BEFORE	the Independent Hearing Panel appointed by the Hamilton City Council
UNDER	the Resource Management Act 1991
And	
IN THE MATTER OF	Proposed Plan Change 5 – Peacocke Structure Plan
BY	Hamilton City Council

STATEMENT OF EVIDENCE OF MOIRA ANNE PRYDE

On behalf of the

DIRECTOR-GENERAL OF CONSERVATION / TE TUMUAKI AHUREI

SUBMISSION 38 FS013

BAT ECOLOGY

Dated: 16 September 2022

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1. INTRODUCTION

1.1. My name is Moira Anne Pryde

1.2. I am a Technical Advisor in the Threatened Species Unit with the Department of Conservation (DOC). I have been in this role since 2005 and have worked for DOC since 1997. My current role is wide ranging but has largely focused on forest birds and bats and the impacts predators have on these fauna as well as on developing conservation recommendations to reverse population declines. An example is in the Eglinton Valley, a long-term study investigating the effectiveness of predator control to support the survival of kaka, mohua, robins, bats and morepork.

1.3. I hold a Post-Graduate Diploma in Wildlife Management in Ecology from Otago University, Dunedin (2001) and a Bachelor of Resource Studies from Lincoln University, Christchurch (1996).

1.4. I have 22 years' experience working with bats throughout New Zealand and overseas. I have extensive, direct experience of radio-tracking; studying movements and the survival of bats and finding roosts in native forests in the Eglinton, Maruia Valley, Heaphy and in fragmented habitats that are similar to the Peacocke Structure Plan, including South Canterbury and the King Country.

1.5. I run the National Database for the distribution of bats and have my own research project on comparing acoustic bat indices with mark-recapture data. This project aims to verify whether acoustic indices can be used to measure population changes over time.

1.6. I have published 11 peer reviewed scientific papers, five of which are on bats. The bat papers focus on the survival of bats in relation to predator control. I have produced management reports and best practice documents on the management of bats in New Zealand.

1.7. I have worked on various significant assessment and consents including the Weston Lea application.

1.8. I have been assessed as an E band trainer by the Department of Conservation Bat Recovery Group which means that I am highly competent to catch, handle and mark bats as well as undertake survey and monitoring. This qualification allows me to train others and is the highest qualification.

1.9. I belong to the Bat Recovery Group that advise on bat research in New Zealand, and I also belong to the Australasian Bat Society.

1.10. The Bat Recovery Group has recently updated the Bat Roost Tree protocol guidelines and I was part of this process.

1.11. I am part of the group that reviews and assesses the threat categories of New Zealand bats every five years.

1.12. I am presenting evidence for the Director-General of Conservation / Te Tumuaki Aruhei in relation to bat ecology matters arising out of the proposed Plan Change 5 – Peacocke Structure Plan.

2. CODE OF CONDUCT

2.1. I confirm I have read the code of conduct for expert witnesses as contained in the Environment Court's Practice Note 2014. I have complied with the practice note when preparing my written statement of evidence and will do so when I give oral evidence before the Hearing Panel.

2.2. The data, information, facts and assumptions I have considered in forming my opinions are set out in my evidence to follow. The reasons for the opinions expressed are also set out in the evidence.

2.3. Unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

3. SCOPE

3.1. I have been asked to provide evidence in relation to bat ecology.

3.2. In preparing this evidence, I have read and considered the following documents:

a) Proposed Plan Change 5 to the Operative Hamilton City District Plan (Peacocke Structure Plan);

b) Plan Change 5: Peacocke Structure Plan Section 32 Report Notification Version July 2021;

c) Submissions and further submissions;

d) Section 42A Hearing Report (dated 2 September 2022);

e) Statements of evidence (dated 2 September 2022) prepared for the Hamilton City Council by:

i. Dr Hannah Mueller (Ecology – Bats, Wetlands, Freshwater Biodiversity);

ii. Dr Matthew James Baber (Ecology – Offsetting/Compensation);

iii. Mr Gerardus (Gerry) Henricus Anthonius Kessels (Ecology); and

iv. Mr John Kinross Mckensey (Lighting);

f) Joint Witness Statements:

i. Planning & Bats 24 August 2022;

g) Davidson-Watts I 2019. Long-tailed Bat Trapping and Radio Tracking Baseline Report 2018 and 2019 Southern Links, Hamilton. Report prepared for AECOM NZ Ltd;

h) Appendix L: Kessels G., Baber M. 2021. Peacocke Structure Plan Area: Ecological Significance Assessment. Report prepared by Tonkin and Taylor for Hamilton City Council. Report number: 1007479.0040.v4;

i) Appendix J: Mueller H, Davidson-Watts I, Kessels G. 2021. Peacocke Structure Area Plan Change Long-tailed bat report For Hamilton City Council. Document name: 4sight_Psp_Bat_Report_Final_June 2021. Appendix J of the "*Plan Change 5 – Peacocke Structure Plan - Assessment of Environmental Effects (2021)"*.

3.3. In preparing my statement of evidence, I have reviewed the draft statements of evidence of the following experts for the Director-General of Conservation:

a) Dr Kerry Borkin (Bat ecology);

b) Susan Mander (Lighting);

c) Dr Ilse Corkery (Offsets and compensation)

d) Jesse Gooding (Planning).

3.4. For ease of reference, I attach as Appendix 1, a consolidated list of the reference material that I have relied upon in my evidence.

3.5. In my evidence I note any relevant assumptions and any certainties or insufficiency of information that underlies my expert opinion/evaluation.

4. EXECUTIVE SUMMARY

4.1. Long-tailed bats are critically endangered that is the highest category before extinction. The presence of long-tailed bats in Hamilton is unusual and rare as in other cities they have been lost.

4.2. The long-tailed bats have survived mainly in the fragmented pastoral landscape of Southern Hamilton. This area is interspersed with deep forested gullies and remnants of native and exotic trees and shrublands along with riparian areas along the Waikato River.

4.3. Long-tailed bats are currently using the entire Peacocke Structure Plan Area.

4.4. Expansion of the urban area to the PSPA in southern Hamilton will lead to an increase in roading, housing, lighting and noise and a decrease in available bat habitat leading to fewer roosts, less connectivity of habitat and smaller bat home ranges.

4.5. The functionality of the bat habitat will be reduced due to the increase in lighting, noise, density of buildings, loss of vegetation including roosts leading to the potential of local extinction.

4.6. The habitat that has been set aside for bats in the PSPA is small, less than 20% of the PSPA.

4.7. Given the uncertainty of the untested mitigation methods eg. lighting restrictions, plantings, revegetation, artificial roost boxes and how they will affect the bat population a precautionary approach should be applied.

4.8. A greater focus on improving connectivity of vegetation onsite, providing additional bat habitat, enhancing the current vegetation onsite, and proactively, carefully considering how connectivity and functional habitat and roosts can be assured across the wider landscape.

5. THE CONSERVATION STATUS OF THE LONG-TAILED BAT

5.1. DOC administers the Wildlife Act 1953 and long-tailed bats are "Absolutely Protected Wildlife" under this Act[1].

[1] **Wildlife Act 1953, Section 3 Wildlife to be protected**

"*Subject to the provisions of this Act, all wildlife is hereby declared to be subject to this Act and (except in the case of wildlife for the time being specified in Schedule 1, Schedule 2, Schedule 3, Schedule 4, or Schedule 5) to be* ***absolutely protected*** *[my emphasis] throughout New Zealand and New Zealand fisheries waters.*"

5.2. Long-tailed bats are classed as "**nationally critical**" which is the highest threat category for New Zealand species[2]. This means that this population (irrespective of size or number of sub-populations) has a very high ongoing or predicted decline (> 70%). A taxon is 'Nationally Critical' when the population has an ongoing trend or predicted decline of > 70% in the total population due to existing threats[3].

5.3. Bats were once common in New Zealand and in the early 1900's bats were regularly seen in all our cities with reports of seeing them in their hundreds and thousands[4]. Since then, there have been significant declines and in the areas that they survive they are still in decline and are now threatened with extinction.

5.4. Hamilton is one of the last cities where bats persist. In the colonies that have been studied to date, the rate of decline is far greater in populations that have no management. This decline is between 5% and 9% per annum[5].

5.5. Declines in bats are from a combination of threats including habitat loss through land clearance, predation and competition by introduced predators, habitat degradation, fragmentation and disturbance at roosts. Introduced predators including stoats, rats, cats and possums and wasps have all been implicated in the decline[6].

5.6. In the Eglinton Valley in Fiordland National Park, the population was declining at 5% per annum due to predators[7], whereas in South Canterbury the population was declining by 9% per annum due to a

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[2] O'Donnell CFJ, Borkin KM, Christie JE, Lloyd B, Parsons S, Hitchmough RA 2018. The conservation status of New Zealand bats, 2018. Department of Conservation, New Zealand Threat Classification Series 21. Department of Conservation, Wellington.

[3] Townsend, A.J.; de Lange, P.J.; Duffy, C.A.J.; Miskelly, C.M.; Molloy, J.; Norton, D.A. 2008: New Zealand threat classification system manual. Department of Conservation Wellington, New Zealand. 35 p

[4] O'Donnell CFJ 2000a. Conservation status and causes of decline of the threatened New Zealand Long-tailed Bat *Chalinolobus tuberculatus* (Chiroptera: Vespertilionidae). Mammal Review 30: 89–106.

[5] Pryde MA, O'Donnell CFJ, Barker RJ 2005. Factors influencing survival and long-term population viability of New Zealand long-tailed bats (*Chalinolobus tuberculatus*): implications for conservation. Biological Conservation 126: 175-185.
Pryde MA, Lettink M, O'Donnell CFJ 2006. Survivorship in two populations of long-tailed bats (*Chalinolobus tuberculatus*) in New Zealand. New Zealand Journal of Zoology 33: 85-89.

[6] O'Donnell CFJ 2000a. Conservation status and causes of decline of the threatened New Zealand Long-tailed Bat *Chalinolobus tuberculatus* (Chiroptera: Vespertilionidae). Mammal Review 30: 89–106.

[7] Pryde MA, O'Donnell CFJ, Barker RJ 2005. Factors influencing survival and long-term population viability of New Zealand long-tailed bats (*Chalinolobus tuberculatus*): implications for conservation. Biological Conservation 126: 175-185.

combination of predators, habitat fragmentation and poor-quality roosts[8]. Based on these results and the fact that bat habitat is continuing to be lost and there is no widescale predator control it is likely that the Hamilton population is also declining.

6. SPECIALIST REQUIREMENTS OF LONG-TAILED BATS

6.1. Long-tailed bats have very specialist requirements in terms of breeding sites, home range and foraging requirements making them vulnerable to any changes in bat habitat arising from activities such as land clearance. I will go through what these are.

6.2. Long-tailed bats are long-lived (>20 years) therefore they can persist in the population for a long time but that may not mean that they are doing well.

6.3. Long-tailed bats breed once a year and generally have one pup. An adult female can start breeding between 1 to 3 years. This means that populations can take a long time to respond to environmental changes.

6.4. Long-tailed bats are insectivores and are generally aerial feeders so they can fly along and scoop up insects in their long tails or catch insects in their mouths. They eat a variety of Diptera (flies), Lepidoptera (moths) and Coleoptera (beetles)[9].

Roosting Behaviour

6.5. Long-tailed bats don't make nests like a bird, they generally roost in tree cavities, if they are available but they can also roost under peeling bark, in splits of trees, in hollow dead trees and tree ferns and cracks or crevices in bluffs[10]. I have seen bats roosting in a hanging wool sack in a farm barn[11] presumably because there were limited sites to choose from.

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[8] Pryde MA, Lettink M, O'Donnell CFJ 2006. Survivorship in two populations of long-tailed bats (*Chalinolobus tuberculatus*) in New Zealand. New Zealand Journal of Zoology 33: 85-89.

[9] Gillingham NJ 1996. The behaviour and ecology of the long-tail bats (*Chalinolobus Tuberculatus* Gray) in the Central North Island. Masters of Science Thesis for Massey University.
Garau AL 2014. The diet of the long-tailed bat, *Chalinolobus tuberculatus*. Masters of Zoology thesis for Massey University.

[10] King C, Forsyth DM (eds) 2021 The handbook of New Zealand mammals. CSIRO Publishing. Chapter 4

[11] Unpublished DOC data from South Canterbury

6.6. In native forests long-tailed bats generally shelter and breed in roost trees. The roost cavities they select are very specific and these can be quite rare in the landscape even in native forest. In the Eglinton Valley only 1.3% of random trees above 20cm DBH (Diameter at Breast Height) had optimum characteristics for breeding which extrapolates to 3.8 cavity bearing trees/ha [12]. A forest such as the Eglinton Valley provides enough possible roosting trees for bats and allows a choice of roost trees. In a fragmented landscape such as Hamilton there will not be as much choice. A lack of choice may lead the use of sub-standard roosts for longer time periods. This may influence survival of young and increased risk of predation or disease[13].

6.7. In native forests adult females congregate in maternity roosts between November and February, generally moving to a new roost most nights and carrying their young with them. Clusters of reproductive females form small social groups of about 20-100 bats. Often several social groups will be found in a bat landscape[14]. Each social group tends to have a distinct roosting area with specific trees that they are faithful to, but the foraging area will be shared with nearby social groups[15].

6.8. Roosting areas change over the season as the needs of the bats change. Maternity roosts tend to be the larger trees in the landscape near to water, whereas male bats choose different trees to roost in[16]. Some areas may be used more frequently than others, but they are still important as part of the area that the group uses.

6.9. In the Eglinton Valley where I work, maternity roosting areas for social groups were concentrated in clusters ranging from 426-1391 ha per group[17]. At this site three groups have been studied in detail. It was found

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[12] Sedgeley JA; O'Donnell CFJ 1999. Factors influencing the selection of roost cavities by a temperate rainforest bat (Vespertilionidae: *Chalinolobus tuberculatus*) in New Zealand. Journal of Zoology (London) 249:437–446.

[13] Pryde MA; Lettink M; O'Donnell CFJ 2006. Survivorship in two populations of long-tailed bats (*Chalinolobus tuberculatus*) in New Zealand. New Zealand Journal of Zoology 33: 85-89.

[14] A bat landscape is likely to consist of several social groups

[15] O'Donnell CFJ 2001. Home range and use of space by *Chalinolobus tuberculatus*, a temperate rainforest bat from New Zealand. Journal of Zoology (London) 253: 253-264.

[16] Borkin KM, Parsons S 2011. Sex-specific roost selection by bats in clearfell harvested plantation forest: improved knowledge advises management. Acta Chiropterologica 13:373-383.

[17] O'Donnell CFJ 2000e. Cryptic local populations in a temperate rainforest bat *Chalinolobus tuberculatus* in New Zealand. Animal Conservation 3:287-297.

that there was very little mixing between the groups. Each group is faithful to a maternity roosting area containing specific roost trees and that group returns those trees each breeding season[18]. It is likely therefore that if you find one maternity roost you will subsequently find others nearby. Bats were only studied during the breeding season, so it is unknown where they roost at other times of year.

6.10. Bats are faithful to individual roosts therefore if they lose one roost, they don’t just go to the next tree available. They are looking for particular features and return to these roosts.

6.11. Roost cavities for reproductive females tend to be well insulated with preferred roosts increasing in temperature during the day reaching a peak at dusk allowing the lactating females to leave the young alone and forage, while the temperature is maintained in the roost until the mother’s return[19]. Males choose different roosts that allow for torpor during the day[20].

6.12. In South Canterbury where I have worked, bats survive in a largely pastoral landscape with exotic plantation forestry, small remnants of podocarp forest and limestone cliffs. Indigenous remnants, shrubland remnants and willows and poplars in the riparian zones were preferred roosting habitats with bats choosing the oldest trees available. Trees with cavities were rare in the landscape.

6.13. Investigation of these cavities found that the cavities and the entrances were larger leading to poor thermal qualities compared to roosts in the Eglinton. Juvenile survival was low compared to the Eglinton studies. 24% of the South Canterbury bats survived to flying compared to virtually all young in the Eglinton surviving to flying[21]. The five-year study showed

[18] O'Donnell CFJ 2000e. Cryptic local populations in a temperate rainforest bat *Chalinolobus tuberculatus* in New Zealand. Animal Conservation 3:287-297.

[19] Sedgeley JA 2001. Quality of cavity micro-climate as a factor influencing maternity roost selection by a tree-dwelling bat, *Chalinolobus tuberculatus*, in New Zealand. Journal of Applied Ecology, 38: 425-438.

[20] Borkin KM, Parsons S 2011. Sex-specific roost selection by bats in clearfell harvested plantation forest: improved knowledge advises management. Acta Chiropterologica 13: 373-383.

[21] Sedgeley JA, O’Donnnell CFJ 2004. Roost use by long-tailed bats in South Canterbury: examining predictions of roost-site selection in a highly fragmented landscape. New Zealand Journal of Ecology 28:1-18.

that the population in South Canterbury was declining by 9% per annum and the population was at risk of extinction[22].

6.14. Reducing the number of available roosts in an already stressed population is a significant risk[23]. In South Canterbury there was local extinction of one social group after 25% of the trees were felled and the land was drained[24].

6.15. Bats surviving in a modified landscape such as Hamilton still tend to choose the largest and oldest trees available[25]. If there are few suitable trees available, they may end up having to choose sub-standard sites. Bats in Hamilton are using some of the artificial roosts, but it is unknown whether these roosts provide a suitable environment for the successful growth and survival of juveniles.

6.16. The Hamilton bats have survived in the peri-urban fragmented landscape, but it is likely that they are declining due to the continuing loss of habitat and the absence of predator control. With the planned increase in urbanization consisting of high and medium density housing and the loss of further habitat is not likely to improve the decline.

Foraging Behaviour

6.17. Foraging areas of long-tailed bats are large. Ecologists describe the area that an animal uses as a home range. Bats use these areas for roosting, foraging, socialising and the connecting areas in between. For colonial species such as long-tailed bats reporting the accumulated home range of all the bats is more representative of the areas that the group covers compared to individual bat home ranges.

[22] Pryde MA; Lettink M; O'Donnell CFJ 2006. Survivorship in two populations of long-tailed bats (*Chalinolobus tuberculatus*) in New Zealand. New Zealand Journal of Zoology 33: 85-89.
[23] Pryde MA; Lettink M; O'Donnell CFJ 2006. Survivorship in two populations of long-tailed bats (*Chalinolobus tuberculatus*) in New Zealand. New Zealand Journal of Zoology 33: 85-89.
[24] Sedgeley JA, O'Donnnell CFJ 2004. Roost use by long-tailed bats in South Canterbury: examining predictions of roost-site selection in a highly fragmented landscape. New Zealand Journal of Ecology 28:1-18.
[25] Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019. Southern Links, Hamilton. Report for AECOM, Auckland.

6.18. In the Eglinton the accumulated data for the three groups studied ranged over 12,000 ha [26]. In Hamilton the accumulated data from all the bats studied (probably just one social group) in the radio-tracking study shows that the range width is ~9.5 km and covers ~5000 ha[27]. This means that managing areas for long-tailed bats has to be considered on a landscape scale rather thinking about small sites such as the Peacocke Structure Plan Area.

6.19. The connectivity of the tree networks has been found to be important to allow bats to commute safely across the landscape and any severance of connectivity may lead to adverse effect on bats[28]. Bats can fly across open areas, but they prefer vegetated areas. If there are large gaps (e.g. bridges, buildings) in the vegetation, they may stop using the flyway. The Peacocke Structure Plan Area is a similar landscape to other fragmented habitat studies[29] and likely to experience the same detrimental effects on bats due to loss of connectivity.

6.20. Long-tailed bats are edge feeders and feed efficiently along the edges of forests, shelter belts, woodlots and above the canopy of the trees[30]. Shelter belts can just be a single line of trees but they provide shelter from the wind and darkness so bats can move along the edge without being detected by predators. During my time working with bats, I have observed bats flying along the edge of the shelter belts at dusk and then flying across grassed areas when it gets dark. Removal of this type of vegetation could lead to less efficient foraging and increased vulnerability to predators.

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[26] O'Donnell CFJ 2001. Home range and use of space by *Chalinolobus tuberculatus*, a temperate rainforest bat from New Zealand. Journal of Zoology (London) 253: 253-264.

[27] Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019. Southern Links, Hamilton. Report for AECOM, Auckland.

[28] Hale JD, Fairbrass AJ, Matthews TJ, Sadler JP 2012. Habitat composition and connectivity predicts bat presence and activity at foraging sites in a large UK conurbation. PLOS ONE. https://doi.org/10.1371/journal.pone.0033300

[29] Frey-Ehrenbold A, Bontadina F, Arlettaz R, Obrist MK 2013 Landscape connectivity, habitat structure and activity of bat guilds in farmland-dominated matrices. Journal of Applied Ecology 50:252-261.
Oprea, M., Mendes, P., Vieira, T.B. Ditchfield AD 2009. Do wooded streets provide connectivity for bats in an urban landscape?. Biodiversity Conservation 18, 2361–2371 (2009). https://doi.org/10.1007/s10531-009-9593-7

[30] Parsons S 2001. Identification of New Zealand bats (*Chalinolobus tuberculatus* and *Mystacina tuberculata*) in flight from analysis of echolocation calls by artificial neural networks. Journal of Zoology 253:447-456.
ODonnell CFJ 2000d Influence of season, habitat, temperature and invertebrate availability on nocturnal activity by the New Zealand long-tailed bat (*Chalinolobus tuberculatus*). New Zealand Journal of Zoology 27: 207-221.
O'Donnell CFJ 2005. Order Chiroptera. In King CM ed. The Handbook of New Zealand Mammals 2nd ed. South Melbourne, Oxford University Press Pg 95-109.

6.21. Long-tailed bats use a variety of habitats for foraging and commuting. In a study in the Eglinton only 4.2% of activity was in the red beech interior of the forest, 56% of bat activity was along forest/grassland edges, 15.6% was on open grassland, 13.1% along quiet roads through forest and 11% in patches of silver beech within 100m of the forest edge[31]. All these habitats are therefore important to the bats.

6.22. The Hamilton radio-tracking study on long-tailed bats found that native and exotic trees were the most used habitats and open water the second most used. Other habitats were also used including parklands, agricultural and lifestyle blocks. The least used habitat was urban and industrial. The amount of time an animal spends in a certain habitat does not always relate to how important each habitat is. All these types of habitats make up the functional area of the colony of bats. Removing one type of bat habitat such as pasture may influence how the bats can forage.

6.23. If we think of this in human terms – if people have only bedrooms and the hallway to live in then they may survive for a while but not having access to the living room, the kitchen or visits to the supermarket and socialising with friends – the quality of life will be impacted, and they will fail to thrive. The long-tailed bat has shown resilience in being able to survive in Hamilton but there will be a limit to this resilience if key habitat is lost.

6.24. Long-tailed bats are insectivores and aerial feeders so they can catch and consume food while they are flying. They feed on a variety of insects mainly Diptera (flies), Lepidoptera (moths) and Coleoptera (beetles). In a study at Kinleith Forest and Pureora they were found to have an opportunistic and generalist diet[32].

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31 O'Donnell CFJ, Christie JE, Simpson W 2006 Habitat use and nocturnal activity of lesser short-tailed bats (Mystacina tuberculata) in comparison with long-tailed bats (Chalinolobus tuberculatus) in temperate rainforest. New Zealand Journal of Zoology, 33:113-124.

32 Gurau AL 2014. The diet of the New Zealand long-tailed bat, Chalinolobus tuberculatus. Masters in Zoology, Massey University, Manawatu, New Zealand.

6.25. Bats at Grand Canyon Cave in Piopio were identified as eating the grass grub beetle (*Costelytra zealandica*)[33]. The grass grub beetle is found throughout New Zealand in tussock, improved grasslands and cropping areas. The larvae form causes damage to the roots of crops and the emergent beetles eat the leaves[34]. The beetles swarm at dusk in summer potentially providing a good food source for long-tailed bats.

6.26. Bats are known to eat agricultural insect pests in other countries for example in New Jersey, the little brown bat eats fruit flies and the big brown bat eat the brown stink bug. The bats therefore provide an important ecosystem service through pest consumption[35].

6.27. Gillingham 1996 noted that long-tailed bat activity may increase in response to low insect numbers rather than migrate to other foraging areas even if they are available[36]. This may be due to lack of group knowledge of new areas. If pasture areas are lost, then bats may end up having to forage for longer to find adequate food rather than look for new foraging grounds even if they were available. This may reduce fitness and survival.

6.28. In Dr Borkin's study in plantation forests they noted that with clearfell harvesting, home ranges declined, fewer roosts were used and group size declined[37]. This shows that bats will not just go somewhere else if they lose habitat.

Lighting

6.29. Long-tailed bats require dark spaces to function in the environment. Artificial lighting associated with urbanisation is known to affect the commuting behaviour, foraging patterns and reproductive cycles of bats

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[33] Gillingham NJ 1996. The behaviour and ecology of long-tailed bats (Chalinolobus tubercualtus Gray) in the central North Island. Masters of Science, Massey University, Manawatu, New Zealand.

[34] https://agresearch.recollect.co.nz

[35] Whitby MD, Kieran TJ, Glenn TC, Allen C 2020. Agricultural pests consumed by common bat species in the United States corn belt:The importance of DNA primer choice. Agriculture, Ecosystems & Environment 303

[36] Gillingham NJ 1996. The behaviour and ecology of long-tailed bats (Chalinolobus tubercualtus Gray) in the central North Island. Masters of Science, Massey University, Manawatu, New Zealand.

[37] Borkin K, O'Donnell C, Parsons S 2011. Bat colony size reduction coincides with clear-fell harvest operations and high rates of roost loss in plantation forest. Biodiversity and Conservation. 20. 10.1007/s10531-011-0144-7.

[38]. Lighting is thought to increase the chance of predation by aerial predators, and delay emergence from roosts meaning that bats miss out on the peak of insect activity at dusk[39]. If bats make use of the urban lighting and feed on the insects flying round the lights then potentially they are more at risk from predators. Alternatively, if they wait for the lights to go off, they reduce the feeding time available[40].

6.30. Lighting reduces the habitat available for bats. Research has found that when bridges were lit, the bridges that were illuminated had 1.7 times lower activity compared to unlit sites. At lit sites the bats flew faster and further away from the bridges thereby reducing the amount of time the habitat was used and the functionality of that habitat[41].

6.31. In my own work with bats, shining lights on bats makes them fly away. Light also stops them coming out of a roost. Lights are used sparingly when working with bats.

Noise

6.32. Bats have been shown to be distracted by noise. In a study on the gleaning pallid bat under exposure to noise successful prey localization[42] declined by half, search time tripled and bats used 25% more sonar pulses than when they were hunting with no noise[43]. This means it takes more time for bats to get adequate food in noisy environments.

6.33. An experiment on five species of bats found that bat activity and feeding behaviour were negatively affected by traffic noise playback suggesting that the results could be applicable more widely[44]. This means that when

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[38] Longcore T, Rich C 2004. Ecological light pollution. Frontier Ecological Environment 2:191-198.
Stone EL, Jones G, Harris G 2009. Street lighting disturbs commuting bats. Current Biology 19: 1123-1127
Stone EL, Harris S, Jones G 2015. Impacts of artificial lighting on bats: a review of challenges and solutions. Mammalian Biology 80: 213-219.

[39] Boldogh SD, Dobrosi D, Samu P 2007. The effects of the illumination of buildings in house dwelling bats and its conservation consequences. Acta Chiropterologica 9: 527-534.

[40] Stone EL, Harris S, Jones G 2015. Impacts of artificial lighting on bats: a review of challenges and solutions. Mammalian Biology 80: 213-219.

[41] Barre K, Spoelstra K, Bas Y Challeat S, Kiri Ing R, Azam C, Zissis G, Lapostolle D, Kiribiriou C, Le Viol I 2021. Artificial light may change flight patterns of bats near bridges along urban waterways. Animal Conservation 24:259-267.

[42] Prey localization: being able to locate and successfully catch prey.

[43] Allen LC, Hristow NI, Rubin JJ, Lightsey JT, Barber JR 2021. Noise distracts foraging bats. Proceedings of the Royal Society B 288:20202689.

[44] Finch D, Schofield H, Matthews F. 2020. Traffic noise playback reduces the activity and feeding behaviour of free-living bats. Environmental Pollution 263: part B.

there was traffic noise playback there were less bat calls and less feeding. My colleague Dr Borkin is doing similar work and the preliminary results are comparable. Her evidence goes into this in more detail.

6.34. Previous research on noise in New Zealand on the long-tailed bat is limited. One study looked at aircraft noise but found no statistically significant effect but acknowledged that the researchers' presence and movement may have influenced the study[45]. In my own work on bats, I have found that if there is a lot of noise at a roost during the day bats can emerge. The standard policy working with bats is to be quiet at roosts.

Predators

6.35. Long-tailed bats are vulnerable to being killed by introduced mammalian predators including cats, possums, stoats and rats. Research to date shows all these mammals need to be controlled to low levels (<5%) to maintain or improve numbers. Predator control needs to be planned at a landscape scale and include at a minimum all roosting areas for numbers of bats to be maintained. In the Eglinton Valley in a beech forest landscape stoat and possum control alone was not enough to protect bats from predation. Small scale rat control (900 ha) was introduced from 2005 onward. This was not effective at increasing numbers until the area controlled was increased to 3350 ha[46]. At this scale entire roosting areas are protected from rats – this is key when aiming to protect bat areas.

6.36. In a South Canterbury study possums were recorded on video visiting a maternity roost six out of 8 nights[47]. Records of cats killed by bats are common[48]. Once a cat finds a source of food it often returns to that site

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45 Le Roux DS, Waas JR 2012. Do long-tailed bats alter their evening activity in response to aircraft noise?. Acta Chiropterologica 14:111-20.

46 Pryde MA, O'Donnell CFJ, Barker RJ 2005. Factors influencing survival and long-term population viability of New Zealand long-tailed bats (*Chalinolobus tuberculatus*): implications for conservation. Biological Conservation 126: 175-185.
O'Donnell CFJ, Pryde MA, van Dam-Bates P, Elliott GP. 2017. Controlling invasive predators enhances the long-term survival of endangered New Zealand long-tailed bats (Chalinolobus tuberculatus): implications for conservation of bats on oceanic islands. Biological Conservation 214:156-67.

47 Sedgeley JA, O'Donnell CFJ 2004. Roost use by long-tailed bats in South Canterbury: examining predictions of roost site selection in a highly fragmented landscape. New Zealand Journal of Ecology 28:1-18.

48 Scrimgeour J, Beath A, Swanney M 2012. Cat predation of short-tailed bats (Mystacina tuberculata rhyocobia) in Rangataua Forest, Mount Ruapehu, Central North Island New Zealand. New Zealand Journal of Ecology 39:257-260.
Daniel MJ, Williams 1984. A survey of the distribution, seasonal activity and roost sites of New Zealand bats. New Zealand Journal of Ecology 7:9-25.

therefore leading to many bats being killed over a period of time. In Rangataua Forest at least 102 short-tailed bats were killed over seven days [49]. There are many records in Hamilton of cats injuring and killing bats. A recent example is a pet cat killing 7 bats over 2 years[50].

6.37. The research on predator control in fragmented landscapes for the protection of long-tailed bats from predators including rats, cats, possums, stoats, weasels is limited but the principles of protecting all roosting areas and connected habitats on a landscape scale should be applied for this to be most likely to be successful at protecting the population.

7. THE SIGNIFICANCE OF THE PEACOCKE STRUCTURE PLAN AREA FOR BATS

7.1. The Peacocke Structure Plan Area (PSPA) is 759 ha (data from HCC shapefile, other reports state size as 720 ha or ~ 740 ha). At present it is a fragmented landscape with a mixture of pasture, farm buildings interspersed with small areas of introduced and native trees, part of the Waikato River and a gully network. It is situated on the southern edge of the current urban area (Figure 1).

7.2. The majority of the detections of bats are in the southern part of Hamilton. All the roosts that have been found are in south Hamilton mostly in the fragmented landscape and a few in the urban edges associated with dark unlit gullies, parks and gardens (Figure 1). The bat work that has been was focussed on the southern part of Hamilton as it was related to the Southern Links Roading Project.

Borkin KM, Easton L, Bridgman L 2022. Bats attacked by companion and feral cats: evidence from indigenous forest and rural landscapes in New Zealand. New Zealand Journal of Zoology.

49 Scrimgeour J, Beath A, Swanney M 2012. Cat predation of short-tailed bats (Mystacina tuberculata rhyocobia) in Rangataua Forest, Mount Ruapehu, Central North Island New Zealand. New Zealand Journal of Ecology 39:257-260.

50 Borkin KM, Easton L, Bridgman L 2022. Bats attacked by companion and feral cats: evidence from indigenous forest and rural landscapes in New Zealand. New Zealand Journal of Zoology.

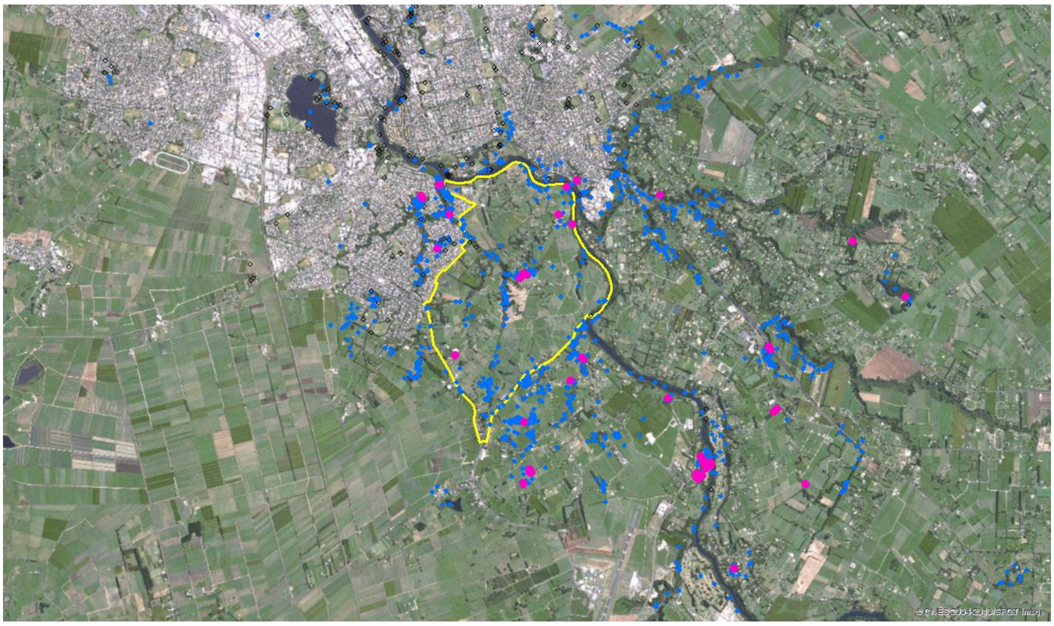

Figure 1 – Outline of the Peacocke area in yellow. Blue dots show where bats have been recorded, pink dots show roosts. Data from DOC bat distribution database and Aecom 2019.

7.3. Bats currently use the whole PSPA area for roosting, socialising foraging and commuting. Seven roosts have been identified in the Peacocke Structure Plan Area (PSPA) as part of the Southern Links Project[51].

7.4. Although the Southern links Project was over two years the data was collected over a few weeks each year over the bat breeding season. Bats were followed 62 nights in 2 years[52]. This is a small amount of time (8.5%) over the 2 years.

7.5. The Southern Links Roading Bat Project run by the Hamilton City Council. was not focussed on the PSPA area but the results produce some good information on the use of bats within the PSPA. The study was a radio-tracking project where transmitters are attached to adult female bats and they are followed to identify flight paths and find roosts.

7.6. Identifying a roost allows you to then catch all the bats in that roost and estimate the group size. Bats can move roosts daily so once you have found a roost one day you may end up at another site the next night.

51 Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

52 Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

7.7. I have worked on a number of these type of projects around the country (eg. Eglinton, South Canterbury, Pureora). It can take many years to understand how bats are using a landscape. This is because tracking bats when they are roosting with young is only a small part of the season of a bat so the results are just a part of how bats use the landscape. To reveal the full extent of how bats use the landscape all seasons would need to be considered.

7.8. The Southern Links bat radiotracking project provides a snapshot of time to show how the bats are using the landscape over part of the breeding season. In 2 years all night radio-tracking was done over a small portion of time (62 nights). The project has identified 54 roosts with 82% in exotic trees, 15 of which are confirmed maternity roosts. 24 bats have been radio-tracked and a total number of 79 bats have been identified. This is an excellent result, but it must be acknowledged that this is only over a fraction of time (8.5%) and there will be more roosts in the landscape[53].

7.9. The home range was calculated for each bat that was radio-tracked. Although the project was not focussed on the PSPA, 13 out of the 24 bats radio tracked had a home range that included the PSPA showing the importance of this area[54] (Figure 2).

7.10. None of the home ranges covered the northern part of the city but this is not surprising as all the bats were caught in the south. The southern part of the city including the PSPA forms the overall range of all the bats tracked (Figure 2). This agrees with the literature to date that shows that the most preferred habitat of long-tailed bats is native and exotic vegetation, river and open water habitat and the least preferred is urban and industrial habitats[55].

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53 Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

54 Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

55 Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

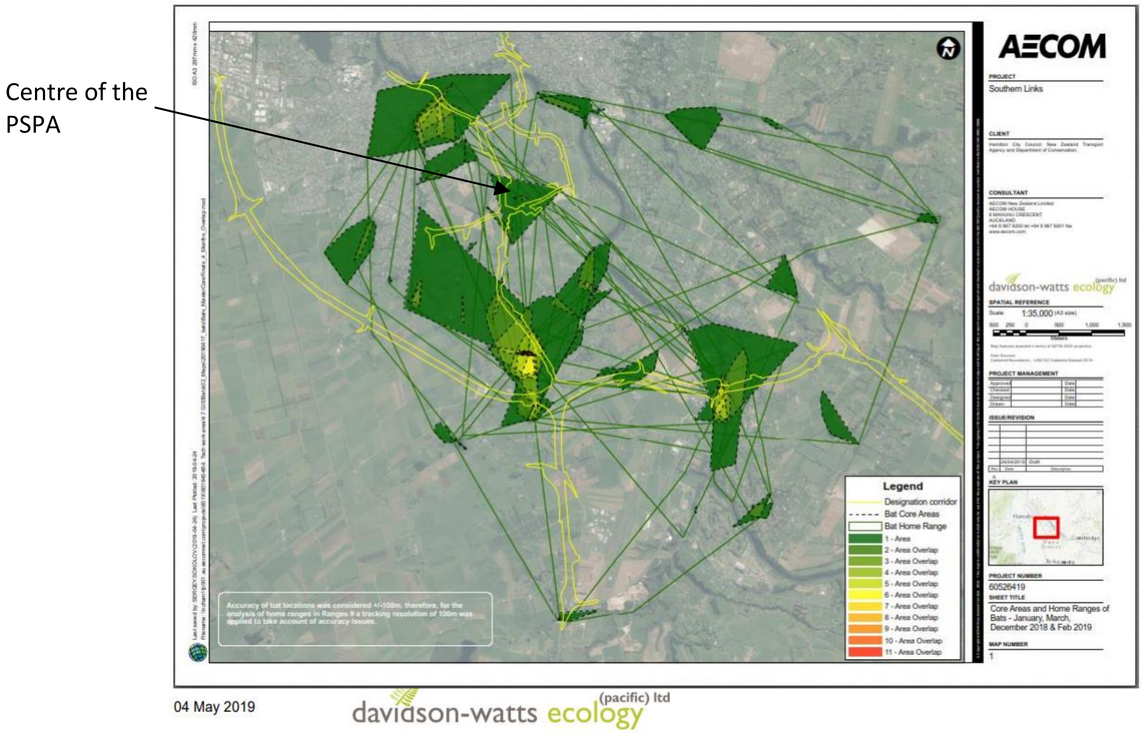

Figure 2: Summary of all bats radio-tracked in January, March and December 2018 and February 2019. The core areas are shown by dotted areas. The overlap is shown as green shaded areas and the lines are the total home range of each bat. The centre of the PSPA is shown.

7.11. The Southern links project[56] and Wildlands consultants[57] identified flight paths that the bats were using with key linkages in the landscape (Figure 3). This combined with the home range data show the bats use the whole of the PSPA as part of their home range (Figure 2).

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[56] Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

[57] Wildlands Consultants 2017. Thermal imaging of long-tailed bats for the Southern Links roading project, Hamilton: Summer 2016-2017. A report for Hamilton City Council and the New Zealand Transport Agency Report number:R4192A.

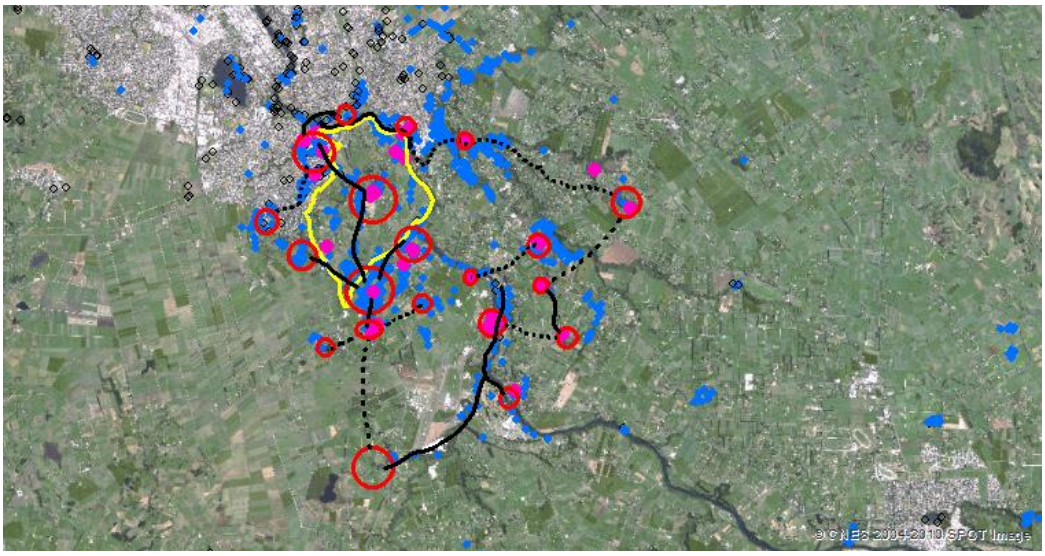

Figure 3: Red circles show important habitat features for the bats tracked. Black lines represent identified linkage during tracking and thermal imaging[58]. Black dotted lines are assumed linkages from bat movements during tracking[59].

7.12. The habitat use map (Figure 4) provided by 4Sight Ecology[60] compares areas in terms of high to low "value". The term, "value" can be misleading as if an area is not used that often it can still be important to the functionality of a species. The "value" of pasture although not the preferred habitat provides a function for connectivity[61] and can provide a foraging area for insects[62]. If only the high value habitats are considered as what is required for bats, then the results will be an unconnected, non-functioning habitat.

58 Wildlands Consultants 2017. Thermal imaging of long-tailed bats for the Southern Links roading project, Hamilton: Summer 2016-2017. A report for Hamilton City Council and the New Zealand Transport Agency Report number: R4192A.

59 Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

60 Mueller H, Davidson-Watts I, Kessels G 2021. Appendix J, 4 Sight Consulting, Hamilton City Council.

61 Bennett RS 2019. Understanding Movement and Habitat Selection of the Lesser Short-tailed Bat to Infer Potential Encounters with Anticoagulant Bait Masters of Science in Zoology, Massey University, Manawatu, New Zealand.

62 Alexander J. 2001. Ecology of long-tailed bats Chalinolobus tuberculatus (Forster, 1844) in the Waitakere Ranges: implications for monitoring (Masters of Science, Lincoln University).

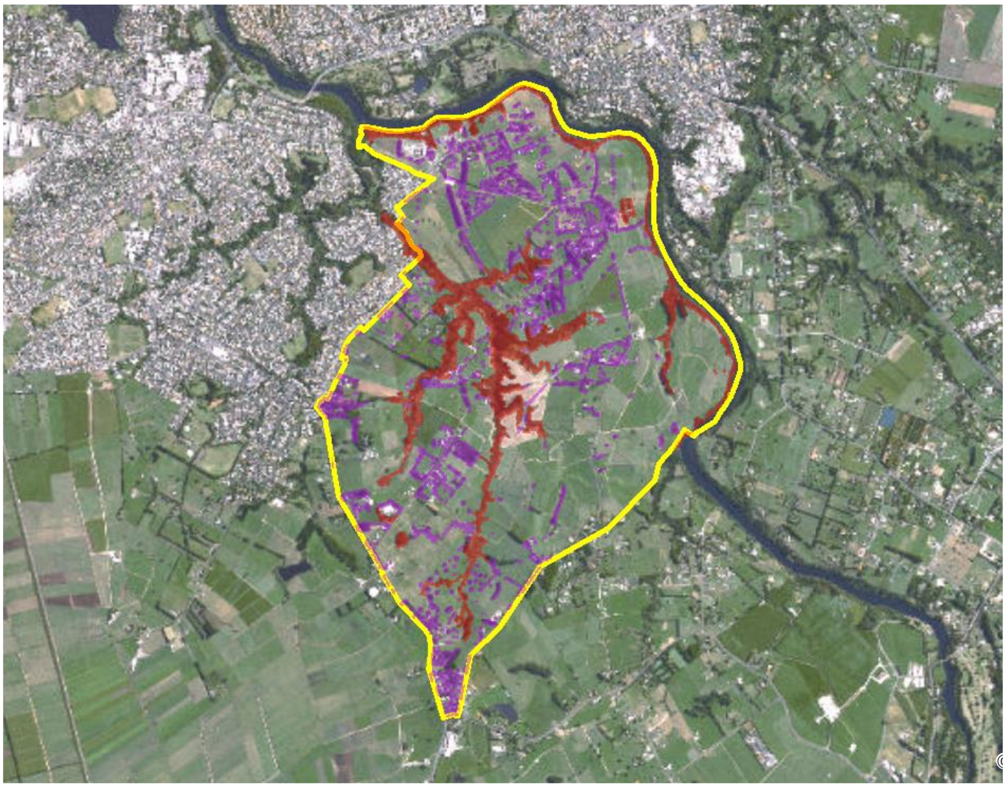

Figure 4: “High value” habitat in brown, “medium value” habitat in purple, the rest is classed as “low value” habitat. Recreated from data obtained from Gerry Kessels September 2022 on behalf of HCC.

8. THE EFFECTS OF DEVELOPMENT ON LONG-TAILED BATS

8.1. Studies of bats in urban areas show that habitat use of an area by bats decreases as urbanization increases[63]. This was shown in Hamilton studies where an increase in housing density showed a decrease in bat activity[64]. The habitat within the PSPA may therefore become unsuitable for bats due to a combination of increasing housing density, roading density and artificial light and existing roost trees being lost and an increase in urban predators eg. cats.

8.2. The potential adverse effects of plan change 5 on bats will be:

[63] Jung K, Threlfall CG 2016. Urbanisation and its effects on bats – a global meta-analysis In Voigt CC, Kingston T (Eds) Bats in the Anthropocene: Conservation of bats in a changling world. Springer International Publishing.

[64] Dekrout A 2009. Monitoring New Zealand long-tailed bats (*Chalinolobus tuberculatus*) in urban habitats: ecology, physiology and genetics. Unpublished Ph.D thesis. The University of Auckland, Auckland, New Zealand.
Dekrout AS, Clarkson BD, Parsons S 2014 Temporal and spatial distribution and habitat associations of an urban population of New Zealand long-tailed bats (*Chalinolobus tuberculatus)* New Zealand Journal of Ecology 41: 285-295.

a) disturbance, direct deaths, injury, displacement through felling of roost trees during the development of the PSPA.

b) loss and fragmentation of feeding habitat and shelter within the proposed PSPA.

c) potential loss of critical present and future breeding roosts leading to significant adverse effects which may threaten the viability of the Hamilton population of bats.

d) increased noise and the introduction of permanent lighting in the PSPA impacting on the feeding, foraging, drinking and commuting of bats[65].

e) impacts of increased traffic on bats including avoidance and possible deaths.

f) increase of urban predators eg. cats

8.3. Even if bats are not killed directly during tree felling, the loss of even one or two maternity roosts could be potentially catastrophic for this population if they cannot find other sites. Bats may be forced to find suboptimal roosts which have been proven to reduce breeding success and survival[66].

8.4. Of the 54 roosting trees found in the Hamilton radiotracking project, 18% were native trees (Kahikatea) and 75% were identified as introduced species including Tasmanian blackwood, pine, eucalyptus and black locust[67]. Introduced trees generally have lower thermal benefits compared to native trees[68]. Low quality roosts leads to lowered reproductive fitness[69].

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65 Hale JD, Fairbrass AJ, Matthews TJ, Sadler JP 2012. Habitat composition and connectivity predicts bat presence and activity at foraging sites in a large UK conurbation. PLOS ONE. https://doi.org/10.1371/journal.pone.0033300.
Russo D, Cistrone L, Libralato N, Korine C, Jones G, Ancillotto L 2017. Adverse effects of artificial illumination on bat drinking activity. Animal Conservation.

66 O'Donnell CFJ, Sedgeley JA 2006. Causes and consequences of tree-cavity roosting in a temperate bat, *Chalinolobus tuberculatus*, from New Zealand. Chapter 17 In: Akbar Z, McCracken GF, Kunz TH (eds.). Functional and Evolutionary Ecology of Bats. Oxford University Press, New York.
Borkin KM, O'Donnell CFJ, Parsons S 2011. Bat colony size reduction coincides with clear-fell harvest operations and high rates of roost loss in plantation forest. Biodiversity and Conservation 30.

67 Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

68 O'Donnell CFJ, Sedgeley JA 2006. Causes and consequences of tree-cavity roosting in a temperate bat, *Chalinolobus tuberculatus*, from New Zealand. Chapter 17 In: Akbar Z, McCracken GF, Kunz TH (eds.). Functional and Evolutionary Ecology of Bats. Oxford University Press, New York.

69 Sedgeley JA, O'Donnell CFJ 2004. Roost use by long-tailed bats in South Canterbury: examining predictions of roost site selection in a highly fragmented landscape. New Zealand Journal of Ecology 28:1-18.

8.5. It is likely that due to the fragmented nature of the landscape and the lack of native and introduced trees, bats are already having to use sub-optimal roosts[70] therefore the loss of any potential current and future roosts is likely to adversely affect this population further and may eventually lead to a non-viable population.

8.6. Single trees and small shelter belts can be incredibly important in a fragmented landscape. For example, in a study I was involved with in South Canterbury there were bats found regularly roosting and breeding in single isolated roost trees[71].

8.7. The Hamilton bat studies highlighted a negative relationship between increasing artificial light intensity, roading and housing density and long-tailed bat activity – less activity by bats in areas with more light, roads and houses[72]. This was supported by modelling that showed the probability of bat presence was inversely related to the distance to residential areas and street lighting[73] - ie. the further you move away from street lighting – more bat activity.

8.8. As there are bats in Sandford Park with roosts close to urban areas this is used as an argument that bats can survive in urban areas. However, Sandford Park is associated with dark, unlit gullies and the bats that were observed coming out of these roosts flew away from these areas to rural/agricultural habitats for the majority of their flying time[74].

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70 Sedgeley JA, O'Donnell CFJ 2004. Roost use by long-tailed bats in South Canterbury: Testing predictions of roost site selection in a highly fragmented landscape. New Zealand Journal of Ecology 28:1-18.

71 Sedgeley JA, O'Donnell CFJ 2004. Roost use by long-tailed bats in South Canterbury: Testing predictions of roost site selection in a highly fragmented landscape. New Zealand Journal of Ecology 28:1-18.

72 Dekrout AS, Clarkson BD, Parsons S 2014 Temporal and spatial distribution and habitat associations of an urban population of New Zealand long-tailed bats (*Chalinolobus tuberculatus)* New Zealand Journal of Ecology 41: 285-295.
Le Roux DS Waas JR 2012a. Do Long-tailed bats alter their evening activity in response to aircraft noise? Acta Chiropterologica 14: 111-120.
Le Roux D, Le Roux N 2012b. Hamilton City Bat Survey Unpublished report prepared for Project Echo by Kessels and Associates, Hamilton.

73 Crewther K, Parsons S 2017. Predictive modelling of long-tailed bat distribution in the Hamilton area. Walking Bats Consultancy. www.walkingbats.com

74 Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

8.9. The radiotracking survey found that generally bats are using the southern parts of Hamilton, and this is associated with a lower density of housing and artificial lighting[75].

8.10. The radiotracking study also demonstrated the fact that bats disperse across open agricultural land[76]. Other research[77] has confirmed long-tailed bats foraging and feeding on open farmland. This highlights that the loss of pasture cannot be ignored or under-estimated.

9. COMMENTS ON SECTION 42A REPORT

Boundary Widths

9.1. Mr Kessels in paragraph 29 notes that 100 m is the minimum width to maintain the use of the gullies[78] without bespoke design. I agree with this, but Mr Kessels then goes onto say that the reason they chose 50 m was because the Sandford Park roosts are close to the vegetated areas and are still functional. I have mapped these roosts (Figure 5). As can be seen from the map the roosts are associated with a gully system. The width of the corridor varies from 270 m to ~30 m. The roosts however are associated with the wider corridors of at least 100 m. There are houses nearby but there are also dark gullies. Given the uncertainty of the ability of this colony of bats to survive it would be prudent to maintain corridor widths of at least 100 m.

[75] Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

[76] Davidson-Watts Ecology (Pacific) Ltd. 2019. Long-tailed bat trapping and radio tracking baseline report 2018 and 2019 Southern Links, Hamilton. Report for AECOM, Auckland.

[77] Bennett RS 2019. Understanding Movement and Habitat Selection of the Lesser Short-tailed Bat to Infer Potential Encounters with Anticoagulant Bait Masters of Science in Zoology, Massey University, Manawatu, New Zealand.
Alexander J. 2001. Ecology of long-tailed bats Chalinolobus tuberculatus (Forster, 1844) in the Waitakere Ranges: implications for monitoring (Masters of Applied Science, Lincoln University).

[78] Pryde MA, O'Donnell CFJ, Barker RJ 2005. Factors influencing survival and long-term population viability of New Zealand long-tailed bats (*Chalinolobus tuberculatus*): implications for conservation. Biological Conservation 126: 175-185.

Figure 5: Sandford Park roosts (pink circle). Yellow boundary of the PSPA. A line (orange) indicating the length of 100 m for scale for the width of the corridors.

Compensation

9.2. The compensation package detailed in Table 8 of the Technical Report consists of revegetation and weed management and mammalian predator control in the riparian area (65 ha) and the forested areas (62.17 ha). This only applies to the small area that has been designated as bat habitat (bright green area in Figure 5). It does not detail whether it would be sufficient to protect bats. Bats are sensitive to rat levels and require large areas of predator control (up to 3350 ha) to be effective with low levels of rats (<5%)[79]. Small areas of predator control may work to some degree to reduce the numbers of bats killed by predators **but only if** they are linked with other areas.

9.3. Revegetation and weed management in the riparian and forested areas may enhance those areas, contribute to connectivity, and provide a buffer to noise and light. There is no detail however on what the revegetation will consist of and whether it will contribute to future roosts, but the time lag is likely to be long ~25- 100 years for roost creation.

[79] Pryde MA, O'Donnell CFJ, Barker RJ 2005. Factors influencing survival and long-term population viability of New Zealand long-tailed bats (*Chalinolobus tuberculatus*): implications for conservation. Biological Conservation 126: 175-185.

9.4. The compensation package offers 700 ha of predator control out of the PSPA but gives no detail on the site or the level of predator control. This is a small area, and it is not clear whether it would cover any of the roosting areas of bats in the PSPA or beyond. For predator control to be effective at protecting bats, it needs to entirely cover the roosting areas and would need to be connected with other predator-controlled areas.

9.5. Alternatively, 190 ha of restoration is offered outside of the PSPA. There would have to be careful consideration of where this should happen to benefit bats. There would need to be a coordinated assessment of the habitat beyond the PSPA and the potential of corridors to enable bats to move though the landscape.

9.6. I think the authors are over optimistic to believe that there will be **no net loss** with this package.

9.7. In my opinion, there needs to be a greater focus on the PSPA. At the moment, according to Mr Sirl paragraph 27, we have ~128 ha of open space zone which has been identified as Bat habitat. Subtracted from this is the orange area (15.6ha) which is the area that is likely to be unavailable to the bats and reduce connectivity due to the Southern Links Motorway (Figure 5). This leaves 112 ha of Bat habitat with reduced connectivity. The open space zone incorporates most of the high value habitat (there are a few small pieces that are not covered) and a very small amount of medium habitat. The majority of the medium habitat (purple area) is not part of the protected bat habitat. The land classed as "medium value" habitat is 47 ha[80]. This is likely to be shelter belts and other vegetation that will be important roosting, foraging and commuting areas.

[80] calculated from shapefile data supplied by G Kessels Sep 2022.

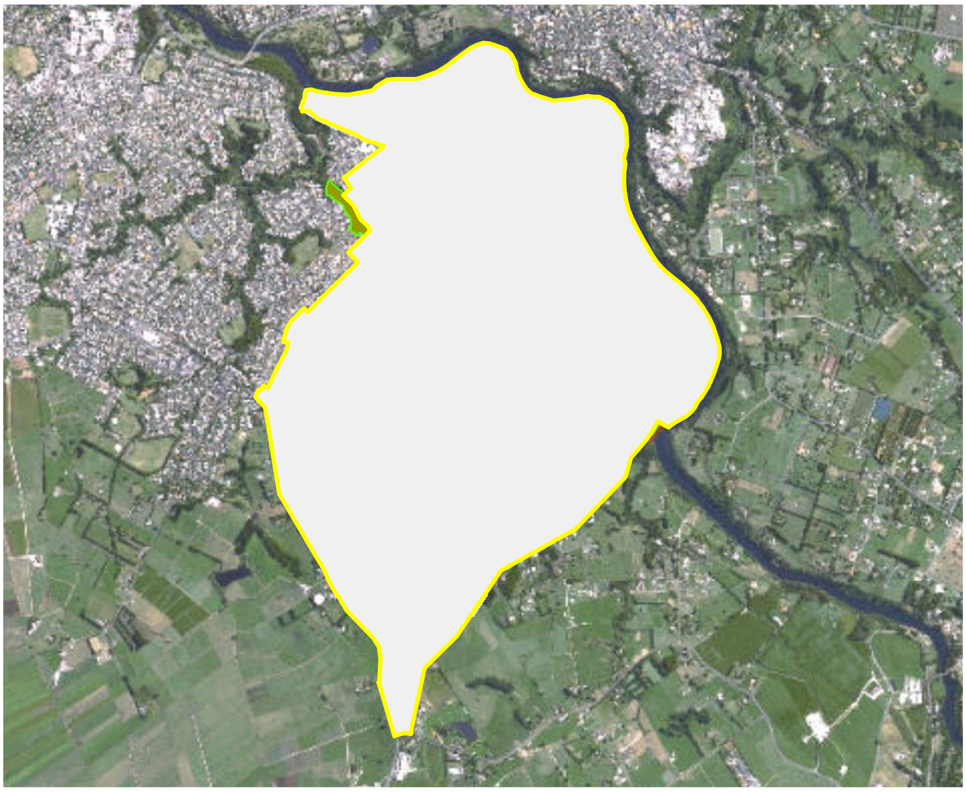

Figure 5: bright green area showing the open space zone. The brown area is the high value habitat and the purple areas is the medium value habitat. The orange area is where the Southern links road crosses the bat habitat, so the land is effectively lost to bats. The white line is the southern links roading.

9.8. The loss of the habitat from the Southern Links Roading footprint will result in a lack of connectivity for the corridor which may or may not be alleviated by hop-overs from the road. Hop overs tend to only work when they follow a flight path that the bats already use[81] and so are relatively experimental as a mitigation tool. There is therefore a reasonable risk that the corridors identified will not work.

9.9. To improve the chances of the corridors working as effective you could provide extra bat habitat corridors and widen the existing corridors. The proposed wetlands and the proposed reserves could be an opportunity for creating more bat habitat (Figure 6). I understand that these areas are indicative only. There are still some gaps in the corridors so they would need to be discussed so that the objective of connectivity is achieved.

[81] Abbott IM, Berthinussen A, Stone E, Boonan M, Melbur M, Altringham J 2015. Bats and Roads. In Handbook of Road Ecology van der Ree R, Smith DJ, Grilo C (Eds). John Wiley & Sons Ltd.

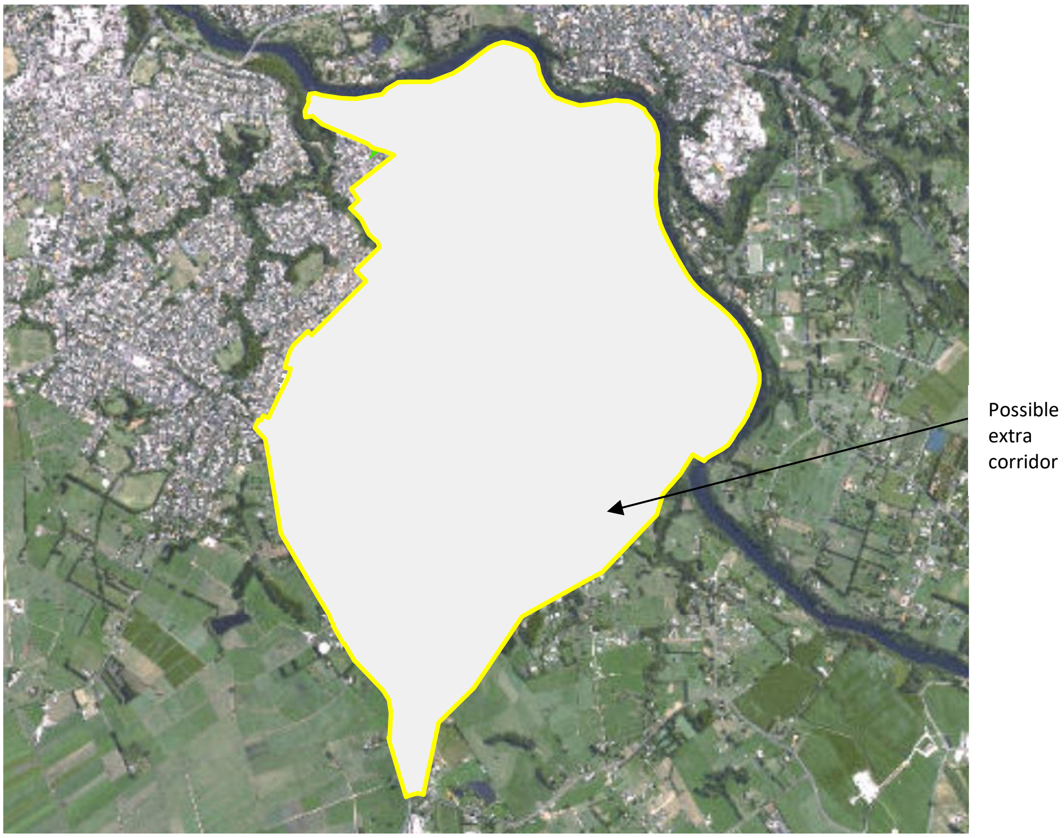

Figure 6: Proposed reserves in green, proposed wetlands in blue (data from HCC shapefiles downloaded August 2022). Note there is an additional corridor in the east that has not been mentioned on previous bat habitat maps.

9.10. I realise that the Department of Conservation has not been a part of the mapping process so to put forward ecological solutions may be problematic due to competing demands of other matters such as the detail relating to existing resource consents and designations that we are not aware of. The solutions therefore I think need to be identified through a collaborative process that takes into account the landscape approach and existing resource consents and designations.

9.11. The amount of habitat that is classed as bat habitat is 112 ha. The average home range of all the bats studied was 704 ha. This means that we are expecting the bats to be able to meet all their needs within the PSPA with only 16% of the average home range of a bat. The amount of habitat that is available for bats needs to be carefully considered at the planning stages of development as once the habitat is lost it will take a long time to recreate it and there is no guarantee that the bats will use it.

9.12. Fariq [82] described a model explaining the extinction threshold. When the amount of habitat is reduced to below the threshold the population threshold drops steeply. The rate of decline will vary with the reproductive rates and dispersal ability of the species. The removal of 50% of habitat lowered the survival of most species studied and this decline dropped steeply to zero where only 20% of the habitat remained. Given that bats are slow breeders and tend to remain faithful to local foraging areas minimising the loss of habitat and maximising connectivity should be a priority.

9.13. In Appendix D section 1.2.2.27 Bat Management Plan, there is acknowledgement that the plan is focussed on mitigation (section D). However, I would have thought it should be focussed on the effects management hierarchy. The first step to the removal of any tree that is 15cm DBH is **avoidance**. Does it really have to be removed? Even with housing there could be the possibility that trees, or groups of trees could be left in place. Roost trees are so rare in the landscape that every tree is important. As long-tailed bats are faithful to a roost area and have specific requirements for what roost they will use the loss of one roost could be drastic. The DOC best practice “Bat Roost Protection Protocol” are referred to which is good, but they are a last resort. The aim of the roost protocols is to lower the risk of bats being killed when trees are cut down. They do not address the loss of roosts. Any mitigation /offsetting / compensation should result in more roosts of an equal standard. The mitigation being offered is:

a) Planting of more trees – this is a long-term plan as they won’t form suitable roosts for at least 20-100 years,
b) Artificial roost boxes: these are only an interim measure. Some of them are being used which is a good sign but that may be indicative of how few roosts are available. The artificial roosts may have lower thermal qualities and result in poorer survival of young.
c) Predator control either on or off site. This needs to be encompass all roost areas and ensure that all predators (cats, stoats, weasels, rats) are below 5% tracking and in perpetuity.

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[82] Fariq L 2001. How much habitat is enough? Biological Conservation 100: 65-74.

d) Protection of roost trees in perpetuity

e) Financial contribution for the benefit of bats in the area.

Predator Control cat control

9.14. The Court recommended that there should be cat control in the Weston Lea decision. I agree with this. New Zealand has one of the highest cat ownership in the world with 41% of New Zealand households having a cat[83]. The Peacocke Structure Plan intends to provide 8400 dwellings so this could potentially lead to the introduction of over 3000 cats. To maintain effective predator control large areas, need to be considered as if you only use small areas then there will be reinvasion.

9.15. Cats are known predators of bats and domestic cats can prey on bats in the same way as feral cats[84]. The home ranges of pet cats may be smaller than feral cats[85] but their impact can be large[86]. Adding extra cats into the environment will be detrimental to bats and will make the Weston Lea decision on cats less effective for bats.

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83 2020 Report — Companion Animals New Zealand

84 Scrimgeour J, Beath A, Swanney M 2012. Cat predation of short-tailed bats (Mystacina tuberculata rhyocobia) in Rangataua Forest, Mount Ruapehu, Central North Island New Zealand. New Zealand Journal of Ecology 39:257-260.
Daniel MJ, Williams 1984. A survey of the distribution, seasonal activity and roost sites of New Zealand bats. New Zealand Journal of Ecology 7:9-25.
Borkin KM, Easton L, Bridgman L 2022. Bats attacked by companion and feral cats: evidence from indigenous forest and rural landscapes in New Zealand. New Zealand Journal of Zoology.

85 Nottingham CM, Buckley HL, Case BS, Glen AS, Stanley MC 2022. Factors affecting home range size of feral cats: a meta analysis. New Zealand Journal of Ecology 46.

86 Kays R, Dunn RR, Parsons AW, McDonald B Perkins AS, Shell L, Mc Donald JL, Cole H, Kikillus H, Woods L, Tindle H, Roetman P 2020. The small home range and large local ecological impacts of pet cats. Animal Conservation 23:516-523.

Monitoring

9.16. Monitoring of bats is difficult. The most robust method is to catch an adult female in the breeding season and attach a transmitter and then follow her to the roost so that you catch all the bats in the roosts and band them. This needs to be repeated many times so that you can catch all the group. Groups of bats tend to go through fission and fusion during the breeding season. Sometimes the group will be split over a number of roosts for a night and then they will all join together another night. You need to sample at least 10[87] maternity roosts in a season to give you an idea of the group size. If this is done annually over a period of at least 5 years, then you can look at the survival of individuals. The survival of individuals can then be used in population modelling to estimate whether the population is increasing or decreasing over time. This type of study was started in Hamilton and run for two years but it was not continued. Catching bats also allows you to assess reproductive status, ie. whether they are breeding or not, the ratio of males to females, body condition by measuring the weights. Attaching transmitters also means you can study how the bats use the landscape. The work is skilled, resource and time intensive but it can be done.

9.17. If less robust methods are used using acoustic recorders, then the objectives of the study must be clearly stated. Once the objectives are clarified and the area you are wanting to make a statement about is identified then you need to assess the number of recorders and the number of nights required. This is normally done through a power analysis[88].The spatial arrangement of recorders is important as if you just put the recorders where you know there are bats then your study will be biased. I am testing a sampling regime based on a spatially balanced design[89]. The algorithm produces a sent of points that you go through in order. You can drop points if they are not suitable, but you have to go to the next one in order. This produces a set of points that are representative of the area, and you can use the same sampling to increase of decrease your target area. This technique is good for a

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87 DOC Best practice bat monitoring.

88 Green P, MacLeod CJ 2016. SIMR: an R package for power analysis of generalized linear mixed models by simulation. Methods in Ecology and Evolution 7: 493-498.

89 van Dam-Bates P, Gansell O, Robertson B 2018. Using balanced acceptance sampling as a master sample for environmental surveys. Methods in Ecology and Evolution 9: 1718-1726.

forested area but in a fragmented site that is about to be urbanised it could be problematic. Bat activity does not differentiate between a lot of calls from one bat or one call each from a number of bats as they pass the recorder. Removing habitat may mean that the remaining bats have to feed for longer in a smaller area – producing an increase in activity when in fact there has been a decline in the number of bats. I have seen projects report increases and decreases in activity using small sample sizes rather than consider the whole project area as a whole. Each separate objective will require an adequate sample size and will have to take into account any changes in the landscape that are not part of the project. I have also seen projects that report the activity is not due to their action but due to other landowners. Isolating the effects is part of good study design

9.18. In summary outcome monitoring is possible but it has to be designed properly so that it can answer the objectives. External factors that may affect bat activity have to be considered at the beginning of the study. Monitoring results can take a long time to detect trends so if a mitigation technique is not working there has to be enough time to change the management.

10. CONCLUSION

10.1. The long-tailed bat is critically endangered which is the highest threat category in New Zealand with the next step being extinction.

10.2. Long-tailed bats are currently present in the PSPA and are using the whole area.

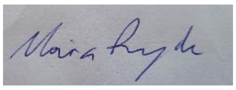
10.3. Expansion of the urban area to the PSPA in southern Hamilton will lead to an increase in roading, housing, lighting and noise and a decrease in available bat habitat leading to fewer roosts, less connectivity of habitat and smaller bat home ranges.

10.4. The functionality of the bat habitat will be reduced due to the increase in lighting, noise, density of buildings, loss of vegetation including roosts leading to the potential of local extinction.

10.5. The habitat that has been set aside for bats in the PSPA is small, less than 20% of the PSPA.

10.6. Given the uncertainty of the mitigation methods eg. lighting restrictions, plantings, revegetation, artificial roost boxes and how they will affect the bat population a precautionary approach should be applied.

10.7. This would involve providing additional habitat onsite, keeping as much of current vegetation as possible, improving connectivity of vegetation onsite and proactively carefully considering how this can be applied to the wider landscape.



Moira Anne Pryde

16 September 2022

Appendix 1: Consolidated List of References in Ms Pryde's Evidence

https://agresearch.recollect.co.nz

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