A critical evaluation of the spatiotemporal patterns of trapping in Barnett Park

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Table of contents

Executive summary

Barnett Park is a 45-hectare reserve located in Redcliffs, Christchurch. This park faces significant ecological pressure from invasive pests, including mice, rats, possums, and mustelids. These predators have historically contributed to the severe decline of native bird populations in New Zealand. This project works in collaboration with our community partner Ashley Rule and Predator Free Redcliffs, aimed to evaluate the spatiotemporal patterns of Barnett Park's trapping programme and identify strategies to inform long-term restoration decisions.

Data recorded on TrapNZ was cleaned, mapped, and analysed using Excel and ArcGIS to identify spatial hotspots and trends in catch rates across varied species. Results revealed strong spatial clustering in heavily vegetated areas, particularly around large rock outcrops providing pest shelter. Temporal patterns were less evident due to the limited two-year dataset, though higher capture rates were observed as the trapping programme continues to be established.

Our analysis suggests that focusing trapping efforts in identified hotspots and expanding coverage in under-represented areas will improve long-term outcomes. Continued monitoring along with sustained community involvement will be critical to ensure the programme's long-term success. Effective pest control in Barnett Park will create conditions for native flora and fauna populations to recover and thrive, making this park a potential model for other future ecological restorations.

Introduction

Stable bird populations are an important component of successful functioning ecosystems. They support the establishment and continued growth of a number of different species of flora through seed dispersal. About 70% of woody species like trees and shrubs in particular rely on vertebrates for dispersal, most commonly birds. (Clout & Hay. 1989)

Mammalian pests have threatened bird populations since their introduction (Blackwell. 2005). Due to our native birds having no experience with these pests, they are not adapted to avoid predation or compete with them (Dowding & Murphy. 2001; O'Donnell, et al. 2015; O'Donnell, et al. 2017). This allows pest populations to thrive and grow to exponential levels. Nowadays there is almost no place in the country that hasn't been invaded by pests, and Barnett Park is no exception.

However, the removal of pests, such as rats and possums, has been shown to lead to significant increases in native bird populations. By reducing predation on eggs and chicks, more nests are successful, allowing bird numbers to recover and grow over time. (Fea et al. 2021). In areas where pest control is actively carried out, species become more abundant, while nearby untreated areas often show little or no improvement (Innes, et al. 2004). This highlights how effective pest management can be in supporting native wildlife and restoring ecosystem balance.

Barnett Park, located in Christchurch's coastal suburb of Redcliffs, has recently become the recipient of both council and community restoration efforts. This includes a range of different initiatives, for example, the reduction in invasive pest populations and native tree planting. The park provides an ideal environment for possums, rats, and mustelids, and their populations have grown rapidly, leading to a decline in native bird numbers.

To address this issue, beginning in January 2021, a local volunteer-driven trapping group implemented its project to eradicate different pest populations. With the goal of managing pest populations and eventually restoring bird life in the park. This report works with Ashley Rule from the Redcliffs Resident Association to evaluate the effectiveness of their current trapping program.

We aim to answer the question ‘How can we use the spatiotemporal patterns of Barnett park’s trapping program to inform its long-term success and help eventually restore the park to a thriving native ecosystem.’ We will do this by assessing the background research on relevant topics associated with our question, followed by an outline of the methods used, presentation of results, and a discussion informed by these findings. By the end of the report, we will be able to provide future recommendations for Ashley and his team and finish by concluding the findings and the opportunities our research will have for future projects.

Theory and concepts

The ecology of invasive mammalian species is important to consider when evaluating their impacts during eradication efforts. Knowing how the pests got here can help avoid future invasions. Generalist species make more successful invaders as they are able to adapt to a wide range of environments (Soto, et al. 2024). Intraspecific aggression amongst invasive species also contributes to their success (Holway & Suarez. 1999). These are traits shared by all the species that plague Barnett Park’s natural biodiversity. Habitats such as the dense brush at Barnett Park are especially great habitats for possums and rats, making them the dominant species in many areas (King, C. M, et al. 2011; Patterson, et al. 2021). Despite the dominance of pests, some bird species are adapting to avoid predation, by changing their nesting times and/or location to avoid peaks in predator abundance (Massaro, et al. 2008). However, this is a slow process, meaning there is still a need for human intervention.

When protecting an area from mammalian pests, a predator-proof fence can be effective in cultivating an environment that allows native birds to thrive (Reardon, et al. 2012). However, as this is not always economically viable, a landscape-scale trapping network of 2100 ha that suppressed pest populations was found to be just as effective as a predator-proof fence in helping native species recover in Eastern Otago (Reardon, et. al., 2012). This is relevant to Barnett Park's long-term future with other Port Hills and Banks Peninsula trapping groups, which could eventually link up and form a large-scale trapping network protecting a regenerated Banks Peninsula.

A challenge that comes up when operating a trapping program is trap shyness, which occurs once a large group of more curious individuals is gone, leaving behind a more careful group. One way that this can be combated is by the use of a variety of different lures. This can make those wary predators that have been difficult to catch more likely to enter a trap (Vattiato et al., 2024). Examples of different lure options could be peanut butter, smooth blue aniseed lure, Nutella or even meat.

To some, pest trapping can be a controversial topic and can often cause pushbacks for trapping programmes. Therefore, public engagement is crucial for the long-term success of Barnett Park's trapping programme. Based on the literature, public engagement comes down to four factors: motivation, barriers, practices and routines, and volunteer retention. Motivation often stems from environmental concern and community pride, community members want to do their part to better their community. Another motivation is social connection, as trapping can be a social activity bringing communities closer (Gerolemou, 2024). On the contrary, barriers stop involvement. These are lack of time and motivation, people are busy with other things so trapping gets neglected (Woolley, 2021). Practices and routines embed trapping into people's daily lives so it becomes a part of their routine instead of a chore which helps sustain involvement (Stronge, 2025). Lastly, volunteer retention keeps volunteers engaged over time through community building. This means good communication between the trappers and a shared end goal (Gerolemou, 2024; Stronge, 2025).

Methods

Data was collected through the TrapNZ app by our community partner, which eliminated the need for us to do any physical data collection. Ashley and his group of volunteers regularly set out and visit every trap along the line. When the traps are reset, if there has been a catch, the specific species caught is logged for that specific trap. A variety of trap types were used, including DOC 150s, DOC 200s, Trapinators, Victors, and 'Flipping Timmys', which all have different species that they specialise in (Figure 1). The data also included date and time checked, as well as the coordinates of each trap.

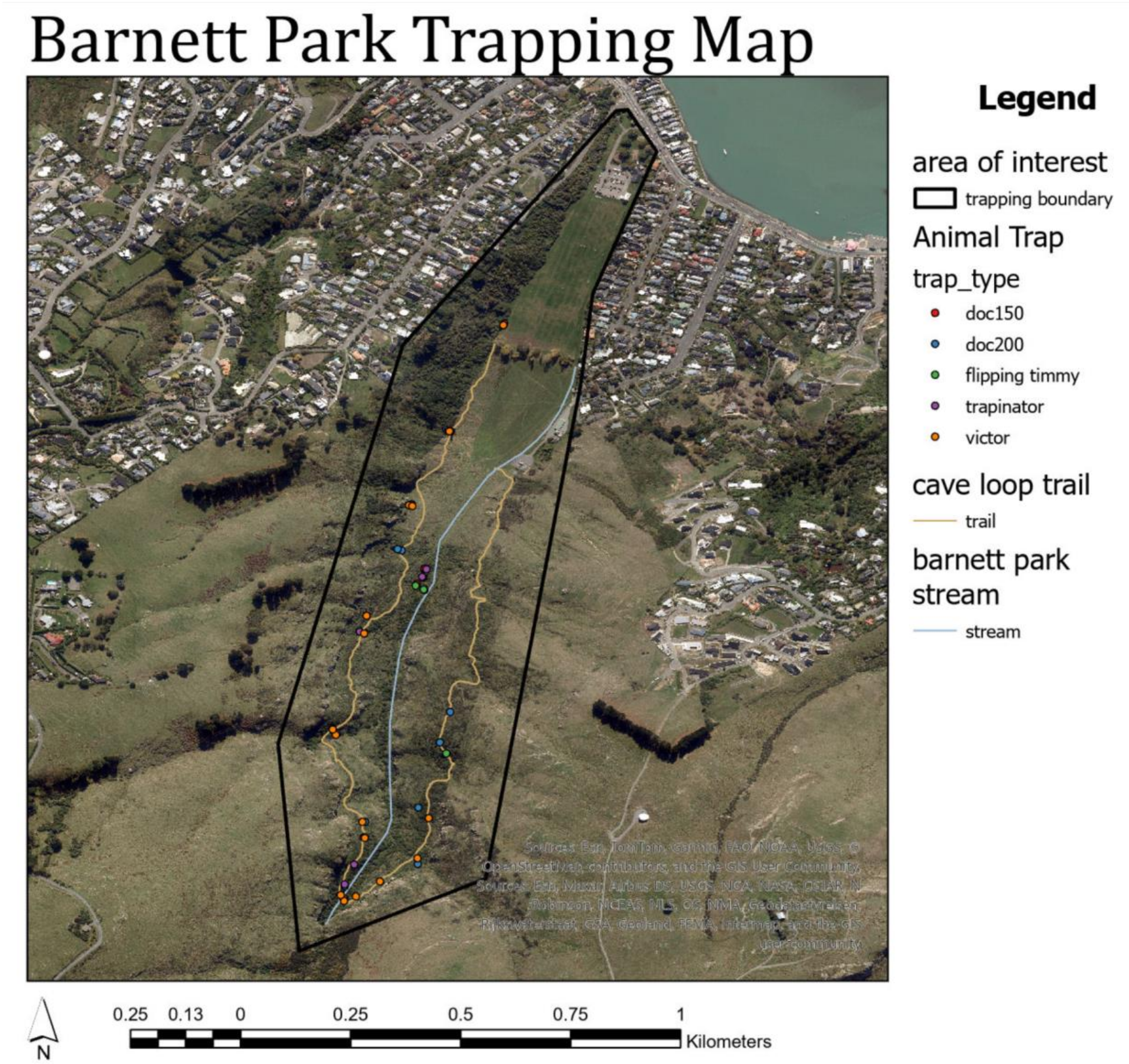

Figure 1: Map of Barnett Park containing trapping boundary, cave trail, stream and traps by trap type.

Our first step was to clean the data, which involved removing variables that were unnecessary for the analysis, such as the name of the trapper who checked the trap. The relevant variables, such as total catches and coordinates, were condensed into totals for each trap to be used in the making of the GIS maps, allowing spatial catch trends to be investigated. To investigate temporal trends, catch data and data were made into a spreadsheet that included every data entry for all 44 traps. Each trap's dataset was then split into half year periods, starting in early 2023 when the first traps were established, and including the incomplete second half of 2025. This data was used to produce a stacked column graph that shows the total catches of each species over time.

For the maps, we used ArcGIS Pro software. Overview photos of Barnett Park sourced from Land Information New Zealand (LINZ) were added along with the trap data using the XY Table to Point tool. A polygon representing the trapping area from TrapNZ was added. The cave loop trail is manually drawn using the overview photo as a reference. The final layer contains the intermittent stream that runs through the middle of the park, sourced from NZ River Centrelines data on the LINZ website. Everything was compiled into a map, as shown in Figure 1.

To get a better understanding of where trapping has been most successful in the park, we used the Kernel Density tool to create six maps using catch numbers of possums, rats, mice, mustelids, hedgehogs and all pests.

To identify areas in the park where pest activity is expected to occur, we used the weighted overlay tool. To create the weighted overlay map, we used three raster layers, representing different factors that contribute to high pest activity. The first layer we used represents the presence of brush which we got from NZ Topo50 Vegetation Data sourced from LINZ. The second layer we used contained gullies which were obtained by delineating a DEM sourced from LINZ using the Fill, Flow Direction, Flow Accumulation and Derive Stream as Line tools from the Hydrology toolkit. The gullies contain denser vegetation compared to the higher elevation areas. The methodology for this step was informed by a previous GEOG309 project focusing on trapping in the Port Hills (Haque et al., 2024). The final layer that will be used for the weighted raster contains the Barnett Park stream mentioned earlier. Each layer was cut to fit into the boundary layer and converted into a raster. The raster layers were reclassified using a scale between 1 (no significance) and 5 (high significance) based on proximity to the relevant feature and weighted. The vegetation data was weighted at 60 percent, gullies at 30 percent, and the stream at 10 percent. Additionally, the areas containing parking lots, sporting grounds and the dog park were excluded on account of high human/pet activity. This was done by copying the area of interest polygon layer and splitting the exclusion area. Finally, we converted the raster into a polygon layer and selected the area with the highest pest activity. A polygon layer was created using the selected area.

Results

The maps produced below (Figure 2, 3, 4, 5, 6, 7) show that hotspots vary spatially from species to species, but the main hotspot taking all catches into account (Figure 2) is close to the main cave, in a relatively highly vegetated area with a high density of traps compared to the rest of the park. Rat and mustelid catch hotspots occur in similar places. The mustelid hotspot is located uphill from the centre line (Figure 3), with the rat hotspot overlapping the mustelids and including the centre line (Figure 4). Mapping catch data is useful for seeing which traps are catching more than others, and which areas catch more of each species. However, it does not accurately represent population density, so any attempt to draw conclusions about populations should only be treated as suggestions. Possums have a hotspot near the main cave, but also have significant hotspots near the climber's cave and the centre line (Figure 5). Mouse catches are widely distributed across the trapping area, being caught in large numbers wherever there are traps (Figure 6). Hedgehogs, while considered bycatch, are still pests and are often caught in the traps, with hotspots on the centre line and northeast of the main cave (Figure 7).

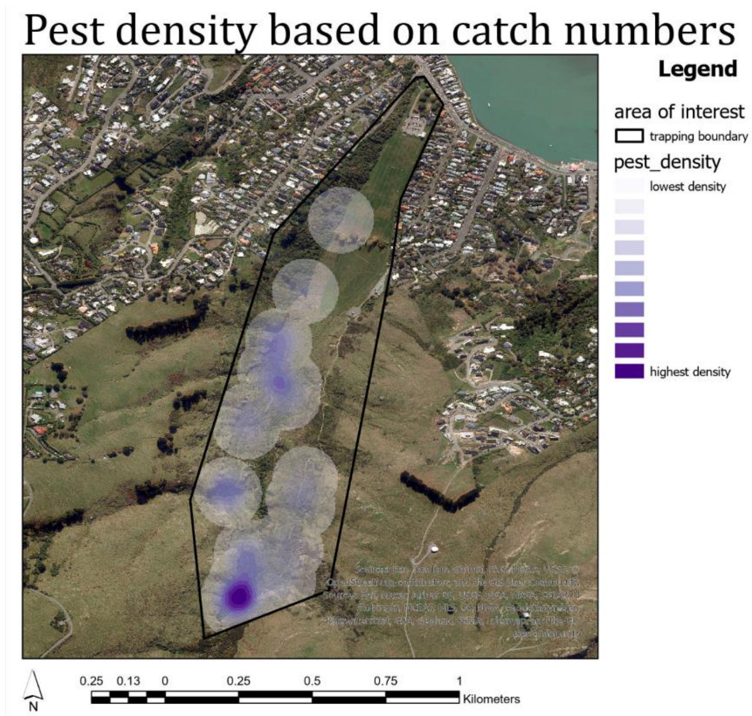

Figure 2: Kernel density map of all pests by catch amount

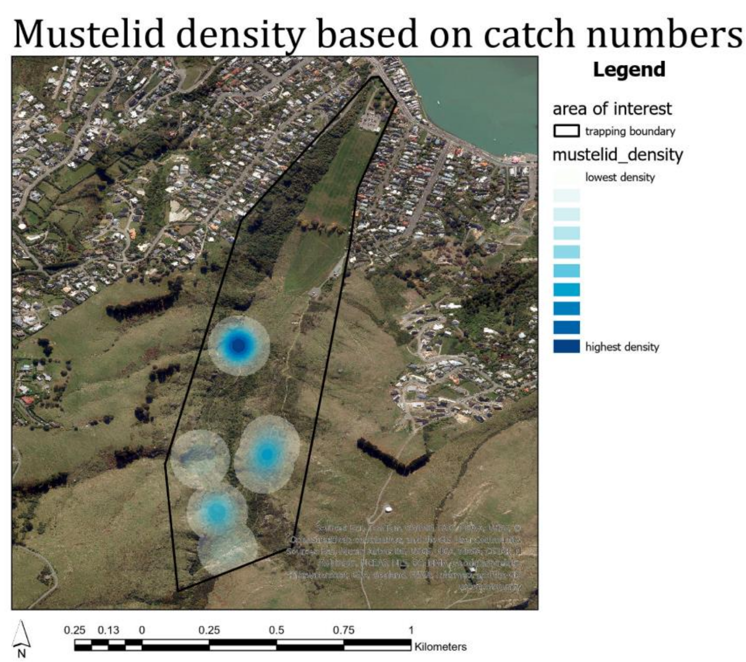

Figure 3: Kernel density map of mustelids by catch numbers

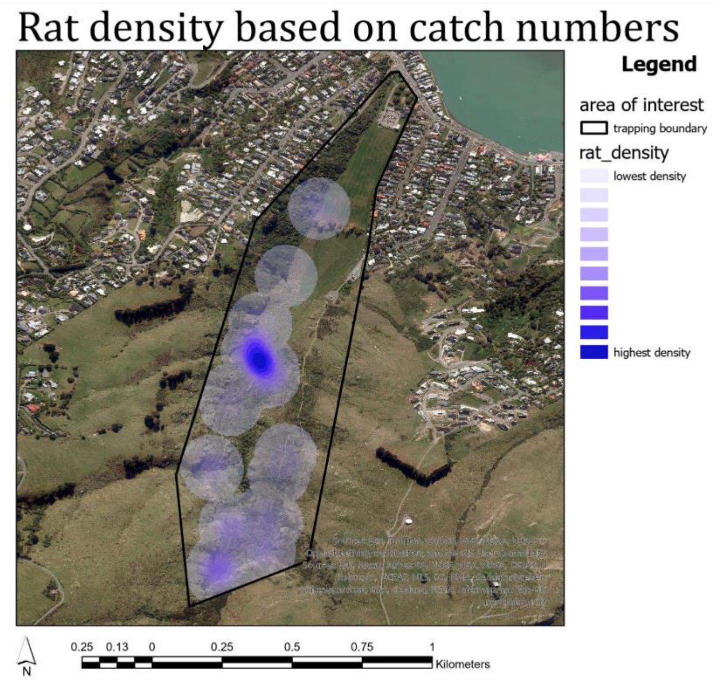

Figure 4: Kernel density map of rats by catch numbers

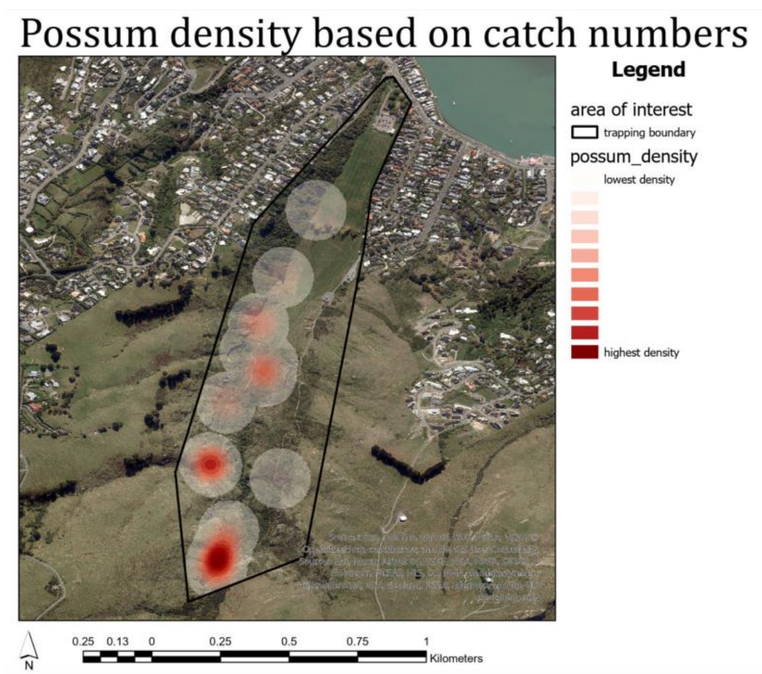

Figure 5: Kernel density map of possums by catch numbers

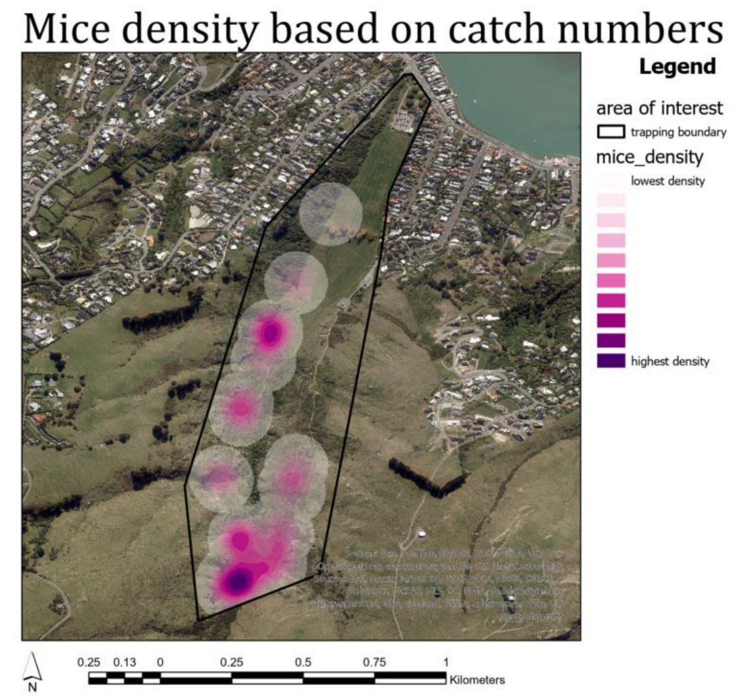

Figure 6: Kernel density map of mice by catch numbers

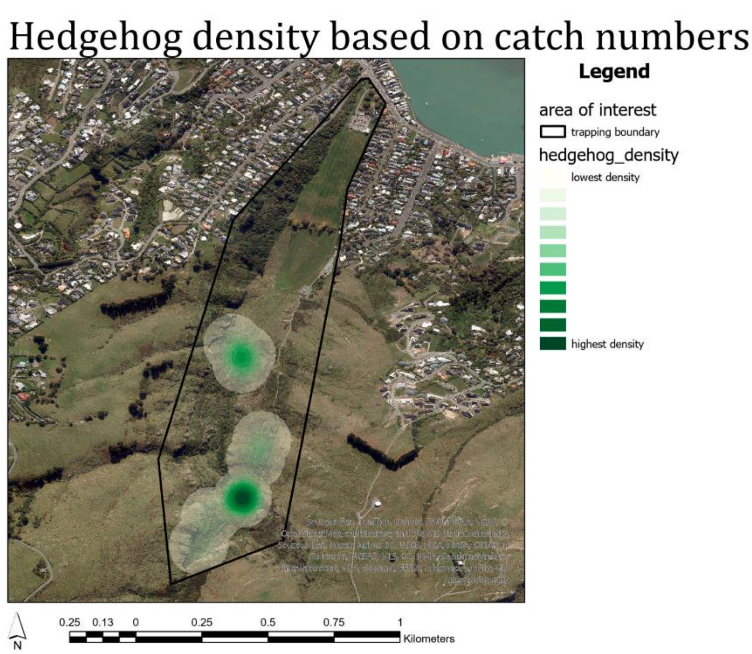

Figure 7: Kernel density map of hedgehogs based on catch numbers

The temporal graph (Figure 8) shows an upward trend in the number of catches, with 2025 on track to being the most successful year yet. This graph answers our community partner's original question, that the trapping program has been successful in trapping a lot of pests and shows no signs of slowing down. Additionally, this graph reveals an unusual pattern; when the possum catches are high, the mouse catches tend to be low and vice versa. This data is not enough to draw conclusions about this relationship, so further observation and research is required to investigate the link and determine whether it is a coincidence or not.

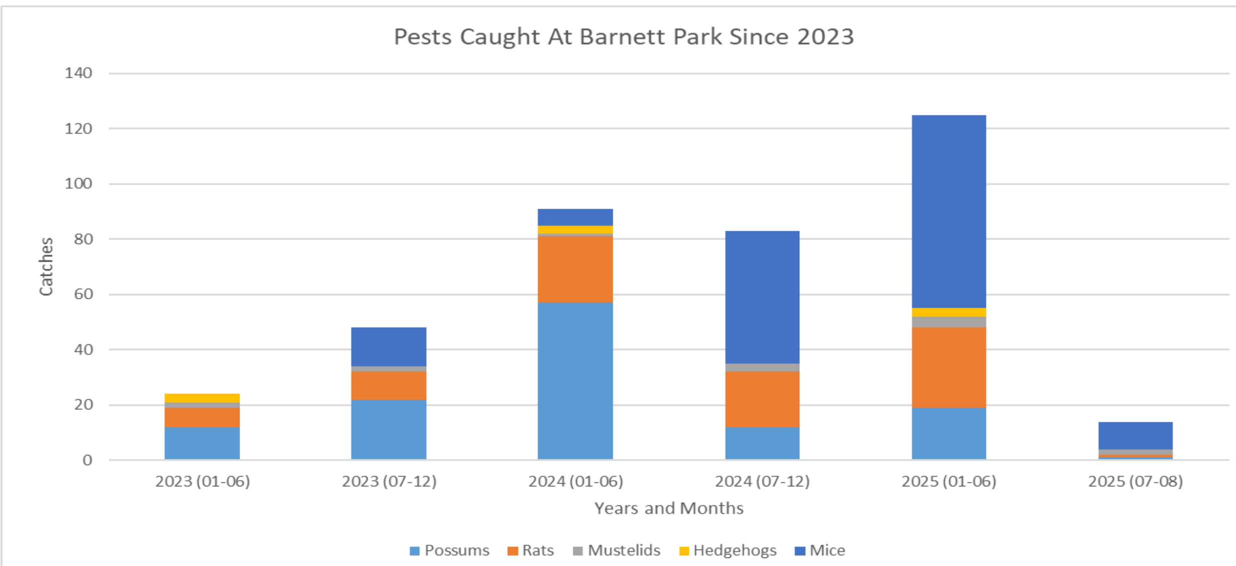

Figure 8: Pests Caught at Barnett Park Since 2023

The maps below (Figure 9 & 10) show that the centre of the park containing the centre line traps and the area around the climbing cave are suitable environments for pests. The brush polygon data that was used for the weighted map is outdated and does not represent the current vegetation cover in Barnett Park. The area of the park close to the main cave is not contained in the vegetation polygon despite containing dense vegetation cover. However, this area has an abundance of traps already. Further trapping endeavours would be better focused elsewhere.

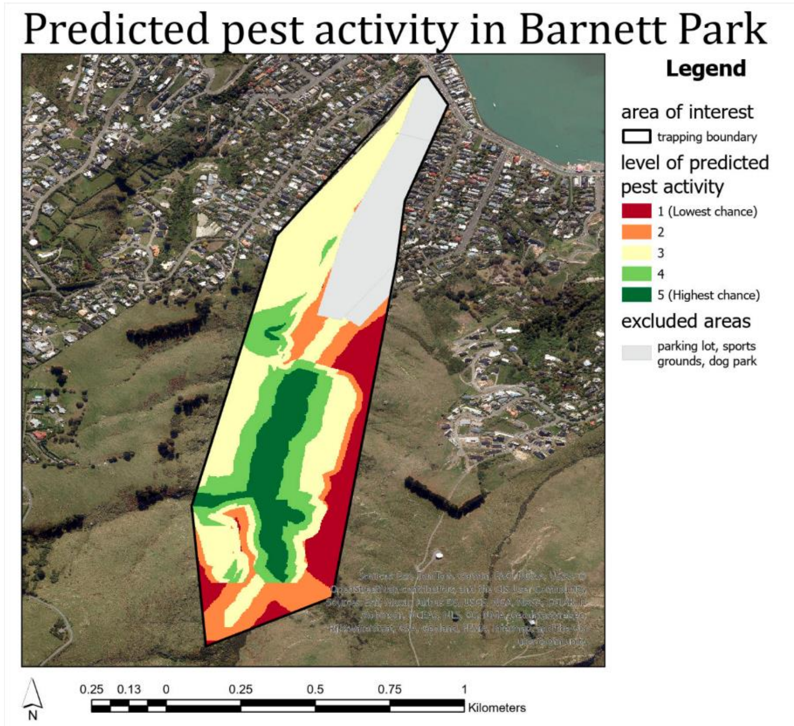

Figure 9: Weighted raster map depicting areas where pest activity is predicted

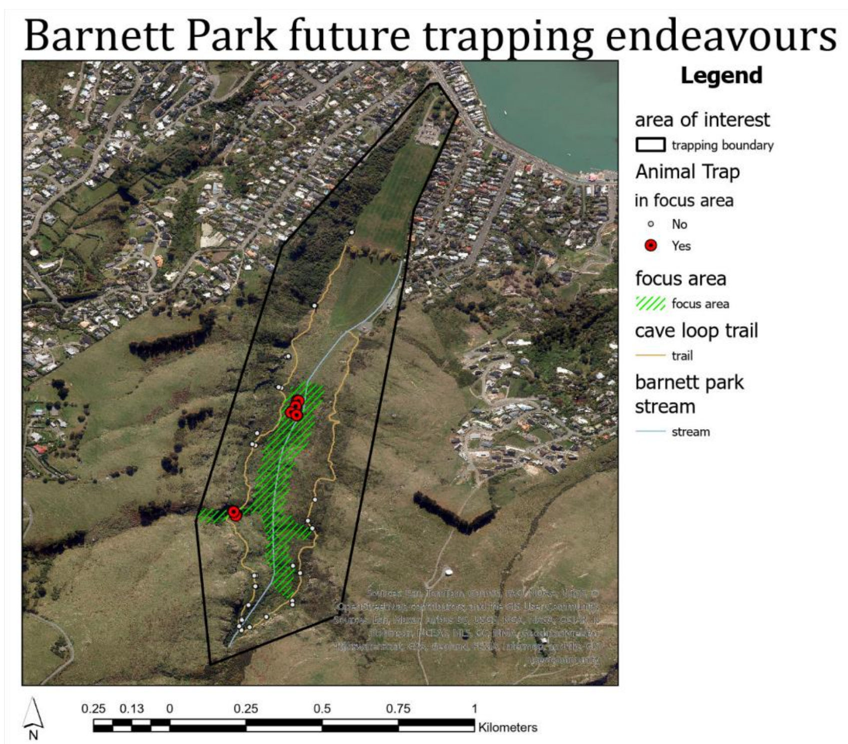

Figure 10: Map depicting area best suited for trapping

Discussion

The spatiotemporal analysis of Barnett Park's trapping data reveals visible patterns that can inform both ecological interpretation and management optimisation. Kernel Density estimation and a weighted overlay surface show clusters in two main areas; the centre line and the cave/outcrop complex. These areas coincide with high vegetation density, soil moisture, and areas suitable to build refuge for pests. These factors are consistently associated with elevated small-mammal abundance in New Zealand ecosystems (King et al, 2011; Innes et al, 2015). These conditions provide foraging opportunities and safety from other predators, partially explaining the clustering of catches in these microhabitats.

Ecological Interpretation – Spatial Trends

The central line and creek hotspot corresponds with ecological literature around the habitat preferences of *Rattus rattus* (ship rat) *and Mustela furo* (mustelids), both of which favour riparian vegetation and dense cover that offer food, water and concealment (Seddon et al, 2005; Efford et al., 2006). The overlapping occurrence of rat and mustelid catches indicates a shared resource chain and predation within Barnett Park's moist and vegetated centre line. This is well documented in other urban reserves; generally, pests exploit overlapping resource bases created by scattered habitats (Ruscoe et al., 2011).

In contrast, *Trichosurus vulpecula* (brushtail possums) displayed a broader spatial distribution, which is consistent with their adaptive nature and the varied vegetation types across the park (Patternson et al, 2021). In (Figure 5) this pattern reflects possums' ability to exploit resources from canopy to ground. The presence of multiple cluster zones across the map highlights the need for trap diversity and adaptive placement rather than uniform spacing.

Additionally, distinguishing trap performance by type in future spatial analyses would make for stronger interpretation. DOC200s and Trapinators are more effective against larger species such as possums and mustelids, while Victor and DOC150 traps are better suited to small rodents (Gilles, 2013). Ensuring that different trap types are present in clusters whenever possible will mean that multiple pest species can be caught in the same area. However, not all habitats will be suitable for this, as a DOC 200 will catch mustelids in a field, while a Trapinator is unlikely to catch possums there.

Temporal Trend Analysis

A temporal analysis of trapping data demonstrates that trapping success evolved alongside network expansion (Figure 8). The initial low capture numbers of 2023 likely reflect immature and incomplete spatial coverage, whereas the subsequent rise in 2024-2025 indicates growing trap establishment. Seasonality in catches could occur, as literature suggests that it should as season changes resource availability (Choquenot & Parkes, 2001), but it is difficult to tell in this dataset. There is a slight reduction in catches in the second half of 2024, but the other years cannot be considered so a conclusion cannot be made without more data. Interpreting the data as the population increasing may be misleading, as similar patterns have been observed in other long-term pest control programs; Where increased captures often mark "functional maturity" of trap systems rather than biological growth in pest populations (Sweetapple et al, 2011). The sustained level of catches over the past two years of data suggests that pest populations within Barnett Park may reach an equilibrium; where capture rates decline locally but are replenished through immigration from neighbouring habitats (Ruscoe et al, 2013).

Complete eradication within Barnett Park is improbable, with pests moving across the landscape to find suitable microhabitats (Johnstone et al, 2023). Since eradication is not achievable, we can aim to diminish pest densities to a desirable level below ecological impact thresholds (Hugget, et al. 2005; Norbury, et al. 2015). In order to infer desirable levels, we have to know what densities of pests have the most impact. To set a threshold, we must recognise the relationship between pest density and viability of the threatened populations (Choquenot & Parkes, 2001). Each pest species has a different density-impact function for different threatened species depending on the closeness of the relationship they have (Norbury, et al. 2015). For example, a pest species that predates a threatened species will have a larger impact on that species than a pest species that has little interaction with the threatened species. Studies argue pest management is most effective when it reduces populations to levels that allow threatened species to grow rather than attempting the improbable goal of total eradication (Choquenot et al, 2003). When setting the threshold, it is important to consider the possibility of interspecific competition that may form between regenerating bird species. For example, often smaller species like the fantail or grey warbler can struggle and be outcompeted by their larger counterparts like the kaka and kereru (Norbury, et al 2015; Fea, et al. 2021).

Another key finding observed in the dataset is the inverse relationship between possum and mouse catches. Between early 2023 and late 2024, possum catches increased from 18 to 41, while mouse catches dropped from 42 to 24. This suggests a relationship possibly due to competitive displacement between large and small omnivore mammals. This has been reported in New Zealand forests, where reductions in brushtail possum densities can lead to temporary increases in rodent abundance due to decreased competition for food resources and nesting sites (Rusecoe et al, 2011). However, alternative explanations such as trap selectivity and trap fatigue cannot be excluded.

Continuing monitoring for long-term datasets would be needed to verify whether this pattern reflects ecological competition or a short-term trend due to trap performance.

Linking the temporal analysis to ecological trends remains the next research step. Studies demonstrate that increased bird sightings often take time to emerge in relation to pest suppression by two to three years. (Innes et al, 2024). Although there has been a measured increase in bird sightings in Barnett Park recently, integrating future bird-count data with ongoing TrapNZ monitoring would provide a holistic measure of ecosystem recovery within the park. (A. Rule, personal communication, 12 September, 2025)

Together these spatiotemporal trends indicate that Barnett Park's trap system is effectively suppressing pest populations while showing room for opportunities of optimisation through spatial weighting and species-specific targeting.

Limitations and Considerations

While the findings from Barnett Park's TrapNZ dataset provide valuable insight into pest distribution and trapping efficiency, there are limitations to acknowledge when interpreting results. The most significant limitation is the short span of the dataset, with only two years of data which restricts the ability to infer long-term population trends and dynamics. Pest species such as ship rats and brushtail possums exhibit strong seasonal fluctuations due to breeding seasons and food availability (Ruscoe et al, 2011; Choquenot et al, 2001). Therefore, a multiyear dataset is required to capture genuine ecological dynamics rather than short-term variability.

The use of Kernel Density maps provides a useful visual representation of activity hotspots; however, its accuracy was constrained by the age of the datasets used. The satellite and vegetation layers obtained from LINZ and NZ Topo50 sources used are older aerial imagery and do not reflect recent changes in the vegetation cover around Barnett Park. As a result, the maps underrepresent new shrub or canopy growth since trapping began, which lead to inaccurate weighting of high-risk pest areas. This is significant because pest distribution is strongly tied to fine-scale habitat features such as ground cover and foliage density. Including recent satellite imagery or drone-based LiDAR imagery would mean better spatial precision and allow for more accurate interpretation of pest-habitat relationships.

Another constraint relates to the mechanical reliability and behavioural interactions with the trapping devices. Unrecorded captures can introduce bias into the dataset, leading to under-estimation of pest captures. In Barnett Park and related field studies have shown that smaller pests can remove bait without triggering traps, in particular with faulty traps that become less sensitive due to wear, moisture build up and debris accumulation (Vattiato et al, 2024; Gillies et al, 2013). This is called "trap fatigue" which reduces trap efficiency and, over time, can distort spatial and temporal trends in data. To mitigate these issues, maintenance and refurbishment of older traps are essential to suppress pest populations. Continuing trap checks or incorporating trail cameras in future can provide a more accurate representation of pest captures ensuring data reliability.

Despite these limitations, there are evident patterns showing success in the trapping program. Spatially, pest activity is concentrated in densely vegetated parts, particularly along the creek line and around the large outcrops, which are consistent with similar findings. (Hooker et al., 2005). Temporally, captures have risen since 2023, showing both the rollout of more traps and improved placement knowledge. The converse trend between possum and mouse captures suggests potential competitive displacement (Ruscoe et al, 2011) though further long-term research is required to confirm this relationship. Overall, these results indicate that Barnett Park's trapping program is achieving positive outcomes in pest population suppression. However, to ensure long-term restoration success, further monitoring should continue to measure the growth of native biodiversity.

Future Recommendations

Future work in Barnett Park should focus on improving both the ecological targeting and operational maintenance of the trapping network. Firstly, increasing trap density in vegetated outcrops, particularly around the climbing cave and along the central creek, will hopefully thin populations in areas where pest abundance is highest. These locations provide moisture, shelter and vegetation cover, which is ideal for habitat conditions for our targeted species; these represent priority zones for continued control.

Building community participation will also be essential for long-term success. Hosting community trapping days targeting local schools and the neighbouring community can foster environmental stewardship and encourage families to get involved with their children to sustain volunteers in the long term. Complementing this is incorporating clear signage about the trapping programme around high foot-traffic areas, which can raise awareness and highlight conservation progress with the potential to attract new volunteers or funding.

If trap shyness is encountered, traps that haven't caught anything in a while should be investigated and moved if necessary, which is work that could be given to future student groups. Additionally, using a variety of lures could be explored as an option, such as experimenting with changing lures at random to see if it increases trap chance.

Future data analysis would be more useful with some monitoring data, so that population density could be accurately determined. While this may not be feasible with a small team, if the resources and personnel become available, annual monitoring would be very helpful to stay on top of understanding where pests are as the vegetation cover of Barnett Park evolves.

Lastly, continued TrapNZ analysis from the trapping program, with future support from GEOG309 projects, will help identify long-term patterns and maintain Barnett Park's goal for pest eradication and restoration of native biodiversity.

Conclusion

The trapping program at Barnett Park is still in its infancy, so it is therefore difficult to pull clear patterns from the data to determine how successful it has been. However, it is safe to say that they have been successful in building an effective trap line that is actively catching pests which can be expanded upon when their means allow for it. Despite not having an optimal amount of data some conclusions can still be drawn. Catch density is highest near the main cave, likely due to the vegetation being hospitable to pests there, but also because the density of traps is high there. We recommend that the trapping group utilises future GEOG309 groups as they collect more data and continue to expand the network where useful and within their means. Future groups can investigate the inverse relationship between mouse and possum catches if it continues to show in the data, as well as looking at traps that haven't caught anything for a while and considering if they should be moved or use a different lure. Occasional monitoring would be useful to observe what the population density is, especially as the vegetation cover develops as a result of planting efforts. Barnett Park will change drastically over the next decade as it regenerates and will become a more habitable environment for pests as well as natives, so staying on top of the trapping is going to be vital moving forward.

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