RESEARCH SUMMARY

The spatial extent of pest management outcomes at Ark in the Park, Waitakere Ranges Regional Park

Report for Ark in the Park and Auckland Council

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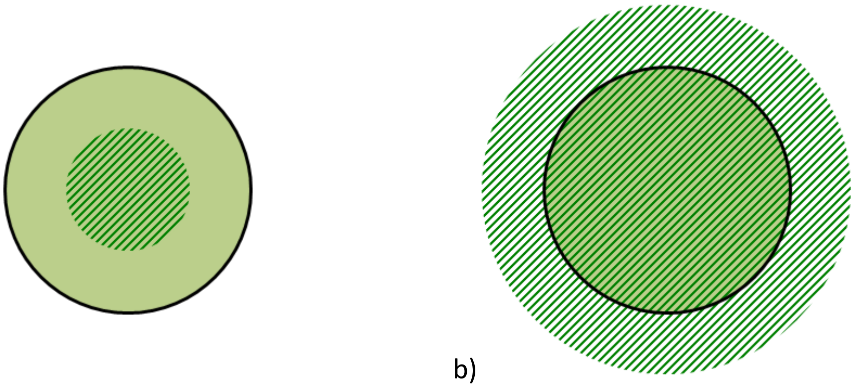
EXECUTIVE SUMMARY

A study was undertaken to determine the spatial relationship between management of mammalian predators and its outcomes at Ark in the Park. The predator pests under investigation were rodents and mustelids. The outcomes consist of changes in the abundance and diversity of taxa impacted by these predator pests. Predicted outcomes include reduced levels of benefit to native biodiversity inside but close to the border of the pest management area (edge effect; figure 1a) and some level of benefit to native biodiversity in the area immediately surrounding the pest management area (spill-over effect; figure 1b). Several biodiversity indices were measured across a 1200 m distance scale with 600 m either side of the pest management border of Ark in the Park. Biodiversity indices measured were: diversity and relative abundance of native birds, lizards and invertebrates; and density of seedlings. Furthermore, relative abundances of the pests themselves were measured, and forest structure and composition assessed in order to relate these factors to the biodiversity indices.

Forest structure and composition was not significantly different inside and outside the pest management area. Stoat and rat densities were found to decrease linearly from the point furthest outside to the point furthest inside the pest management area. Lizards were never observed. For all other biodiversity indices, at least some taxa were observed with increasing frequency from the point furthest outside to the point furthest inside the pest management area. These results suggest the occurence of both edge and spill-over type effects occuring at the borders of the pest management area, and that these effects are a consequence of predation by or competition with mammalian pests. This information will be of use to Ark in the Park management and field operators to improve cost-effectiveness and ensure adequate protection is provided to the area to meet its conservation goals. Evidence of spill-over benefits also indicate that the localised pest management applied at Ark in the Park may improve biodiversity outcomes over a larger landscape level by promoting connectivity to otherwise isolated pest management areas.



a) b)

Figure 1 – Diagrams representing a) edge effect and b) spill-over effect. The black circle with solid shading represents the spatial extent of pest management application, the angled stripes represent the spatial extent of the beneficial outcomes (as measured by biodiversity indices) of the applied pest management

STUDY DESIGN

- Four 1200 m transects were sampled for various biodiversity indices.
- Each transect bisected the western border of Ark in the Park's mammalian pest management activity (i.e. with 600 m outside and 600 m inside the management area) whilst remaining inside contiguous forest habitat.
- At 200 m intervals along each transect, a suite of biodiversity indices was sampled at a monitoring station.
- These included indices of mustelid and rodent abundance to determine relative pest abundance inside and outside the Ark. In addition, biodiversity indices were used to determine the relative composition of seedlings, and bird, lizard and invertebrate communities inside and outside the pest management area.
- The methods used for the measurement of the biodiversity outcomes were designed to be repeatable by volunteers or untrained community group members. This is because monitoring at Ark in the Park is largely undertaken in this manner, and it is hoped that the monitoring programme established for this study could be continued by these volunteers. All four transects were located in areas which had been under pest management for no less than two years at the time of transect establishment.
- After the establishment of each transect, sampling was not undertaken for a period of eight weeks to allow for animals to overcome potential neophobia and begin making use of the newly placed monitoring equipment, including tracking tunnels, lizard artificial refuges and invertebrate monitoring equipment.
- Each transect was fully sampled on three occasions. The transects were sampled on a rotating basis with 6-7 weeks between sampling of the same transect.

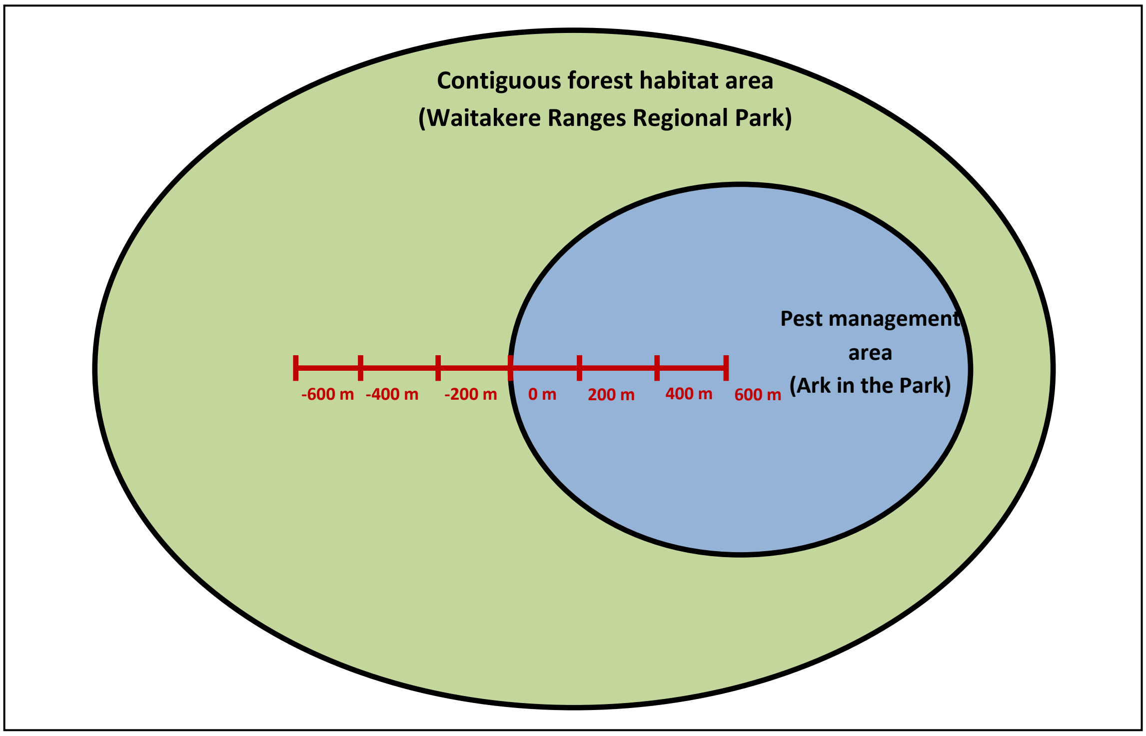


Figure 2 – Diagrammatic representation of transect design and positioning within the study site. While only one transect is depicted, four were undertaken. NB not to scale

Figure 3 - Map of Ark in the Park with dashed brown lines showing locations of pest control lines and solid red lines showing locations of the experimental transects
(Image credit: Ark in the Park)

PESTS

Relative mustelid and rodent abundances were measured across the 1200 m distance scale, in order to determine the relationship between distance from the pest management border and the relative levels of predation pressure on native species.

Methods

- Mustelid and rodent abundances were measured using footprint tracking tunnels (after King & Edgar, 1977)
- One tracking tunnel was located at each of the 28 monitoring stations (200m apart)
- Tracking tunnels were baited with approximately 20 g of defrosted frozen rabbit mince, to attract mustelids, and peanut butter, to attract rodents
- The proportion of tunnels tracked by mustelids, rats or mice overnight was used as an index of mustelid, rat or mouse abundance

Results

- Over a total of 84 tracking tunnel nights (28 tracking tunnels for three nights), six cards were tracked by stoats, 27 by rats and three by mice
- Significant linear relationships were demonstrated for both rats and stoats with respect to distance from the border of pest management
- No significant relationship was found for mice

Both edge and spill-over effects were demonstrated for both stoats and rats. Forest structure and composition, as measured by basal area per unit area and species diversity, was not significantly different inside and outside the pest management area. The pattern of relative abundance of these pest species in relation to the pest management border is concluded to be the prime determinant of variation in the biodiversity indices across the spatial dimension.

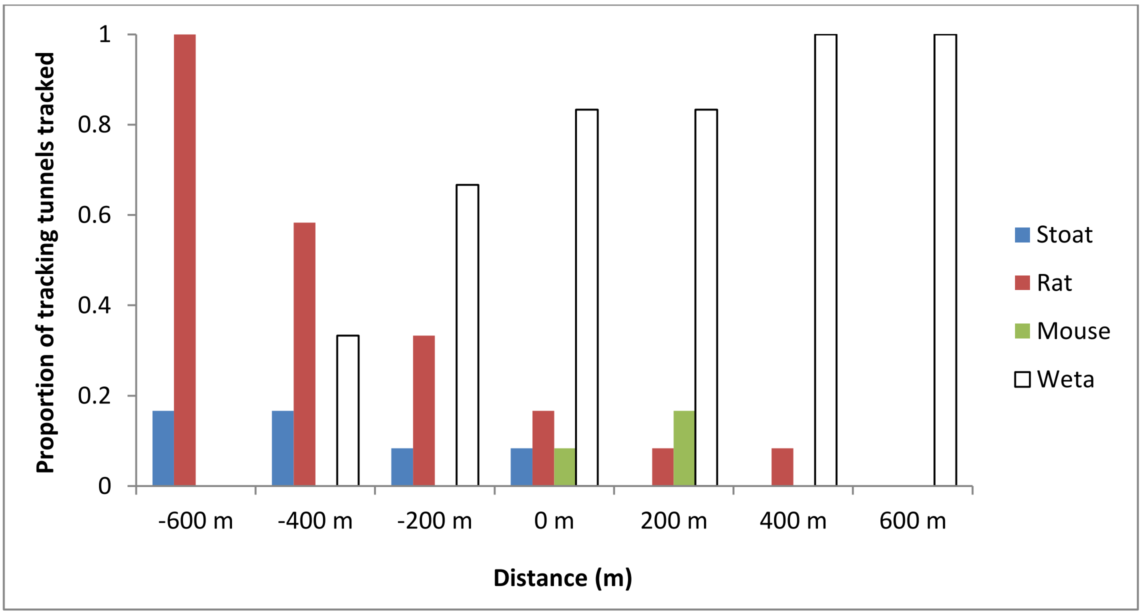


Figure 4 – Detection rates of animal taxa recorded in tracking tunnels at each 200 m interval along the 1200 m transects bisecting the border of the pest management area. For each distance level, n=12

BIRDS

Birds are heavily impacted by rodents and, particularly, by mustelids. Mammal-naïve endemic birds are the most vulnerable and most heavily impacted bird species.

Methods

- Local bird abundance and diversity was monitored using the five-minute point count technique (after Dawson & Bull, 1975)
- This technique involved standing at the centre of each monitoring station for five minutes and recording all individual birds detected, noting species and whether the bird was seen or heard
- On each sampling occasion one five-minute bird count was undertaken at each monitoring station

Results

- Over a total of 84 five minute bird counts, 11 different bird species were recorded. Of these, six (54.5%) were endemic, two (18.2%) were indigenous (i.e. native but also found elsewhere) and three (27.3%) were introduced
- Relative abundances of tui, fantail, grey warbler, tomtit and kereru all appeared to increase across the distance scale (although statistically significant relationships were found only for tui and fantail)

In general, endemic bird species tended to exhibit a positive response to the pest management area, with relative abundances increasing across the distance scale. This suggests that both edge and spill-over effects are occurring for endemic bird species at the borders of Ark in the Park.

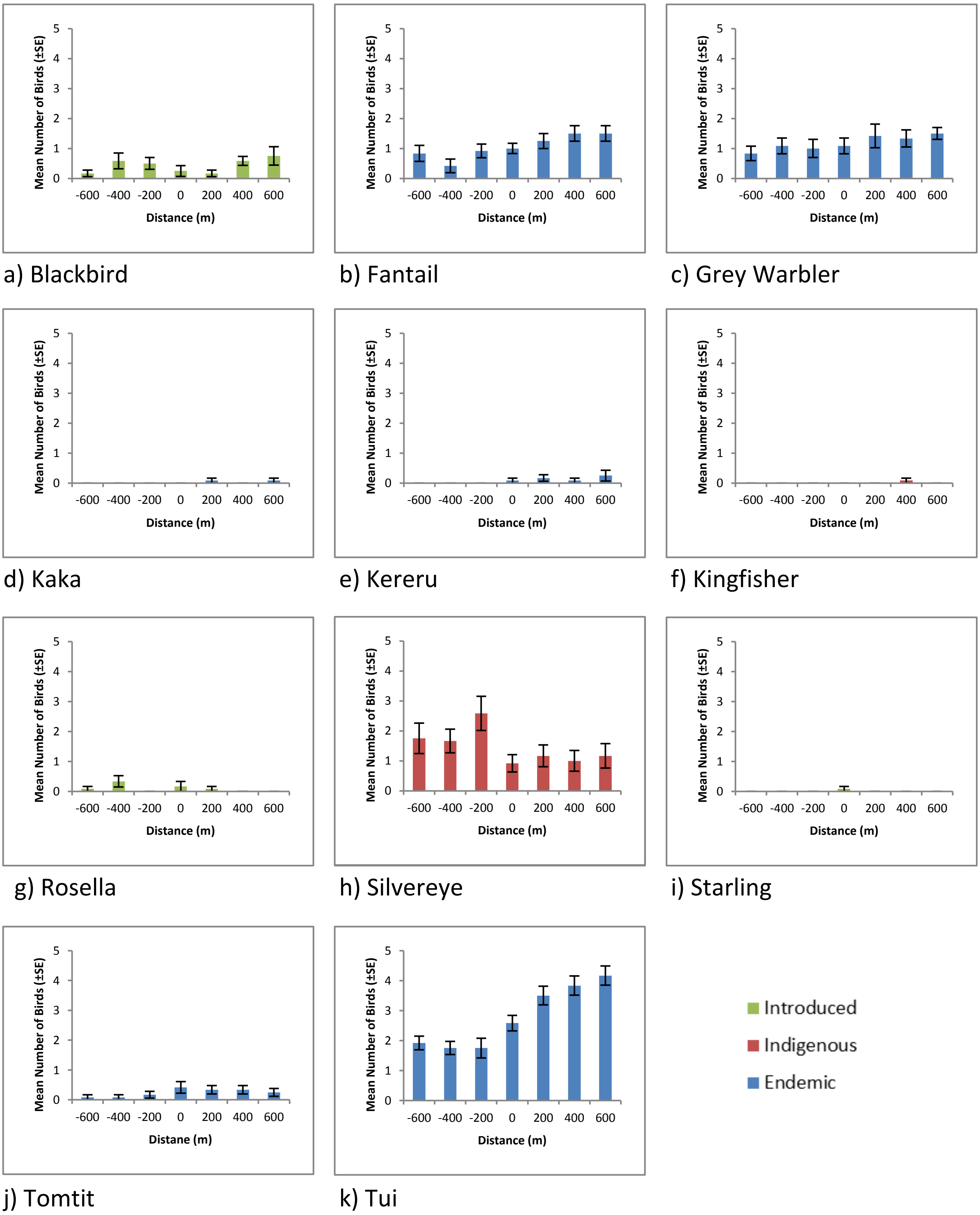


Figure 5 – Mean number of each bird species recorded at each 200 m interval along the 1200 m distance scale (±SE). For each distance level, n=12

LIZARDS

Both skinks and geckos are heavily impacted by both rodents and mustelids.

Methods

- Lizards were monitored using specially constructed artificial refuges. Two types of refuge were employed:
  - onduline artificial cover objects (ACOs) for ground-dwelling skinks (after Lettink, Cree, Norbury, & Seddon, 2008)
  - closed-cell foam covers for arboreal geckos (after Bell, 2009)
- One ACO and one foam cover were located at each monitoring station
- On monitoring occasions, equipment was manually checked for occupancy by skinks or geckos

Results

- Over a total of 84 checking occasions, for both the onduline ACOs and the closed-cell foam covers, neither skinks nor geckos were ever observed utilising the artificial refuges

Possible explanations for the lack of lizard observations include: i) that there were no lizards present to be observed; ii) that the monitoring equipment (or the way in which it was used) was inadequate in the attraction or detection of lizards; iii) that the sample size (either number of refuges or number of checking occasions) was too low to allow for the detection of any lizards; or iv) that the underlying density of lizards at Ark in the Park was simply too low to be detected by any practicable means.

Across both the ground-based ACOs and the tree trunk foam covers, it may be that the seasonality of the sampling was responsible for the lack of lizard observations. This is perhaps the most likely explanation, as lizard activity levels vary greatly with environmental fluctuations associated with season and time of year, such as temperature and precipitation (Adolph & Porter, 1993, 1996). All sampling took place between June and October of 2012, i.e. early winter to mid spring. Optimal timing for sampling of lizards is over the summer months, when higher temperatures and lower precipitation result in higher activity levels (Jones, 1986). As such, checking the ACOs and foam covers again in January or February of 2013 may have resulted in at least some level of successful lizard detection.

INVERTEBRATES

Invertebrates are heavily impacted by rodent predation, and weta in particular are known to be particularly adversely affected.

Methods

- Invertebrates were monitored using specially constructed artificial refuges. Two types of refuge were employed:
  - Simple 'weta motels' were used to monitor tree weta abundance (after Bleakley, Stringer, Robertson, & Hedderley, 2006)
  - 30 x 30 cm pine tiles were used to monitor ground invertebrate abundances (after Bowie & Frampton, 2004)
- Five weta motels and three pine tiles were located at each monitoring station
- On each monitoring occasion:
  - The proportion of refuges occupied by weta at each monitoring station was used to determine an index of weta abundance
  - The number of invertebrates counted under the pine tiles in each class or order was used as an index of soil surface invertebrate abundance and diversity

Results

- Across a total of 420 inspections of the 140 weta motels, weta were present on 131 occasions (31.2%). A statistically significant linear increase in weta motel occupancy rate was seen with increasing distance from 600 m outside to 600 m inside the pest management area
- Over a total of 252 pine square observations, 12 different invertebrate taxa were recorded. No statistically significant relationships between abundance and distance were found for any invertebrate taxon

Although the pine tiles were relatively unsuccessful, both the motel data and the incidental tracking tunnel data (Figure 4) exhibited evidence of both edge and spill-over effects occuring for weta.

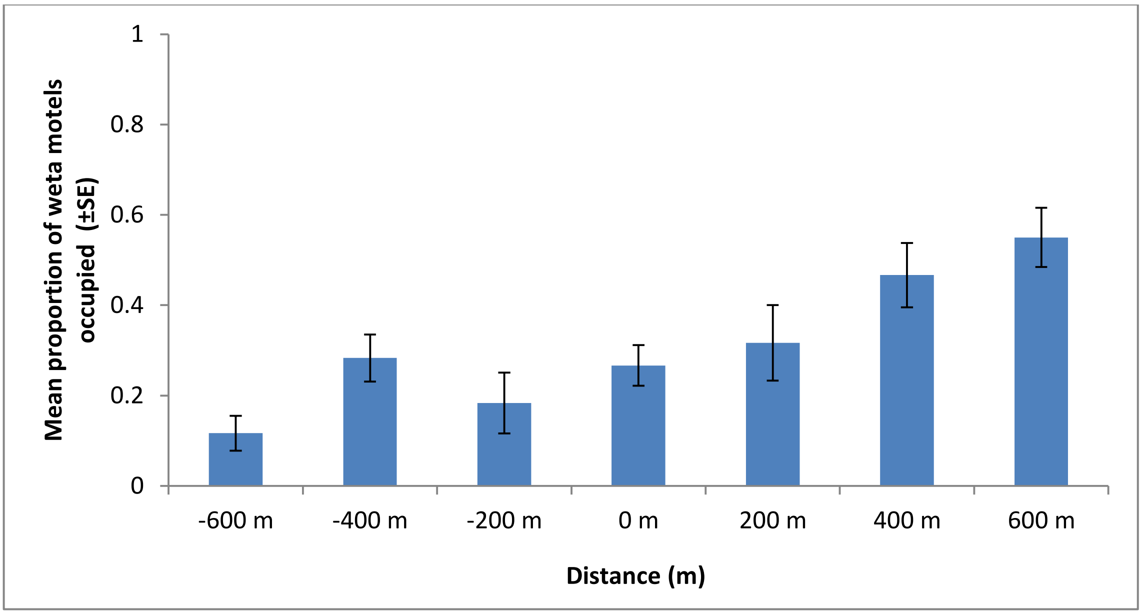


Figure 6 – Mean proportion of weta motels occupied by weta recorded at 200 m intervals along the 1200 m distance scale (±SE). For each distance level, n=12

SEEDLINGS

Rodents consume seedlings, seeds, flowers and fruits of numerous native tree species, and so relative seedling density was measured as an index for assessing the effect of rats on plants.

Methods

- Four 0.75 m^2 seedling plots were sampled per monitoring station (after section 5.7 of Hurst & Allen, 2007).
- All seedlings within a radius of 0.49 m from this centre point were counted and identified as belonging to one of four taxa; fern (pteridophyte), conifer (gymnosperm), narrowleaf (monocotyledon) or broadleaf (dicotyledon)
- For each taxon, the density of seedlings in these plots was used to generate an estimate of seedling density at each monitoring station

Results

- Over a total of 112 seedling plots, 536 dicotyledons, 237 monocotyledons, 52 gymnosperms and 61 pteridophytes were counted
- Statistically significant linear relationships were found between dicotyledon and monocotyledon abundances with increasing distance
- Neither gymnosperms nor pteridophytes showed any particular pattern in count frequency with relation to the distance scale

Evidence was found in favour of both edge and spill-over effects occuring for both broadleaves and narrowleaves, but not for conifers or ferns. This makes sense as broadleaf seeds and seedlings are known to be favoured targets for rat predation, as are nikau seeds, which was by far the most commonly recorded narrowleaf seedling species. On the other hand, conifer seeds are not known to be heavily targeted by rat predation and ferns produce spores rather than seeds.

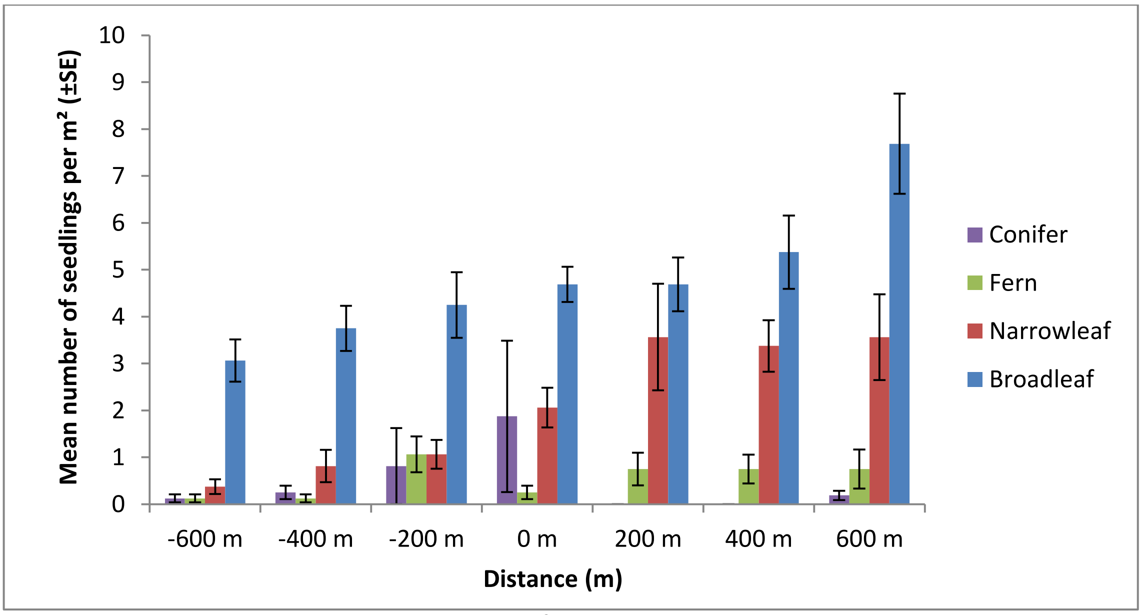


Figure 7 – Mean number of seedlings per m^2 in each plant taxon recorded at 200 m intervals along the 1200 m distance scale (±SE). For each distance level, n=12

CONCLUSIONS

The overall aim of this study was to determine the spatial relationship between the management of mammalian predator pests and its outcomes. The edge and spill-over effects investigated constitute opposite but non-exclusive spatial effects which alter the spatial extent of the outcomes of this pest management relative to the spatial extent to which the management action is applied. For both the pests themselves, and for all biodiversity indices (except lizards), at least some species or taxa exhibited evidence of both edge and spill-over effects. For some taxa, edge and spill-over effects were observed concurrently.

The overall conclusion from these observations is that the border of a pest management area is only an absolute edge in the sense that it is where the management action itself ends. In terms of results and outcomes, the edge is much more diffuse. It represents a zone of transition between the interior of the pest management area, which receives the highest level of biodiversity benefit, and an exterior point where proximity to the pest management area no longer has a significant influence on biodiversity. This refutes the null hypothesis that the spatial extent of applied pest management is equal to the spatial extent of its results and outcomes.

Evidence was gained from this study of both edge and spill-over effects occurring in relation to a pest management border. This provides information useful for optimising the effectiveness and cost effectiveness of site-based pest management, both at Ark in the Park and elsewhere.

The evidence of spill-over effects occurring for many taxa is also suggestive that localised pest management areas can enhance landscape connectivity and therefore promote metapopulation dynamics. This could lead to greater resilience of native biodiversity at the level of the landscape, and therefore more beneficial conservation outcomes as a whole.

MANAGEMENT RECOMMENDATIONS

- Monitoring for lizards using the same methodology and equipment as this study should be repeated over the summer months, when lizards are more active and more likely to be detected. Doing this will determine whether these methods are adequate for ongoing (possibly annual) lizard monitoring at Ark in the Park. If successful enough, this may also provide an indication of the spatial extent of edge and spill-over effects for this taxon.
- Alternatively, tracking tunnels should be baited on some occasions with honey (van Winkel, 2008) in order to at least gain presence/absence data for lizards inside and outside the pest management area, and perhaps some indication of the spatial effects.
- Weta motels are recommended over tracking tunnels for the monitoring of weta populations. This is because the weta motel methodology used in this study returns a proportional response of relative abundance rather than a simple presence/absence recording, allowing for a finer resolution of observation. Additionally, weta motels are likely to be less influenced by a behavioural response of weta to altered pest densities. Weta are known to avoid movement across open ground at higher pest densities (Rufaut & Gibbs, 2003). Furthermore, there is competition between rodents and weta over the peanut butter attractant used in the tracking tunnels, so high rodent densities may supress tracking tunnel usage by weta (Watts, Armstrong, Innes, & Thornburrow, 2011). However, tracking tunnels are already in use for pest monitoring. Whilst bearing these caveats in mind, incidental weta data should still be analysed to provide further information on weta populations.
- Weta motels are recommended over pine squares for the monitoring of invertebrates in general. Weta motels proved very successful in determining relative levels of weta abundance, including significant observations across the spatial scale of the transects. The pine squares, on the other hand, were less successful. Only a few taxa exhibited significant results, and even then these were limited to comparisons of the inside and outside of the pest management area rather than the spatial scale of the transects.
- At Ark in the Park, and pest management sites in general, edge and spill-over effects should be quantified for various taxa of interest in order to assess whether a buffer zone of pest management is necessary, or whether a smaller pest management area with a halo zone is adequate to meet the targeted goals of the site.

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