New Zealand Journal of Zoology

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tnzz20

Bats attacked by companion and feral cats: evidence from indigenous forest and rural landscapes in New Zealand

Kerry M. Borkin, Luke Easton & Lucy Bridgman

To cite this article: Kerry M. Borkin, Luke Easton & Lucy Bridgman (2023) Bats attacked by companion and feral cats: evidence from indigenous forest and rural landscapes in New Zealand, New Zealand Journal of Zoology, 50:3, 425-432, DOI: 10.1080/03014223.2022.2098782

To link to this article: https://doi.org/10.1080/03014223.2022.2098782

Published online: 09 Aug 2022.

NEW ZEALAND JOURNAL OF ZOOLOGY
2023, VOL. 50, NO. 3, 425–432
https://doi.org/10.1080/03014223.2022.2098782

Taylor & Francis
Taylor & Francis Group

SHORT COMMUNICATION

Bats attacked by companion and feral cats: evidence from indigenous forest and rural landscapes in New Zealand

Kerry M. Borkin [a], Luke Easton [b] and Lucy Bridgman [c]

[a]Department of Conservation, Taupō, New Zealand; [b]Department of Conservation, Whakapapa, New Zealand. Previously Department of Conservation, Te Kuiti, New Zealand; [c]Department of Conservation, Hamilton, New Zealand

ABSTRACT

Cats are known predators of bats, but there are few published accounts of predation attempts. In this paper we report on two recent examples of bats being attacked by cats (*Felis catus*) in New Zealand. We found a Central lesser short-tailed bat (*Mystacina tuberculata rhyacobia*) in the gastrointestinal tract of a feral cat that was trapped in indigenous forest. We also report on a case where seven long-tailed bats (*Chalinolobus tuberculatus*) were killed or injured over two years by a companion cat living in a rural landscape. We confirmed cat attack/predation using diet analyses, and pathological assessment and identification of the predator using DNA. We consider that depredation of bats by feral, stray, and companion cats is likely to be substantial and occur within all habitats where bats and cats overlap.

LSID: urn:lsid:zoobank.org:pub:8933333F-D145-41CF-BA20-3AE73D3B86B4

ARTICLE HISTORY
Received 4 May 2022
Accepted 4 July 2022

HANDLING EDITOR
Graham Hickling

KEYWORDS
Predation; long-tailed bat; lesser short-tailed bat; pekapeka; Felis catus

Introduction

Feral, stray and companion cats (*Felis catus*) are predators of bats within New Zealand (Daniel and Williams 1984; Scrimgeour et al. 2012) and worldwide (Oedin et al. 2021). In the United Kingdom, cats are thought to kill as many as 250 000 bats annually (Altringham 2011), and many more may be injured (Khayak et al. 2020). Whilst cats may be a significant cause of mortality for bats, they may not be a significant food item for cats (Rodríguez-Durán et al. 2010) so are unlikely to be detected or reported in cat diet studies (Oedin et al. 2021). Few details of confirmed predation attempts are published (Oedin et al. 2021); with this in mind we decided to report our observations.

Aotearoa-New Zealand has two extant bat species, both threatened with extinction. Long-tailed bats, *Chalinolobus tuberculatus* are classified as 'Nationally Critical' and are declining at rates of 5–9% annually where there is no effective predator control (Pryde et al. 2005, 2006); the Central sub-species of the lesser short-tailed bat, *Mystacina tuberculata rhyacobia*, is classified as 'At-Risk: Declining' (O'Donnell et al. 2018). Cats are known predators of both species (Daniel and Williams 1984; Scrimgeour et al.

CONTACT Kerry M. Borkin kborkin@doc.govt.nz
This article has been corrected with minor changes. These changes do not impact the academic content of the article.

2012). Daniel and Williams (1984) first identified domestic cats as a threat to New Zealand bats, but were only aware of this because some companion cat owners reported injured or dead bats being brought home by their pets. They attempted to alert the conservation community to the risk feral and companion cats played to New Zealand bats, particularly at easily accessible roosts. The first record of New Zealand bats being attacked by a cat at their roost was outlined by Scrimgeour et al. (2012). Such predation events usually go unnoticed because even in bat populations where cat predation has been confirmed, and there have been hundreds of hours of filming of bats emerging from roosts, they usually remain undetected (Scrimgeour et al. 2012). We describe confirmed cat attacks/predation events on both species, and the injuries sustained. These events took place in two habitat types in the North Island of New Zealand: the first in indigenous forest, confirmed by feral cat gastrointestinal tract dissection and diet analyses; the second, at a rural residence using pathological and molecular techniques.

Materials and methods

Indigenous forest, cat diet assessment: On 25 January 2020, a cat scat was found near a known Central lesser short-tailed bat maternity roost tree in the Pikiariki Ecological Area, Pureora Forest Park. The Pikiariki Ecological Area is important because it contains a cluster of maternity roost trees where adult female bats gather to raise their young over summer. This prompted Department of Conservation (DOC) staff to set three SA2 Kat cat traps (Steve Allen, Whangārei, New Zealand) near the roost tree cluster. An adult male cat was trapped on 18 February 2020 (470 mm in body length; 775 mm body length + tail) and a female cat was trapped (435 mm in body length; 645 mm in body length + tail) on 27 February 2020.

The scat and gastrointestinal tracts of the two trapped cats were subsequently examined for any undigested remains of prey items that could be identified.

Rural residence, bat found by cat owners: On 25 January 2020, DOC staff were contacted by the occupier of a residence in a rural area approximately 20 km south-west of Ōtorohanga, Waikato, after they found an injured bat in their house; they had discovered three dead bats the previous day: two on the driveway and one on the doorstep. LB travelled to the property, confirmed that the injured animal was a juvenile male long-tailed bat, and took it to a veterinarian for treatment, and collected the dead bats. The bat was administered subcutaneous fluids for treatment of dehydration following Borkin (2019), and was placed in an artificial bat box (dimensions 20 cm width and depth and 30 cm height at the highest point with a sloping roof and a 3 cm slot at the base that bats can exit from. A felt 'curtain' hangs on the interior back of the box for the bats to hang from. The sloping roof lifts for access) and returned to the residence for self-release later that evening. Residents of the property were asked to contain pets overnight. Unfortunately, despite the bat leaving the box, it was found the next morning on the trunk of a tree in the garden of the property with additional injuries, including a small puncture wound to the shoulder. Residents had tried to contain pets but were unsuccessful. The bat was provided with veterinary care, including antibiotics, subcutaneous fluids, food, and water, and was cared for by LB for four days. A decision was then made to euthanise the bat because of lack of improvement, and a high likelihood of broken bones that were unlikely to repair adequately for a safe release.

All four bats were necropsied by Stuart Hunter, Massey University School of Veterinary Science. To confirm the identity of the predator, swabs were taken from the carcasses of the juvenile male bat (that was found injured and subsequently euthanised) and two of the three bats that were found dead and sent to EcoGene® (a business unit of Manaaki Whenua – Landcare Research) for testing to detect the presence of cat DNA. The swab samples taken from the two bats found dead were pooled for DNA testing (found in the driveway and on doorstep); the third bat (found in the driveway) was too deteriorated for a sample to be taken. Swabbing protocols were followed as advised by EcoGene® (Landcare Research NZ Ltd 2022).

On 9 February 2021 LB was contacted by the occupier of the rural residence to report that they had found two more dead bats and another injured one on the same doorstep/driveway area as those found in 2020. The injured bat received veterinary care, including subcutaneous fluids, food, and water. It was successfully released at the property the following night. The dead bats were not necropsied or swabbed for predator DNA due to the high likelihood of the pet cat being the culprit.

We estimated forest cover within a 5 km radius of the rural residence where the long-tailed bats were injured or killed and the site where the cat was captured at Pikiariki by summing LCDB5 categories: Broadleaved Indigenous Hardwoods, Deciduous Hardwoods, Exotic Forest, Indigenous Forest (Landcare Research New Zealand Ltd 2020).

Results

Indigenous forest, cat diet assessment: Remains of tree wētā (*Hemideina* species unconfirmed), manuka beetle (*Pyronota festiva*), rat (*Rattus* species unconfirmed but likely *Rattus rattus*) and huhu beetle (*Prionoplus reticularis*) were found in the cat scat recovered from Pikiariki. Multiple rats (species and number of individuals unconfirmed, but >1 individual) and tree wētā were identified in the gastrointestinal tract of the adult male cat. Rats (species and number of individuals unconfirmed, but >1 individual), tree wētā (>1), and at least one entire lesser short-tailed bat (identified by an entire head, and wing parts, including wing membrane, wrist, thumb, and metacarpals) were found in the gastrointestinal tract of the female cat.

Forest cover within a 5 km radius of where the cat was captured was 66%.

Rural residence, bats found by cat owners: Pathological assessment found the injured juvenile male bat, which was subsequently euthanised, weighed 8.8 grams and was in good body condition. There were two full thickness circular puncture wounds to the skin of the right wing (known as wing tears); both defects were ∼4–5 mm in diameter and ∼20 mm apart (with wing fully extended, Figure 1). There was bruising/haemorrhaging in the soft tissue/musculature over the right abdominal wall and the right shoulder; and a closed, displaced transverse fracture of the right proximal humerus. The stomach was empty. No other abnormalities were noted on gross post-mortem. Injuries were considered consistent with cat predation, and euthanasia was confirmed as the most humane option.

Details of the pathological assessment of the three additional bats that were found dead were as follows: The first bat, found in the driveway, (possibly female) weighed 8.9 grams and was in moderate body condition; the internal organs were in an advanced state of autolysis. At least six full thickness, circular to ovoid, skin defects (wing tears)

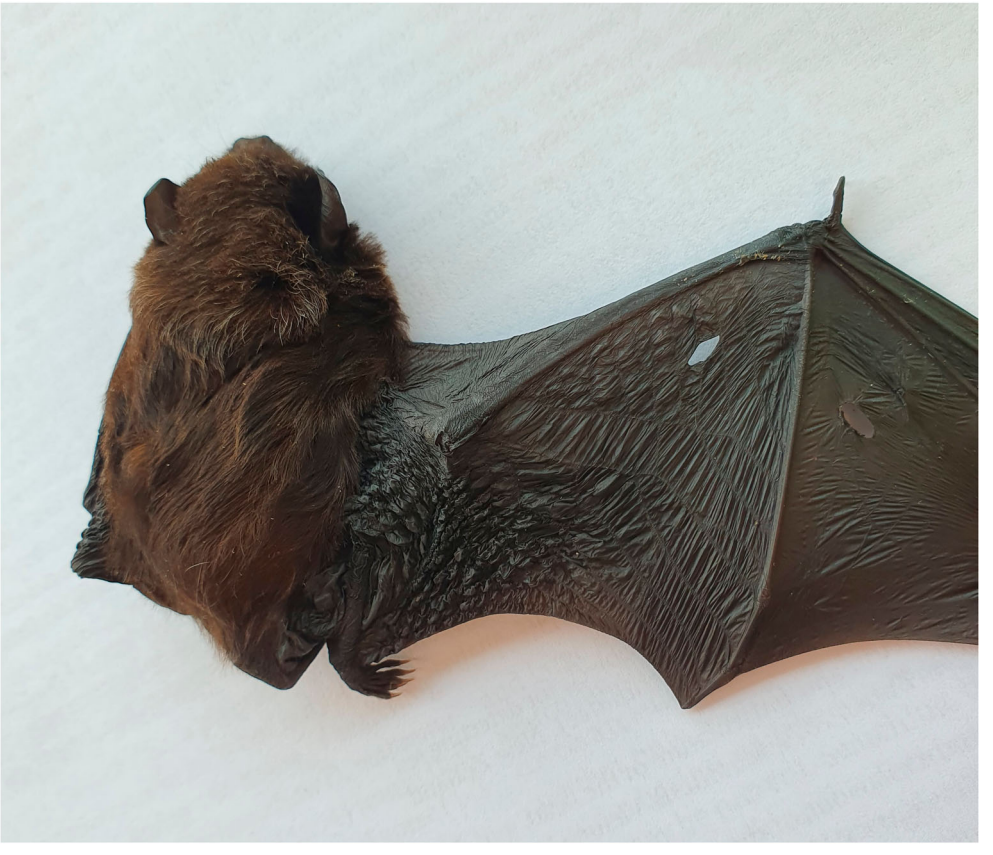

Figure 1. Injured juvenile male long-tailed bat with its wing extended to show two wing punctures. Defects were ~4–5 mm in diameter and ~20 mm apart (with wing fully extended). This bat was euthanised due to poor prognosis.

were present in the webbing of the right wing; the largest measuring ~7 × 3 mm in diameter. The second bat, found on the doorstep, (possibly female) weighed 8.4 grams and was in moderate body condition; the internal organs were in an advanced state of autolysis. There were at least 10 full thickness, circular to ovoid, skin defects (wing tears) present in the webbing of the right wing; the largest measuring ~5 × 5 mm in diameter. There was a ~5 mm area of haemorrhaging in the left pectoral muscle. The third bat necropsied (found in driveway, unknown sex) weighed 5.4 grams, but this does not reflect the true weight as the animal was desiccated and flattened. There were multiple full thickness, circular to ovoid, skin defects (wing tears) present in the webbing of both wings. In summary, all three bats had multiple puncture wounds to one or both wings, and one bat also had a suspect puncture wound to the pectoral muscle; due to decomposition no further information could be gleaned. These puncture wounds are known as wing tears. The diagnosis was consistent with cat predation.

Other potential predators that were considered included dogs (*Canis familiaris*), mustelids (particularly stoats, *Mustela erminea*, and weasels, *Mustela nivalis*), common brushtail possums (*Trichosurus vulpecula*), rats (particularly Norway rat, *Rattus*

norvegicus; and ship rat, *Rattus rattus*) and avian predators (particularly ruru, *Ninox novaeseelandiae*). These were excluded as the culprit because (a) dogs kill by crushing and shaking their prey, so damage to a bat from a dog attack would have been far more severe than was observed; (b) mustelids and possums would potentially kill a bat in a similar method to a cat but prey would be cached (mustelid) or consumed (possum) rather than being left on the driveway/doorstep; (c) rats tend not to bite, rather they leave gnaw marks as they have incisors and lack canines. The wounds in the bats had relatively smooth, regular margins whereas gnaw marks tend to be ragged and irregular. Avian predators peck and tear strips off their prey — this was not seen with these bats.

Our conclusion from the pathological examinations is supported by confirmation of cat DNA being present in the pooled sample taken from the carcasses of the first two bats necropsied. Testing of the sample taken from the juvenile male bat (that was found injured and subsequently euthanised) was inconclusive, as only small amounts of PCR product were amplified. The tests suggested, but could not confirm, that cat DNA was present on that sample as well.

Forest cover within a 5 km radius of the rural residence was estimated as 9%.

Discussion

We report two examples of cats depredating bats, and either consuming or 'bringing home' their prey. In the case of the rural residence companion cat, this was repeated the next year, highlighting how individual cats can have a prolonged impact on a single colony of bats over a long period. We are aware of several other cases where companion cats have brought bats to their owners but have sparse details about these. We suggest that the two cases that we report on are just the tip of the iceberg. Daniel and Williams (1984) considered that cats 'may be a significant cause of mortality [for bats], particularly near accessible roosts.' We share their concern. Further research would be required to understand the impact of cats on bats at a population level, including recruitment of pups.

Cats are the most common companion animal in New Zealand; 41% of households have cats as a pet, most of these have more than one cat (Paul 2020). This equates to 1.219 million cats in households in New Zealand; over 1 million of these cats are allowed to roam outdoor and indoor by their owners (Paul 2020). These numbers do not include 'stray cats' which have some of their needs met by humans, or feral cats which do not (Zito et al. 2019). We provide evidence of companion and feral cats depredating bats in New Zealand and contend that stray cats are likely to do the same. Given these numbers, companion, stray, and feral cats are all likely to impact upon endemic bat populations where they co-occur. Increases in housing density are likely to increase cat numbers in areas where bats persist.

We report on bats being attacked by cats in areas with low and high proportions of forest cover. Lesser short-tailed bats are generally only found in or near old-growth native forest (Parsons and Toth 2021) where companion cats are less likely to occur, whereas long-tailed bats are more widely distributed, including within or near to some larger cities (O'Donnell and Borkin 2021) so are at risk from all types of cats. In rural New Zealand companion cats travel as far as 2.29 km from home (maximum straight-

line distance; Metsers et al. 2010), so owning a pet cat in a rural area can risk bats up to 2.29 km from home. Feral cats range further (Fitzgerald and Karl 1986). The distance between the two most outlying of all of the known lesser short-tailed bat maternity roosts at Pikiariki is 1.75 km; clearly within the reach of one companion or feral cat (L. Bridgman, personal observation following assessment of roost location database, 17 June 2022). Our observations remind conservationists that bats are at risk of cat predation in heavily modified and fragmented landscapes.

Cats probably find bat roosts easy to locate because of their strong smell and noises emitted (Scrimgeour et al. 2012), and bats can be conspicuous when feeding on swarming invertebrates (authors, pers. obs.). Cats can catch free-flying bats by 'sitting on their hind legs and catching the bats in the air with a swift movement of their paws', or 'by jumping and catching the bats in midair' (Rodríguez-Durán et al. 2010), or attack whilst bats are roosting during the day (Scrimgeour et al. 2012). So, reducing risks of predation by cats both at roosts, when bats are relatively inactive, and when bats are free-flying is important. We suggest that when owners keep their cats in at night this will only reduce predation of free-flying bats.

All of the bats attacked by the companion cat had at least one wing tear i.e., puncture to the wing membrane. We suggest the bats attacked by the companion cat did not die from their wing tears, but rather from other more immediately serious injuries. However, wing tears are a common injury found in bats still alive post-cat attack (Oedin et al. 2021) and can have serious consequences, particularly for their ability to fly, feed (Voight 2013) and survive. Natural wing repair is possible, but tears of the size we observed can take more than 100 days to repair completely (Faure et al. 2009). Wound infection is likely with cat bites because of the presence of bacteria, notably *Pasteurella multocida* (Mühldorfer et al. 2011). When in care, bitten bats often must be euthanised because of complications arising from bites (Borkin 2019) including infections, fractures, tearing of ligaments, and neurological damage due to the bat being shaken (New South Wales Wildlife Information Rescue and Education Service Inc. 2018). Bats are unlikely to recover from these complications when in care and are unlikely to survive in the wild.

Impacts of cats on bats in New Zealand could be managed by reducing numbers of cats or excluding cats entirely from areas where bats are likely to be present. To enable this, Gepp (2019) suggested considering the creation of a single, targeted law, or improvements to existing legislation and current practice focused on reducing/managing impacts of cats on wildlife. Large scale predator control that targets all predators of bats will most likely reduce cat impacts. In some cases, like our Pikiariki example, additional tools may be required, such as trapping that targets cats. Companion cats could be kept contained, either indoors, or with access to an outside enclosure ('catio') or secure garden (with cat-proof fencing). Alternatively, behavioural interventions could take place. For example, providing cats with high meat protein, grain-free food and introducing 5–10 min of daily object play with their humans reduced the number of prey items cats brought home; attaching bells to cats' collars did not (Cecchetti et al. 2020).

Conclusions

We report examples of companion and feral cats attacking and injuring or consuming bats in indigenous forest and rural landscapes; both had the opportunity to kill multiple

bats with likely effects on the local population. We note that not all cat attacks result in immediate death but may reduce likelihood of survival over a long period, due to reduced manoeuvrability and foraging success (Voight 2013). We suggest that the impact of feral, stray, and companion cats on bats is substantial and methods that minimise cat impacts be considered wherever bats and cats coincide.

Acknowledgements

We thank Callum Styles, DOC Pureora, for rapidly deploying the cat traps after the cat scat was found in Pikiariki. We thank the cat-owner, Ōtorohanga Kiwi House staff, veterinarians, and Leo and Neil Fitzgerald, whānau of LB, for support, contacting DOC, and taking care of injured bats. Talia Brav-Cubitt and team at Ecogene®, Manaaki Whenua – Landcare Research, New Zealand completed the DNA analyses; Stuart Hunter, Massey University Wildlife Diagnostic Service Laboratory, New Zealand completed the pathological assessments. We thank Jo Monks, Graham Hickling, Talia Brav-Cubitt, Stuart Hunter, Moira Pryde, Craig Gillies and an anonymous reviewer for reviewing and improving this manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Kerry M. Borkin http://orcid.org/0000-0002-0077-3666
Luke Easton http://orcid.org/0000-0002-9333-1137
Lucy Bridgman http://orcid.org/0000-0003-4022-5071

References

Altringham JD. 2011. Bats – from evolution to conservation. Oxford, United Kingdom: Oxford University Press.

Borkin KM. 2019. Initial veterinary care for New Zealand bats. Rotorua, New Zealand: Department of Conservation Kirikiriroa/Hamilton Office, Department of Conservation Wildlife Health Unit, The Wildlife Society of the New Zealand Veterinary Association, New Zealand Transport Agency. Wildland Consultants Contract Report No. 4984. https://ftp.doc.govt.nz/public/folder/J8y-HgKTuEmoYMZtafa6nA/bat-recovery/Best%20practice%20manual%20of%20conservation%20techniques%20for%20bats/Initial%20Veterinary%20Care%20for%20NZ%20Bats.pdf.

Cecchetti M, Crowley SL, Goodwin CED, McDonald RA. 2020. Provision of high meat content food and object play reduce predation of wild animals by domestic cats *Felis catus*. Current Biology. 31(5):1107–1111.

Daniel MJ, Williams GR. 1984. A survey of the distibution, seasonal activity and roost sites of New Zealand bats. New Zealand Journal of Ecology. 7:9–25.

Faure PA, Re DE, Clare EL. 2009. Wound healing in the flight membranes of big brown bats. Journal of Mammalogy. 90(5):1148–1156.

Fitzgerald BM, Karl BJ. 1986. Home range of feral house cats (*Felis catus* L.) in forest of the Orongorongo Valley, Wellington, New Zealand. New Zealand Journal of Ecology. 9:71–81.

Gepp S. 2019. Cats and wildlife: is New Zealand's existing regulatory framework too fragmented to enable effective management of cats' impacts on native species? [Paper submitted in partial fulfilment of Master of Laws; LLM Research Paper LAWS 582: Masters:Legal Writing]. Victoria University.

Khayak ROS, Grant RA, Ryan H, Melling LM, Dougill G, Killick DR, Shaw KJ. 2020. Investigating cat predation as the cause of bat wing tears using forensic DNA analysis. Ecology and Evolution. 10(5):1–11.
Landcare Research New Zealand Ltd. 2020. LCDB v5.0 - Land Cover Database version 5.0, Mainland, New Zealand. [accessed 2022 March 3]. https://lris.scinfo.org.nz/layer/104400-lcdb-v50-land-cover-database-version-50-mainland-new-zealand/metadata/.
Landcare Research New Zealand Ltd. 2022. Submit a sample. New Zealand: Manaaki Whenua-Landcare Research NZ Ltd; [accessed 2022 June 20]. https://www.landcareresearch.co.nz/partner-with-us/ecogene-dna-based-diagnostics/submit-a-sample/.
Metsers EM, Seddon PJ, van Heezik YM. 2010. Cat-exclusion zones in rural and urban-fringe landscapes: how large would they have to be? Wildlife Research. 37:47–56.
Mühldorfer K, Speck S, Kurth A, Lesnik R, Freuling C, Müller T, Kramer-Schadt S, Wibbelt G. 2011. Diseases and causes of death in European bats: dynamics in disease susceptibility and infection rates. PLoS ONE. 6(12):e29773.
New South Wales Wildlife Information Rescue and Education Service Inc. 2018. The bat manual: identification, rescue, rehabilitation and release. Brookvale, NSW 2100, Australia.
O'Donnell CF, Borkin KM. 2021. *Chalinolobus tuberculatus*. In: King CM, Forsyth DM, editors. The handbook of New Zealand mammals. Melbourne, Australia: CSIRO Publishing; p. 99–130.
O'Donnell CF, Borkin KM, Christie J, Lloyd B, Parsons S, Hitchmough R. 2018. Conservation status of New Zealand bats, 2017. New Zealand Threat Classification Series 21. Wellington, New Zealand: Department of Conservation. 4 p.
Oedin M, Brescia F, Millon A, Murphy BP, Palmas P, Woinarski JC, Vidal E. 2021. Cats *Felis catus* as a threat to bats worldwide: a review of the evidence. Mammal Review. 51(3):323–337. doi:10.1111/mam.12240.
Parsons S, Toth C. 2021. *Mystacina tuberculata*. In: King CM, Forsyth DM, editors. The handbook of New Zealand mammals. 3rd ed. Melbourne, Australia: CSIRO Publishing; p. 95–130.
Paul A. 2020. Companion animals in New Zealand 2016. Auckland, New Zealand.
Pryde MA, Lettink M, O'Donnell CF. 2006. Survivorship in two populations of long-tailed bats (*Chalinolobus tuberculatus*) in New Zealand. New Zealand Journal of Zoology. 33(2):85–95.
Pryde MA, O'Donnell CF, 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.
Rodríguez-Durán A, Pérez J, Montalbán MA, Sandoval JM. 2010. Predation by free-roaming cats on an insular population of bats. Acta Chiropterologica. 12(2):359–362.
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 Zoology. 39(3):257–260.
Voight CC. 2013. Bat flight with bad wings: is flight metabolism affected by damaged wings? Journal of Experimental Biology. 216(8):1516–1521.
Zito S, Walker J, Gates MC, Dale A. 2019. A preliminary description of companion cat, managed stray cat, and unmanaged stray cat welfare in Auckland, New Zealand using a 5-component assessment scale. Frontiers in Veterinary Science. 5:40.