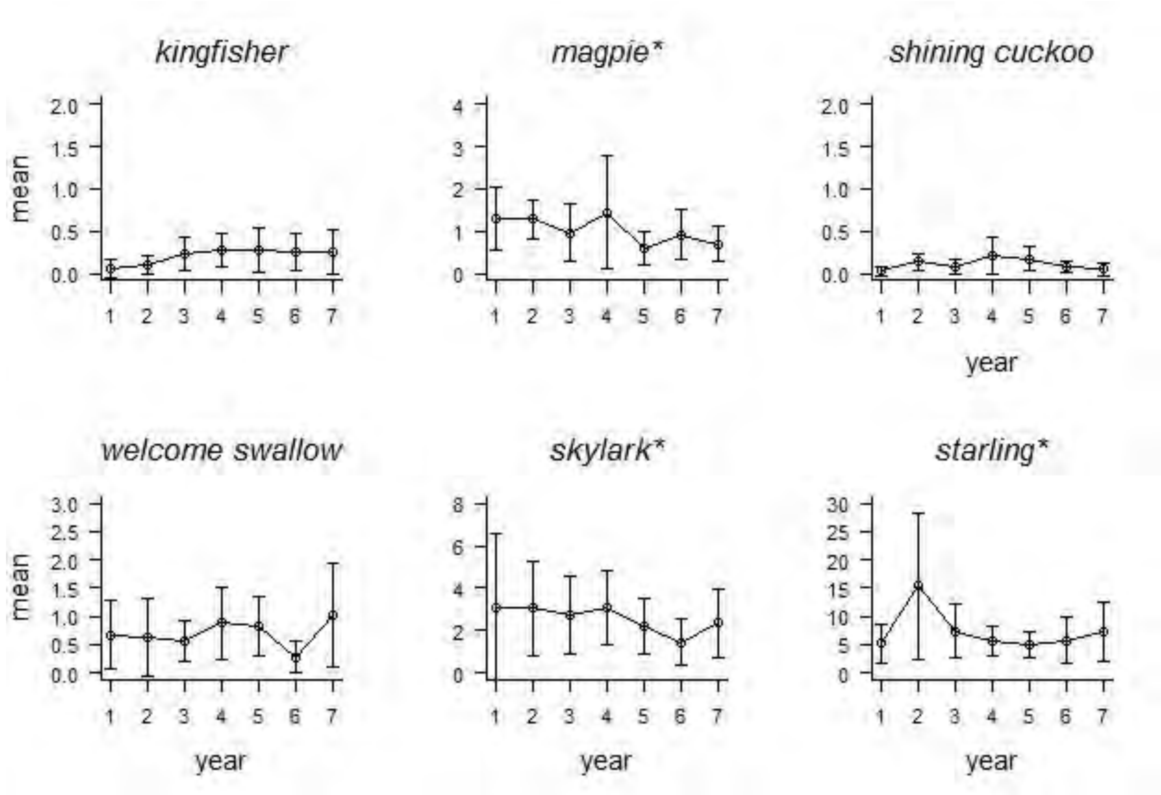


Figure 4. Mean counts per transect of 6 smaller birds on Otago Peninsula 2010-2017.



Few consistent trends can be identified for other species which have either few observations (kingfisher, shining cuckoo, brown creeper, tomtit), large confidence intervals (mallard, paradise duck, skylark, silvereye), or small and/or inconsistent trends (black-backed gull, harrier hawk, welcome swallow, starling, chaffinch, goldfinch, greenfinch, song thrush, house sparrow, yellow hammer, fantail, kereru, tui, rifleman).

3.2 Bird distribution

Maps in Appendix 4 show the annual average number of birds on each transect in Years 2-7 for the native forest bird species in Figure 1. Coloured dot size on the maps is proportional to the annual average number of birds, yellow dots always represent 0 while transects that were not measured in any year are not shown.

3.3 Threatened or at risk species

Numerous 'threatened' or 'at risk' (Robertson et al., 2012) bird species are present on Otago Peninsula including high profile species such as royal albatross and yellow-eyed penguin.

Eight species with a conservation status other than 'not threatened' were recorded on the slow walk transect monitoring. All of these species are classified as 'at risk' (see Table 1) below. The eight 'at risk' species recorded have relatively few observations or are patchily distributed and are shown on maps in Appendix 5.

Table 1. Eight 'at risk' species recorded on OPBG slow walk bird count transects between 2010-2017.

Common name	New Zealand status	Conservation status	Total number of observations
black shag	native	At Risk - naturally uncommon	11
New Zealand falcon	endemic	At Risk - recovering	19
South Island fernbird	endemic	At Risk - declining	32
South Island pied oystercatcher	endemic	At Risk - declining	56
New Zealand pipit	endemic	At Risk - declining	2
red-billed gull	native	At Risk - declining	71
royal spoonbill	native	At Risk - naturally uncommon	7
variable oystercatcher	endemic	At Risk - recovering	5

4. Discussion

4.1 Changes in bird abundance

Slow walk transect bird counts provide a measure of relative (rather than absolute) abundance. Methods such as slow walk transects and five-minute bird counts are called incomplete counts because of the difficulty of distinguishing between a bird being not present or present but not detected when a null observation is recorded.

Bird density may increase and bird distribution expand after possum control due to release from both predation and food competition. However the effect is unlikely to be uniform for all species as different bird species differ in the extent they are vulnerable to the effects of possums. In addition, a range of other introduced predators are likely to be influencing the density and distribution of native birds on Otago Peninsula e.g. rodents (mice, rats), mustelids (weasels, stoats, ferrets), feral cats and hedgehogs.

Several native bird species appear to have increased in abundance over the last few years such as bellbird, grey warbler and pukeko. OPBG receives many anecdotal reports, for example from a landowner seeing tui for the first time on their place in 50 years or a resident noticing that bellbirds seem more abundant over the past 4 years. Several introduced bird species also appear to have increased such as blackbird and dunnock. Other species appear to have declined including native birds such as spur-winged plover.

Results presented here need to be interpreted with some caution. Averaging raw bird count data is not optimal as the data is not normally distributed and zero counts are commonly overrepresented in the data. No analysis has been undertaken to assess the statistical significance of the results as the data requires statistical modelling treatment that is beyond the scope of this report. Statistical modelling procedures are used to distinguish between variation in counts resulting from differing environmental or sampling conditions and variation in the actual number of birds observed to account for the fact that it is not possible to standardise all aspects of surveys between years (Greene, 2012).

In addition, inconsistent data collection can exacerbate the effects of natural variability when averaging bird numbers for the annual transect count e.g. a large group of tui in a kowhai tree in spring on a transect measured only twice in a year will inflate the average for that year compared to a transect that has been measured eight times during the year but still only encounters the one large group of tui. Results from Year 1 in particular should be viewed with caution as many transects were only measured once in that year.

Also, transects are located in a range of habitat types, therefore the site is somewhat stratified and sample numbers (i.e. number of transects) in some habitat types, e.g. wetland, may not be adequate to robustly detect changes across the site. Bird detectability is also different in different habitat types although provided all transects are consistently measured every year this should not influence the data which is relative abundance measure.

The detection of a possum effect on native bird species abundance may not be straightforward. Measuring bird responses to the removal or reduction of a pest mammal can give some indication of the strength of interactions between the species involved (Innes et al., 2010). It is reasonable to propose that such an effect is present as possums are now well known to be opportunistic predators of native fauna and are competitors with many bird species for food. Increases in native bird species such as tui, bellbird, robin, whitehead, and kereru were measured on Kapiti Island after possum control and eventual eradication (Innes et al., 2010) in the presence of rats which were eventually eradicated too.

However, the effect of possums may be relatively small compared to the individual or combined effects of the rest of the predator suite still present on Otago Peninsula such as feral cats, rats and mustelids. For example, the eradications of possums and wallabies from Rangitoto Island were not followed by increases in bird populations (with the possible exception of silvereyes). The remaining ship rats, stoats, cats and commercial honeybees may have sustained predation and/or food shortage (Innes et al., 2010) which may have continued the suppression of bird numbers.

The monitoring transects are split between the two main possum control operational areas and most of the transects are in Sector 4 which has only had possum control since 2013 and therefore only three or four years of low possum densities. Therefore, it is likely that the full effect of removing possums on the bird population will take a longer time to detect.

Attributing trends in bird abundance to the removal of possums may also be complicated by other pest control efforts that target other predators on Otago Peninsula. The extent of such operations is currently unquantified although is unlikely to constitute more than small localised efforts at this stage.

4.2 Changes in possum densities on Otago Peninsula

Possum control operations in Sectors 1-3 (east of the Portobello-Hoopers Inlet Road) were carried out in 2011 and 2012. Possum control operations in Sector 4 (west of the Portobello-Hoopers Inlet Road) were carried out between 2013 and 2015 (OPBG, 2013a). As of March 2017, over 11,000 possums had been removed from the 9,500 hectare (ha) operational area.

Interpretation of trends is limited due to the lack of a non-treatment site and possum density data i.e. pre- and post-control RTC data and history of possum control. Additionally, the relative effects of other predators on the bird population is currently unknown and is likely to be significant. Changes in the density of other predators after possum control is another factor that requires data to inform interpretation of the results of the bird monitoring.

One possible consequence of removing possums is an increase in ship rat abundance, which may directly increase predation on birds, and/or increase food resources to other predators such as stoats. Ship rats compete with possums for food and research in North Island forests has shown that removing possums may result in increased ship rat numbers (e.g. Griffiths & Barron, 2016). However, recent analysis of rat abundance on Otago Peninsula concluded that there has been no detectable increase in rat abundance in association with possum control operations since OPBG began rodent tracking over 5 years ago (Wilson, 2017).

The effect of removing possums on native bird fauna abundance is likely to be most noticeable if possum densities shift from high to very low. Possum density data was unavailable for this report but would add to future analysis and interpretation of results from the slow walk transect data.

4.3 Implementation of slow walk transect methodology

The current set up of the slow walk transects should be adequate to detect changes in native forest bird density and distribution over time at the site. The monitoring project is entirely run by volunteers and there are 12 observers who have consistently measured their transects since the start of the monitoring.

This is a remarkable achievement and is to be congratulated. As is the commitment of the volunteer who has entered all the data since the monitoring began.

However, it is clear that on some transects there is a varying amount of application to collecting the data and it is important to minimise the amount of inconsistency between transects (and years) as much as possible. It is recognised that this can be understandably difficult for community groups and volunteers however the monitoring here requires greater consistency to have the best opportunity to show that controlling possums has benefitted native bird species.

There may be several ways to achieve this. Firstly, consider dropping transect 22 altogether, particularly if it frees up a volunteer to help complete other sites. Secondly, a reminder system for observers and a team of back up observers to substitute in for regular observers when they are unavailable. Thirdly, regularly re-iterate the importance of consistency of data collection to observers. Lastly, discuss the current commitment with observers and establish whether or not it is realistic for everyone. Most transects appear to take less than an hour to complete, plus any travel so the annual commitment for volunteer observers is likely to be around 10 hours per year. If observers can't commit to at least 6 measurements per year then consider replacement observers or shared transects. Rationalisation of transects in habitat types such as pasture could also be considered if it frees up volunteer time elsewhere.

The line transect bird count method is most effective when transects are repeated annually over relatively long time frames (> 10 years), when sample sizes (i.e. number of transects) are high, and when variation in observers, times of day and conditions are minimised (Greene, 2012).

As discussed above the relative effect of possums compared to other predators may be small and difficult to detect with certainty in the short term. However, the slow walk monitoring transects are still very valuable for the project overall as the long term goal is to control other predators on Otago Peninsula, the benefits of which to native birds can be demonstrated by continued monitoring of the transects.

The inherent and inherited nature of the line transect bird count data in this monitoring project requires a more detailed statistical analysis that accounts for zero-inflated count data, inconsistent data collection and natural variability, and utilises data on predator densities. It would be prudent for OPBG to seek relationships over the next few years that may be able to provide such analysis at minimal cost in 2023 or thereabouts. The most likely partners are Otago University teaching staff and/or their postgraduate students in the ecological sciences or statistics departments. The data collected here provides an excellent real-life teaching resource that demonstrates many of the challenges of ecological science and monitoring generally. It also may provide an opportunity to publish results on the effect of removing only possums on a mainland bird population.

5. Conclusions and Recommendations

Few strong trends are discernible from the slow walk bird count transects over the last few years, although there are encouraging signs in the data and anecdotally that bird numbers are increasing for some species.

In ecological terms, it is a relatively short time since possum control began and a number of other predators remain uncontrolled, therefore large increases in bird populations would not be expected at this stage of the programme.

However, it is reasonable to assume that possums have been affecting native bird numbers, although the effects are likely to have varied for different species. A more detailed analysis of the bird count data which accounts for non-normally distributed and inconsistency collected data, and includes pest abundance data would be required to fully investigate the benefits of removing possums for native bird species on Otago Peninsula.

The following recommendations are made to promote the best opportunity to demonstrate that controlling possums has benefitted native bird species:

1. Continue monitoring birds on the slow walk transects but reiterate to volunteers the importance of consistency and ask for a firm commitment to the plan.
2. Remove transects 1, 6, 13, 15 from the programme.
3. After 10 years of possum control across the peninsula e.g. in 2023, undertake detailed analysis using statistical modelling approaches to investigate trends in bird density and distribution.

6. Acknowledgements

The OPBG wish to thank members of the Dunedin Branch of BirdsNZ for their expert advice on a suitable monitoring method, and ecologist Marcia Dale for walking many of the proposed 1k transects and undertaking the mapping.

OPBG are most grateful to Derek Onley for his enjoyable and instructive training sessions and providing the recording sheet and CD of bird calls and songs. Derek kindly reviewed the monitoring data collected from Nov 2011 to Sept 2013 and suggested improvements to the counting procedure.

On the first training day in 2010, Sharyn Broni generously offered to enter all the bird data and has continued ever since. Sharyn has made a huge contribution over the past 6 years, in addition to her own Cape Saunders transect, and OPBG are greatly indebted to her.

And finally, thank you to all those wonderful volunteers who have done their birds counts year in, year out. There are some very competent amateur ornithologists in the team, but mostly they are local residents with a keen interest in birds and an appreciation of the importance of collecting the data.

The author would like to acknowledge and give thanks for the assistance of Sarah Irvine, Sharyn Broni and in particular Moira Parker from OPBG. Colin MacLeod (Otago University Botany Department) also provided assistance to the author.

OPBG bird count volunteers at a training session (photo supplied by Moira Parker).

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Appendix 1. List of birds recorded on Otago Peninsula during slow walk transect counts.

Common name	Scientific name	New Zealand status	Conservation status	Total number of observations
bellbird	*Anthornis melanura*	endemic	not threatened	594
black shag	*Phalacrocorax carbo novaehollandiae*	native	naturally uncommon	11
black swan	*Cygnus atratus*	native	not threatened	28
southern black-backed gull	*Larus dominicanus*	native	not threatened	470
blackbird	*Turdus merula*	introduced - naturalised		740
brown creeper	*Mohoua novaeseelandiae*	endemic	not threatened	26
Canada goose	*Branta canadensis*	introduced - naturalised		1
chaffinch	*Fringilla coelebs*	introduced - naturalised		538
dunnock	*Prunella modularis*	introduced - naturalised		473
New Zealand falcon	*Falco novaeseelandiae*	endemic	recovering	19
South Island fantail	*Rhipidura fuliginosa*	endemic	not threatened	333
South Island fernbird	*Bowdleria punctata*	endemic	declining	32
European goldfinch	*Carduelis britannica*	introduced - naturalised		302
European greenfinch	*Carduelis chloris*	introduced - naturalised		179
grey warbler	*Gerygone igata*	endemic	not threatened	499
harrier hawk	*Circus approximans*	native	not threatened	513
house sparrow	*Passer domesticus*	introduced - naturalised		337
kereru	*Hemiphaga novaeseelandiae*	endemic	not threatened	101
New Zealand kingfisher	*Todiramphus sanctus vagans*	native	not threatened	146
little owl	*Athene noctua*	introduced - naturalised		10
little shag	*Phalacrocorax melanoleucos brevirostris*	native	not threatened	20
Australian magpie	*Gymnorhina tibicen*	introduced - naturalised		315
mallard	*Anas platyrhynchos*	introduced - naturalised		205
paradise duck	*Tadorna variegata*	endemic	not threatened	519
South Island pied oystercatcher	*Haematopus finschi*	endemic	declining	56
pied stilt	*Himantopus leucocephalus*	native	not threatened	18
New Zealand pipit	*Anthus novaeseelandiae*	endemic	declining	2
pukeko	*Porphyrio melanotus*	native	not threatened	214
red-billed gull	*Larus novaehollandiae scopulinus*	native	declining	71
redpoll	*Carduelis flammea cabaret*	introduced - naturalised		244
South Island rifleman	*Acanthisitta chloris chloris*	endemic	not threatened	77
rock pigeon	*Columba livia*	introduced - naturalised		4
shining cuckoo	*Chrysococcyx lucidus*	native	not threatened	79
Australasian shoveler	*Anas rhynchotis*	native	not threatened	14
silvereye	*Zosterops lateralis*	native	not threatened	576
Eurasian skylark	*Alauda arvensis*	introduced - naturalised		375
song thrush	*Turdus philomelos clarkei*	introduced - naturalised		451
royal spoonbill	*Platalea regia*	native	naturally uncommon	7

spur-winged plover	*Vanellus miles novaehollandiae*	native	not threatened	194
European starling	*Sturnus vulgaris vulgaris*	introduced - naturalised		572
South Island tomtit	*Petroica macrocephala macrocephala*	endemic	not threatened	12
tui	*Prosthemadera novaeseelandiae novaeseelandiae*	endemic	not threatened	283
variable oystercatcher	*Haematopus unicolor*	endemic	recovering	5
welcome swallow	*Hirundo neoxena neoxena*	native	not threatened	166
white-faced heron	*Egretta novaehollandiae novaehollandiae*	native	not threatened	48
yellowhammer	*Emberiza citrinella caliginosa*	introduced - naturalised		242

Appendix 2. List of slow walk transects

Transect number	Habitat type*	Transect names	Total number of transect counts	Name of data collectors	New or additional data collectors
1	M	Pipikaretu	5	Rik Wilson	Moira Parker
2	M	Tamatea Rd	46	Jenny Winter	Jean McGibbon, Moira Parker, Orma B, Billy Paul, Emilie Bourdet, Sam, Jose Jean McG's granddaughter
3	P	Riddell Rd	76	Mike Hazel	Sharyn Broni, Lala Frazer, Jon Bailey, Sue Lorell-Smith, Sue Griffiths
4	W	Okia Reserve	49	Lala Frazer	Mike Hazel, Jon Bailey, Carol Tharme, Heather Collier, Rowena East, Derek Onley, Lesley Gowans, Max Harvey
5	P	Roselle Farm	27	Annette Cross	Ruth Seenay?
6		Allans Beach Rd	0		
7	B	Varleys Hill	58	Moira Parker	
8	P	Cape Saunders Rd	57	Sharyn Broni	Rachel Duell, Bev Dickson, Anna & Hebe
9	M	Otapahi	23	Leith Thompson (YEPT)	
10	B	Dicksons Hill	48	Shaun Murphy	
11	M	Leith Walk	54	Shantelle Jackson	Brenda Cameron & Laurel Dunn
12	M	Bacon St	40	Neville Peat	S Peat
13		Ara Kotare	0	Rose Sweet Kelly	
14	P	Camp Road	35	Penny Kagan	Penny Dickson, Glen MacGreggor, Diane Potter, Aiden Dickson
15		McTaggart Street	2	Jane & Richard Higham	Helen Clark
16	M	Greenacres St	76	Barbara Smith	
17	S/B	Howard St	41	Alun Baines	Chris and Nina Hewitt, Ruth Seenoy
18	M	Sandymount	29	Carol Tippett	
19	P	Ridge Road	33	Peter & Evelyn Steers	Ruth Seenoy, Helen Davidson
20	M	Peggy's Hill	26	Ian Turnbull & Jane Forsythe	Lisa Walis, GP Walis, Jeanne Hutchison & Moira Parker
21	M	Paradise Track	48	Karen O'Neill	Helen Clark & Dave Chalmers, Ruth Seenoy
22	M	Centre Road	13	Belinda & David Lyttle	
23	S	Irvine Rd	35	Rod Morris	Warren Baker
24	P	Karetai Track	20	Marcia Dale	Tony Green, Sara Larcombe, Jon Bailey, G Sommerville
25	W/B	Tomahawk	27	Marcia Dale	Tony Green, Sara Larcombe, Anne Ryan, Moira Parker

* B=bush, P=pasture, M=mixed bush and pasture, W=wetland, S=suburban.

Appendix 3. Map of slow walk transects

Note transects 1, 5, 7, 9, 10, 13 and 23 are on private land and not shown on this map. Transects 6 and 15 are no longer monitored.

Appendix 4. Maps of common native forest bird species recorded

Maps of the density and distribution common native forest bird species are provided in a separate appendix booklet for Years 2-7. Observations are coloured differently for each bird species with the annual average of the number of individuals counted on each transect represented by different sized dots. Yellow dots always represent 0 while transects that were not measured are not shown.

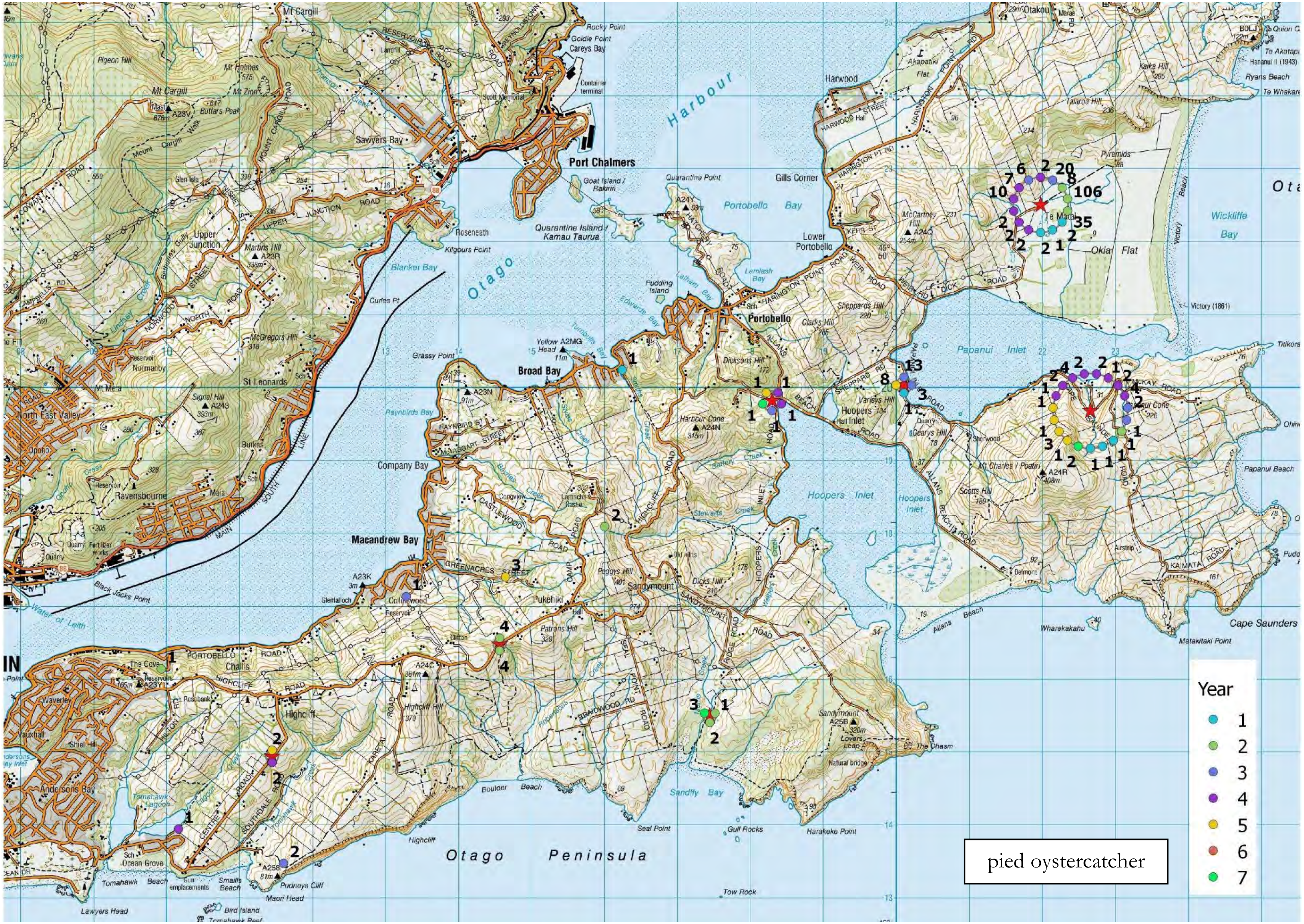
Appendix 5. Maps of 'at risk' species recorded

Maps of all observations of 'at risk' bird species are provided below. Observations are coloured differently for each year (see legend on each map) with the number of individuals shown next to each observation point. Red stars show the location of the transect while the coloured dots represent the observations for each transect.


Otago Harbour
Port Chalmers
Portobello
Broad Bay
Macandrew Bay
Company Bay
Portobello Bay
Papanui Inlet
Hoopers Inlet
Otago Peninsula
Harwood
Okia Flat
Wickliffe Bay
Sandfly Bay
Cape Saunders
Highcliff
Tomahawk Beach
Ocean Grove
Water of Leith
Year
1
2
3
4
5
6
7
black shag


Year
1
2
3
4
5
6
7
falcon
Otago Harbour
Port Chalmers
Portobello
Broad Bay
Macandrew Bay
Papanui Inlet
Hoopers Inlet
Otago Peninsula
Cape Saunders
Wickliffe Bay
Okia Flat
Sandfly Bay


Year
1
2
3
4
5
6
7
fernbird
Otago Harbour
Port Chalmers
Portobello
Broad Bay
Macandrew Bay
Company Bay
Otago Peninsula
Hoopers Inlet
Papanui Inlet
Wickliffe Bay
Okia Flat
Pyramids
Cape Saunders
Harwood
Sandfly Bay
Highcliff
Mt Cargill
Sawyers Bay
Ravensbourne
St Leonards
Roseneath
Quarantine Island / Kamau Taurua
Portobello Bay
Gills Corner
Lower Portobello
Tomahawk
Ocean Grove


pied oystercatcher
Year
1
2
3
4
5
6
7
Otago Harbour
Otago Peninsula
Port Chalmers
Portobello
Broad Bay
Macandrew Bay
Company Bay
Portobello Bay
Papanui Inlet
Hoopers Inlet
Wickliffe Bay
Okia Flat
Harwood
Sandfly Bay
Cape Saunders
Allans Beach
Tomahawk Beach
Ocean Grove
Sawyers Bay
St Leonards
Ravensbourne
North East Valley
Mt Cargill
Harbour Cone
Highcliff
Sandymount
Boulder Beach
Seal Point
Quarantine Island / Kamau Taurua
Goat Island / Rakiriri
Blanket Bay
Andersons Bay
Lawyers Head


pipit
Year
1
2
3
4
5
6
7
Otago Harbour
Otago Peninsula
Port Chalmers
Mt Cargill
Sawyers Bay
Roseneath
Quarantine Island / Kamau Taurua
Goat Island / Rakiriri
Portobello Bay
Portobello
Lower Portobello
Harwood
Gills Corner
Te Matai
Okia Flat
Wickliffe Bay
Papanui Inlet
Hoopers Inlet
Harbour Cone
Broad Bay
Company Bay
Macandrew Bay
St Leonards
Ravensbourne
North East Valley
Normanby
Sandymount
Pukehiki
Highcliff
Andersons Bay
Waverley
Tomahawk Beach
Ocean Grove
Sandfly Bay
Boulder Beach
Seal Point
Cape Saunders
Allans Beach
Papanui Beach
The Chasm
Lawyers Head
Black Jacks Point
Grassy Point
Curles Pt
Blanket Bay
1
2

Year
1
2
3
4
5
6
7
red-billed gull
Otago Harbour
Port Chalmers
Portobello
Portobello Bay
Broad Bay
Macandrew Bay
Company Bay
Harwood
Papanui Inlet
Hoopers Inlet
Otago Peninsula
Sandfly Bay
Allans Beach
Cape Saunders
Wickliffe Bay
Okia Flat
Quarantine Island / Kamau Taurua
Goat Island / Rakiriri
St Leonards
Ravensbourne
North East Valley
Highcliff
Pukehiki
Sandymount
Andersons Bay
Tomahawk
Lawyers Head
Boulder Beach
Mt Cargill
Sawyers Bay
Roseneath
Upper Junction

spoonbill
Year
1
2
3
4
5
6
7
Otago Harbour
Otago Peninsula
Port Chalmers
Portobello
Macandrew Bay
Broad Bay
Company Bay
Papanui Inlet
Hoopers Inlet
Okia Flat
Wickliffe Bay
Cape Saunders
Sandfly Bay
Highcliff


Year
1
2
3
4
5
6
7
variable oystercatcher
Otago Harbour
Otago Peninsula
Port Chalmers
Portobello
Broad Bay
Macandrew Bay
Company Bay
Harwood
Papanui Inlet
Hoopers Inlet
Sandfly Bay
Cape Saunders
Wickliffe Bay
Portobello Bay
Mt Cargill
Sawyers Bay
St Leonards
Ravensbourne
North East Valley
Highcliff
Andersons Bay
Ocean Grove
Tomahawk Beach
Boulder Beach
Allans Beach
Okia Flat
Te Matai
Sandymount
Pukehiki
Lower Portobello
Gills Corner
Quarantine Island / Kamau Taurua
Goat Island / Rakiriri
Quarantine Point
Roseneath
Papanui Beach
Victory Beach

Beetles from Otago Peninsula

Summary

There are at least 250 species of beetles on Otago Peninsula. The most common is perhaps the cryptophagid *Paratomaria crowsoni*, found everywhere on vegetation and in litter. Surpringly, this species was not described until 1996.

Some of the beetles are particularly interesting. *Kenodactylus audouini*, a carabid, known from one specimen from Boulder Beach is the only mainland record of a species otherwise known only from Stewart Island and the Subantarctic Islands, including the Falkland Islands. One of three known species of Cavognathidae, *Taphropiestes dumbletoni*, known from Okia Flat, lives in birds' nests where it feeds on fleas. Its larva have been found on sea birds.

There are two species of beetle so far endemic to the peninsula; *Microsilpha litoralis* and an undescribed species of *Brouniellum*, both staphylinids (rove beetles). The first is known from Sandfly Bay and elsewhere where it congregates on grasses on warm nights prior to heavy rains, presumably for mating and dispersal. The second is known from litter from the top of Paradise Track, Pukehiki and Sandymount. Nothing is known about its biology.

The biggest beetle is the carabid *Mecodema sculpturatum* at about 22 mm (probably the most commonly encountered carabid species on the peninsula). Although one would expect the huhu beetle, *Prionoplus reticularis* (up to 30 mm) also to occur, it hasn't been found there yet. The smallest beetles are members of the family Ptiliidae (feather-winged beetles), some of which are less that 1 mm long.

Beetles overlap somewhat in terms of their habitat.
Loosely speaking, the habitats are as follows:

In wood, solid and decayed	55 species
On vegetation	48 species
Forest litter	47 species
On beaches	34 species
On the ground, under stones and logs	20 species
In compost	16 species
In soil	11 species
Under bark	8 species
In tussock litter	6 species
In birds' nests	6 species
In moss	5 species
In carrion	4 species
On larger fungi	3 species
In water	3 species

My estimate is that there are about 700 beetle species to be found on the peninsula.

John Nunn, entomologist April 2017

Note The above is only a summary. The full list has 233 species of beetle, with dates and sites specified.

Beetles from Otago Peninsula (233 at 24/1/2017)

John Nunn (Entomologist)

Carabidae (ground beetles)

Nearly all are terrestrial predators, mostly nocturnal. Carabid diversity is an important ecological indicator.

Carabidae: Trechinae

Bembidion (Ananotaphus) rotundicolle Bates, 1874
Example: Tomahawk Lagoon, 16 X 2015, in litter at edge of lagoon.

Bembidion (Zecillenum) chalmeri (Broun, 1886)
Example: Morris Creek, Sandfly Bay (where the creek emerges from vegetated banks to the beach proper), 1 II 2004, in sand at edge of creek.
Comments: occurs in situations similar to the example above, from Otago Peninsula down to the Catlins coast.

Kenodactylus audouini (Guerin-Meneville, 1830)
Example: Boulder Beach, 7 XII 2002, washed up with incoming tide.
Comments: Washed up dead but its fresh condition indicates an origin close by. This is the only mainland New Zealand record of a marine litoral species otherwise known from Falklands Islands, Patagonia, South Georgia, Straits of Magellan, Antipodes Island, Bollons Island (Antipodes), Auckland Islands, Campbell Island, Snares Islands and, rarely, on Stewart Island (Townsend, 2010)

Mecodema alternans Laporte de Castelnau, 1867
Example: Sandfly Bay, 1 II 1999, walking on dunes.

Mecodema sculpturatum Blanchard, 1853
Example: Collinswood Bush, Macandrew Bay, 19 X 2014, in decayed wood.
Observations: +2, Collingswood Bush, under log; +1, paddock adjacent to Collinswood Bush, under log; +2, Taiaroa Bush, under rocks; +1 Vauxhall, in decayed ngaio log; +1, Harbour Cone (dead specimen), 312m, 20 VIII 2015, in ground litter.

***Oopterus* sp. 1**
Example: Track to Collinswood Bush, Macandrew Bay, 16 X 2014, in decayed *Hoherius* wood.
Example: Harbour Cone, 310m, 9 XI 2015, in litter under *Melicytus.*
Example: Varleys Hill, 2 III 2015, in much dacayed matai wood.
Observations: +10, Collinswood Bush, in decayed wood; +2, Vauxhall, in decayed ngaio wood, +5, Peggys Hill, 26 II 2015, sifted moss from tree boles, +1 Peggy's Hill, 26 II 2015, in decayed mahoe wood; +8, Taiaroa Bush, in decayed wood; +8, Collinswood Bush, 29 III 2015,in dry, dead *Hoheria* wood; +2, Colinswood Bush, 29 III 2015, between two old planks; +3, Taiaroa Bush, 31 VIII 2015, in decayed wood; +1, Vauxhall, 12 IX 2015, in dead *Populnea* wood.
Comments: abundant around Dunedin sheltering in decayed wood during the day and active at night.

***Oopterus* sp. 2**
Example: Collinswood Bush, Macandrew Bay, 22 X 2014, under stone in bush.
Example: Varleys Hill, 2 III 2015, in much dacayed matai wood.
Comments: found under stones, particularly in damp places.
Observations: +4: Collinswood Bush, under rocks on forest floor; +2, Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.

***Oopterus* sp. 3**
Example: Allens Beach (south end), 28 IX 2015, under driftwood log on sandy beach.
Example: Victory Beach, 3 X 2015, under driftwood above high water mark.

Oregus aerus
Example: Varleys Hill, 2 III 2015, under log in kanuka forest.

Pelodiaetus lewisi Jeannel, 1937
Reference: "Otago Harbour", Moore, 1980.

Pelodiaetus sulcatipennis Jeannel, 1937
Reference: "Otago Harbour", Moore, 1980.
Comments: more precise locality data is not available. Like the species above, this is a minute, blind, wingless, depigmented soil-dwelling carabid. Both nominal species were originaly found in 1901, but neither have been subsequently seen from either side of Otago Harbour. The two names perhaps represent a single variable species.

Oregus aereus (White, 1846)
Example: Buskin Track (upper end), 22 VII 2015, under rock.
Observations: +1, as above.

Carabidae: Harpalinae
Anchomenus otagoensis
Examples: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Observations: 30, as above.

Holcaspis placida Broun, 1881
Example: Collinswood Bush, Macandrew Bay, 29 X 2014, under log in bush remnant.
Example: Varleys Hill, 2 III 2015, Under planter box.
Observations: 3; Buskin Track (upper end), 22 VII 2015, under rock; 1, Vauxhall, 9 XII 2014, in old *Cupressus macrocarpa* stump.
Reference:1: "Otago Peninsula": Butcher, 1984.

Holcaspis punctigera Broun, 1882
"Harbour Cone": Butcher, 1984
Comments: known from South Canterbury to Southland.

Holcaspis subaenea (Guerin-Meneville, 1841)
Comments: only known from the female type specimen described in 1841. "It is posible that *H. subaenea* was a locally restricted, rare element of the carabid fauna of the Otago Peninsula, and that subsequent land development by Europeans led to its extinction. No other *subaenea*-like specimens are found in this region of the South Island": Butcher, 1984. The original type locality was given as "Port Otago", today's Port Chalmers and thus the species cannot

be listed for Otago Peninsula in the sense of this list.

Lecanomerus latimanus Bates, 1874
Examaple: Taiaroa Bush, 24 XI 2014, under stone near seepage area.
Example: Varleys Hill, 2 III 2015, under stone in kanuka scrub; M. Parker collection.

Scopodes fossulatus (Blanchard, 1843)
Example: Vauxhall, 29 IX 2015, in garden compost.
Example: Tomahawk Beach, 16 X 2015, on sand dunes.

Triplosarus novaezelandiae (Laporte de Castelnau, 1867)
Example: Sandfly Bay, 12 I 1999, running on sand dunes, early evening.

Dytiscidae (diving beetles)
Aquatic predators generally occuring in well-vegetated waters.

Antiporus femoralis (Boheman, 1858)
Examaple: Tomahawk Lagoon, 4 IV 1999, in lagoon water.

Rhantus suturalis (Macleay, 1825)
Examaple: Tomahawk Lagoon, 4 IV 1999, in lagoon water.

Hydrophilidae (water scavenger beetles)
There are two main groups; terrestrial and aquatic. Adults are herbiverous or scavengers.

Cyloma thomsonus Sharp, 1884
Examples: 2, Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.

Histeridae (pill beetles)
Almost always predators on the larvae of other insects.

***Parepierus* sp. 1**
Example: Collinswood Bush, Macandrew Bay, 19 X 2014, in decayed wood.
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Observations: +2, Collinswood Bush, in decayed wood; 3: Collinswood Bush, under stone covering *Prolasius advenus* ants' nest; +11: Vauxhall, in decayed ngaio wood.
Observations: +22, Taiaroa Bush, in decayed wood; +1, Collinswood Bush, 29 III 2015, on gilled fungus; +3, Collinswood Bush, 29 III 2015, in dead, dry *Hoheria* wood; +1, Harbour Cone near summit trig, 21 VIII 2015, in mahoe litter; +10, Boulder Beach, 21 X 2015, in litter under totara.

Reichardtia pedatrix (Sharp, 1876)
Example: Boulder Beach, 29 XII 2001.
Example: Victory Beach, 3 X 2015, under dead seal above high water mark.
Comments: lives under dry carrion, such as dead seabirds and fish, on sandy beaches.

Saprinus detritus (Fabricius, 1775)
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.
Examples: 2, Victory Beach, 3 X 2015, under dead seal aboe high water mark.
Comments: adults and larvae are predators on maggots.

Hydraenidae (cascade beetles)
Mainly occuring in fast moving streams.

Ptiliidae (feather-winged beetles)
Minute beetles thought to feed on fungal hyphae and spores, and most usually associated with decaying vegetable matter.

***Acrotrichis* sp**
Examples: 3, Harbour Cone, 312m, 21 VIII 2015, In mahoe litter from boulder scree.
Example: Collinswood Bush, 16 X 2014, in forest floor litter.

***Notoptenidium* sp. 1**
Example: Peggys Hill, 25 X 2014, washed soil sample.
Examples: 7, Okia Flat, 1 III 2015, in litter from abandoned yellow-eyed penguin bowl.
Examples: 7, Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.

***Notoptenidium* sp. 2**
Examples: 3: Vauxhall, 19 I 2015, in decayed ngaio wood.
Observations: +17, as above.

***Notoptenidium* sp. 3**
Example: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter.

***Ptinella* sp. 1**
Examples: Vauxhall, 19 I 2015, in decayed ngaio wood.
Observations: +2: as above

***Ptinella* sp. 2**
Examples: 2, Vauxhall, 19 I 2015, in decayed ngaio wood.
Example: Karetai Road, 5 X 2015, washed soil sample from clifftop basin.
Observations: +53, as above.
Notes: As in this case, some species of *Ptinella* have females which are apterus, depigmented and blind. I can not sort them out into differents species although a number of species could be involved.

Agyrtidae (carrion beetles)
Under carrion. Only two New Zealand species, one in the North Island and one in the South Island.

Leiodidae (small carrion beetles)
Found in carrion, dung, fungi and leaf litter. A few feed on slime moulds.

Inocatops compactus Broun, 1893
Example: Collinswood Bush, Macandrew Bay, 19 XI 2014, in forest floor litter.
Example: Victory Beach, 3 X 2015, under driftwood above high tide mark.

Isocolon **sp.**
Examples, 2; Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Paracatops **sp. 1**
Examples: 2, Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.
Example: Varleys Hill, 3 III 2015, in much decayed matai wood.
Examples: 2, Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Observations: 6, as above.

Paracatops **sp. 2**
Examples: 2, Varleys hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Observations: 3, as above.

Zeadolopus **sp.**
Example: Collinswood Bush, Macandrew Bay, 22 X 2014, in decayed wood.
Example: clifftop basin off the Karetai Track, 5 X 2015, in litter under *Hebe elliptica, Asplenium* and silver tussock.

Camiarinae sp. 1
Example: Varleys Hill, 2 III 2015, in much decayed matai wood; M. Parker collection.
Comments: this undescribed species belongs in a new genus.

Staphylinidae (rove beetles)
A very diverse group, most of which are predators.

Staphylinidae: Microsilphinae
Microsilpha litorea Broun, 1886
Example: Sandfly Bay, 22 III 1999, leeside of dune at dusk on warm. still night.
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Comments: This species, only known from the vicinity of Otago Harbour, swarms at dusk on warm nights preceding rain. It may feed on endogean fungi (A. Newton, personal comment). Originally discovered on Aramoana Spit.

Microsilpha **sp. 1**
Example: Vauxhall, between Glendevon Place and Larnach Road, 14 X 2001, flight intercept trap.
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Staphylinidae: Omaliinae
Brouniellum **sp. 1**
Example: Cape Saunders, 21 IV 2016, wahed soil sample.

Brouniellum **sp. 2**
Example: Cape Saunders, 21 IV 2016, washed soil sample.

Macralymma puntiventre Cameron, 1945
Example: Sandfly Bay, 19 X 2014, under seaweed on sandy beach.
Observations: +1, Sandfly Bay, 14 IX 2015, under driftwood log.
Comments: common from Dunedin southwards under seaweed embedded on sandy beaches.

Omaliomimus conicum Fauvel, 1878
Example: Sandfly Bay, 19 X 2014, under seaweed on sandy beach.
Example: Victory Beach, 3 X 2015, under seaweed on sandy beach.

"*Stenomalium*" sp. 1
Example: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter.
Example: Collinswood Bush, Macandrew Bay, 22 X 2014, in decayed wood.
Observations: +2, Collinswood Bush, ground litter; +2, Varleys Hill, 2 III 2015, in ground litter; +4, Collinswood Bush, 30 III 2015, on *Favolaschia calocera* fungus.
Comments: Although currently classified in *Stenomalium,* this species belongs in a new genus.

"*Stenomalium*" sp. 2
Example: Glendevon Place, Vauxhall, 18 X 2014, in garden compost.

"*Stenomalium*" sp. 3
Example: Okia Flat, 1 III 2015, in litter from abandoned yellow-eyed penguin bowl.
Observations: +2, as above.

Staphylinidae: Pselaphinae
***Eupinogitus* sp.**
Example: Sandymount / Sandfly Bay Track, 14 IX 2015, in *Phormium* and grass litter.

***Euplectopsis* sp. 1**
Example: Collinswood Bush, Macandrew Bay, 19 X 2014, in decayed wood.

***Euplectopsis* sp. 2**
Example: Vauxhall, 19 I 2015, in decayed ngaio wood.

***Euplectopsis* sp. 3**
Example: Boulder Beach, 21 X 2015, in litter under totara trees.

Pseudoexeirarthra colorata (Broun, 1914)
Example: Taiaroa Bush, 24 XI 2014, in moss and lichen on tree bole.
Example: Harbour Cone, near trig, 9 XI 2015, in litter under *Melicytus*.
Example: as above, but 9 XI 2015.
Examples (2): as above, but washed soil sample.
Comments: identity of these specimens requires checking. If *Ps. colorata*, then known from Mid Canterbury, southern Westland, Dunedin and Fiordland.

Sagola anisarthra Broun, 1893
Example: Boulder Beach, 19 XI 2004, washed up live with incoming tide.
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.
Examples: 17, Taiaroa Bush, 31 VIII 2015, in shallow forest floor litter (all except 2 are females).
Comments: Previously known specimens have been mostly collected by sifting mossy leaf or log litter. Known from Mid Canterbury, Otago Lakes, Dunedin, Fiordland and Southland.

Sagola castanea Broun, 1886

Example: Varleys Hill, 2 III 2015, in decayed totara wood on floor of regenerated forest; J. Nunn collection.
Comments: Occurs from the McKenzie Country south to Southland and Stewart Island. Mostly previously collected by sifting leaf, moss and wood litter.

***Sagola* sp. 1**
Example: Taiaroa Bush, 24 XI 2014, in decayed wood.

***Sagola* sp. 2**
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.
Sagola unsorted
Example: Taiaroa Bush, 24 XI 2014, in moss and lichen on tree bole. Example: Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.
Examples: +1, Taiaroa Bush, 31 VIII 2015, in shallow forest floor litter; +2, same, but in decayed wood.
Comments: *Sagola* species that I can not sort to morphospecies are shown here, and may include species in addition to those listed above in bold font.

Stenosagola (?chandleri) Park & Carlton, 2013.
Example: Peggys Hill, 26 II 2015, sifted moss from tree boles and branches.
Comments: *Stenosagola* species can not be differentiated without dissection. *S. chandleri* is the only *Stenosagola* species known from the Dunedin area, and the specific identity is inferred from this. *S. chandleri* is known from 30 specimens from Marlborough Sounds, Nelson, Marlborogh/Buller, Mid Canterbury, Otago Lakes, Central Otago, Dunedin, Fiordland and Southland, collected mostly by sifting forest litter.
All species in the genus come in three forms; winged males, wingless males and wingless females.

***Zelandius* sp. 1**
Example: Taiaroa Bush, 24 XI 2014, in decayed wood.

Staphylinidae: Euaesthetinae
***Protopristus* sp.**
Example: Peggys Hill bush remnant, 25 X 2014, washed soil sample; on loan to the Field Museum of Natural History, Chicago.
Example: Taiaroa Bush, 24 XI 2014, washed soil sample; on loan to the Field Museum of Natural History, Chicago.
Examples: 3: Varleys Hill, 2 III 2015, washed soil sample; on loan to the Field Museum of Natural History, Chicag□
Examples: 5: Harbour Cone, near summit trig, ground litter under low, Mahoe dominant forest, 20 VIII 2015; on loan to Field Museum of Natural History, Chicago.
Examples: 5, clifftop basin off the Karetai Track, 5 X 2015, in litter under *Hebe elliptica*, silver tussock and *Asplenium*; 3, same, but washed soil sample, on loan to the Field Museum of Natural History, Chicago.
Comments: species of *Protopristus* live in soil or deep leaf litter. There are perhaps more than 100 species with restricted distributions and, because they can not be differentiated at this stage, all Otago Peninsula records are shown under this single entry.

Staphylinidae: Aleocharinae
Aleochara subaenea Fauvel, 1877
Examples: 5, Victory Beach, 3 X 2015, under dead seal.
Examples, 2: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Observations: 5, as above.

Comments: the larvae parasitise fly puparia.

Arena fultoni Cameron, 1945
Example: Victory Beach, 3 X 2015, under dead seal above high water mark.
Comments: this species is strictly marine litoral on sandy beaches, usually found under deeply embedded driftwood.

Atheta trinotata (Kraatz, 1856)
Example: Vauxhall, 11 II 2013, under pile of dead grass in garden.
Comments: an introduced species.
Observations: +5, as above.

Austrasilida zealandica (Cameron 1948)
Example: 2: Taiaroa Bush, 24 XI 2014, on encrusting fungus on underside of mahoe log.
Observations: +1, Taiaroa Bush, in decayed wood.

***?Austrasilida* sp. 1**
Example: 2: Taiaroa Bush, 24 XI 2014, in decayed wood.
Observations: +3, Taiaroa Bush, in decayed wood.

Cordalia obscura (Gravenhorst, 1802)
Example: Glendevon Place, Vauxhall, 18 X 2014, in garden compost.
Comments: an introduced species.

Gyrophaenina sp. 1
Example: Taiaroa Bush, 24 XI 2014, in decayed wood.

Mocyta fungi (Gravenhorst, 1806)
Example: Glendevon Place, Vauxhall, 18 X 2014, in garden compost.
Example: Glendevon Place, Vauxhall, 29 IX 2015, in compost from suburban garden.
Example: Smaills Beach, 1 X 2015, underside of log at edge of Tomahawk Creek.
Example: Allens Beach, 28 IX 2015, on slip-face of sand dune.
Comments: an introduced species.

Myrmecocephalus micans (Broun, 1880)
Example: Tomahawk Lagoon, 16 X 2015, underside of log at edge of lagoon.

Oligota hudsoni Williams, 1976
Example: Okia Flat, 4 III 2015, on *Melicytus alpinus*.

***Oligota* sp. 1**
Examples: 2, Collinswood Bush, Macandrew Bay, 16 X 2014, in forest floor litter

***Oligota* sp. 2**
Example: Vauxhall 11 X 2015, in garden compost.
Comments: probably an adventive species.

Paradiglotta nunni Ashe & Ahn, 2005
Example: Smaills Beach, on wet sand at edge of incoming waves; donated to Chungnam National University, South Korea.
Comments: this is a marine literal species, found from the intertidal zone through to foredunes.

?*Stenomastax dentata* Cameron, 1945
Example: Vauxhall, 19 1 2015, in decayed ngaio wood.

***Sytus* sp. 1**
Examples: 4, Vauxhall, 19 I 2015, in decayed ngaio wood.
Observations: +2, as above.

***Thamiaraea* sp.**
Example: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter.
Example: Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood.
Observations: +>50 Collinswood Bush, in ground litter. Also Harbour Cone near summit trig.
Comments: this species prefers earthy ground litter.

Aleocharinae sp. 1
Example: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter.
Example: Collinswood Bush, Macandrew Bay, 19 XI 2014, forest floor litter.
Examples: 4, bush gully north of top of Paradise Tck., 21 X 2015, washed soil sample.
Observations: +5, Collinswwod Bush, in ground litter.

Aleocharinae sp. 2
Examples: 4, Taiaroa Bush, 24 XI, 2014, washed soil sample.

Aleocharinae sp. 3
Examples: 4: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.

Aleocharinae sp. 4
Example: Allens Beach, 28 IX 2015, on slip face of sand dune.
Comments: this species is recognisable by having two discal punctures each side of the pronotal midline.

Aleocharinae sp. 5
Example: Victory Beach, 3 X 2015, on slip-face of sand dune.
Comments: head conspicuously punctate, and with a longitudinal median groove.

Aleocharinae sp. 6
Examples: 3, Vauxhall, 19 I 2015, in compost from urban garden.
Observations: +4, as above.

Aleocharinae sp. 7
Example: Vauxhall, 25 I 2015, in dry decayed wood.

Observations: +7, as above.

Aleocharinae sp. 8
Example: Taiaroa Bush, 31 VIII 2015, in shallow forest floor litter.

Aleocharinae sp. 9
Example: Okia Flat, 31 XIII 2015, in ground moss under bracken.
Examples: 5, Sandfly Bay, 4 X 2015, in abundance on sand dunes after strong north-westerly wind.
Observations: +17, Sandfly Bay, 4 X 2015, in abundance on sand dunes after strong north-westerly wind.

Aleocharinae sp. 10
Example: Allens Beach, 28 IX 2015, on slip-face of sand dune.

Aleocharinae sp. 11
Example: The Cove, 21 I 2004, in beach gravel at high water mark.
Comments: this species belongs in a new genus near *Gnypeta*.

Athetini unsorted
Example: Tomahawk Lagoon, 16 X 2015, in litter at edge of lagoon.
Example: Boulder Beach, 21 X 2015, in litter under totara trees.

Staphylinidae: Tachyporinae
Sepedophilus auricomus (Broun, 1880)
Example: Taiaroa Bush, 24 XI 2014, in decayed wood.

***Sepedophilus* sp. 1**
Example: Collinswood Bush, Macandrew Bay, 29 X 2014, in dead *Hoherius* wood.
Observations: + 4, Collinswood Bush, in dead, dry *Hoheria*wood.

***Sepedophilus* sp. 2**
Example: Taiaroa Bush, 24 XI 2014, in decayed wood.
Observations: +12, Taiaroa Bush, in decayed wood.

Tachyporus nitidulus (Fabricius, 1781)
Example: Okia Flat loop walk, 31 VIII 2015, in ground moss under bracken.
Observations: +3, Sandfly Bay, 4 X 2015, on sand dunes; +2, clifftop basin off the Karetai Track, 5 X 2015, in litter under *Hebe elliptica*, silver tussock and *Asplenium*.
Comments: an adventive species.

Staphylinidae: Scydmaeninae (stone beetles)
***Maorinus* sp. 1**
Example: 2, Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter.
Example: Collinswood Bush, Macandrew Bay, 13 X 2015, in decayed tree fern caudex.

Scydmaeninae sp. 1
Examples: 2, Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood.

Scydmaeninae sp. 2
Example: Taiaroa Bush, 24 XI 2014, in decayed wood.

Scydmaeninae sp. 3
Examples: 2, Harbour Cone, 312m. 21 VIII 2015, in mahoe litter from boulder scree.
Examples: bush gully north of top of Paradise Tck., 21 X 2015, washed soil sample.

Scydmaenini unsorted
Examples: 3, Taiaroa Bush, 31 VIII 2015, in decayed wood.
Example: Harbour Cone, 312m. 21 VIII 2015, in mahoe litter from boulder scree.
Comments: There are over 200 species of Scydmaenini in New Zealand; all very hard to differentiate. Hence, any found on Otago Peninsula have been put aside in case there is an opportunity for a specialist to examine them.

Staphylinidae: Scaphidiinae
Brachynopus scutellaris (Redtenbacher, 1867)
Example: Papanui Inlet, near mouth, 12 X 2015, underside of log in rough pasture.
Example: Collinswood Bush, Macandrew Bay, 29 VIII 2016, in decayed wood.

Scaphisoma hanseni Lobl & Leschen, 2003
Example: Varleys Hill, 2 III 2015, found dead in much decayed matai wood; M. Parker collection.

Staphylinidae: Leptotyphlinae
Neotyphlinae sp. 1
Example: Peggys Hill bush remnant, 25 X 2014, washed soil sample; on loan to the Field Museum of Natural History, Chicago.
Comments: Leptotyphlinae are minute, blind, depigmented rove beetles that spend their entire life cycle in soil. No New Zealand species have yet been described.

Staphylinidae: Oxytelinae
***Anotylus* sp.**
Example: entrance to Sandymount Recreation Park, 27 X 2014, in twiggy ground litter from forest remnant; J. Nunn collection.
Comments: an introduced species.

***Bledius* sp. 1**
Example: Sandfly Bay, 14 IX 2015, under driftwood on sandy beach.
Example: Smaills Beach, 30 X 2014, under seaweed on sandy beach.
Example: Victory Beach, 3 X 2015, under seaweed on sandy beach.

Teropalpus unicolor (Sharp, 1900)
Example: Smaills Beach, 30 X 2014, under seaweed on sandy beach.
Example: Sandfly Bay, 14 IX 2015, under driftwood on foredunes.

Staphylinidae: Paederinae
Hyperomma mandibulare Broun, 1893
Example: Glendevon Place, Vauxhall, 18 X 2014, in garden compost.
Comments: Flightless. This is the most commonly collected species of *Hyperomma*, and the only one known from the Dunedin area. It is recorded from Otago Lakes, Central Otago,

Dunedin and Southland.

Staphylinidae: Staphylininae
***Cafius* sp. 1**
Example: Smaills Beach, 30 X 2014, under seaweed on sandy beach.

***Cafius* sp. 2**
Example: Smaills Beach, 30 X 2014, under seaweed on sandy beach.
Examples: 2, Victory Beach, 3 X 2015, under seaweed on sandy beach.
Example: Allens Beach, 28 IX 2015, under driftwood on sandy beach.
Example: Victory Beach, 12 X 2015, under seaweed on sandy beach.

Gyrohypnus fracticornis (Muller, 1776)

Notolinus socius (Fauvell, 1877)
Example: Glendevon Place, Vauxhall, 18 X 2014, in garden compost, J. Nunn collection.
Example: Sandfly Bay, 19 X 2014, on sand dunes.
Example: Sandfly Bay, 14 IX 2015, under driftwood on foredunes.
Example: 4: paddock adjacent to Collinswood Bush, 19 XI 2014, under old logs, J. Nunn collection.
Comments: An adventive species. Specimens need to be examined by a specialist to determine whether the series might include an undescribed species.

Maorothius brouni (Steel, 1949)
Example: Taiaroa Bush, 24 XI 2014, in decayed wood; J. Nunn collection.
Example: Peggys Hill, 26 II 2015, in decayed wood, J. Nunn collection.
Observations: +1, Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.
Comments: distributed across the southern part of the South Island except the extreme west.

□*Quedius*□ sp. 1
Example: Taiaroa Bush, 24 XI 2014, in decayed wood; J. Nunn collection.
Comments: our New Zealand □*Quedius*□ are not congeneric with Northern Hemisphere *Quedius*; hence the inverted commas. There are are few adventive genuine *Quedius*.

□*Quedius*□ sp. 2
Example: Taiaroa Bush, 24 XI 2014, under stone in forest; J. Nunn collection.
Example: Karetai Road, 30 IX 2015, in clump of dead grass, open farmland.

□*Quedius*□ sp. 3
Example: Vauxhall, 15 IX 2015, in old pile of grass in garden; J. Nunn collection.
Comments□ perhaps an adventive species.

□*Quedius*□ sp. 4
Example: Vauxhall, 15 IX 2015, in old pile of grass from suburban garden.
Comments: this species is more at home under loose bark of logs in forest.

Lucanidae (stag beetles)
All are associated with dead wood apart from one species that lives in ant colonies.

Scarabaeidae (scarabs, dung beetles and chafers)
Includes scavengers and plant feeders.

Costelytra giveni Coca-Abia & Romero-Samper, 2016
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Observations: 50+, as above.

Odontria autumnalis Given, 1952
Example: Vauxhall, 27 IX 2015, flying at dusk.
Comments: originally described from the Nelson area.

Odontria striata White, 1846
Example: Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree, J. Nunn collection.
Comments: common from Bluff to North Canterbury, with occasional records from the North Island (Given, 1952).

Pericoptus punctatus (White, 1846)
Example: Sandfly Bay, 17 I 2015, dead on sand dunes.
Comments: coastal; on foredunes.

Phycocus graniceps Broun, 1883
Example: Sandfly Bay, 17 I 2015, dead at base of sand dune.
Comments: confined to sandy beaches.

Saprosites fortipes (Broun, 1881)
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.
Comments: strictly coastal, usually under high-stranded driftwood logs.

Scirtidae (marsh beetles)
Mostly living in the vicinity of water.

Scirtidae sp. 1
Examples: 8, Okia Flat car park, 24 XI 2014, on *Muehlenbeckia*.

Scirtidae sp. 2
Example: Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.

Clambidae (clam beetles)
Some species, at least, feed on fungal spores.

Clambidae sp.
Examples: 2, Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl; J. Nunn collection.

Byrridae (moss beetles)
All feed on moss and/or perhaps lichen. A very diverse group in New Zealand.

***Cytilissus* sp. 1**
Example: Collinswood Bush, Macandrew Bay, 22 X 2014, underside of stone in bush.
Example: Peggys Hill, 26 II 2015, in moss on tree in bush remnant.
Example: Collinswood Bush, Macandrew Bay, 13 X 2015, in decayed *Griselinia* wood.

"*Pedilophorus*" sp. 1
Example: Peggys Hill, 26 II 2015, in decayed, moss-covered wood from bush remnant.
Comments: *Pedilophorus* is a Norther Hemisphere genus, and New Zealand species assigned to it belong in a new genus.

***Synorthus* sp. 1**
Example: Taiaroa Bush, 24 XI 2014, in moss and lichen on tree bole.
Example: Peggys Hill, 26 II 2015, In moss on tree from bush remnant.

Elmidae (riffle beetles)
All are aquatic or semi-aquatic.

Eucnemidae (false click beetles)
Larvae are associated with dead wood.

Elateridae (click beetles)
Adults on foliage, in dead wood or in the ground. Larvae can be saprophitic, predators or vegetarian (mainly on plant roots).

***Betamonides* sp. 1**
Examples, 2: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Observations: 2, as above.

***Protelater* sp. 1**
Example: 2: Taiaroa Bush, 24 XI 2014, in decayed wood; J. Nunn collection.

Elateridae sp. 1
Examples: 2: Vauxhall, 3 XII 2014, in garden.
Example: Vauxhall, 13 XII 2014, in urban garden.
Observations: 1: Vauxhall, 13 XII 2014, in urban garden.
Comments: the larvae feed on root vegetables.

Cantharidae (soldier beetles)
Asilis sp. nov.
Examples,2: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Dermestidae (hide beetles)
Feeding on dry animal remains.

Anobiidae (borer beetles and spider beetles)
Mainly associated with dead woody material.
Anobiidae sp.1
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

***Xenocera* sp. 1**
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Trogossitidae (cadelle beetles)
Predators as both adults and larvae.

Phanodesta sobrina (White, 1846)
Example: Track to Collinswood Bush, Macandrew Bay, 16 X 2014, in decayed *Hoherius* wood.
Example: Collinswood Bush, Macandrew Bay, 29 X 2014, in dead *Hoherius* wood.
Example: Taiaroa Bush, 24 XI 2014, in moss and lichen on tree bole.
Example: Taiaroa Bush, 24 XI 2014, in dead wood.
Example: Portobello Road / Tor Street zig-zag, 11 X 2015, in dead ngaio wood.
Observations: 2: Vauxhall, 8 XII 2014, in wood from dead silver birch; +2, Vauxhall, 20 X 2015, in dead ngaio wood.

?*Rentonellum* sp. 1
Example: 2, Taiaroa Bush, 24 XI 2014, washed soil sample.
Example: 2: Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.
Observations: 1: Collinswood Bush, Macandrew Bay, forest floor litter.

?*Rentonellum* sp. 2
Example: 3, Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.

Rentoniinae sp. 1
Example: Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood; J. Nunn collection.
Example: Peggys Hill, 26 II 2015, in decayed wood. On loan to M. Gimmell.

Rentoniini sp. 2
Examples: 2, Okia Flat, 4 III 2015, On partly dead *Lupinus arboreus.*

Chaetosomatidae (southern cadelle beetles)
Under the bark of dead trees where they feed on the larvae of insects.

Chaetosoma scaritides Westwood, 1851
Example: Sandfly Bay, 19 X 2014, on sand dunes. J Nunn collection.

Cleridae (checkered beetles)
Larvae in dead wood where they feed on beetle larvae. Adults generally on vegetation in sunny situations.

Phycosecidae (beach beetles)
Limited to sandy beaches and fore-dunes where they scavenge dead animal material.

Phycosecis limbatus (Fabricius, 1781)
Example: Allens Beach, 28 IX 2015, on sand dune.
Observations: +1, as above.

Melyridae (flower beetles)
Adults generally on flowering shrubs where they feed on pollen.

Dasytes **sp. 1**
Example: Okia Flat, 4 III 2015, on *Melicytus alpinus.*

Nitidulidae (sa beetles)
Found in a diverse range of habitats.

Epuraea antarctica (White, 1846)
Example: Glendevon Place, Vauxhall, 18 X 2014, in garden compost, J. Nunn collection.

Monotomidae
All introduced species, in compost, lawn clippings, hen houses, etc.

Silvanidae
Generally found under bark of dead trees where they feed on dead plant material and fungi. Some are pests of stored products.

Cryptamorpha brevicornis (White, 1846)
Example: Vauxhall, 11 II 2015, under pile of dead grass in garden; J. Nunn collection.
Observations: +7, as above; +2, Vauxhall, 12 IX 2015, in old pile of grass in garden; +7, vauxhall, 11 X 2015, in garden compost..

Cavognathidae (birds' nest beetles)
Taphropiestes dumbletoni (Crowson, 1973)
Examples: 3, Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl; J. Nunn collection.

Cryptophagidae
Cryptophagus **sp. 1**
Examples: 2, Vauxhall, 29 IX 2015, in garden compost.
Comments: an adventive species.

Ephistemus globulus (Paykull, 1798)
Example: Varleys Hill, 2 III 2015, in much decayed matai wood; M. Parker collection.
Observations: +24, Vauxhall, 29 IX 2015, in garden compost; +>50, Vauxhall, Winter and Autumn 2015, in garden compost.

Paratomaria crowsoni Leschen, 1996
Observations: +1, Harbour Cone near summit trig, 21 VIII 2015, in mahoe litter; +1, Taiaroa Bush, 31 VIII 2015, in shallow forest floor litter; +4, Taiaroa Bush, 31 VIII 2015, in decayed wood; +2, Vauxhall, 12 IX 2015, in dead *Populnea* wood, +12, Sandymount, 14 IX 2015, on gorse and other shrubs, +13, Collinswood Bush, 15 IX 2015, on various types of flowers and foliage; +25, Karetai Track, 30 IX 2015, on flowering gorse.

Erotylidae (pleasing fungus beetles)
Feeeding inside the friting bodies of fungi, or under bark.

Cryptodacne ferrugata Reitter, 1879
Example: Vauxhall (between Glendevon Place and Larnach Road), 1 VII 2000, flight intercept trap; J. Nunn collection.
Observations:

Bothrideridae
All are predacious, most usually found under bark of dead trees.

***Ascetoderes* sp.**
Example: Track to Collinswood Bush, Macandrew Bay, 16 X 2014, in decayed *Hoherius* wood, J. Nunn collection.
Example: Track to Collinswood Bush, Macandrew Bay, 29 XI 2014, dead in spider's web under bark of dead *Hoheria*; J. Nunn collection.
Comments: A rather rare species.

Cerylonidae (waxen beetles)
Thought to feed on fungal hyphae and spores.

Hypodacnella rubriceps (Reitter, 1880)
Example: Track to Collinswood Bush, Macandrew Bay, 16 X 2014, in decayed *Hoherius* wood, J. Nunn collection.
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl; J. Nunn collection.
Observations: +1, Taiaroa Bush, in decayed wood; +1, Collinswood Bush, in fungus on bole of dead *Hoheria,* +3, Collinswood Bush, 29 III 2015, underside of stone on forest floor; +2, Collinswood Bush, 29 III 2015, in dead, dry *Hoheria* wood; +1, Allens Beach, 28 IX 2015, under driftwood log; +1, Victory Beach, 3 X 2015, underside of driftwood on sandy beach.

Endomychidae (waisted mildew beetles)
***Holoparamecus* sp.**
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl; J. Nunn collection.

Coccinellidae (ladybirds)
Mostly predatory on soft-bodied insects and mites.

***Adoxellus* sp. 1**
Example: Taiaroa Bush, 24 XI 2014, on forest vegetation; J. Nunn collection.
Observations: +5, Taiaroa Bush, 31 VIII 2015, in shallow forest floor litter; +1, Vauxhall, 12 IX 2015, in dead *Populnea* wood.

Coccinella leonina Fabricius, 1775
Example: Okia Flat, 24 XI 2014, flying in sunshine; J. Nunn collection.
Observations: +1, Allens Beach, 28 IX 2015, on sand dune slip face.

Coccinella undecimpunctata (Linnaeus, 1758)
Example: Sandfly Bay, 19 X 2014, on sand dunes; J. Nunn collection
Observations: +14, Allens Beach, 28 IX 2015, on sand dune slip faces; +1, Karetai Track, 30 IX 2015, on flowering gorse; +3, Victory Beach, 3 X 2015, at base of dunes; +2, Sandfly Bay, 4 X 2015, on sand dunes.

Comments: this is the well known 11-spotted ladybird; an introduced species.

***Rhyzobius* sp. 1**
Example: Karetai Track, 30 IX 2015, on flowering gorse.

***Rhyzobius* sp. 2**
Example: clifftop basin off the Karetai Track, 5 X 2015, in litter under *Hebe elliptica*, silver tussock and Asplenium.

***Veronicobius* sp.**
Example: Vauxhall, 11 II 2015, under pile of dead grass in garden.

Corylophidae (hooded beetles)
Known to feed on fungi.

***Arthralips* sp. 1**
Example: Vauxhall, cut out of silver birch log (live but moribund wood), 1 XI 2014; J. Nunn collection.

***?Arthralips* sp. 2**
Example: Collinswood Bush, Macandrew Bay, 19 XI 2014, in forest floor litter, J. Nunn collection.

***Holopsis* sp. 1**
Example: 2: Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood; J. Nunn collection.
Observations: +2, Collinswood Bush, in ground litter.

***Holopsis* sp. 2**
Example: Collinswood Bush, Macandrew Bay, 19 XI 2014, in forest floor litter.

***Sericoderus* sp. 1**
Example: Track to Collinswood Bush, Macandrew Bay, 29 XI 2014, in decayed wood.

Latridiidae (mildew beetles)
Adults and larvae feed on fungal spores.

Bicava fulgurita Belon, 1884
Example: entrance to Sandymount Recreation Park, 27 X 2014, in twiggy ground litter from forest remnant; J. Nunn collection.
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl; J. Nunn collection.
Example: Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Comments: abundant everywhere around Dunedin, in ground litter and decayed wood, and on vegetation. An introduced species.
Observations: +12: Vauxhall, in dry decayed wood; +1, Collinswood Bush, 30 III 2015, in solid dead wood; +2, Harbour Cone near summit trig, 21 VIII 2015, in mahoe litter; +3, Taiaroa Bush, 31 VIII 2015, in decayed wood, +7, Sandymount, 14 IX, 2015, in litter under *Phormium tenax*, +2, same but in litter under *Melicytus*.

***Bicava* sp. 1**
Example: Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree; J. Nunn collection.

Cartodere bifasciatus(Reitter, 1877)
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl; J. Nunn collection.

Corticaria formicaephila Broun, 1893
Example: Gills Corner, Harrington Point, 12 X 1997, under semi-mummified seagull on sand dunes; J. Nunn collection.

Corticaria lata Reike, 2010
Example: Boulder Beach, 14 I 2005, washed up with incoming tide; J. Nunn collection.

***Enicmus* sp 1**
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

***Melanophthalma* sp. 1**
Example: Taiaroa Bush, 24 XI 2014, on forest vegetation; J. Nunn collection.
Observations: 6: Taiaroa Bush, 24 XI 2014.

***Melanophthalma* sp. 2**
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Rethusa pustulosus (Belon, 1884)
Example: 2: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter, J. Nunn collection.

Latridiidae sp. 1
Example: Tomahawk Beach, 2 XI 2014, on slip-face of sand dune; J. Nunn collection.

Latridiidae sp. 2
Example: Tomahawk Beach, 2 XI 2014, on slip-face of sand dune; J. Nunn collection.

Mycetophagidae (hairy fungus beetles)
On fungi, or organic material infested with fungi.

***Triphyllus* sp. 1**
Example: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter, J. Nunn collection.
Example: Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood; J. Nunn collection.
Example: Tomahawk Beach, 2 XI 2014, on slip-face of sand dune; J. Nunn collection; J. Nunn collection.
Observations: +4, Collinswood Bush, in ground litter; +8, Taiaroa Bush, in decayed wood; +1, Collinswood Bush, in dead, dry *Hoheria* wood; +4, Collinswood Bush, 30 III 2015, on *Favolaschia calocera* fungus.

***Triphyllus* sp. 2**
Example: Taiaroa Bush, 24 XI 2014, in moss and lichen on tree bole; J. Nunn collection.

Melandriidae (leaping beetles)

***Hylobia* sp. I**
Examples, 3: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Ciidae (shelf fungus beetles)

Mainly associated with fungi, especially shelf fungi, but also in dead wood or under bark.

Cis undulatus (Broun, 1880)
Example: Vauxhall, cut out of log from dying silver birch, 1 XI 2014; J. Nunn collection.

***Cis* sp. 1**
Example: 2, Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood; J. Nunn collection.
Observations: +2, Taiaroa Bush, 31 VIII 2015, in decayed mahoe wood.

Melandryiidae (leaping beetles)

Often in leaf litter or on dead branches.

***Hylobia* sp.1**
Example: entrance to Sandymount Recreation Park, 27 X 2014, in twiggy ground litter from forest remnant; J. Nunn collection.
Examples, 3: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Mordellidae (pintail beetles)

Adults usually on flowers.

Rhipiphoridae (antlered beetles)

Adults are parasitoids on insect larvae.

Zopheridae (rough mould beetles)

Mostly fungus feeders and associated with dead wood or leaf litter.

***Ablabus* sp. 1**
Example: 2: Collinswood Bush, Macandrew Bay, 19 XI 2014, in decayed wood, J. Nunn collection.
Example: 5: Track to Collinswood Bush, Macandrew Bay, 29 XI 2014, in decayed wood, J. Nunn collection.
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.
Observations: +3, Collinswood Bush, 29 III 2015, in dead, dry *Hoheria*wood; +2, Collinswood Bush, 30 III 2015, in soild dead wood.

Bitoma rugosa Sharp, 1876
Example: Vauxhall, cut from log of dying silver birch, 1 XI 2014; J. Nunn collection.
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

***Bitoma* sp. 1**
Example: Collinswood Bush, 19 XI 2014, under log in paddock adjacent to bush reserve; J. Nunn collection.

Chorasus costatus (Broun, 1893)
Examples : 2, Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree; J. Nunn collection.
Examples: 2, as above, but 9 XI 2015.
Examples: 3, Sandymount Recreation Park car park, 14 IX 2015, in mahoe litter; J. Nunn collection.
Observations: +1, Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.

***Notocoxelus* sp. 1**
Example: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter, J. Nunn collection.
Example: Tomahawk Beach, 2 XI 2014, on slip-face of sand dune; J. Nunn collection.
Example: Collinswood Bush, 19 XI 2014, in decayed wood, J. Nunn collection.
Example: Collinswood Bush, 19 XI 2014, in forest floor litter, J. Nunn collection.
Examples: 3: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl; J. Nunn collection.

***Notocoxelus* sp. 2**
Example: Taiaroa Bush, 24 XI 2014, on dead branches, J. Nunn collection.
Observations: +1, Taiaroa Bush, in decayed wood; +2, Harbour Cone near summit trig, 21 VIII 2015, in mahoe litter.

Pristoderus bakewelli (Pascoe, 1866)
Example: Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood; J. Nunn collection.
Observations: +1, Collinswood Bush, in ground litter; +1, Collinswood Bush, 29 III 2015, in dead, dry *Hoheria* wood.

Pycnomerus caecus Broun, 1886
Example: Varleys Hill, 2 III 2015, in partly decayed kanuka wood; J. Nunn collection (in ethanol).
Comments: Not uncommon around Dunedin. It most usually lives in subhumified wood.

***Pycnomerus* sp.**
Example: Collinswood Bush, Macandrew Bay, 22 X 2014, in decayed wood; J. Nunn collection.

***Tarphiomimus* sp.**
Examples: 5, Collinswood Bush, 15 IX 2015, on dead, fallen *Sophora* branch; J. Nunn collection.

Tenebrionidae (darkling beetles)
Many live in rotten wood.

Actizeta albata Pascoe, 1875
Example: Victory Beach, 3 X 2015, on slipface of sand dune.

Observations: +1, as above.
Comments: restricted to sandy beaches where it forages for organic detritus.

Artystona rugiceps Bates, 1874
Example: Taiaroa Bush, 24 XI 2014, on forest vegetation.
Observations: +1, 31 Highcliff Road, 10 IX 2015, under bark of *Cupressus macrocarpa* log.
Observation: +1, Varleys Hill, 24 I to 28 II 2017, flight intercept trap.
Comments: this species feeds on lichen and is active at night.

Chaerodes trachyscelides White, 1846
Example: Sandfly Bay, 19 X 2014, under seaweed on sandy beach.
Observations: +5, Sandfly Bay, 23 IX 2015, under kelp embedded in dand on beach.

***Lorelus* sp. 1**
Example: Sandymount / Sandfly Bay track, 14 IX 2015, on dead *Phormium tenax* leaves; J. Nunn collection.

***Lorelus* sp. 2**
Example: Collinswood Bush, 15 IX 2015, amongst dead *Astelia* leaves; J. Nunn collection.
Comments: very similar to *Lorelus* sp. 1, but with the pronotum more transverse, and less convex.

Mimopeus opaculus (Bates, 1873)
Example: Taiaroa Bush, 24 XI 2014, in space under rock; J. Nunn collection.
Observations: 1: Sandfly Bay, on sand dunes; 2: Vauxhall, zig-zag track between Tor Street and Portobello Rd, 15 VIII 2015, under old *Eucalyptus* log.
Comments: prefers dry places.

Mimopeus elongatus Breme, 1842
Example: Sandfly Bay, 4 X 2015, on sand dunes.
Observations: 2, Sandfly Bay, 28 II 2017, walking on sand dunes.

Mitua tuberculocostatum
Example: Vauxhall, zig-zag track between Tor Street and Portobello Road, 15 VIII 2015, underside of *Eucalyptus* log.
Observations: 1: Vauxhall, 9 XII 2014, dead and disarticulated specimen in old *Cupressus macrocarpa* log; 5: Vauxhall, zig-zag track between Tor Street and Portobello Road, 15 VIII 2015, underside of *Eucalyptus* log.
This species naturally occurs from Auckland down to Buller and Marlborough. Evidently a colony has been established outside its historic distribution range.

Omedes substriatus (Broun, 1880)
Example: Sandfly Bay, 17 I 2015, dead on sand dunes.
Comments: generally coastal at the back of beaches.

Zeadelium aeratum (Broun, 1880)
Example: Track to Collinswood Bush, Macandrew Bay, 16 X 2014, in decayed *Hoherius* wood, J. Nunn collection.
Example: Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood; J. Nunn collection; +3, Collinswood Bush, 30 III 2015, in cavities in solid dead wood; 4: Vauxhall,

zig-zag track between Tor Street and Portobello Road, 15 VIII 2015, in partly decayed *Eucalyptus* log.
Comments: very common around Dunedin.
Observations: +1, Collinswood Bush, in ground litter; +1 Taiaroa Bush, under stone in forest; Collinswood Bush, under stone on forest floor; +1, Collinswood Bush, 29 III 2015, in dead, dry *Hoheria* wood; +1, Harbour Cone near summit trig, 21 VIII 2015, in mahoe litter; +1, Collinswood Bush, 13 X 2015, in decayed tree fern caudex; +1, same, but in decayed *Griselinia* wood.

Zeadelium lentum (Broun, 1880)
Example: Glendevon Place, Vauxhall, 18 X 2014, in garden compost, J. Nunn collection.

Oedemeridae (lax beetles)
Many species live on beaches under decayed wood.

Baculipalpus rarus Broun, 1880
Example: Boulder Beach, 1 I 2000, under driftwood on sandy beach; J. Nunn collection.

Thelyphassa diaphana Pascoe, 1876
Example: Sandfly Bay, 11 I 2002, underside of driftwood on sandy beach; J. Nunn collection.

Thelyphassa lineata (Fabricius, 1775)
Example: Taiaroa Bush, pupa collected 24 XI 2014 from friable decayed wood, and one adult emerged 12 XII 2014, J. Nunn collection.
Observations: 2: pupae, Taiaroa Bush, 24 XI 2014.

Thelyphassa nemoralis Broun, 1886
Example: Paradise Track, Pukehiki, 30 I 2001; J Nunn collection.
Examples, 2: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Salpingidae (bark mould beetles)
Adults generally on foliage or dead branches.

Diagrypnodes wakefieldi Waterhouse, 1876
Example: 2: Collinswood Bush, Macandrew Bay, 29 XI 2014, under bark of dead *Hoheria*; J. Nunn collection.

***Salpingus* sp. 1**
Example: 2, Taiaroa Bush, 24 XI 2014, in moss and lichen on tree bole.

***Salpingus* sp. 2**
Example: Vauxhall (between Glendevon Place and Larnach Road), 16 X 2015, beaten from dead *Muehlenbeckia* vines.

Anthicidae (ant beetles)
General scavengers in decaying vegetation.

Lagrioida brouni
Example: Allens Beach, 28 IX 2015, under driftwood on sandy beach.
Observations: +8, Victory Beach, 3 X 2015, underside of driftwood on sandy beach.

Observations: 17, Sandfly Bay, 28 II 2017, underside of driftwood on sandy beach.

Aderidae (ant-like leaf beetles)
Adults generally on foliage.

***Xylophilus* sp. 1**
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Scraptiidae (soft leaping beetles)
Adults often on foliage or flowers.

***Nothotelus* sp. 1**
Example: Vauxhall (between Glendevon Place and Larnach Road), 16 X 2015, beaten from dead *Muehlenbeckia* vines.

Cerambycidae (longhorn beetles)
Almost always wood-borers in dead wood; sometime dying trees and shrubs.

Nodulosoma picticornis (Broun, 1895)
Example: Harbour Cone near summit trig, 21 VIII 2015, in mahoe litter, J. Nunn collection.

***Nodulosoma* sp. 1**
Examples: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

***Psilocnaeia* sp. 1**
Example: Tomahawk Beach, 16 X 2015, on sand dunes.

Ptinosoma spinicollis
Example: Harbour Cone near summit trig, 21 VIII 2015, in mahoe litter, J. Nunn collection.
Observations: +3, as above; +1, Okia Flat loop walk, 31 VIII 2015, in ground moss under bracken.

Xyloteles griseus (Fabricius, 1775)
Observation: Tomahawk Beach, 16 X 2015, on sand dunes.

Zorion australe Schnitzler, 2005
Example: Vauxhall, cut out of silver birch log (live but moribund wood), 1 XI 2014; J. Nunn collection.
Observations: +2, Vauxhall, in wood of dying silver birch; +2, Okia Flat car park, on *Muehlenbeckia*.

Cerambycidae sp. 1
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Chrysomelidae (leaf beetles)
Living and feeding on living vegetation.

Nemonychidae (straight-horned weevils)

Rhinorhynchus rufulus (Broun, 1880)
Example: Taiaroa Bush, 24 XI 2014, on totara foliage.
Comments: feeds on pollen of podocarps and phylloclades.

Anthribidae (fungus weevils)

On standing vegetation, or in leaf litter.
Cacephatus incertus
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Micranthribus atomus
Examples, 2: Okia Flat, 4 II 2015, on partly dead *Lupinus*.

Phymatus phymatodes
Example: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

Sharpius brouni (Sharp, 1876)
Example: Vauxhall, cut out of silver birch log (live but moribund wood), 1 XI 2014.
Observations: 1: Vauxhall, 8 XII 2014, on dead silver birch branchlets.

Sharpius sandageri (Broun, 1893)
Example: Collinswood Bush, Macandrew Bay, 19 XI 2014, in forest floor litter.

Xenanthribus hirsutus Broun, 1893
Example: Track to Collinswood Bush, Macandrew Bay, 16 X 2014, in decayed *Hoherius* wood.
Example: entrance to Sandymount Recreation Park, 27 X 2014, in twiggy ground litter from forest remnant; J. Nunn collection.
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.
Observations: +3, Collinswood Bush, in ground litter; +1: Vauxhall, in dry decayed wood..

Belidae (austral weevils)

Some species are host-specific on podocarps; others on angiosperms.

Rhicnobelus aenescens (Broun, 1915)
Reference: □Cape Saunders□; Kuschel, 2003.
Comments: associated with *Phyllocladus* and probably other podocarps.

Brentidae

Exapion (Ulapion) ulicis (Fabricius, 1775)
Example: Karetai Track, 30 IX 2015, on flowering gorse.
Observations: +1, Tomahawk Beach, 16 X 2015, on sand dunes.
Comments: this species has been deliberately introduced to control gorse.

Curculionidae (weevils)

All are feeders on dead or living plant material.

Curculionidae: Cossoninae
***Agastegnus* sp. 1**
Example: Sandymount, 14 IX 2015, under bract on fower stem of *Phormium*.

Eucossonus sp.
Examples: 5, Sandymount, 21 XII 2016, on *Phormium tenax*.
Observations: 29, as above.

***Euophryum* sp. 1**
Example: Vauxhall, 12 IX 2015, in dead *Populnea* wood.

Macrorhyncolus littoralis (Broun, 1880)
Example: Allens Beach, 28 IX 2015, undeside of driftwood log.
Observations: +3, Victory Beach, 3 X 2015, under side of driftwood on sandy beach; +17, Papanui Beach, 26 X 2015, under driftwood on sandy beach.
Comments: this species is strictly marine litoral and thought to be adventive. It occurs on the underside of dritwood at and above the high tide line.

Microtribus huttoni Wollaston, 1879
Example: Sandfly Bay, 23 IX 2015, under driftwood on sandy beach.

Paedaretus hispidus Pascoe, 1871
Example: Vauxhall, cut out of silver birch log (live but moribund wood), 1 XI 2014.
Examples: 2, Vauxhall, 12 IX 2015, in dead *Populnea* wood.
Observations:
Observations: +1: Vauxhall, 8 XII 2014, in wood from dead silver birch; 2: Vauxhall, 21 XII , in decayed ngaio wood; +1, Vauxhall, 12 IX 2015, in dead *Populnea* wood.

Pentarthrum carmichaeli Waterhouse, 1864
Examples: 3, Taiaroa Bush, 24 XI 2014, on forest vegetation.
Example: Allens Beach (south end), 28 IX 2015, underside of driftwood log on sandy beach.
Example: Boulder Beach, 14 X 2016, underside of driftwood above high tide line.
Observations: +7, Papanui Inlet, 26 X 2015, under driftwood on sandy beach.
Comments: this species occurs on old driftwood on beaches above the high tide line.

Pentarthrum subseriatum Wollaston, 1873
Example: Track to Collinswood Bush, Macandrew Bay, 16 X 2014, in decayed *Hoherius* wood.

Pentarthrum zealandicum Wollaston, 1873
Example: 2: Collinswood Bush, Macandrew Bay, 29 X 2014, in dead *Hoherius* wood.
Observations: 2: Collinswood Bush, under bark of dead *Hoheria*.

***Pentarthrum* sp. 1**
Example: Collinswood Bush, Macandrew Bay, 29 X 2014, in dead *Hoherius* wood.
Observations: +1, Taiaroa Bush, 31 VIII 2015, in decayed mahoe wood.

Phloeophagosoma pedatum
Examples: 20: Sandymount, 14 IX 2016, under bract on flower stem of *Phormium*.

Sericotrogus subaenescens Wollaston, 1873
Example: Vauxhall (between Glendevon Place and Larnach Road), 16 X 2015, beaten from dead *Muehlenbeckia* vines.

***?Stilbocara* sp. 1**
Example: Varleys Hill, 2 III 2015, in much decayed matai wood; M. Parker collection.

Cossoninae sp. 1
Example: Sandymount / Sandfly Bay track, 14 IX 2015, in dead *Phormium tenax* leaves; J. Nunn collection.
Comments: probably host-specific on *Phormium.*

Curculionidae: Curculioninae
Abantiadinus nodipennis Broun, 1914
Example: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter.
Example: Peggys Hill Bush, 25 X 2014, washed spoil sample.

Adstantes rudis (Broun, 1881)
Examplre: Taiaroa Bush, 24 XI 2014, in decayed wood.

***Allanalcis* sp. 1**
Example: Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.

Aphela algarum Pascoe, 1870
Examples: 2, Papanui Inlet, near mouth, 12 X 2015, in sand under driftwood.

***Clypeolus* sp. 1**
Example: Taiaroa Bush, 24 XI 2014, in decayed wood.

Crisius ornatus Broun, 1893
Example: Sandfly Bay, 4 X 2015, on sand dunes.

***Crisius* sp. 1**
Example: entrance to Sandymount Recreation Park, 27 X 2014, in twiggy ground litter from forest remnant.
Example: Collinswood Bush, Macandrew Bay, 19 XI 2014, in forest floor litter.
Observations: +1, Boulder Beach, 21 X 2015, in litter under totara.

***Crisius* sp. 2**
Example: Collinswood Bush, 19 XI 2014, in forest floor litter.

***Didymus* sp. 1**
Example: Okia Flat car park, 24 XI 2014, on *Muehlenbeckia*.
Examples: 2, Vauxhall (between Glendevon Place and Larnach Road), 16 X 2015, beaten from dead *Muehlenbeckia* vines.
Observations: 1: Okia Flat car park, 24 XI 2014, on *Muehlenbeckia.*

Hoplocneme punctatissima Pascoe, 1876
Example: Collinswood Bush, Macandrew Bay, 19 XI 2014, in forest floor litter.
Comments: normally associated with *Hebe* species.

***Hypotagea* sp.**
Example: entrance to Sandymount Recreation Park, 27 X 2014, in twiggy ground litter from forest remnant; J. Nunn collection.

Listronotus bonariensis (Kuschel, 1955)
Example: Sandfly Bay, 23 IX 2015, under driftwood on sandy beach.Observations: +1, Tomahawk Beach, 16 X 2015, on sand dunes.

***Microcryptorhynchus* sp. 1**
Examples: 2, Vauxhall (between Glendevon Place and Larnach Road), 16 X 2015, beaten from dead *Muehlenbeckia* vines.

***Pachyderris* sp. 1**
Examples, 2: Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

***Pactolotypus* sp. 1**
Example: Taiaroa Bush, 24 XI 2014, on forest vegetation.

Peristoreus acceptus (Broun, 1881)
Example: Sandymount / Sandfly Bay track, 14 IX 2015, beated from *Muehlenbeckia australis*. Comments: this species is host-specific on *Muehlenbeckia*.

***Peristoreus* sp. 1**
Example: Collinswood Bush, 15 IX 2015, beaten from tangle of *Muehlenbeckia, Rubus* and *Parsonsia*.

Philacta testacea Broun, 1880
Example: Sandfly Bay, 21 III 1999, under driftwood on sandy beach; Landcare Research, Auckland.

Psepholax sulcatus White, 1843
Example: Vauxhall (between Glendevon Place and Larnach Road), 16 X 2015, beaten from dead *Muehlenbeckia* vines.

Strongylopterus hylobioides (White, 1846)
Example: Varleys Hill, 2 III 2015, in partly decayed kanuka wood; M. Parker collection.
Examples: 2, Varleys Hill, 16 XII 2016 to 24 I 2017, flight intercept trap.

***Trinodicalles* sp. 1**
Example: Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood.
Observations: +1, Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree.

Curculionidae: Molytinae
***Phrynixus* sp.**
Example: Collinswood Bush, Macandrew Bay, 29 X 2014, in dead *Hoherius* wood.
Example: paddock adjacent to Collinswood Bush, 19 XI 2014, underside of old log.
Observations: +1,Vauxhall, in decayed ngaio wood; +1, Harbour Cone, 312m, 21 VIII 2015, in mahoe litter from boulder scree; Tomahawk Lagoon, 16 X 2015, underside of log at edge of lagoon; +1, Tomahawk Lagoon, 16 X 2015, underside of log at edge of lagoon..

Phrynixini sp. 1
Example: Collinswood Bush, Macandrew Bay, 19 XI 2014, in forest floor litter.
Example: Tairoa Bush, 24 XI 2014, in decayed wood.
Observations: Vauxhall, in decayed ngaio wood.

Curculionidae: Entiminae
***Brachyolus* sp.**
Example: 2: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter.
Example: Peggys Hill Bush, 25 X 2014, sifted ground litter and decayed wood.
Observations: +14, Collinswood Bush, in ground litter; +1, Taiaroa Bush, in decayed wood; +1, Peggys Hill, 26 II 2014, in moss on tree trunks and branches; +3, Harbour Cone near summit trig, 21 VIII 2015, in mahoe litter; +5, Taiaroa Bush, 31 VIII 205, in shallow forest floor litter; +1, Sandymount Recreation Park car park, 14 IX 2015, in mahoe litter; +14, Harbour Cone, near trig, 9 XI 2015, in ground litter under *Melicytus*.

***Cecyropa* sp. 1**
Example: Allens Beach (south end), 28 IX 2015, at bottom of sand dune slip face.

***Cecyropa* sp. 2**
Example: Sandfly Bay, 4/10/15, on sand dunes.

***Irenimus* sp. 1**
Example: 2: Collinswood Bush, Macandrew Bay, 16 X 2014, forest floor litter.
Observations: +2 Collinswood Bush, ground litter.

***Irenimus* sp. 2**
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.

***?Mandolotus* sp.**
Example: Okia Flat, 1 III 2015, in debris from abandoned yellow-eyed penguin bowl.

Entiminae sp. 1
Example: Sandfly Bay, 17 I 2015, running on sand dunes.

Curculionidae: Scolytinae
Hylastes ater Paykull, 1800
Examples: 5, Sandfly Bay, 23 IX 2015, under driftwood on sandy beach
Observations: +2, Allens Beach, 28 IX 2015, on slip face of sand dune; +4, Victory Beach, 3 X 2015, at base of sand dunes; +1, Sandfly Bay, 4 X 2015, on sand dunes; +1, clifftop basin off the Karetai Track, 5 X 2015, in ground litter; +7, Tomahawk Beach, 16 X 2015, on sand dunes (some dead).
Comments: despite all the records from beaches above, *Hylastes ater* is a pest of *Pinus* species and other conifirs, generally attacking seedlings.

Phloeosinus cupressi Hopkins, 1903
Observation: Varleys Hill, 2 III 2015, under bark of *Cupressus macrocarpa* log in wood pile.
Comments: host-specific on *Cupressus,* the larvae tunneling under the bark of dying branches. Adventive species.

Otago Peninsula Lizard Monitoring Report 2016

Prepared for the Otago Peninsula Biodiversity Group (OPBG)

Carey Knox, Herpetologist, Knox Ecology November 2016

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).

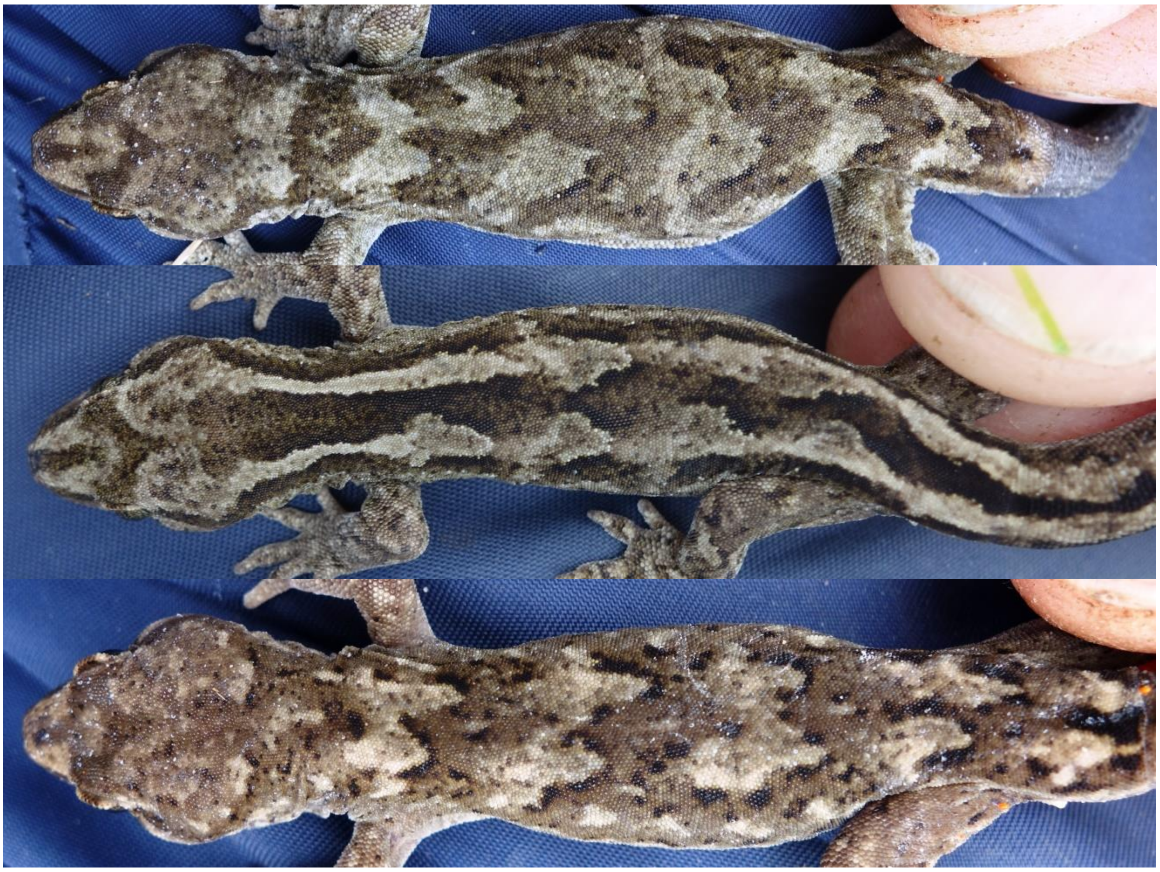


Fig. 3. Variation in the dorsal patterns of korero geckos (*Woodworthia* sp.) can be used to identify individuals within populations, assisting monitoring.

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).

Gear pack-up and storage

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.

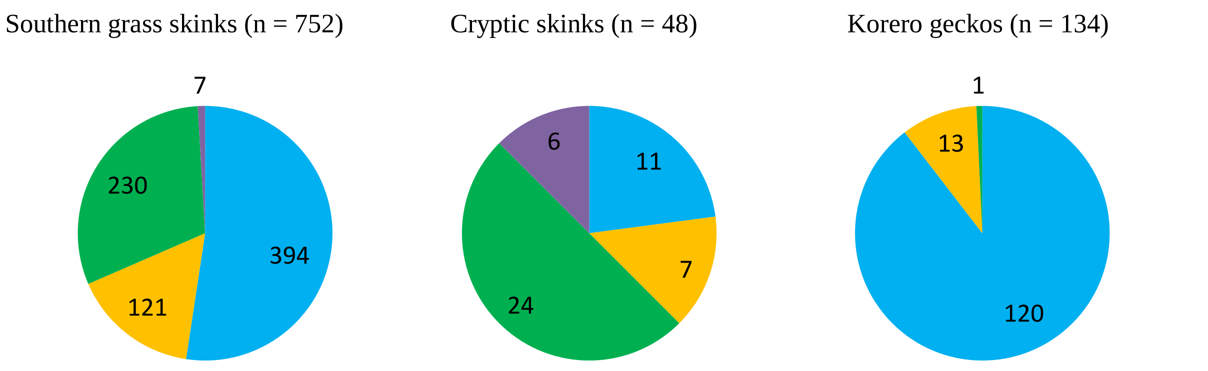
Results

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.

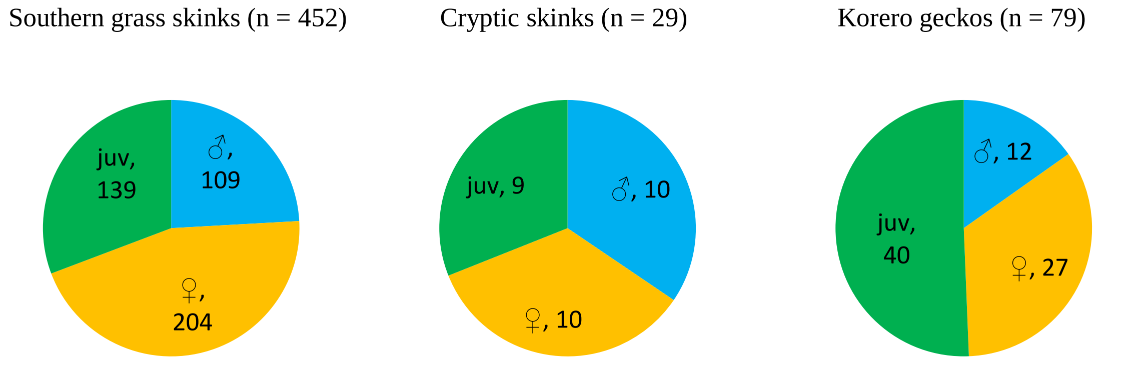


Fig. 5. The proportion of females, males, and juveniles, for three lizard species encountered during lizard monitoring on Otago Peninsula. The species common name is above each graph. Sample sizes are displayed.

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 traılled 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.

Acknowledgements

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Abundance of rats (*Rattus* species) following brushtail possum control operations on the Otago Peninsula

Abundance of rats (*Rattus* species) following brushtail possum control operations on the Otago Peninsula

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Contents

Summary

Project and client

- Brushtail possums (*Trichosurus vulpecula*) and rats (ship rats *Rattus rattus* and Norway rats *R. norvegicus*) are often managed as pests in New Zealand because of their impacts on indigenous species and because possums carry bovine tuberculosis. Research in North Island forests has shown that removal of possums may lead to increased numbers of ship rats, which compete with possums for food.
- The Otago Peninsula Biodiversity Group (OPBG) began removing possums from consecutive sectors of the Otago Peninsula, South Island, in 2011. Later that year they established a network of inked footprint-tracking tunnels to test for changes in rat abundance on the peninsula. This report describes the analysis of 5 years of quarterly rat-track data used as an index of rat abundance (ship rats and Norway rats, collectively), and the results and conclusions from that analysis.

Objectives

- To test for a change in the abundance of rats since possum control was implemented on the Otago Peninsula.

Methods

- In 2011 the OPBG established 10 lines of inked footprint-tracking tunnels on the Otago Peninsula, each with 10 tracking tunnels separated by 50 m. Three additional lines of tracking tunnels were added in 2015. Most lines of tunnels were located in a part of the peninsula (sector 4) where possum control began in 2013. Two lines were placed where possum control had already been done earlier in 2011 (sectors 2 and 3). Every 3 months, inked cards were placed in baited tunnels, removed the next day, and checked for footprints.
- A statistical model was used to test whether the proportion of tunnels per line in which rat tracks were recorded on each monitoring occasion was related to weeks since possum control. The model also included weeks as a quadratic term (to test for a possible curved pattern; e.g. increasing rat numbers followed by stability), as well as the variables season, elevation and presence of grazing livestock.

Results

- On average 10.1% of tunnels had rat tracks, across all lines and all sampling occasions.
- The proportion of tunnels per line that had rat tracks was not significantly related to the number of weeks since possum control ($P > 0.1$). The other explanatory variables in the model were also not statistically significant.

Conclusions

- There has been no detectable increase in rat abundance in more than 5 years since the OPBG implemented rodent tracking in association with possum removals on the Otago Peninsula.
- There was considerable variation in the percentage of inked tunnels tracked by rats, both between lines of tunnels and between monitoring occasions. Differences between the lines may have been the combined result of variation in habitat, surrounding land use, and pest control by landowners.

Recommendations

- The collection and analysis of rodent tracking data has been a major OPBG sub-project, requiring extensive volunteer time and purchases of materials. In addition to testing for a rat population response to possum removal, the work has expanded public knowledge and awareness of the presence of both predatory mammals and indigenous lizards on the peninsula.
- The OPBG can now consider whether funds and volunteer time could usefully be reassigned to other goals.

1 Introduction

Brushtail possums (*Trichosurus vulpecula*) and ship rats (*Rattus rattus*) are common, widespread, introduced mammals in New Zealand. Norway rats (*R. norvegicus*) are also found throughout New Zealand, but with a patchier distribution (Innes 2005a). Possums and rat species are often managed as pests because of their impacts on indigenous species and because possums carry bovine tuberculosis (Cowan 2005; Innes 2005a, b). Possums feed on the foliage, flowers and fruit of forest and garden plants, and prey on invertebrates and on birds and their eggs (Cowan 2005). Ship rats and Norway rats eat fruit, seeds and other plant parts, and prey on invertebrates, bird eggs and chicks, and lizards (Innes 2005a, b).

Ship rats have been identified as one of the most important nest predators in urban and peri-urban environments, and in forest fragments (van Heezik et al. 2008; Morgan et al. 2011; Innes et al. 2015). Controlling ship rats or both ship rats and possums can benefit birds in North Island forest fragments (Armstrong et al. 2014; Innes et al. 2015). However, controlling only a subset of interacting invasive species can have unexpected consequences for other species that are their competitors, prey or predators (e.g. Ruscoe et al. 2011; Norbury et al. 2013). This report describes monitoring for any changes in the abundance of rat species as a consequence of widespread removal of possums.

2 Background

The Otago Peninsula Biodiversity Group (OPBG) began removing possums from the Otago Peninsula (henceforth 'the peninsula') in 2011. Research in the North Island has shown that after possums and rats are removed with aerial toxin drops, ship rats may increase to higher numbers than at non-treatment sites where toxin was not applied (Ruscoe et al. 2011; Griffiths & Barron 2016). These increases are thought to occur because with fewer possums present, more food is available to ship rats, which compete with possums for food (known as competitive release; Sweetapple & Nugent 2007; Ruscoe et al. 2011).

The OPBG wanted to test for a similar increase in rat populations (ship rats and/or Norway rats) as a consequence of possum removal on the peninsula. Therefore, in order to detect changes in rodent activity, they established a network of inked footprint-tracking tunnels on the peninsula in 2011. Rodents have been monitored quarterly on this tunnel network, beginning in November 2011 and with the most recent monitoring completed in February 2017. In 2016 the OPBG obtained funding from the Otago Regional Council's Environmental Enhancement Fund for this analysis of the resulting rat-track data.

3 Objectives

The purpose of this analysis was to test for a change in the abundance of rats since possum control was implemented on the peninsula. The proportion of inked footprint tracking tunnels containing rat tracks was used as an index of rat abundance. This index actually measures rat activity, not abundance, as individual rats are not identified. Therefore standard methods were followed (see Gillies & Williams 2013) to minimise variation in factors (such as weather) that affect only activity and not abundance. It is not possible to distinguish rat species (ship rats vs Norway rats) from their footprints.

4 Methods

4.1 Study site

The Otago Peninsula (centred near 45°52'S, 170°40'E) is c. 20 km long and up to 9 km wide. Its southwestern end adjoins the mainland in a 1.5 km-wide isthmus. Although part of Dunedin City, it is sparsely populated, with most small communities located on its northwestern shore along the Otago Harbour. The land is dominated by steep, open pasture, with pockets of indigenous shrubs and forest, and exotic trees planted for fruit, shelter or forestry.

Possums were removed progressively from four sectors of the peninsula, beginning in the north and east, and proceeding southwest towards the isthmus in the suburbs of Dunedin city (for a sector map, see www.pestfreepeninsula.org.nz). The main possum 'knockdown' operations in sectors 1–3 were done from March to June 2011, and in sector 4 from December to April 2013. These operations were followed by 'mop-up' and 'hot-spot' possum removals that still continue. Control operations have used a combination of toxins (in bait stations) and traps.

4.2 Tracking tunnel lines

The OPBG established 10 lines of inked footprint-tracking tunnels on the peninsula in October 2011 and began using them to monitor rats in November 2011 (Fig. 1). The lines followed walking tracks, fences or gullies, in places with indigenous or exotic trees, shrubs and/or dense ground cover, including rank grass, ferns or bidibids (*Acaena* spp). Most lines were separated by more than 300 m, but one pair of lines was only 64 m apart at their closest point (Hereweka and Leith Walk). Each line comprised 10 tracking tunnels separated by 50 m, according to Department of Conservation guidelines (Gillies & Williams 2013). Lines were established in both the presence (three lines with grazing at eight or more tunnels per line) and absence (seven lines) of livestock, because grazing was expected to reduce rodent activity (Knox et al. 2012). The grazed lines were Bacon Street, Marine Station and Sandymount Shrubland.

Eight lines were placed in sector 4 prior to the possum knockdown operation there (December–April 2013). One line was placed in sector 2 and one in sector 3, where possums had already been removed (knockdown operations in May and June 2011, respectively). These sector 2 and 3 locations were chosen for comparison with the results of tracking tunnel monitoring in a previous study (2009/10; Knox et al. 2012), and include an ungrazed and a grazed line. However, because of small differences between the OPBG's tracking tunnel protocol (below) and that of Knox et al. (2012), the earlier data from 2009/10 were not included in the statistical analysis described here.

Three additional lines of tracking tunnels were established by the OPBG in ungrazed locations in sector 4 in February 2015 (Fig. 1), in order to increase the sample size for detection of changes in rodent tracking rates. An additional tunnel line operated by the environmental group Save The Otago Peninsula (STOP) is not considered here because rat control is carried out in its vicinity.

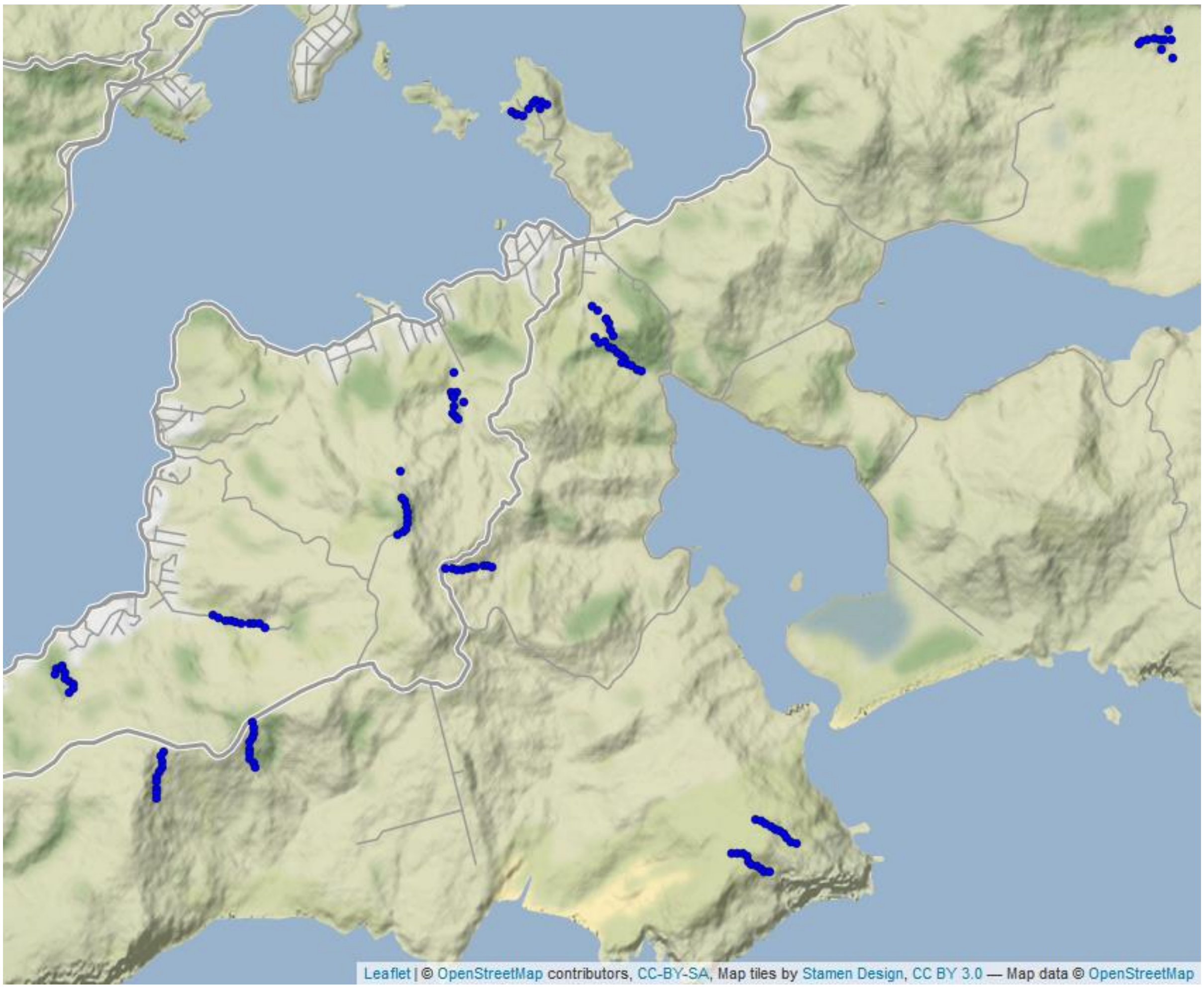

Figure 1 Lines of inked footprint-tracking tunnels used for rodent monitoring on the Otago Peninsula from 2011 to 2017. From north to south, the lines are known as Pyramids (sector 2), Marine Station (sector 3), Hereweka, Leith Walk (the latter two lines are close together), Bacon Street, Camp Road, Stewarts Creek, Greenacres, Glenfalloch, Paradise, Buskin, Sandymount Macrocarpa and Sandymount Shrubland. All lines except the two northern-most are in sector 4. Ten lines were established in October 2011, and Greenacres, Glenfalloch and Buskin were added in February 2015. Map copyright information is at www.openstreetmap.org/copyright. Sector map is at www.pestfreepeninsula.org.nz. For scale, each line of tunnels is c. 450 m long.

4.3 Tracking tunnel protocol

The design of the tracking tunnels and the protocol for operating them followed Gillies & Williams (2013). Tracking tunnels (615 × 100 × 100 mm) were made from black plastic (Corflute) with wooden bases. Every 3 months, when little or no overnight rain was forecast, volunteers placed an inked card (Gotcha Traps, Warkworth) in each tunnel and baited the tunnel with peanut butter smeared at each end. Cards were checked and removed the next day. Volunteers identified animal footprints with the aid of Ratz (1997), Agnew (2009), Gillies & Williams (unpublished), and expert opinion (from G. A. Pickerell, University of Otago, pers. comm.).

4.4 Analytical methods

A statistical model was fitted to the rat-tracking data. The type of model used was a generalised linear mixed-effects model for binomial data (with a logit link function). The response variable was the number of successes (rat detections) given the number of independent trials (tunnels) on each line on each occasion. Tunnels that were missing, overturned or had tracking cards pulled out (probably by possums) were omitted from the analysis.

A variable 'line' identifying the different lines of tunnels was fitted as a random effect to account for repeatedly monitoring the same locations instead of establishing new tunnel lines at each monitoring occasion. This variable estimated consistent differences over time in tracking probability between the lines. These differences might arise from local vegetation type, surrounding land use, pest control by landowners, and other unmeasured factors affecting rat distribution and abundance around each line.

The main explanatory variable of interest was the number of weeks since possum control, based on completions of the main knockdown operations (31 May 2011, 30 June 2011 and 30 April 2013 in sectors 2, 3 and 4, respectively). After rat populations in the Tararua Range (North Island) were reduced to low levels by aerial poisoning, the pattern of rat-tracking data suggested exponential population growth (i.e. linear growth, on a logarithmic scale) for 2.5 years, which then levelled off (Griffiths & Barron 2016). These authors therefore restricted their analysis to this initial 2.5 years of data.

Such a pattern was not obvious in rat-tracking data from the peninsula, where rat populations were not reduced by the ground-based possum control. Therefore, I added a quadratic term ($weeks^2$) to the model to allow for a curved relationship between tracking rates and weeks since control, which could result from an increasing rat population followed by stability or decline. Function poly in R (R Core Team 2016) was used to calculate orthogonal (i.e. independent) linear and quadratic explanatory variables so that the quadratic term would account only for variation not already explained by the linear 'weeks' term.

Additional explanatory variables fitted as fixed effects were season (spring, summer, autumn and winter, corresponding to November, February, May/June and August), the mean elevation of the tracking tunnel locations on each line (as in Griffiths & Barron 2016), and the presence or absence of livestock grazing (as in Knox et al. 2012) on the line (at eight or more tunnels). I evaluated whether a classification of lines by vegetation type, based on the New Zealand Land Cover Data Base (LCDB version 4.1), could be used as an explanatory variable. However, this was not suitable because some classes were not replicated between lines of tunnels; i.e. one line was dominated by each of the classes low producing grassland, mixed exotic shrubland, and mānuka and/or kānuka. Prior to analysis I rescaled elevation to have mean 0 and standard deviation 0.5 by subtracting the mean and dividing by two standard deviations in order to improve numerical stability. The R function 'poly', described above, also rescaled the variables weeks and $weeks^2$.

This binomial model relied on the assumptions that each tunnel had an equal probability of being tracked by a rat and that tunnels were independent of each other. As discussed above, the model's random line effect accounted for differences in tracking probability between lines of tunnels. However, because the tunnels within a line were only 50 m apart and ship rats and Norway rats range much further (Innes 2005a, b), tunnels that were close together were probably not independent (see also Griffiths & Barron 2016).

This problem can lead to over-dispersion (i.e. excess variance not accounted for by the model, which can bias the statistical analysis). I accounted for over-dispersion by adding an observation-level random effect (i.e. fitting an additional normally distributed error term for each observation; Browne et al. 2005). This additional effect was included after testing whether it improved the model, based on Akaike's information criterion adjusted for small samples (AIC_c; Burnham & Anderson 2002), computed in the MuMIn package for R (Bartoń 2016).

An explanatory variable was considered statistically significant ($P < 0.05$) if the 95% highest posterior density interval (HPDI) of its model coefficient excluded zero. I used these intervals because the usual method of estimating 95% confidence intervals (CI) is not straightforward for mixed-effects models. All HPDI were calculated from 1,000 draws from the posterior distribution for each of the estimated fixed effects, using the HPDinterval function in the coda package for R (Plummer et al. 2006).

Two lines of tunnels (Hereweka and Leith Walk) were not independent. A single individual rat could potentially track tunnels on both lines, which were separated by only 64 m (see above), which is less than the typical home range lengths of ship rats and Norway rats (Innes 2005a, b). To test how this non-independence affected the statistical results, I used a separate model with data omitted from two tunnels on each of these lines, so that the resulting two eight-tunnel lines were separated by ≥200 m, as recommended in Gillies & Williams 2013.

Marginal R^2 (variance in the data explained by the explanatory variables [fixed effects] in the model) and conditional R^2 (variance explained by both fixed and random effects) are provided as measures of model goodness-of-fit (Nakagawa & Shielzeth 2012). Models were fitted in the lme4 package (Bates et al. 2015) in R version 3.3.0 (R Core Team 2016).

5 Results

On average, 10.1% of tunnels had rat tracks, across all lines and all sampling occasions (±0.8% standard error [SE]). During most of the study the average percentage of tunnels with rat tracks on each line varied between 5 and 22% in sector 4, and between 0 and 15% in sectors 2 and 3 combined (Fig. 2). The average in sectors 2 and 3 reached 36% on the most recent sampling occasion in February 2017, owing to a 50% tracking rate at Marine Station, which was not extreme compared with previous results on other lines (Fig. 3). Tunnels also recorded footprints of possums, house mice (*Mus musculus*), European hedgehogs (*Erinaceus europaeus*) and indigenous lizards (presumed to be skinks *Oligosoma* spp. and kōrero geckos *Woodworthia* sp. 'Otago large'; Knox 2016).

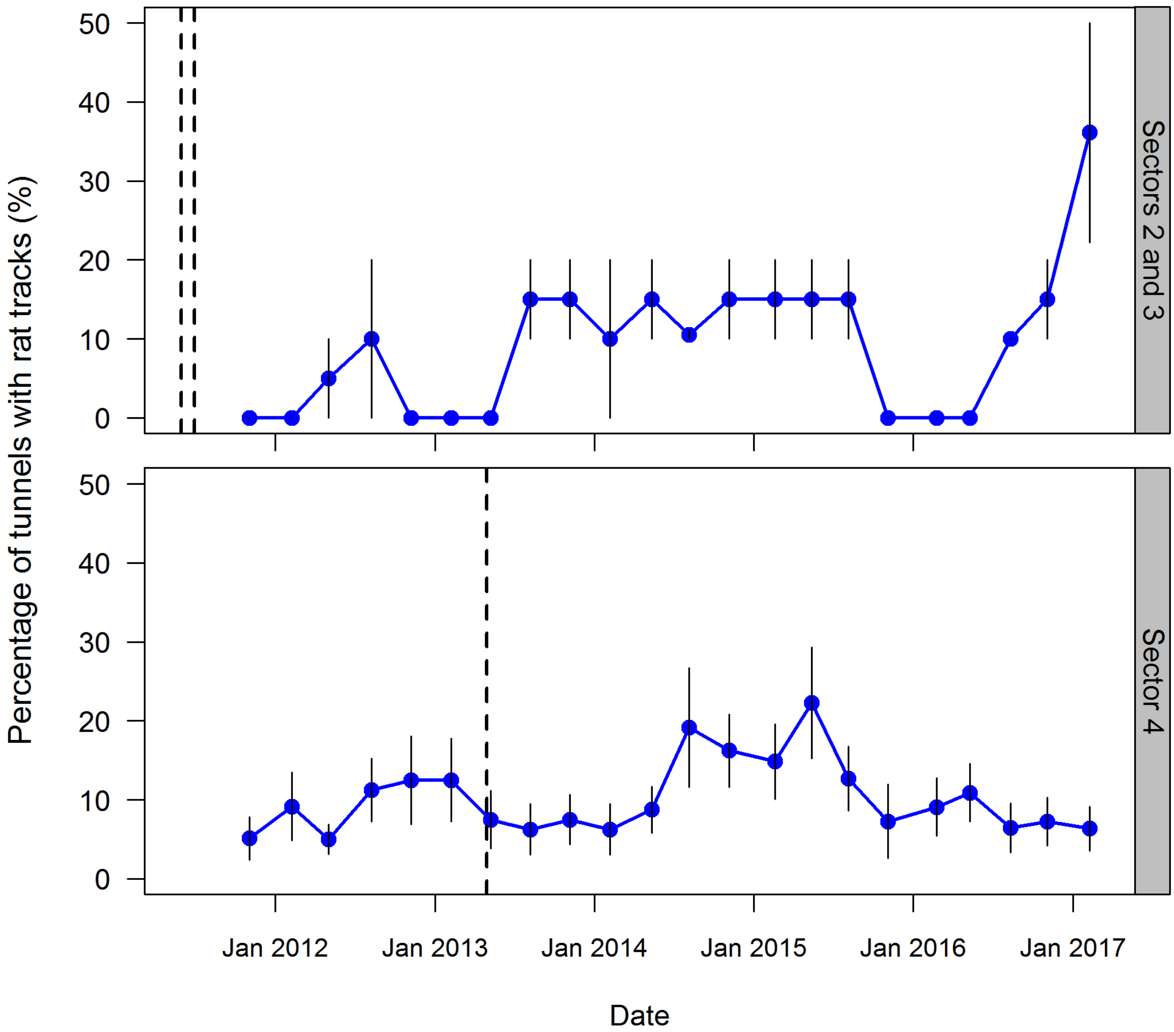

Figure 2 Mean percentage of tunnels with rat tracks on lines of tunnels in sectors 2 and 3 combined (Pyramids and Marine Station lines) and in sector 4 (all other lines) from November 2011 to February 2017. The dashed lines show the dates of possum knockdown operations in each sector. Error bars indicate standard errors (SE).

The proportion of tunnels per line that were tracked by rats was not significantly related to the number of weeks since possum control (*P* > 0.1), in either its linear (weeks) or quadratic (weeks^2) forms. The other explanatory variables in the model (season, elevation, grazing) were also not statistically significant (*P* > 0.1).

There was considerable variation in rat-tracking rates between the different lines (Fig. 3) due to unmeasured differences between locations. Variation between monitoring occasions was not consistent between seasons (Fig. 3). Adding the observation-level random effect improved the model, lowering AIC_c by 3.2 units. The model explained only 23% of variation in the data without including random effects of line and observation (i.e. marginal R^2), but 44% of variation when the random effects were included (conditional R^2).

A separate exploratory model, with data omitted from two tunnels on each of the Hereweka and Leith Walk lines so that the lines were at least 200 m apart, gave similar results to those described above. As a result, the non-independence of these two lines did not affect the conclusions.

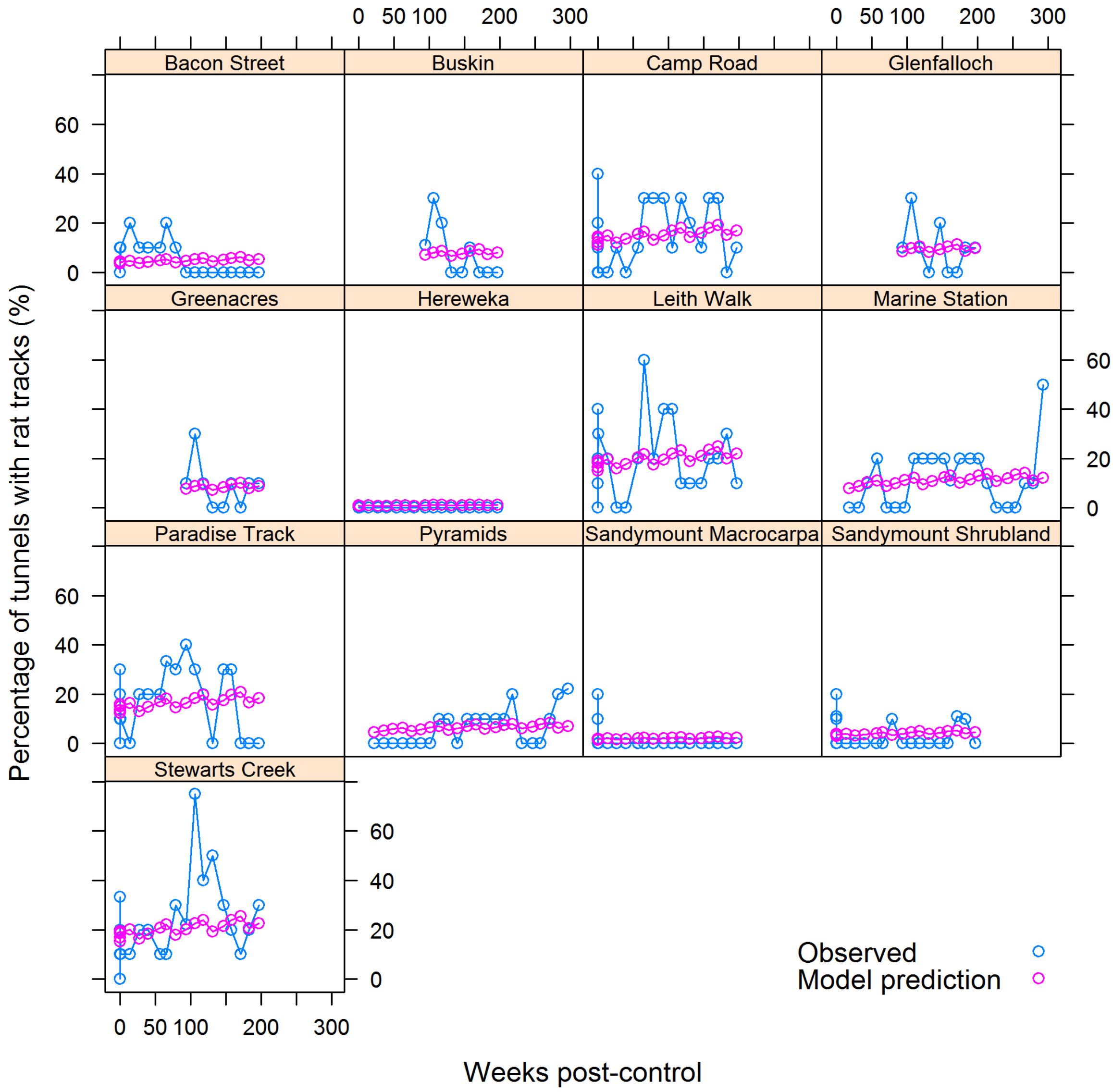

Figure 3 Percentage of tunnels tracked by rats on each line of tracking tunnels, both observed (blue) and predicted by the fitted statistical model (pink). Although the model predicted an increasing probability of rat tracks as a function of weeks since possum control, this positive slope estimate did not differ significantly from zero. Model predictions shown here include random line effects but not random observation-level effects.

6 Discussion and conclusions

6.1 No evidence for a significant rat population increase on the peninsula

The analysis found no evidence that rat numbers have increased since possum control began on the Otago Peninsula. Instead, the percentage of inked tunnels tracked by rats varied considerably between lines of tunnels and between monitoring occasions. There was no strong seasonal pattern: although rat abundance is often highest in May or August after summer breeding (Innes 2005a, b), the average tracking rates peaked at other times in some years. Differences between the lines may have been the combined result of variation in vegetation cover, surrounding land use, and pest control by landowners.

The average rat-tracking rate on the peninsula (c. 10%) was low compared with data from North Island forests (e.g. Sweetapple & Nugent 2011; Griffiths & Barron 2016) and a South Island forest (Murphy et al. 2008). Few South Island standard rat-tracking studies have been published, particularly for patchy landscapes like the peninsula. In an earlier peninsula study, rat-tracking rates in shrubland (*Coprosma* spp.) and regenerating kānuka forest (*Kunzea robusta*; de Lange 2014) averaged <5% in grazed sites and c. 40% in ungrazed sites (Knox et al. 2012). Possibly bait placement in the middle of each tracking tunnel in this earlier study may have elevated tracking rates relative to the OPBG study, with bait placed at tunnel ends (following Gillies & Williams 2013).

Livestock grazing lowers rodent activity and abundance by removing dense ground vegetation, which supplies rodents with shelter and food (Innes et al. 2010; Knox et al. 2012). In the OPBG study, rat-tracking rates often exceeded 20% at Camp Road, Leith Walk, Paradise Track and Stewarts Creek (Fig. 3), all ungrazed locations. It is clear, however, that grazing was not the only factor leading to low rat-tracking rates, as two other ungrazed locations (Hereweka and Sandymount Macrocarpa) had 0% rat tracking on all or most occasions. The lack of a clear effect of grazing in the OPBG study may be the result of variable grazing intensity between lines and over time, or over-riding effects of other habitat elements such as vegetation type.

6.2 Alternative study designs

After both possum and ship rat populations were reduced to low densities by aerial 1080 (sodium fluoroacetate) toxin operations in North Island forests, rat numbers increased to higher levels than at non-treatment sites (indicated by trapping or tracking; Ruscoe et al. 2011; Griffiths & Barron 2016). These experimental studies each had two independent toxin treatment sites and one or more non-treatment sites (Ruscoe et al. 2011; Griffiths & Barron 2016). In the earlier tracking tunnel study, each site had 15–20 lines of tracking tunnels (Griffiths & Barron 2016). These study designs allowed for relatively powerful statistical comparisons between treatment and non-treatment sites.

In contrast, because the peninsula study was not an experimental one, possum control was applied to most of the area, with neither non-treatment nor replicated treatment sites. Sector 5 at the southwest end of the peninsula, where possums have not yet been controlled, was not considered a suitable non-treatment site because of its small area and largely suburban land use. Instead of comparing between sites, the statistical analysis was aimed at detecting changes in peninsula rat-tracking rates over time since the major possum control operations. It proved impossible to identify any long-term temporal trend against the background of other variation between lines, monitoring occasions and years.

In an earlier North Island forest study, average rat abundance (indexed as disturbance of flour-and-icing sugar lures placed for possums) was higher after aerial poisoning than before (allowing 1.5 years for the rat population to recover after the poison operation; Sweetapple & Nugent 2007). The increased rat abundance could not be attributed with certainty to possum removal, because the study was unreplicated and had no non-treatment site (Sweetapple & Nugent 2007). The same limitation would apply to conclusions from the present peninsula project, which has a similar design.

Rat population increases were apparent in the three North Island projects described above, despite variation in the degree to which possum numbers were reduced. Post-control possum numbers were measured in different ways in the three studies, and were summarised as:

- possums per hectare: 25% of non-treatment sites (Ruscoe et al. 2011)
- possum bites on waxtag blocks (Thomas et al. 2003): c. 0% compared with 30% at non-treatment sites (Griffiths & Barron 2016)
- <1 possum capture per 100 trap-nights (Sweetapple & Nugent 2007).

Griffiths and Barron (2016) found an inverse relationship between rat-tracking indices and the percentages of waxtags bitten by possums near tracking tunnel lines. On the peninsula, possum removals are ongoing and some possum hot-spots remain. Chew-cards (Sweetapple & Nugent 2011) used to record possum activity on the peninsula coincide with five tracking tunnel lines. In any future study, chew-cards placed along all tunnel lines from the beginning of the study could help to explain variation in rat-tracking rates.

A final improvement to the design of a future peninsula study would be to restrict tracking tunnel lines to a particular habitat of interest (e.g. ungrazed indigenous forest fragments). This constraint would tend to reduce variation in rat-tracking rates between lines of tunnels.

6.3 Potential for new research

Peninsula bird populations could benefit from rat control in forest patches, in combination with existing possum control. The importance of ship rats as nest predators is best known for the North Island (Morgan et al. 2011; Armstrong et al. 2014; Innes et al. 2015). Relative predation by different mammalian species on birds and their nests has not been studied on the peninsula, but ship rats, possums and possibly house mice were identified as nest predators in urban Dunedin (van Heezik et al. 2008). Using motion-activated cameras to study bird nesting success on the peninsula would show the relative impacts of different predator species on peninsula birds, and would help to establish priorities for future predator management.

The species of rats whose footprints were found in tracking tunnels is not known. Ship rats are the most widespread rat species in New Zealand, living in many habitats including forests, hedgerows, farms, parks and buildings (Innes 2005b). Norway rats are commensal with humans in urban areas and farms; in the wild their distribution is patchy and not well studied, but they are often found in wetland habitats (Innes 2005a). Given the peninsula's patches of forest and shrublands, long coastline, streams, farms and villages, both species may be active in the vicinity of the OPBG's tracking tunnel lines. Differences in their ecology and behaviour could obscure relationships between tracking rates and the variables considered in this analysis (i.e. season, elevation, grazing and time since possum control).

In recent studies in New Zealand cities the ratio of ship rats to Norway rats captured was approximately 90:10 in forest reserves, gullies and parks in Hamilton (Morgan et al. 2009), New Plymouth and Tauranga (Bartlam et al., unpublished). In contrast, the ratio of ship rats to Norway rats was only 25:75 in orchards and farms in the outskirts of Hamilton (Morgan et al. 2011). In these studies, rat traps were placed where tracks in tunnels or chewing on waxtags indicated that rats were present. A similar study on the peninsula (e.g. after the next planned tracking tunnel monitoring in May 2017) would show which rat species predominates and hence which indigenous species are most at risk. For example, ship rats are more arboreal than Norway rats (Innes 2005a, b), and hence more likely to threaten tree-nesting birds and arboreal lizards.

7 Recommendations

There has been no detectable increase in rat abundance in the more than 5 years since the OPBG implemented rodent tracking in association with possum removals on the Otago Peninsula. The collection and analysis of data have been an extensive OPBG sub-project, requiring considerable volunteer time and repeated procurement of tracking cards and bait. In addition to testing for a rat population response to possum removal, this work has expanded public knowledge and awareness of the presence of both predatory mammals and indigenous lizards on the peninsula.

The OPBG can now consider whether funds and volunteer time could usefully be reassigned to other goals. If so, rodent monitoring could be reinitiated in future to test for the effects of new predator control operations (e.g. multi-species control, or possum control in sector 5 where none has yet been attempted). Monitoring rodents at multiple treatment and non-treatment sites, if feasible, would help to detect changes in rodent populations resulting from these new projects. Other design improvements, including restricting rodent lines to a habitat of interest and placing chew-cards along rodent lines as an index of possum abundance, are discussed above.

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21 June 2017

Cover image: Volunteers from OPBG measuring FBI plot (photo supplied by Moira Parker)

Contents

1. Introduction and Objectives

The Otago Peninsula Biodiversity Group (OPBG) is a community trust which has been carrying out intensive possum control on the Otago Peninsula since 2011. The aim of the trust is to enhance the biodiversity of the Otago Peninsula by removing possums as a first step towards a long-term goal of making the peninsula pest-free. As of March 2017, over 11,000 possums had been removed from the 9,500 hectare (ha) operational area.

The OPBG has implemented a range of biodiversity monitoring programmes to inform progress towards this goal, including vegetation monitoring. The primary purposes of the vegetation monitoring are to enable change (in indigenous forest health and regeneration trajectories resulting from control or eradication of possums) to be measured and communicated, and to inform management actions (Kunzea Consultants Ltd, 2011).

Possums usually focus their feeding on a small set of "key species", and often only target particular individuals of those species at a site (Nugent et al., 2010). This can cause the progressive reduction and elimination of preferred food species (Bellingham et al., 1999; Nugent et al., 2001; Sweetapple et al. 2004; Nugent et al., 2010) and even lead or contribute to the collapse of forest canopies over large areas (see Payton, 2000 for a review). On Otago Peninsula, these food preferences are likely to include the following species where present; wineberry (*Aristotelia serrata*), Hall's totara (*Podocarpus laetus*), mahoe (*Melicytus ramiflorus*) and tree fuchsia (*Fuchsia excorticata*).

The Foliar Browse Index (FBI) method can help guide management by measuring the impacts of possums on nominated "indicator species". It can also provide evidence of conservation benefits to susceptible tree species after possum control has been conducted (e.g. Nugent et al., 2010; Gormley et al., 2012). The method uses repeated measures of permanently-marked trees to determine trends (an increase or decrease) in both the foliar cover and dieback of tree canopies and possum browse on their leaves. Combined with result monitoring data (i.e. indices of possum abundance) outcome monitoring data can answer questions about the effectiveness of management.

The OPBG established vegetation monitoring in 2011 on 14 permanent vegetation plots with an additional plot added in 2012. FBI monitoring on a subset of indicator trees on or nearby plots was carried out as part of the vegetation monitoring programme. This report presents the results from the first 6 years of FBI monitoring and aims to answer the following question:

'Has a reduction in possum densities improved the condition of palatable canopy and sub-canopy tree species?'

2. Methodology

2.1 Study area

Otago Peninsula lies to the east of the Dunedin City urban area and is approximately 9,500ha in size. The landform is the eroded flank of an extinct volcano ranging in altitude from sea level to 408m. Originally mostly forested in the recent pre-human era, the current vegetation is a mosaic of pasture with native/exotic shrubland or scrub, remnant native forest patches, small pine plantations and hedgerows, and other vegetation types such as those on wetlands and/or coastal dunes. Pastureland is currently the predominant landcover type.

Map 1. Otago Peninsula landscape.

Approximately 5% of the land area on Otago Peninsula currently supports native forest or scrub. The forest is remnant and regenerating podocarp-broadleaved forest with scattered podocarps, primarily Hall's totara (*Podocarpus laetus*) and matai (*Prumnopitys taxifolia*). Other trees characteristic of the forested areas include broadleaf (*Griselinia littoralis*), ngaio (*Myoporum laetum*), kohuhu (*Pittosporum tenuifolium*), lemonwood (*Pittosporum eugenioides*), narrow-leaved lacebark (*Hoheria angustifolia*), lowland ribbonwood (*Plagianthus regius*), mahoe (*Melicytus ramiflorus*), tree fuchsia (*Fuchsia excorticata*) and kowhai (*Sophora microphylla*) (Johnson, 2004).

Vegetation plots where FBI monitoring has been carried out are located variously in forest remnants throughout the peninsula and plot locations are shown in Map 2 below. Plot locations are also shown in Appendix 3.

Map 2. Location of vegetation monitoring plots where FBI monitoring has been carried out on Otago Peninsula.

2.2 Foliar Browse Index (FBI) monitoring

A total of 46 indicator trees were selected for FBI monitoring in 2011 and 2012; 26 mahoe, 13 tree fuchsia, 3 lancewood (*Pseudopanax crassifolius*), 2 narrow-leaved lacebark and 2 broadleaf. Indicator trees were subjectively located within or nearby permanent vegetation monitoring plots. A subset of baseline measurements for 42 indicator species on 11 plots was carried out in April 2011, with an additional 4 indicator species on 1 plot added in 2012 when the full range of baseline measurements was carried out on all indicator species. Further details of the baseline establishment can be found in Kunzea Consultants Ltd (2011).

Measurements were carried out annually from 2011 until 2017 (6 measurements in total) and followed Payton et al., (1999).

The baseline measurement in 2011 recorded Diameter at Breast Height (DBH), Foliage Cover, Browse (whole), Dieback (whole, as a percentage), Stem Use and Insect Browse parameters.

Measurements from 2012 to 2017 scored the following parameters; Foliage Cover, Dieback (top third and whole), Browse (top third and whole), Stem Use, Recovery, Flowering, Fruiting and Insect Browse. Indicator tree descriptors such as DBH, Abundance, Tier and Segment were also recorded.

Indicator trees were measured at different times on different plots through the summer season in each measurement year, although care was taken to measure each indicator tree in the same month each time.

The scoring protocol for the key possum impact parameters (Foliage Cover, Browse, Dieback and Stem Use) is detailed in Appendix 1.

2.3 Data analysis

Data for mahoe and tree fuchsia was pooled (39 indicator trees) for both analysis and plotting on graphs as these species have similar attributes and both are considered good indicator species for FBI monitoring (Department of Conservation, 2013). Data for broadleaf, lancewood and narrow-leaved lacebark was not used as the sample numbers for each species is very low and these species are either not considered as good indicator species or little used nationally as indicator species.

Foliage cover data was analysed by fitting a linear mixed effects model to produce adjusted means and 95% confidence intervals. This approach takes account of the fact that sample design is not random because samples are grouped on plots. The model also allows for missing and added data. Categorical data such as browse, dieback and stem use were plotted using histograms. The 'some' browse category (0.5, 1-5% of leaves browsed) was merged with the 'light' browse category (1, up to 25% of leaves browsed).

All analyses and graphics work undertaken used the R statistical computing environment (version 3.3.3; R Development Core Team, 2017). Satellite imagery in Map 1 and Appendix 3 is derived from Google Earth.

2.4 Key measured variables

BROWSE:

The browse variable is a measure of direct possum use of, and impacts on, trees and score changes reflect changes in possum numbers i.e. a decrease in browse reflects decreased use of trees by possums.

STEM USE:

The stem use variable is also a measure of direct possum use of trees and score changes reflect changes in possum numbers i.e. a decrease in stem use reflects decreased use of trees by possums.

Photos of stem use (bite and scratch marks) from OPBG monitoring plots (photo supplied by Moira Parker).

DIEBACK:

Dieback refers to the presence of dead stems in the canopy, so a decrease in dieback is regarded as an improvement in tree and canopy condition.

*Photo of possum browse and dieback (dead stems) on haumakaroa (*Raukaua simplex*) from Stewart Island (photo: Richard Ewans).*

FOLIAGE COVER:

Foliage cover is a measure of canopy thickness and an increase is regarded as an improvement of tree condition and therefore canopy health.

Photo of lancewood from OPBG monitoring plots illustrating canopy thickness (photo supplied by Moira Parker).

3. Results

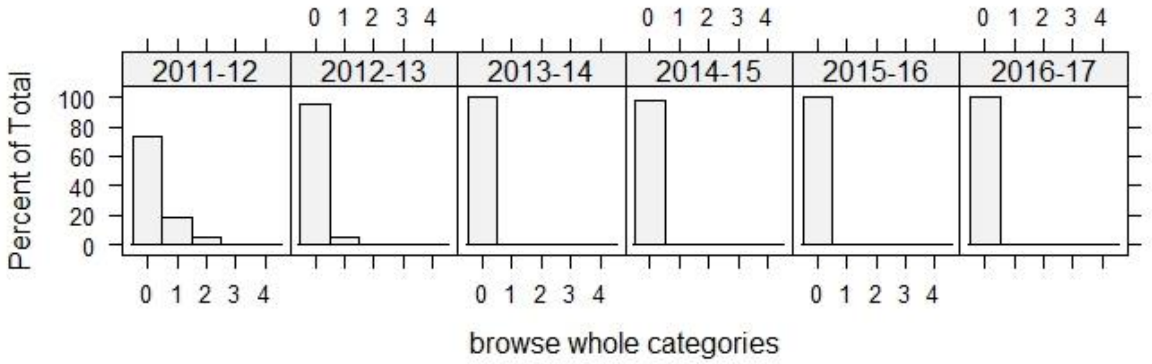
3.1 Browse

Browse is measured as the proportion of possum-browsed leaves in the whole canopy (and top third in Payton et al., 1999).

The number of trees recording possum browse has decreased since 2011 and no trees have recorded possum browse since the 2012-13 season. Browse in the top third of the canopy was not measured in 2011 and was negligable in all categories in all years so is not presented here.

The proportion of moderately to heavily browsed trees (browse score of 2 and above, more than 25% of canopy browsed) was low at the start of the survey although approximately a quarter of indicator trees showed some level of browse in the 2011-12 season.

Figure 1. Histogram of possum browse on indicator trees between 2011-2017.

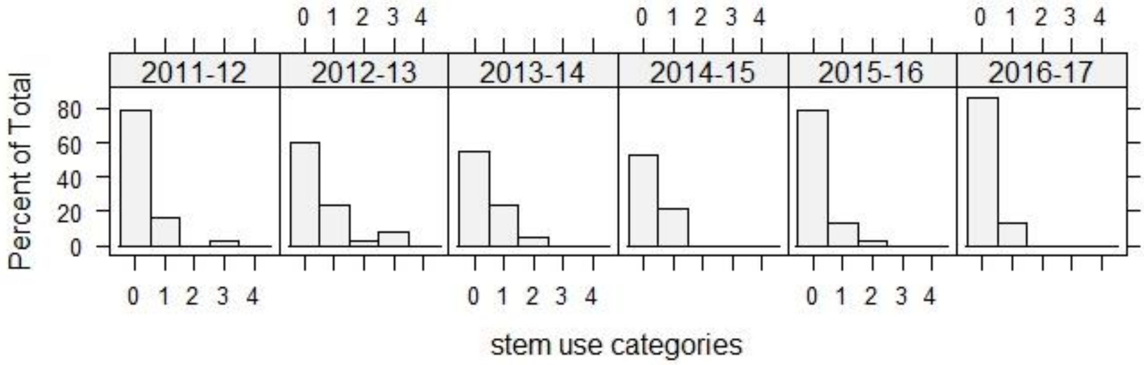


3.2 Stem use

Stem use is measured as the amount of recent (fresh) possum scratch and bite marks on the indicator tree trunk below 2m high.

The proportion of trees recording stem use was lower towards the end of the monitoring period (14% in 2016-17). Between the 2012-13 and 2014-15 seasons the proportion of trees recording stem use ranged between 21-34%. Stems that were unable to be scored numbered 6 and 10 in 2013-14 and 2014-15 respectively and are not included in the histogram.

Figure 2. Histogram of possum stem use on indicator trees between 2011-2017.

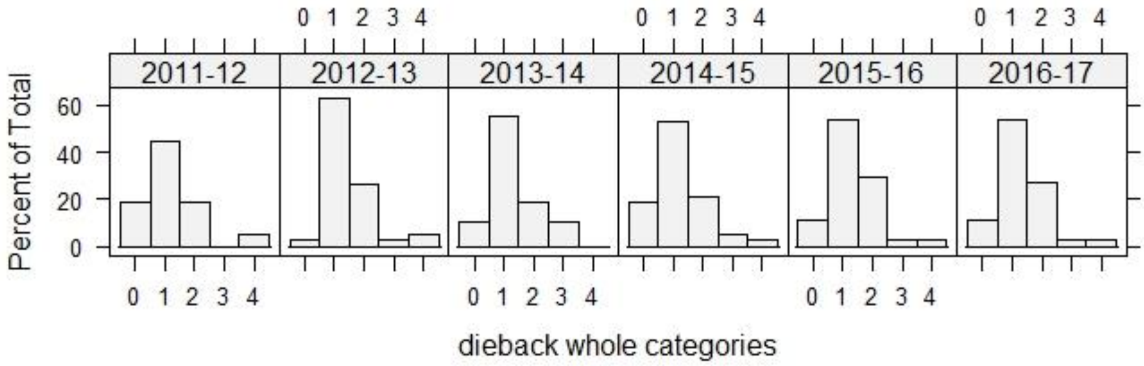


3.3 Dieback

Dieback is recorded as the conspicuous presence of dead stems in the whole canopy (and top third in Payton et al., 1999).

The proportion of trees with dieback has changed little over the monitoring period. A natural level of dieback is normal in many species but would not usually score more than a 1 i.e. is less than 25%. The proportion of trees with a dieback score greater than 1 i.e. more than 25% remained similar throughout the monitoring period and ranged between 27-35%. Dieback in the top third of the canopy was not measured in 2011 and showed little difference in trends to the dieback-whole measurement so is not presented here.

Figure 3. Histogram of dieback on indicator trees between 2011-2017.



Sign of vegetation recovery is recorded on trees where dieback has been recorded. Recovery refers to a flush of epicormic growth which often appears on browsed trees after possums have been removed i.e.

new shoots on the trunk or major branches. Recovery is recorded as present in the upper, lower or whole canopy.

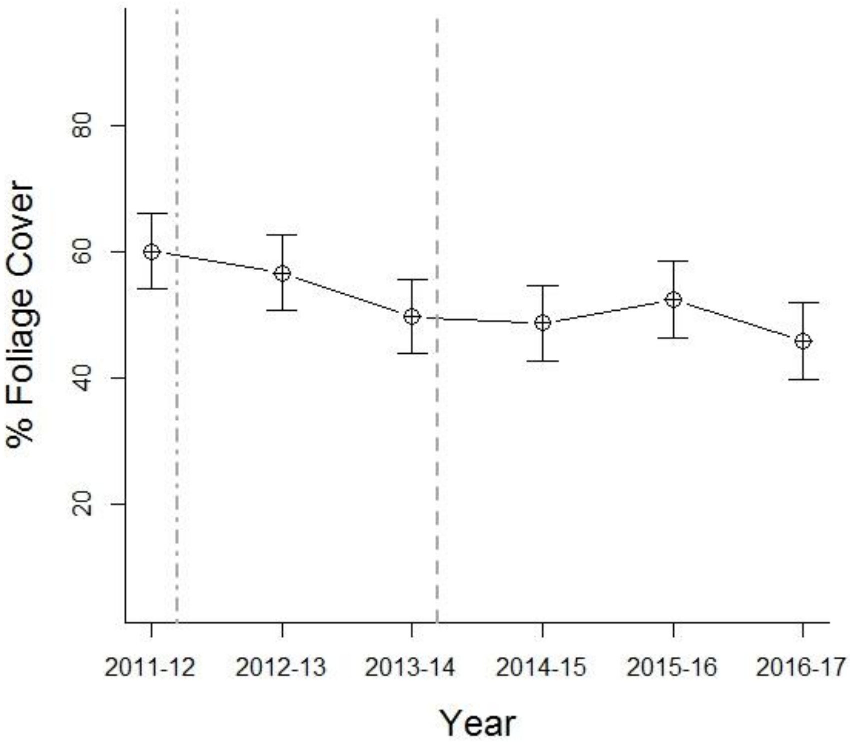
The proportion of trees with recovery was similar in 2011-12 (40%) and 2016-17 (42%) although was considerably higher in 2014-15 at 61%.

3.4 Foliage Cover

Foliage cover is recorded as the percentage of canopy cover measured on a 10-point foliage cover scale.

Average foliage cover decreased overall between 2011 and 2017 from 60% to 45%.

Figure 4. Average foliage cover (adjusted means) of indicator trees between 2011-17. Error bars are 95% confidence intervals. The vertical dashed lines indicate when possum control began in Sectors 1-3 (2011) and Sector 4 (2013).



4. Discussion

Overall, the results suggest a reduction in possum use of indicator trees and no possum browse has been recorded since the 2012-13 season. However, the measures of canopy health suggest little change and if anything, a decrease in canopy thickness as measured by foliage cover.

Interpretation of trends is limited due to the lack of a non-treatment site and possum density data i.e. pre- and post-control RTC data and history of possum control, however the results are discussed in context below.

4.1 Change in forest health as measured by FBI indices

Possum browse would be expected to decrease after intensive possum control and is a relatively straightforward to measure. Therefore, it is likely this trend reflects a real change in possum use of indicator trees.

The large majority of indicator trees recorded no stem use in the 2016-17 season. Stem use has declined since 2012-13 which is likely to reflect the reduction in possum numbers. Possums do not always feed in the trees they scratch and bite, however this measure does give an indication of possum densities in the general area and is relatively straightforward to measure.

Light dieback is usually present in most trees although the proportion of trees with dieback higher than 25% (i.e. category 2 or higher) is still relatively high and would be expected to decrease after intensive possum control on mature trees. The persistence of elevated levels of dieback may reflect the lingering effects of possum use in the past, or a natural level of dieback due to the position of trees in the forest.

The apparent decrease in foliage cover is contrary to what would be expected after the removal of the large majority of possums. However, this is the most subjective variable to measure in the field and observer variation is a likely explanation for this observed trend (which mostly occurred between 2011-13 with relatively stable levels after 2013). Examination of trends for individual indicator trees suggest some large decreases in foliage cover between early measurements and later ones which suggests observer bias. The observed decrease in foliage cover is highly unlikely to be attributable to possums as possum browse was higher when foliage cover was higher, and browse was reduced to nil after the 2012-13 season. In addition, numerous other biotic and abiotic factors can influence foliage cover. Insect browse was recorded as moderate to light on the large majority of trees over the monitoring period and is unlikely to have been an influencing factor on the overall foliage cover trend.

4.2 Changes in possum densities on Otago Peninsula

Possum control operations in Sectors 1-3 (east of the Portobello-Hoopers Inlet Road) were carried out in 2011 and 2012. Possum control operations in Sector 4 (west of the Portobello-Hoopers Inlet Road) were carried out between 2013 and 2015 (OPBG, 2013a). As of March 2017, over 11,000 possums had been removed from the 9,500ha operational area. The monitoring plots are split between the two main possum control operational areas, with most of the indicator trees in Sector 4 where possum control began later.

Foliar Browse Index monitoring trends are generally most marked when possum abundances are either very high or very low, or change between the two states. More site-specific possum abundance data would add to the interpretation of the results reported on here.

The possum-density/plant-condition relationship is likely to be site-specific and related to the abundance of palatable species and relative palatability of other foods (Sweetapple et al., 2004). Browse scores were relatively low at the start of the monitoring period suggesting possum impacts in forest remnants were not high generally. Therefore, large changes in forest health may not be expected over the time period.

The abundance of tree fuchsia, mahoe and other food sources in the areas sampled, along with prior pest control and/or recreational/commercial possum fur recovery may also help explain the relatively low possum impacts recorded on the indicator species at the start of the monitoring project.

The continuation of FBI monitoring by OPBG in the medium term is recommended, particularly given the project goal of eradicating possums from Otago Peninsula. Although few, if any, possum impacts would be expected now that possum densities are presumably very low, FBI monitoring can demonstrate the continued forest health benefit of low possum numbers, and provides another means of possum detection in an eradication context. All scores of direct possum use on trees i.e. browse and stem use should be zero once eradication has been achieved.

4.3 Implementation of FBI monitoring methodology

Some factors involved in the implementation of the FBI method may have influenced the results observed.

1. A key issue in many FBI programmes is the influence of observer bias. The difference in observations between different people is a well-recognised risk for FBI monitoring. Using the same observers and regular calibration with experienced observers should be utilised as much as possible.

2. FBI is preferably carried out on mature trees with minimal use of the option to use just a segment (or stem) of indicator trees as possums generally prefer large trees that have canopy directly available to sunlight. The methodology (Payton et al., 1999 & Department of Conservation, 2013) recommends trees and stems with a minimum DBH of at least 5cm be measured. Eight of the indicator trees/stems in the OPBG project are smaller than this. In addition, a high proportion (approximately two-thirds) of the indicator trees are only partly measured i.e. only one stem of the tree is tagged and measured. Therefore, the overall sample is one of small trees/stems which may not be ideal for capturing possum impacts.

3. Although when pooled sample numbers are close to the recommended 50 individuals, sample numbers are still probably too low, particularly for tree fuchsia. The grouping of trees in or around plots also reduces the independence of the samples.

4. Currently measurements are made throughout the summer (October to February), although care is taken to measure the same trees in the same month each time. Limiting measurements to January and February should avoid seasonal influences in foliage cover, particularly for tree fuchsia which is deciduous.

Many of these factors have been inherited by OPBG from the original vegetation monitoring set up. The groups observers have shown admirable application to regular measurement of the full set of variables in the FBI monitoring programme to date.

4.4 Proposed amendments to the current monitoring methodology

There are some aspects of the monitoring that could be relaxed in order to spend time increasing the number of larger trees sampled into the future.

1. Annual measurements are not necessary, particularly now that possum control has been ongoing for a number of years. Biennial monitoring would reduce the burden on volunteers but be regular enough to maintain consistently collected data in the medium term. Many FBI programmes operate on 3-5 year rotations.

2. Reducing the variables measured, down to the most important possum-impact variables (browse, dieback, stem use and foliage cover) would reduce the amount of time spent measuring each tree allowing more trees to be measured. The latest FBI manual (Department of Conservation, 2013) does not include stem use, recovery or separate measurements for browse and dieback in the top third of the canopy. It also does not include flowering or fruiting, or insect browse. It is the opinion of the author that stem use should be retained (particularly in an eradication context) as it is sensitive to possum densities and relatively easy and quick to measure. It is also direct evidence of possum use. The author also recommends retaining measurements for browse and dieback in the top third of the canopy as possums can browse heavily in the top third of the canopy, and natural dieback is often less pronounced in the top third of the canopy.

Bush remnant containing vegetation monitoring plots at Peggy's Hill on Otago Peninsula (photo supplied by Moira Parker).

5. Conclusions and Recommendations

Few strong trends are discernible from the FBI monitoring over the last few years on the OPBG monitoring plots, although the observed reduction in possum browse to zero is very encouraging.

Factors likely to have influenced some results include the number of small stems used as indicator trees and variation in observers. Additionally, forest health parameters such as dieback and foliage cover may take longer to respond to reduced possum numbers.

The following recommendations are made to promote the efficient and effective use of the FBI method for future re-measurements:

1. Increase the number of tree fuchsia samples to 25.
2. Increase the number of mature whole tree samples.
3. Remove stems less than 5cm DBH from the monitoring.
4. Move to biennial monitoring (once every 2 years).
5. Measure only stem use, browse (top and whole), dieback (top and whole) and foliage cover on each indicator tree.
6. Arrange calibration exercises with an experienced observer prior to each measurement.

6. Acknowledgements

The vegetation monitoring plots were established in April 2011 by Kunzea Consultants Ltd with funding from New Zealand Lottery and Heritage Grants Board.

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The OPBG wish to thank Steve Owens for access onto his property to assess plots 3, 4 and 5. Over 12 volunteer observers undertook the field work at various times during the project. Without their efforts, this report would not have been written and the OPBG is most grateful to all those in the monitoring team for their contribution.

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Volunteer Anita Pillai assessing FBI foliage cover score on OPBG monitoring plot (photo supplied by Moira Parker).

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Appendix 1. Foliar Browse Index scoring method

Each tagged indicator tree is scored in the field using the Foliar Browse Index methodology detailed in Payton *et al.* (1999) and Department of Conservation (2013) and outlined briefly as follows. Note that dieback and browse are assessed both for the top third of the canopy and for the whole tree.

Foliage cover (%): 5, 15, 25, 35, 45, 55, 65, 75, 85, 95

Dieback:

0	(0-5% of canopy, no dieback)
1	(6-25% of canopy, light dieback)
2	(26-50% of canopy, moderate dieback)
3	(51-75% of canopy, heavy dieback)
4	(>75% of canopy, severe dieback)
X	(unable to estimate)

Browse:

0	(no leaves browsed)
0.5	(1-5% of leaves browsed, very light browse)
1	(6-25% of leaves browsed, light browse)
2	(26-50% of leaves browsed, moderate browse)
3	(51-75% of leaves browsed, heavy browse)
4	(76-100% of leaves browsed, severe browse)
X	(unable to estimate)

Stem use:

0	(no scratching or bite marks)
1	(occasional scratching and bite marks, light stem use)
2	(numerous clearly defined scratch and bite marks, moderate stem use)
3	(bark worn smooth with evidence of a well-developed possum run, heavy stem use)
X	(unable to estimate, moss or epiphytes on trunk)

Appendix 2. List of indicator trees

PLOT	SPECIES	TAG NO.	DBH (cm) 2012-13	TIER	SEGMENT
1	mahoe	SI1549	3.3	subcanopy	tree
1	mahoe	SI1551	3.1	subcanopy	tree
1	mahoe	SI1552	2.7	subcanopy	tree
2	mahoe	SI 1651	10.4	canopy	stem
3	tree fuchsia	SI1618	6.2	subcanopy	stem
3	mahoe	SI1643	8	subcanopy	stem
4	mahoe	SI1591	14	canopy	stem
4	tree fuchsia	SI1593	10	canopy	stem
4	tree fuchsia	SI1604	17.3	canopy	stem
4	mahoe	SI1606	11.4	subcanopy	tree
5	mahoe	SI1577	6.5	subcanopy	tree
5	tree fuchsia	SI1584	24.4	canopy	tree
5	tree fuchsia	SI1588	9.9	subcanopy	tree
6	mahoe	SI1976	10.1	canopy	stem
6	mahoe	SI1987	4.2	subcanopy	stem
6	mahoe	SI1962	11	canopy	stem
7	mahoe	SI1934	10.7	canopy	tree
7	mahoe	SI1895	5.5	canopy	stem
7	mahoe	SI1879	6.5	canopy	stem
7	mahoe	SI1908	2.7	subcanopy	stem
8	mahoe	SI1849	4.6	subcanopy	tree
8	mahoe	SI1825	5.6	subcanopy	tree
12	tree fuchsia	ED19820	9.5	canopy	stem
12	mahoe	SI1805	10	canopy	stem
12	mahoe	SI1793	8.5	subcanopy	stem
12	mahoe	SI1792	11.3	canopy	stem
12	tree fuchsia	SI1775	5.7*	canopy	stem
13	tree fuchsia	SI1715	17.7	subcanopy	tree
13	tree fuchsia	SI1762	9	subcanopy	tree
13	mahoe	SI1773	19.9	canopy	stem
13	mahoe	SI1750	12.5	subcanopy	stem
13	tree fuchsia	SI1723	3.5	subcanopy	stem
13	mahoe	SI1737	5	subcanopy	stem
14	mahoe	SI1714	18.2	canopy	tree
14	tree fuchsia	SI1704	9.5	subcanopy	stem
14	mahoe	SI1699	15.5	canopy	stem
14	tree fuchsia	ED19823	26.7	canopy	tree
14	mahoe	SI1692	18.3	canopy	stem
15	tree fuchsia	ED19560	3.5	canopy	stem

* from 2013-14.

Appendix 3. Map of FBI plot locations

Minutes of an ordinary meeting of Council held in the Council Chambers at Otago Regional Council on Wednesday 27 September 2017, commencing at 10:32am

Membership

Cr Stephen Woodhead	*(Chairperson)*
Cr Gretchen Robertson	*(Deputy Chairperson)*
Cr Graeme Bell	
Cr Doug Brown	
Cr Michael Deaker	
Cr Carmen Hope	
Cr Trevor Kempton	
Cr Michael Laws	
Cr Ella Lawton	
Cr Sam Neill	
Cr Andrew Noone	
Cr Bryan Scott	

Cr Woodhead welcomed Councillors, members of the public, staff and media to the meeting.

1. APOLOGIES

Resolution
Moved: Cr Woodhead
Seconded: Cr Bell

That the apology for Cr Ella Lawton be accepted.
CARRIED

2. LEAVE OF ABSENCE

Resolution
Moved: Cr Hope
Seconded: Cr Neill

That the request for leave of absence from Cr Deaker be accepted.
CARRIED

3. ATTENDANCE

Peter Bodeker	*(CEO)*
Nick Donnelly	*(Director Corporate Services)*
Sian Sutton	*(Director Stakeholder Engagement) Public Forum Item 11.1*
Gavin Palmer	*(Director Engineering, Hazards and Science)*
Scott MacLean	*(Director Environmental Monitoring and Operations)*
Lauren McDonald	*(Committee Secretary)*
David Benham	*Chair, Audit & Risk Subcommittee (Item 11.2)*
Scott Hawkins	*Deloitte (Item 11.2)*
Mike Hawken	*Deloitte (Item 11.2)*
Sharon Bodeker	*(Item 11.2)*
Stuart Lanham	*(Item 11.2/12.1)*
Gerard Collings	*Manager Support Services (Item 11.1)*
Suzanne Watt	*(Item 11.4)*
Dale Meredith	*(Item 11.4)*
Sylvie Leduc	*(Item 11.4)*
Andrea Crawford	
Charlotte Panton	
Geoff Plunkett	*Port Otago Ltd*

4. CONFIRMATION OF AGENDA

Resolution
Moved Cr Woodhead
Seconded Cr Hope

The re-ordering of the agenda items as:

- Public Forum
- Confirmation of minutes
- 11.1 Commercial School Bus Service Withdrawal
- 11.2 Annual Report
- Return to agenda at item - 10.2 Chairperson's Report
- Late item - Otago Urban Water Quality Strategy for adoption to be taken as Item 11.4

CARRIED

5. CONFLICT OF INTEREST

No conflicts of interest were advised.

6. PUBLIC FORUM

Public forum speakers:

Ms Rosemary Penwarden and Prof Ralph Alder spoke to the "Our Climate Declaration" circulated to councillors. The Council and individual councillors were encouraged to sign the declaration and to follow the principles for future decision making, to assist with mitigating the effect of climate change.

Six speakers spoke to the cessation of commercial school bus services by Go Bus Ltd.

- Cr Christine Garey – Dunedin City Council
- Mr Paul Pope – Chairman Otago Peninsula Community Board
- Mr Tony Hunter – Principal Tahuna Intermediate School
- Ms Judith Forbes – Principal Bayfield High School
- Ms Heidi Hayward – Principal Dunedin North Intermediate
- Mrs Kjesten Nilsson – Parent

The following concerns were raised:

- Lack of notification to the schools for the loss of the service.
- Safety of pupils travelling unsupervised on public transport, walking or cycling
- Loss of direct service for pupils to schools.
- Winter weather and traffic conditions
- Extended travel times for pupils (early starts, late home) via public transport
- Impact on:
    - the public transport through loss of the school bus service
    - peninsula communities/families
    - pupils with disabilities and mobility issues

The speakers confirmed their desire to find safe and efficient options to get pupils to and from school.

A request was made for Council to provide support for a short term solution for Term 4 2017 and then to assist in further discussion for a long term solution.

Presenters responded to points of clarification from Councillors.

Cr Woodhead thanked the public forum speakers and supporters for their presentations and acknowledged the time and effort made by them in attending the meeting.

7. PRESENTATIONS

No presentations were held.

8. CONFIRMATION OF MINUTES

That the minutes of the public portion of the Council meeting held on 16 August 2017 be received and confirmed as a true and accurate record.

Moved: Cr Robertson
Seconded: Cr Noone
CARRIED

9. ACTIONS

No current items for action.

10. CHAIRPERSON'S AND CHIEF EXECUTIVE'S REPORTS

10.1. Chairperson's Report
Meeting with Outram residents - Cr Woodhead confirmed that discussion with the DCC in regard to a long term waste water plan (urban water quality) would be held.

10.2. Chief Executive's Report
Mr Bodeker encouraged councillors to read the report '*Research to inform the management for Kārearea/NZ falcon in Eastern Otago'* (tabled with his report) on project aims and results as part of ORC grant provided by the Environmental Enhancement Fund.

Resolution

That the Chairperson's and Chief Executive's reports be received.

Moved: Cr Woodhead
Seconded: Cr Deaker
CARRIED

11. MATTERS FOR COUNCIL DECISION

11.1. Commercial School Bus Service Withdrawal
This report outlined for Council consideration, options to respond to community concerns raised in response to Go Bus Transport's advice of its intention to withdraw from the provision of a number of commercial school services.

Council acknowledged the urgency to the affected schools to have a solution in place for Term 4 and were sympathetic to the situation the schools were facing.

It was clarified that the current school bus service was a commercial service that ORC was not a party to the contract.

Discussion focussed on preferred options C and D of the report.

Resolution

That ORC facilitate a discussion with the Ministry of Education, schools and NZTA to find a solution to the withdrawal of the commercial bus services which may include a financial contribution from ORC on the condition that:

1) *Any financial contribution from ORC be for Term 4 2017 only*
2) *The Chairperson and the Chief Executive be delegated responsibility to negotiate any ORC contribution.*
3) *Regular updates are provided to Council*

Moved: Cr Woodhead
Seconded: Cr Laws
CARRIED

The meeting adjourned at 11:53am and resumed at 11:58am with Item 11.2.

11.2. Annual Report 2016-2017
Council's Annual Report and Financial Statements for the period 1 July 2016 to 30 June 2017 were tabled for adoption by Council.

Mr Benham, Chair of the Audit and Risk Subcommittee outlined the review of the Annual Report with the Council's auditors (Deloitte) by the subcommittee and recommended that Council adopt the Annual Report.

Mr Scott Hawkins and Mr Mike Hawken from Deloitte discussed the audit opinion, and advised this would be issued and included in the final Annual Report, after its adoption by Council.

Resolution

a) That this report be received.
b) That Council adopt the Annual Report and Financial Statements for the year ended 30 June 2017.

Moved: Cr Brown
Seconded: Cr Noone
CARRIED

<u>Retirement of Mr Geoff Plunket, CEO, Port Otago Ltd</u>

Cr Woodhead invited councillors to provide their comments to Mr Geoff Plunket, retired CEO of Port Otago Ltd in acknowledgement of his 29 years of service to Port Otago Ltd. He read out the speech made on Council's behalf by Cr Kempton at Mr Plunket's official retirement function.

Councillors individually offered their thanks to Mr Plunket for his role in positioning Port Otago Ltd competitively for the future, for the financial performance of the Port in providing a regular healthy divided to ORC and of Mr Plunket's management of challenging situations, especially his care for Port employees and for his willingness to engage in community issues. Councillors wished Mr Plunket well in his retirement.

Mr Plunket acknowledged and thanked councillors for their comments. He advised he felt that Port Otago Ltd was in the best position in 29 years to move forward with its diversified earnings base.

The meeting adjourned at 12:44pm and resumed at 1:24pm.

11.3. Schedule of Ordinary Council and Committee Meetings, Jan-Dec 2018
A draft schedule of Council and Committee meetings for the 2018 calendar year was submitted to Council for consideration and adoption.

Resolution

That the attached draft Schedule of Ordinary Council and Committee Meetings for 2018 be adopted.

Moved: Cr Noone
Seconded: Cr Hope
CARRIED

11.4. Urban Water Quality Strategy for adoption (tabled)
It was resolved at the 13 September 2017 Policy Committee that the proposed Urban Water Quality Strategy be amended and brought to the Council meeting 27 September 2017 for decision. The Strategy was circulated separately from the agenda.

Cr Woodhead confirmed the review process for the proposed strategy, including the forums and workshops held with stakeholders.

Discussion was held on the amendments requested at the Policy Committee meeting.

Mr Bodeker advised the intent would be for the Urban Water Quality Strategy to be used by the territorial authorities to inform the district plans and infrastructure.

Resolution

(a) That the Urban Water Quality Strategy is adopted.

Moved: Cr Noone
Seconded: Cr Deaker
CARRIED

12. MATTERS FOR NOTING

12.1. Investment Report to 30 June 2017
The report provided information on the management and performance of the Council's short term and long term investments for the year ended 30 June 2017.

Mr Donnelly advised that the summary report was discussed at the Audit and Risk Subcommittee meeting of 21 September and it was recommended that this public investment report be tabled with Council on a six monthly basis.

Discussion was held on the managed fund investment strategy for NZ fixed interest.

Resolution

That this report be received.

Moved: Cr Neill
Seconded: Cr Kempton
CARRIED

12.2. Documents signed under Council's Seal, March-September 2017
To inform the Council of delegations which have been exercised.

Resolution

That the report be noted.

Moved: Cr Woodhead
Seconded: Cr Deaker
CARRIED

13. REPORT BACK FROM COUNCILLORS

C Noone - Attended the Rural Advisory Group meeting, hosted by the Otago CDEM. Discussion was held on the gaps in information and resourcing to support of emergency management. An example was given on the lack of knowledge about lifestyle block locations. The group intend to seek the assistance of community boards for this type of information. Cr Noone confirmed his role as member of the Rural Advisory Group.

Cr Brown: Attended the recent NOSLaM community meeting. He advised approximately 50 properties were represented with a desire to have "pod" groups established throughout the catchment.

Cr Laws Attended:

- Guardians of Lake Dustan meeting and confirmed he is now a Guardian member.
- Probus Cromwell giving feedback on ORC issues.
- Met with residents from the Pisa Moorings in regards to rabbit control.
- Met with the principal of Mount Aspiring College in regards to planning for a 1600 pupil college over the next 5 years. He advised that the Ministry of Education predictions for population growth for high schools in the Central Otago were far higher than that of the territorial authorities.

Cr Robertson: Advised that she and Mr Bodeker took part in an interview focussing on issues where smart technologies could assist Dunedin, such as climate change, sea level rise. The discussion was held as part of the "Gigatown" focus of Dunedin as a smart city.

14. NOTICES OF MOTION

No Notices of Motion were advised.

15. RECOMMENDATIONS ADOPTED AT COMMITTEE MEETINGS HELD ON 13 SEPTEMBER 2017

15.1. Recommendations of the Policy Committee

Resolution
Moved: Cr Robertson
Seconded: Cr Scott
CARRIED

15.2. Recommendations of the Regulatory Committee

Resolution
Moved: Cr Scott
Seconded: Cr Neill
CARRIED

15.3. Recommendations of the Communications Committee

Resolution
Moved: Cr Deaker
Seconded: Cr Bell
CARRIED

15.4. Recommendations of the Technical Committee

Resolution
Moved: Cr Noone
Seconded: Cr Bell
CARRIED

15.5. Recommendations of the Public Portion of the Finance and Corporate Committee

Resolution

Moved: Cr Brown
Seconded: Cr Noone
CARRIED

16. RESOLUTION TO EXCLUDE THE PUBLIC

Resolution

Moved: Cr Woodhead
Seconded: Cr Noone

That the public be excluded from the following parts of the proceedings of this meeting, namely:

> *Confirmation of the In Committee Minutes of the Ordinary Council meeting held on 16 August 2017, public excluded.*

The general subject of each matter to be considered while the public is excluded, the reason for passing this resolution in relation to each matter, and the specific grounds under section 48(1) of the Local Government Official Information and Meetings Act 1987 for the passing of this resolution are as follows:

General subject of each matter to be considered	Reason for passing this resolution in relation to each matter	Ground(s) under section 48(1) for the passing of this resolution
Confirmation of the In Committee Minutes of the Ordinary Council meeting held on 16 August 2017, public excluded.	The withholding of the information is necessary to—prevent the disclosure or use of official information for improper gain or improper advantage – Section 7(2)(j)	Section 48(1)(a); Section 7(2)(j)

After discussion of item 16, the meeting returned to public session on the motion of Crs Woodhead and Robertson.

17. CLOSURE

The meeting was declared closed at 2:15pm.

<u>**Chairperson**</u>

Report No.	Report Title	Presented to	Date of meeting	Resolution	Status
11.1	Commercial School Bus Service Withdrawal	Council	27/9/17	That ORC facilitate a discussion with the Ministry of Education, schools and NZTA to find a solution to the withdrawal of the commercial bus services which may include a financial contribution from ORC on the condition that: 1) Any financial contribution from ORC be for Term 4 2017 only 2) The Chairperson and the Chief Executive be delegated responsibility to negotiate any ORC contribution. 3) Regular updates are provided to Council	CLOSED Negotiations completed 29/9/17.

Who's putting local issues on the national agenda?

We are. LGNZ.

Local Government Leaders' Water Declaration

As the leaders of their communities the Mayors and Chairs of New Zealand declare their continuing and absolute commitment to valuing and managing water as a precious resource. We want New Zealand to be world leaders in sustainable water management and will work with our communities and partners towards that goal.

Our water resource is precious and must not be taken for granted. The quality of our water and its abundance is fundamental to the social, cultural, economic, and environmental wellbeing of New Zealand. Water is a taonga and our lifeblood. Iwi have a special relationship with freshwater and this is reflected in the statutes and in the National Policy Statement for Freshwater Management (NPSFM). Specifically, the NPSFM requires that freshwater is managed to give effect to Te Mana o te Wai, an integrated approach to fresh-water management that recognises the association of the wider community with the rivers, lakes and streams but also the relationship of iwi and hapū and their values with freshwater bodies.

Protecting our freshwater - lakes, rivers, streams and groundwater - is important because it ensures there is enough clean and safe water for all of our uses, now and into the future, and to ensure the health of freshwater ecosystems. Achieving this will require a collaborative effort from many parties – councils, communities, central government, Māori/Iwi, business and the primary sector.

Local government plays a central role in the management of our water resources, and because of this is uniquely placed to play a leading role in this long-term effort:

- Regional and unitary councils are responsible for managing water quality and quantity. They may permit some activities and require consents for others, such as taking water and the discharge of contaminants, and prevent certain activities.
- Territorial authorities are typically responsible for providing and managing infrastructure for drinking water, stormwater and sewage (although arrangements differ in some regions), and manage land use through district plans.

Councils work every day to deliver better water outcomes – it is core business and makes up a significant proportion of council work and expenditure. We engage with communities and by working together we have seen some good successes, but there is much more work to do. As well as our ongoing clean-up work, demand for water from businesses, the primary sector and growing urban communities are bringing greater challenges for us all and these are exacerbated by climate change.

As a result, in 2017 and 2018, local government will scope the costs of maintaining and/or improving water quality and its continued supply through its Water 2050 project. Water 2050 will underpin the need to think about water in a holistic way, raising the cost implications of investment in drinking, waste and stormwater assets and services to meet increased standards for water quality, and outlining the need for a national conversation on costs and new funding tools.

We, the Mayors and Chairs commit to:

1. Continue to make water a key priority

- Improve the water in our regions with, and for, our people and their descendants, asking our communities and stakeholders for their priorities for water and reflecting these in key planning documents.
- Respect the cultural values and special connections held by Māori to our water, honour our obligations to Māori and work with Māori to implement Treaty of Waitangi Settlements. This includes recognising Te Mana o te Wai in freshwater management which includes the relationship that iwi and hapū have with, and values for, water bodies. This will be expressed in our plans, and in the engagement processes with Māori used to develop these plans. It may also be reflected in our governance structures.
- Ensure that those people who have the privilege of using our water do so responsibly, by requiring and enforcing conditions of resource consent. We will lead work to change how people value water and consider their individual and collective impact. Provide clean, safe and reliable drinking water for our communities as a priority.

2. Work with our communities to improve our freshwater

- Work with our communities to foster a sense of pride in the freshwater of New Zealand and maintain or improve water quality across our region and manage water use and consumption. This will include working to improve the quality of our stormwater by deterring the use of certain products, and initiatives to manage demand for domestic consumption.
- To lead, champion and support communities to take action to restore and protect water. For example, this might include setting nutrient limits across a catchment, riparian planting and fencing of waterways.

3. Provide information on the state of our freshwater

- Provide information about the state of our freshwater, and make access to information about water easy for everyone by hosting information on the national website, LAWA (Land, Air, Water Aotearoa), and on our own websites.
- Issue a national report annually on the state of freshwater across our jurisdictions. This will provide New Zealanders with a "national state of water," and a region-by-region summary, of key water quality measures.

4. Be clear about the costs of improving our water

- Work with our communities so that the costs and priorities for investment in infrastructure to provide a secure supply of water and maintain and improve water quality are clearly understood. We will do this through our long term planning processes and as we change our resource management plans to give effect to the National Policy Statement for Freshwater Management. Water 2050 will also be critical work in creating the case for new funding and financing tools for water infrastructure.

We, the Mayors and Chairs call on the government of the day to:

1. Take an integrated approach to water

- Recognise the interlinked nature of all water, whether natural rivers, lakes, streams or groundwater and drinking water, stormwater or wastewater, and reflect this in coherent, integrated water policy.

- Recognise the impacts of climate change on our water resources and work with us to develop options to address these.

2. Quantify the costs of meeting increased standards

- Quantify, with local government, the costs and trade-offs required to meet freshwater quality standards and limits for water quality. This includes understanding the cost implications for our infrastructure and the costs to meet water quality standards and limits such as restoration and mitigation.
- Identify, with local government, additional funding required to meet any increase in standards and targets, and provide local government with additional tools to fund maintenance and upgrading of infrastructure to meet both existing and new standards.

3. Work with us to meet the costs to improve water quality

- Work with local government on a plan to meet these costs and develop new tools for funding and financing infrastructure.
- Increase funding where necessary to fund improvements in freshwater quality.

4. Work with us to be world leaders in water management

- Give long-term cross-party commitment to improve water quality, manage water quantity and provide stability, to enable us to work toward New Zealand being a world leader in water management.
- Explore the role of economic instruments in water policy and in pricing for water services. Options include pricing water, taxing water consumption and setting a royalty for consumption.

The current state of our water is the result of impacts over many years. We believe there is now a consensus that as a nation we want better for New Zealand. This Declaration is local government's commitment to achieving the goals we all want – plentiful clean and safe water for generations to come.

UNDERSIGNED BY THE NATIONAL COUNCIL OF LOCAL GOVERNMENT NEW ZEALAND:

Dave Cull
President, Local Government New Zealand
Mayor, Dunedin City Council

Stuart Crosby
Vice President, Local Government New Zealand
Councillor, Bay of Plenty Regional Council

Hon Phil Goff
Mayor, Auckland Council

Justin Lester
Mayor, Wellington City Council

Lianne Dalziel
Mayor, Christchurch City Council

Doug Leeder
Chair, Bay of Plenty Regional Council

Rachel Reese
Mayor, Nelson City Council

Jan Barnes
Mayor, Matamata-Piako District Council

Brian Hanna
Mayor, Waitomo District Council

Hon John Carter
Mayor, Far North District Council

Wayne Guppy
Mayor, Upper Hutt City Council

Don Cameron
Mayor, Ruapehu District Council

Tracy Hicks
Mayor, Gore District Council

Richard Kempthorne
Mayor, Tasman District Council

THE FOLLOWING MAYORS AND CHAIRS ALSO SUPPORT THIS DECLARATION

Mayor John Booth
Carterton District Council

Mayor Alex Walker
Central Hawke's Bay District Council

Steve Lowndes, Acting Chair
Environment Canterbury

Nicol Horrell, Chair
Environment Southland

Mayor Meng Foon
Gisborne District Council

Chris Laidlaw, Chair
Greater Wellington Regional Council

Mayor Ray Wallace
Hutt City Council

Mayor John Tregidga
Hauraki District Council

Mayor K (Guru) Gurunathan
Kāpiti Coast District Council

Mayor Winston Gray
Kaikoura District Council

Mayor Graham Smith
Mackenzie District Council

Mayor Helen Worboys
Manawatu District Council

Mayor John Leggett
Marlborough District Council

Mayor Lyn Patterson
Masterton District Council

Mayor Bill Dalton
Napier City Council

Mayor Neil Holdom
New Plymouth District Council

Bill Shepherd, Chair
Northland Regional Council

Mayor John Forbes
Opotiki District Council

Mayor Grant Smith
Palmerston North City Council

Mayor Mike Tana
Porirua City Council

Mayor Andy Watson
Rangitikei District Council

Mayor Sam Broughton
Selwyn District Council

Mayor David Trewavas
Taupo District Council

Mayor Allan Sanson
Waikato District Council

Mayor David Ayers
Waimakariri District Council

Mayor Craig Rowley
Waimate District Council

Mayor Jim Mylchreest
Waipa District Council

Mayor Viv Napier
South Wairarapa District Council

Mayor Gary Kircher
Waitaki District Council

Mayor Garry Webber
Western Bay of Plenty District Council

Mayor Tony Bonne
Whakatane District Council

Who's putting local issues on the national agenda?

We are. LGNZ.

Under embargo until 10am Wednesday 25 October 2017

Water declaration reaffirms commitment to quality and signals cost issues

A local government leaders' water declaration has been launched to further reiterate the sector's commitment to lifting water quality and call on the new Government for greater action.

Water is a key issue for New Zealanders. Lifting the quality of freshwater resources and improving our drinking, waste and stormwater will require a huge effort and the Water Declaration is local government's commitment to playing its part in achieving these goals.

The Local Government Leaders' Water Declaration acknowledges the increasing importance of water to New Zealanders. It follows a climate change declaration launched in July and recognises the interlinked nature of what are two major issues for New Zealand.

Local Government New Zealand President Dave Cull says councils manage freshwater quality and quantity, the delivery of drinking water and the provision of waste and storm water services.

"There is no doubt water is a challenging and complex area to address," Mr Cull says.

"Local government is already working with its communities to lift the outcomes for all of our waters and is seeing good success in some areas. But we face have a number of challenges in achieving this, particularly around funding to deliver investment in the improvement our communities want to see."

Lifting the quality of freshwater resources and improving our drinking, waste and stormwater provision will require a collaborative effort and will come at a significant cost. Additional funding tools will be needed to ensure this work can be carried out and councils are very likely to need financial support from the Government in some areas to make real gains.

The Declaration builds on the Water 2050 project started this year by local government to scope the costs of maintaining and improving water quality and its continued supply. Water 2050 will underpin the need to think about water in a holistic way, raising the cost implications of investment in drinking, waste and storm water assets and services to meet increased standards for water quality, and outlining the need for a national conversation on costs and new funding tools.

"Water, along with climate change, is a top priority for local government. As a nation we need to take significant steps towards making improvement, and this declaration is a commitment to action from local government," Mr Cull says.

The Declaration outlines a number of local government commitments. These include:

- improving the water in our regions with, and for, our people and future generations;
- ensuring that those people who have the privilege of using our water do so responsibly; and
- working with our communities so that the costs and priorities for investment in infrastructure to provide a secure supply of water and maintain and improve water quality are clearly understood.

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The Declaration also outlines key steps for the new Government, including:

- recognising the interlinked nature of all water, whether natural rivers, lakes, streams or groundwater and drinking water, stormwater or wastewater, and reflecting this in coherent, integrated water policy;
- acknowledging the impact climate change will have on our water resources and developing policy options to address these; and
- working with local government on a plan to meet these costs and develop new tools for funding and financing infrastructure.

Click here to read the Local Government Leaders' Water Declaration.

Ends

For more information contact LGNZ's Deputy Chief Executive Advocacy, Helen Mexted on 029 924 1221 or helen.mexted@lgnz.co.nz

About LGNZ and local government in New Zealand
Local Government New Zealand (LGNZ) is the peak body representing New Zealand's 78 local, regional and unitary authorities. LGNZ advocates for local democracy, develops local government policy, and promotes best practice and excellence in leadership, governance and service delivery. Through its work strengthening sector capability, LGNZ contributes to the economic success and vibrancy of communities and the nation.

The local government sector plays an important role. In addition to giving citizens a say in how their communities are run, councils own a broad range of community assets worth more than $120 billion. These include 90 per cent of New Zealand's road network, the bulk of the country's water and waste water networks, and libraries, recreation and community facilities. Council expenditure is approximately $8.5 billion dollars, representing approximately 4 per cent of Gross Domestic Product and 11 per cent of all public expenditure.

For more information visit www.lgnz.co.nz

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Minutes of a meeting of the Policy Committee held in the Council Chambers at Otago Regional Council on Wednesday 18 October 2017, commencing at 1:29pm

Membership

Cr Gretchen Robertson *(Chairperson)*
Cr Michael Laws *(Deputy Chairperson)*
Cr Graeme Bell
Cr Doug Brown
Cr Michael Deaker
Cr Carmen Hope
Cr Trevor Kempton
Cr Ella Lawton
Cr Sam Neill
Cr Andrew Noone
Cr Bryan Scott
Cr Stephen Woodhead

Welcome

Cr Woodhead welcomed Councillors, members of the public and staff to the meeting.

1. APOLOGIES

Resolution

That the apologies for Crs Brown and Noone be accepted.

Moved: Cr Hope
Seconded: Cr Kempton
CARRIED

2. LEAVE OF ABSENCE

Leave of Absence was noted for Cr Deaker

3. ATTENDANCE

Peter Bodeker	*(CEO)*
Nick Donnelly	*(DCS)*
Tanya Winter	*(DPPRM)*
Sian Sutton	*(DSHE)*
Gavin Palmer	*(DEHS)*
Scott MacLean	*(DEMO)*
Dale Meredith	Policy Manager
Lauren McDonald	*(Committee Secretary)*

4. CONFIRMATION OF AGENDA
The agenda was confirmed as tabled.

5. CONFLICT OF INTEREST
No conflicts of interest were advised.

6. PUBLIC FORUM
No public forum was held.

7. PRESENTATIONS
No presentations were held.

8. CONFIRMATION OF MINUTES
Resolution

That the minutes of the meeting held on 13 September 2017 be received and confirmed as a true and accurate record.

Moved: Cr Hope
Seconded: Cr Robertson
CARRIED

9. ACTIONS
Status report on the resolutions of the Policy Committee. No current items for action.

10. MATTERS FOR COUNCIL DECISION

10.1. Director's Report on Progress
The report provided an overview of significant activities undertaken by the Policy directorate for the period 25 August to 29 September 2017, including: national policies, strategies and plans; consent applications and water quantity planning.

Resolution
a) *That this report be noted.*

Moved: Cr Kempton
Seconded: Cr Bell
CARRIED

10.2. National direction for clean water and Otago

The report provided a summary of: recent government freshwater reforms; amendments to the National Policy Statement for Freshwater Management (NPS-FM); the 2017 review of Council's implementation of the NPS-FM by the Ministry for Primary Industries (MPI) and Ministry for the Environment (MfE) and the ORC actions underway to implement recent amendments to the NPS-FM.

A request was made for regular progress updates on the ORC's implementation of the NPS-FM amendments to the Otago Water Plan.

Discussion was held on the alignment of terminology to that used in the NPS, enforcement, SOE monitoring and stakeholder engagement.

Resolution

That Council:

a) *Note the Clean Water 2017 changes with respect to freshwater management (Attachment 1);*

b) *Note the findings of three recent reviews of Council's implementation of theNational Policy Statement for Freshwater Management by:*
   - *the Ministries for the Environment and Primary Industries;*
   - *Pattle Delamore Partners Ltd; and*
   - *the National Institute of Water and Atmospheric Research;*

c) *Endorse the actions underway and proposed by Council to implement the National Policy Statement for Freshwater Management*

d) *be provided six weekly progress reports on table 1 and table 2 (steps identified to reflect NPS-FM 2014 amendments in the Otago Water Plan).*

Moved: Cr Woodhead
Seconded: Cr Laws
CARRIED

11. MATTERS FOR NOTING

No matters for noting were tabled.

12. NOTICES OF MOTION

No Notices of Motion were advised.

13. CLOSURE

The meeting was declared closed at 02:07 pm.

<u>Chairperson</u>

Minutes of a meeting of the Regulatory Committee held in the Council Chambers at Otago Regional Council on Wednesday 18 October 2017, commencing at 2:09pm

Membership

Cr Bryan Scott	*(Chairperson)*
Cr Sam Neill	*(Deputy Chairperson)*
Cr Graeme Bell	
Cr Doug Brown	
Cr Michael Deaker	
Cr Carmen Hope	
Cr Trevor Kempton	
Cr Michael Laws	
Cr Ella Lawton	
Cr Andrew Noone	
Cr Gretchen Robertson	
Cr Stephen Woodhead	

1. APOLOGIES

The apologies of Crs Brown and Noone were noted.

2. LEAVE OF ABSENCE

Leave of Absence for Cr Deaker was noted.

3. ATTENDANCE

Peter Bodeker	*(CEO)*
Nick Donnelly	*(DCS)*
Tanya Winter	*(DPPRM)*
Sian Sutton	*(DSHE)*
Gavin Palmer	*(DEHS)*
Scott MacLean	*(DEMO)*
Lauren McDonald	*(Committee Secretary)*

4. CONFIRMATION OF AGENDA

The agenda was confirmed as tabled.

5. CONFLICT OF INTEREST

No conflicts of interest were advised.

6. PUBLIC FORUM

No public forum was held.

7. PRESENTATIONS

No presentations were held.

8. CONFIRMATION OF MINUTES

Resolution

That the minutes of the meeting held on 13 September 2017 be received and confirmed as a true and accurate record.

Moved: Cr Scott
Seconded: Cr Woodhead
CARRIED

9. ACTIONS

No current items for action.

10. MATTERS FOR COUNCIL DECISION

10.1. Director's Report on Progress

The report outlined the regulatory activity for the reporting period 26 August to 29 September 2017, including: Biosecurity - mycoplasma bovis and rabbit control; wallaby activity in the region, Harbourmaster and compliance activities; wilding conifer control; freshwater biosecurity and the Environmental Risk Assessment (ERA) programme.

Mr MacLean outlined the Agricultural Compounds and Veterinary Medicines (ACVM) application process.

Resolution

a) *That this report is received.*

Moved: Cr Bell
Seconded: Cr Laws
CARRIED

10.2. Harbour ByLaws

The report provided an update on the progress on development of draft Harbour Bylaws for navigational safety in Otago waters, including the consultation process.

Mr MacLean provided a point of clarification - the reference to the Otago and Karitane harbours refers to the lapsed 2004 bylaw, therefore the new draft bylaw will cover all navigational waters in Otago (including out to the 12 mile nautical limit), with the exception of those delegated to the Queenstown Lakes District Council (QLDC) and the Central Otago District Council (CODC).

Resolution

a) *That this report be received.*
b) *That the timetable for adopting the bylaw be endorsed.*

Moved: Cr Robertson
Seconded: Cr Hope
CARRIED

11. MATTERS FOR NOTING

11.1. Resource Management Act 1991, Biosecurity Act 1993 and Building Act 2004 Enforcement Activities

The report detailed the Resource Management Act 1991, Biosecurity Act 1993 and Building Act 2004 enforcement activities undertaken during the reporting period 26 August to 29 September 2017.

Resolution

a) *That this report be noted.*

Moved: Cr Kempton
Seconded: Cr Woodhead
CARRIED

11.2. Consents and Building Control

The report covered the consents and building control progress for the reporting period 25 August to 29 September 2017.

Resolution
a) *That this report is noted.*

Moved: Cr Bell
Seconded: Cr Neill
CARRIED

12. NOTICES OF MOTION

No Notices of Motion were advised.

12. CLOSURE

The meeting was declared closed at 2:34pm.

<u>Chairperson</u>

Otago Regional Council

Minutes of a meeting of the Communications Committee held in the Council Chambers at Otago Regional Council on Wednesday 18 October 2017, commencing at 12:34pm

Membership

Cr Michael Deaker	*(Chairperson)*
Cr Carmen Hope	*(Deputy Chairperson)*
Cr Graeme Bell	
Cr Doug Brown	
Cr Trevor Kempton	
Cr Michael Laws	
Cr Ella Lawton	
Cr Sam Neill	
Cr Andrew Noone	
Cr Gretchen Robertson	
Cr Bryan Scott	
Cr Stephen Woodhead	

Welcome

Cr Hope welcomed Councillors, members of the public and staff to the meeting.

1. APOLOGIES

Resolution

That the apologies for Cr Brown be accepted.

Moved: Cr Bell
Seconded: Cr Noone
CARRIED

2. LEAVE OF ABSENCE

Cr Deaker

3. ATTENDANCE

Peter Bodeker	*(CEO)*
Nick Donnelly	*(DCS)*
Tanya Winter	*(DPPRM)*
Sian Sutton	*(DSHE)*
Gavin Palmer	*(DEHS)*
Scott MacLean	*(DEMO)*
Suzanne Watt	
Eleanor Ross	
Lisa Gloag	
Andrea Crawford	
Lauren McDonald	*(Committee Secretary)*

4. CONFIRMATION OF AGENDA

The agenda was confirmed as tabled.

5. CONFLICT OF INTEREST

No conflicts of interest were advised.

6. PUBLIC FORUM

No public forum was held.

7. PRESENTATIONS

No presentations were held.

8. CONFIRMATION OF MINUTES

Resolution

That the minutes of the meeting held on 13 September 2017 be received and confirmed as a true and accurate record.

Moved: Cr Woodhead
Seconded: Cr Noone
CARRIED

9. ACTIONS

Status report on the resolutions of the Communications Committee.

Curious minds South Dunedin – What lies beneath. Investigation into the changing environment in South Dunedin	**13/9/17**	***Opportunities for similar initiatives across ORC functions be developed and considered for incorporation into the 2018/28 Long-Term Plan.***	**OPEN**

10. MATTERS FOR COUNCIL DECISION

10.1. Director's Report on Progress

The report provided the community, stakeholder and staff engagement activities carried out by the Stakeholder Engagement directorate staff for the period 25 August to 29 September 2017.

A request was made for regular reporting on website followers statistics.

Discussion was held on the website redevelopment.

Resolution

a) *It is recommended that this report is noted.*

Moved: Cr Woodhead
Seconded: Cr Noone
CARRIED

11. MATTERS FOR NOTING

No matters for noting.

12. NOTICES OF MOTION

No Notices of Motion were advised.

13. CLOSURE

The meeting was declared closed at 12:57 pm.

<u>Chairperson</u>

Minutes of a meeting of the
Technical Committee held in the
Council Chambers at Otago Regional Council
on Wednesday 18 October 2017,
commencing at 10:30 am

Membership

Cr Andrew Noone	*(Chairperson)*
Cr Ella Lawton	*(Deputy Chairperson)*
Cr Graeme Bell	
Cr Doug Brown	
Cr Michael Deaker	
Cr Carmen Hope	
Cr Trevor Kempton	
Cr Michael Laws	
Cr Sam Neill	
Cr Gretchen Robertson	
Cr Bryan Scott	
Cr Stephen Woodhead	

Welcome

Cr Noone welcomed Councillors, members of the public and staff to the meeting.

1. APOLOGIES

Resolution

That the apologies for Cr Brown be accepted.

Moved: Cr Noone
Seconded: Cr Woodhead
CARRIED

2. LEAVE OF ABSENCE

The Leave of Absence by Cr Deaker was noted.

3. ATTENDANCE

Peter Bodeker	*(CEO)*
Nick Donnelly	*(DCS)*
Tanya Winter	*(DPPRM)*
Sian Sutton	*(DSHE)*
Gavin Palmer	*(DEHS)*
Scott MacLean	*(DEMO)*
Dean Olsen	*(Manager Resource Science)*
Deborah Mills	*(Environmental Scientist)*
Lauren McDonald	*(Committee Secretary)*

4. CONFIRMATION OF AGENDA

The agenda as tabled was confirmed.

5. CONFLICT OF INTEREST

No conflicts of interest were advised.

6. PUBLIC FORUM

No public forum was held.

7. PRESENTATIONS

No presentations were held.

8. CONFIRMATION OF MINUTES

Resolution

That the minutes of the meeting held on 13 September 2017 be received and confirmed as a true and accurate record.

Moved: Cr Robertson
Seconded: Cr Hope
CARRIED

9. ACTIONS

Status report on the resolutions of the Technical Committee.

10. MATTERS FOR COUNCIL DECISION

10.1. Director's Report on Progress

The report provided information on the: Heavy rainfall event of 21 and 22 July; Southern Alpine Lakes; Climate change and sea level rise; Leith Flood Protection Scheme engineering works; Robson lagoon improvements and Urban Water Management.

Southern Alpine Lakes - Dr Palmer confirmed the initial focus was for the identification of the scientific research and information jointly sought by ORC, Environment Canterbury and Environment Southland. He confirmed this would be aligned into the ORC Long Term Plan.

Resolution

a) That this report is noted.

Moved: Cr Robertson
Seconded: Cr Neill
CARRIED

10.2. Air Quality Research Opportunities

The report outlined the development and implementation of the national research strategy and its alignment with ORC's air quality research needs. The report included current strategic thinking for national interest research topics, emission control technology opportunities and public health considerations.

Ms Mills responded to questions on air quality reduction initiatives for domestic chimneys, monitoring of particulates, public health impacts and affordable residential monitoring methods.

A request was made for the report Health Affects of Ambient Air Quality in Otago to be circulated to Councillors, to assist with future discussion.

Resolution

a) That this report be noted.
b) That the ideas presented in this report are endorsed for consideration for inclusion into the 2018/28 Draft Long-Term Plan.

Moved: Cr Robertson
Seconded: Cr Scott
CARRIED

11. MATTERS FOR NOTING

There were no matters for noting.

12. NOTICES OF MOTION

There were no Notices of Motion tabled.

13. CLOSURE

The meeting was declared closed at 11:10 am.

Chairperson

Minutes of a meeting of the Finance and Corporate Committee held in the Council Chambers at Otago Regional Council on Wednesday 18 October 2017, commencing at 10:30 am

Membership

Cr Doug Brown	*(Chairperson)*
Cr Andrew Noone	*(Deputy Chairperson)*
Cr Graeme Bell	
Cr Michael Deaker	
Cr Carmen Hope	
Cr Trevor Kempton	
Cr Michael Laws	
Cr Ella Lawton	
Cr Sam Neill	
Cr Gretchen Robertson	
Cr Bryan Scott	
Cr Stephen Woodhead	

Welcome

Cr Noone welcomed Councillors, members of the public and staff to the meeting.

1. APOLOGIES

Resolution

That the apologies for Cr Brown be accepted.

Moved: Cr Noone
Seconded: Cr Hope
CARRIED

2. LEAVE OF ABSENCE

Cr Michael Deaker

3. ATTENDANCE

Peter Bodeker	*(CEO)*
Nick Donnelly	*(DCS)*
Tanya Winter	*(DPPRM)*
Sian Sutton	*(DSHE)*
Gavin Palmer	*(DEHS)*
Scott MacLean	*(DEMO)*
Fraser McRae	*(Executive Officer)*
Lauren McDonald	*(Committee Secretary)*

4. CONFIRMATION OF AGENDA

The agenda was confirmed noting a Public Forum speaker - Mary McFarlane.

5. CONFLICT OF INTEREST

No conflicts of interest were advised.

6. PUBLIC FORUM

Mary McFarlane spoke in response to the presentation of the Port Otago Ltd (POL) Annual Report at the 13 September Finance and Corporate Committee meeting. She advised she sought more opportunity for community involvement in regard to the new POL Health & Safety mandate, noise control mitigation for the wharf extension. She expressed her concern at the impact of the increased operations at the port, including cruise ship visits on the local community.

7. PRESENTATIONS

7.1. Otago Rescue Helicopter Trust

Presentation of the Otago Helicopter Trust Annual Report by Chairman, Ross Black. Board member, Martin Dippie and HelioOtago operational manager, Graeme Gale in attendance.

Mr Black summarised the Trust's activities for the year ending 30 June 2017 and thanked the ORC for their continued support. He highlighted the flight safety enhancement of the HeliOtago helicopters (utilizing GPS) for safe travel routes in adverse weather and hoped this would become a national standard. Mr Black outlined the upcoming tender procurement process with the ACC, Ministry of Health and the Southern DHB. He confirmed that the Otago Helicopter Trust would not submit for the tender but would support Graeme Gale, HeliOtago (as operator) and that the Trust would continue in an active role for community advocacy.

Cr Noone thanked and acknowledged the efforts of the trustees and the skilled team lead by Graeme Gale and offered the support of the ORC for the tender process.

8. CONFIRMATION OF MINUTES

Resolution

That the minutes of the (public portion of the) meeting held on 13 September 2017 be received and confirmed as a true and accurate record.

Moved: Cr Noone
Seconded: Cr Lawton
CARRIED

9. ACTIONS

No current items for action.

10. MATTERS FOR COUNCIL DECISION

10.1. Director's Report - October 2017

The report provided the significant financial and corporate activity for the reporting period along with account payments for endorsement.

Resolution

a) That this report be received.
b) That the payments and investments summarised in the table above and detailed in the payment schedule, totalling $5,787,442.25, be endorsed.

Moved: Cr Bell
Seconded: Cr Hope
CARRIED

11. MATTERS FOR NOTING

11.1. Public Transport Update - October 2017

The report provided an update on the implementation of the Dunedin and Wakatipu Public Transport Network upgrades and the outcome of the Dunedin commercial schools transport service withdrawal by GoBus Ltd. The report sought Council endorsement of the Queenstown Integrated Transport Programme Business Case.

Mr Collings, Manager Support Services responded to questions from councillors and confirmed the Queenstown Integrated Transport Programme Business Case had been endorsed by QLDC and the NZTA.

Resolution

a) That this report be received.
b) The Finance and Corporate Committee endorse the Queenstown Integrated Transport Programme Business Case

Moved: Cr Woodhead
Seconded: Cr Kempton
CARRIED

11.2. Financial Report - August 2017

Resolution

a) *That this report be received.*

Moved: Cr Hope
Seconded: Cr Woodhead
CARRIED

12. NOTICES OF MOTION

No Notice of Motion advised.

13. RECOMMENDATIONS OF MEETINGS

13.1. Recommendations of the Audit and Risk Subcommittee

Resolution

That the recommendations of the Audit and Risk Subcommittee meeting of 21 September 2017 be adopted.

Moved: Cr Robertson
Seconded: Cr Woodhead
CARRIED

14. RESOLUTION TO EXCLUDE THE PUBLIC

Resolution

Moved: Cr Noone
Seconded: Cr Hope
CARRIED

That the public be excluded from the following parts of the proceedings of this meeting, namely:

Adoption of the recommendations of the public excluded portion of the Audit and Risk Subcommittee meeting held on 21 September 2017.

The general subject of each matter to be considered while the public is excluded, the reason for passing this resolution in relation to each matter, and the specific grounds under section 48(1) of the Local Government Official Information and Meetings Act 1987 for the passing of this resolution are as follows:

General subject of each matter to be considered	Reason for passing this resolution in relation to each matter	Ground(s) under section 48(1) for the passing of this resolution
Adoption of the recommendations of the public excluded portion of the Audit and Risk	To protect information where the making available of the information—would be likely unreasonably to prejudice the commercial position of the person who supplied or who is the subject of the information – Section 7(2)(b)(ii)	Section 48(1)(a); Section 7(2)(b)(ii) Section 7(2)(c)(i) Section 7(2)(h)

Subcommittee meeting held on 21 September 2017.	To protect information which is subject to an obligation of confidence or which any person has been or could be compelled to provide under the authority of any enactment, where the making available of the information—would be likely to prejudice the supply of similar information, or information from the same source, and it is in the public interest that such information should continue to be supplied – Section 7(2)(c)(i) To enable any local authority holding the information to carry out, without prejudice or disadvantage, commercial activities – Section 7(2)(h)	

I also move that Mr Peter Bodeker and Mr Nick Donnelly be permitted to remain at this meeting after the public has been excluded, because of their knowledge of the matters subject to the recommendations. This knowledge, which will be of assistance in relation to the matter to be discussed, is relevant to the matter because of their membership or attendance of the Audit and Risk Subcommittee.

Resolution

That the meeting resume in public session at 12:32pm.

Moved: Cr Noone
Seconded: Cr Lawton
CARRIED

15. CLOSURE

The meeting was declared closed at 12:32pm.

Chairperson