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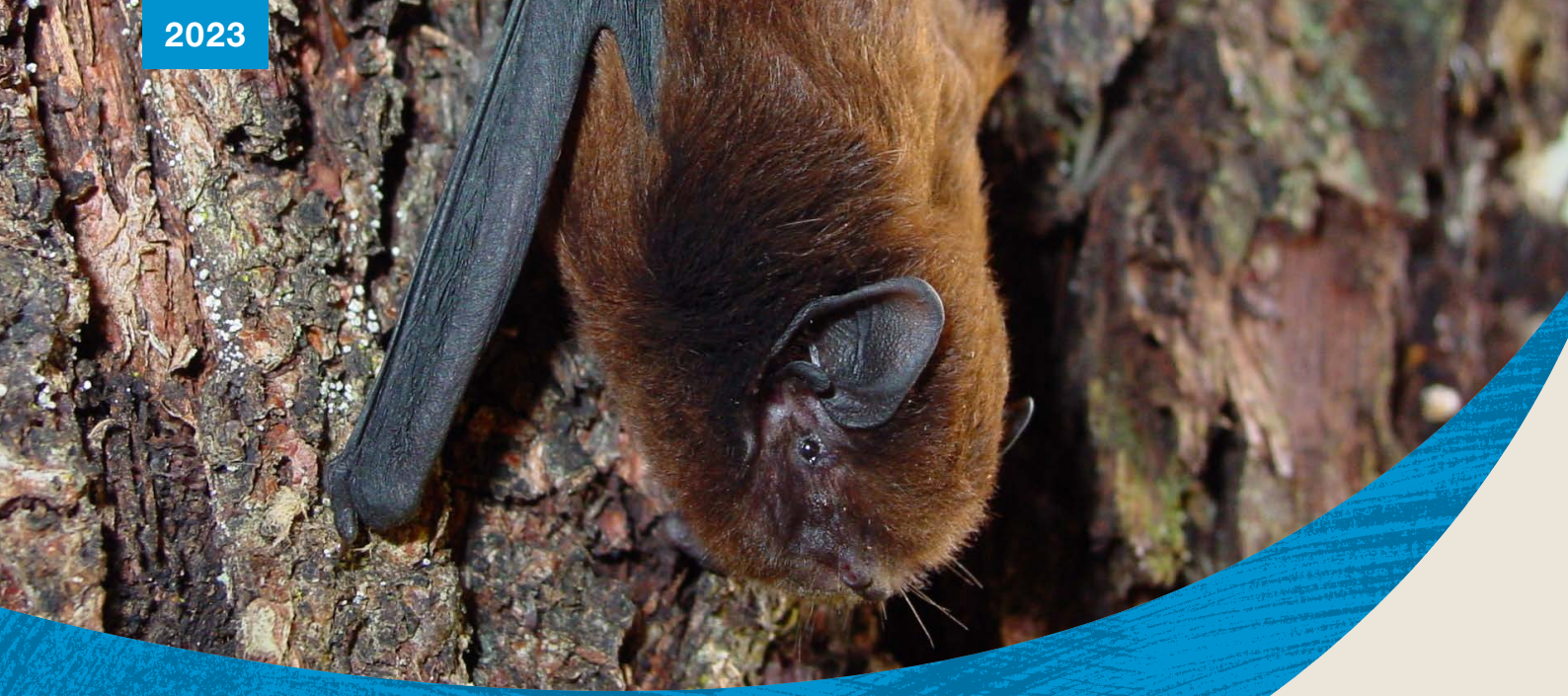

NEW ZEALAND THREAT CLASSIFICATION SERIES 41

Conservation status of bats in Aotearoa New Zealand, 2022

Colin F.J. O'Donnell, Kerry M. Borkin, Jenny Christie, Ian Davidson-Watts, Gillian Dennis, Moira Pryde and Pascale Michel

Department of Conservation
Te Papa Atawhai

Te Kāwanatanga o Aotearoa
New Zealand Government

Cover: Long-tailed bat (*Chalinolobus tuberculatus*; Threatened – Nationally Critical) in the Eglinton valley. *Photo: Colin O'Donnell*

New Zealand Threat Classification Series is a scientific monograph series presenting publications related to the New Zealand Threat Classification System (NZTCS). Most will be lists providing the NZTCS status of members of a group (e.g. algae, birds, spiders, fungi). There are currently 31 groups, each of which is assessed approximately once every 5 years. From time to time the manual that defines the categories, criteria, and process for the NZTCS will be reviewed. Publications in this series are considered part of the formal international scientific literature.

This publication is available for download from the Department of Conservation website. Refer www.doc.govt.nz under *Publications*.

The NZTCS database can be accessed at nztcs.org.nz. For all enquiries, email threatstatus@doc.govt.nz.

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Conservation status of bats in Aotearoa New Zealand, 2022

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Abstract

The conservation status of all six known taxa of bats in Aotearoa New Zealand was reassessed using the New Zealand Threat Classification System (NZTCS). A list of these taxa is presented, along with a statistical summary and notes on their current status. This list replaces all previous NZTCS lists for bats. In total, three taxa were assessed as being Threatened, one as At Risk and one as Non-resident Native – Vagrant. One further taxon was assessed as Data Deficient (i.e. insufficient information is available to assess its conservation status). Aotearoa New Zealand has low natural bat diversity compared with other countries, and bats have also suffered considerable declines since humans arrived in the country. One species, the greater short-tailed bat (*Mystacina robusta*), has not been seen since 1967. Extant taxa are subject to similar threats, namely habitat loss, habitat degradation, disturbance and the impacts of introduced predators. Recent studies have indicated that effective predator control can reverse these declines, at least in cool forests, although the number of bat habitats where intensive and effective predator control is being undertaken remains small. Furthermore, some threats are increasing in intensity, particularly as a result of increases in the scale and frequency of infrastructure projects in bat habitats, and climate change is an emerging threat that is likely to result in increased pressure from predators and changes in habitat quality.

Keywords: long-tailed bat, Mystacinidae, Pteropodidae, short-tailed bat, Vespertilionidae

O'Donnell, C.F.J.; Borkin, K.M.; Christie, J.; Davidson-Watts, I.; Dennis, G.; Pryde, M.; Michel, P. 2023: Conservation status of bats in Aotearoa New Zealand, 2022. *New Zealand Threat Classification Series 41*. Department of Conservation, Wellington. 18 p.

1. Background

The New Zealand Threat Classification System (NZTCS) was developed in 2002 to complement the International Union for Conservation of Nature (IUCN) Red List system. Categories and criteria were defined to reflect Aotearoa New Zealand's unique environments and to account for the country's relatively small size and diversity of ecosystems, as well as the large number of taxa with naturally restricted ranges and/or small population sizes (Molloy et al. 2002). The conservation status of bats in Aotearoa New Zealand was first assessed using the NZTCS in 2002, when six taxa were listed (Hitchmough 2002), and was re-assessed in 2005 (Hitchmough et al. 2007).

The NZTCS methodology was refined in 2007 to ensure that all possible combinations of status and trend were covered within the different categories. The resulting manual (Townsend et al. 2008) was used to re-assess the conservation status of bats in 2009 (O'Donnell et al. 2010), 2012 (O'Donnell et al. 2013) and 2017 (O'Donnell et al. 2018). Some minor changes to the categories, criteria and qualifiers have since been proposed by Rolfe et al. (2021) and Michel (2021) and were incorporated into this latest assessment, as follows:

- The status At Risk – Recovering A for taxa with increasing populations that still have relatively small, vulnerable populations (1000–5000 mature individuals or occupy less than 100 ha) has been moved into the Threatened category and renamed Threatened – Nationally Increasing, with no change to the criteria. This was done to address the fact that when the growth of a population assessed as Recovering A stabilised, the taxon moved to the category Threatened – Nationally Vulnerable, despite there being no deterioration in the taxon's population. The term Nationally Increasing does not imply that the population is increasing consistently across its entire geographical range but rather that the total population of the taxon in Aotearoa New Zealand is predicted to increase by >10% in three generations.
- The qualifier Climate Impact (CI) has been added to reflect newly recognised pressures from changing environments and to acknowledge taxa that are or will be adversely affected by long-term climate trends and/or extreme events.
- The qualifier Conservation Research Needed (CR) has been added to indicate the need for research to better understand the causes of decline and/or a solution for recovery.
- The qualifier Population Fragmentation (PF) has been added, covering some taxa that previously triggered the qualifier Sparse, to indicate that gene flow between sub-populations is hampered as a direct or indirect result of human activity.

NZTCS assessments are reviewed approximatively every 5 years by a panel comprising experts from the New Zealand Department of Conservation Te Papa Atawhai (DOC) and external organisations, as well as independent experts. The assessment panel brings together experts in the fields of taxonomy, conservation biology and ecology who have deep knowledge on a specific taxonomic group and/or are recognised by their peers as active experts in the field. The panel also includes people with a good technical knowledge of the NZTCS process to ensure consistent approaches across the various assessment panels. For this assessment, the expert panel consisted of six members plus one administration/support staff. Four of the panel members were employees of DOC and two were external to DOC, and all six were currently active in bat management and research work.

A call for information was advertised through DOC's 'Have your say' process (www.doc.govt.nz/new-assessment-of-the-conservation-status-of-new-zealand-bats), the NZTCS website and expert networks. This engagement process was initiated 3 months prior to the assessment meeting with the aim of collating data from local and regional monitoring programmes before the expert panel met. For this assessment, three submissions were received and considered by the expert panel.

In making their assessments, experts consider the previously published assessment as the starting point for the new assessment and evaluate any new information available, both published and unpublished. Taxa are assessed according to the reported population size and trend since the last assessment (usually over the past 5 years) and predicted future changes over the next 10 years or three generations, whichever is the longest. Thus, assigning accurate threat classifications is dependent on knowing species distributions, population sizes, population trends and generation lengths.

While the distributions of bats in Aotearoa New Zealand are relatively well known, their population sizes are not, and reasonable estimates of population decline have only been calculated for long-tailed bats (*Chalinolobus tuberculatus*). O'Donnell et al. (2010) estimated a generation length of 12 years for Aotearoa New Zealand taxa, and this still remains our best estimate. Pacifici et al.'s (2013) database gave a much shorter generation length of 5.2–5.6 years for bats in Aotearoa New Zealand, but this was considered an underestimate as it was extrapolated from bat species in other countries. Recalculation of the generation length using Equation 1 in Pacifici et al. (2013) and modern data suggests a generation length of 8.67 years for all Aotearoa New Zealand taxa. However, marking studies in Aotearoa New Zealand are yet to record maximum longevity, because the oldest bats were marked as adults and many of these individuals are still alive. The oldest known-age marked female long-tailed bat breeding in the Eglinton valley was at least 24 years old, since it was banded as a breeding adult (O'Donnell & Borkin 2021), and in the longest running tagging study of lesser short-tailed bats (*Mystacina tuberculata*), numerous bats tagged as adults in the first 2 years of the study are still alive, 16 years later (M. Pryde, unpubl. data). Recent modelling suggests that long-tailed bats can live for >30 years (Colchero et al. 2019). Thus, the panel considered that the generation length was underestimated using Pacifici et al.'s (2013) calculation. Therefore, the assessments were made over 36 years (three generations).

Assessment criteria and categories are interpreted in the context of scientific evidence (e.g. population monitoring) and expert understanding of the ecology of each taxon/order (e.g. natural population fluctuations), and the NZTCS manual requires that a precautionary approach is applied where a taxon is on the border of two possible threat categories, resulting in the higher threat category being chosen. Notes from the expert panel meeting and rationale for the reclassification of taxa have been summarised in the present report. Full details can be found online on the assessment page for each taxon on the NZTCS website (https://nztcs.org.nz/reports/1082).

2. Summary

This report presents the conservation status of all six known taxa of bats in Aotearoa New Zealand. It is the latest update in a regular series of reassessments of the conservation status of bat taxa in Aotearoa New Zealand (Hitchmough 2002; Hitchmough et al. 2007; O'Donnell et al. 2010, 2013, 2018), using the criteria specified in the NZTCS manual (Townsend et al. 2008).

The conservation status of all six taxa has remained the same since the previous assessment in 2017 by O'Donnell et al. (2018) (Table 1). In total, three taxa were assessed as being Threatened, one as At Risk and one as Non-resident Native – Vagrant. One further taxon was assessed as Data Deficient (i.e. insufficient information is available to assess its conservation status).

Table 1. Comparison of the status of bat taxa in Aotearoa New Zealand assessed in 2002 (Hitchmough 2002), 2005 (Hitchmough et al. 2007), 2009 (O'Donnell et al. 2010), 2012 (O'Donnell et al. 2013), 2017 (O'Donnell et al. 2018) and 2022 (this report).

CONSERVATION STATUS	2002	2005	2009	2012	2017	2022
Data Deficient	1	1	1	1	1	1
Threatened – Nationally Critical			1	1	1	1
Threatened – Nationally Endangered	3	2	1	2		
Threatened – Nationally Vulnerable	1	1	2	1	1	1
Threatened – Nationally Increasing*					1	1
At Risk – Declining			1	1	1	1
At Risk – Naturally Uncommon	1					
Non-resident Native – Vagrant			1	1	1	1
Total	**6**	**4**	**7**	**7**	**6**	**6**

* The status At Risk – Recovering A defined in Townsend et al. (2008) and used in 2017 has been renamed Threatened – Nationally Increasing in this assessment following Michel (2021).

3. Threats to bats in Aotearoa New Zealand

Long-tailed and both lesser and greater short-tailed bats are subject to similar threats, namely habitat loss, habitat degradation, disturbance and the impacts of introduced predators (O'Donnell et al. 2010). Lesser short-tailed bats are also at some risk of primary or secondary poisoning from some of the anticoagulant toxins that are used in pest control if they are used incorrectly or in sensitive locations (Dennis & Gartrell 2015). Recent studies have indicated that effective predator control can reverse the declines in both long-tailed and lesser short-tailed bats, at least in cool forests (O'Donnell et al. 2011, 2017; Edmonds et al. 2017). However, the number of locations where intensive predator control is being undertaken to protect bats remains small and, in the absence of effective predator control, populations are likely to be declining at rates of 5–9% each year (Pryde et al. 2005, 2006).

While the loss of habitat and felling of forests on a large scale mainly occurred historically, some habitat loss and fragmentation is ongoing and, in some cases, is intensifying due to an increase in the scale and frequency of major infrastructure projects in bat habitats. For example, there are recent examples of the potential loss of significant long-tailed bat habitats for rural subdivisions (Pryde 2022), refuse sites (Thurley 2022), large roading projects (O'Donnell 2014) and wind farms (Thurley 2021) – and in some areas, there are examples of trees being felled with bats being killed. These threats are especially relevant to the survival of long-tailed bats, which use riparian habitats that are under threat in some parts of the country and are under pressure from logging in plantation forests, particularly in the North Island (Borkin et al. 2011).

There has been a significant increase in the number of proposed wind farms in Aotearoa New Zealand (Zhang et al. in press). Installation of additional wind turbines would heighten the risk of collisions when placed where bats are present. There has been widespread international research on the significant effects of wind farms, which kill numerous bat species wherever they occur (Barclay et al. 2007; Baerwald et al. 2008; Cryan & Barclay 2009; Grodsky et al. 2011; Arnett & Baerwald 2013; Roscioni et al. 2013). Direct causes of fatalities include collisions with the towers and blades, and barotrauma (injuries caused by the increased air pressure) (Cryan & Barclay 2009). Bats may also be attracted to wind turbines to investigate if they are a potential roost because the tower produces an echo signature that is similar to that of a tree (Cryan et al. 2014).

Another emerging threat is the recent spread of the soil-borne pathogen *Phytophthora agathidicida* in the northern North Island, which has resulted in the loss of kauri (*Agatha australis*) (Bradshaw et al. 2020). These trees are primary roosts for both long-tailed and lesser short-tailed bats in this region (Daniel 1979; Alexander 2001).

There is concern that a warming climate will increase the predation pressure on bats by introduced predators, particularly rats (*Rattus* spp.). Research suggests that a warming climate will lead to increases in both the frequency and volume of mast seeding events that drive rat irruptions (Richardson et al. 2005). This, along with predicted increases in occupancy of higher altitudes by rats (Walker et al. 2019), means that there will be fewer cool forest locations where bats will be less exposed to high levels of predation pressure from rats. This also means that there will be higher rat abundance with higher predation pressure on bats for longer periods across all altitudes and forest types. Additionally, increased rat densities would likely result in an increased intensity and frequency of vertebrate pesticide use, increasing the risk of non-target exposure and any unknown long-term effects of this on the health of bats in Aotearoa New Zealand, potentially increasing the risk of death (Dennis 2019).

Other climate change effects are more speculative. For example, an increased frequency of storm events may result in more wind-throw events, resulting in an increased mortality of tree roosts; more frequent mast seeding may influence the longevity and senescence of forest trees; and drought events, particularly in the northernmost forests, could potentially reduce food availability.

4. Conservation status of all known bat taxa in Aotearoa New Zealand

4.1 Species accounts

4.1.1 Long-tailed bat (*Chalinolobus tuberculatus*)

Long-tailed bat populations are declining at a rate of 5–9% per annum, equating to an 84–96% decline over three generations (estimated as 36 years), in places where their predators are not managed to very low levels (Pryde et al. 2005, 2006). Although population declines have been reversed in the Eglinton and Whirinaki forests through intensive predator management (O'Donnell et al. 2017; S. Wills, DOC Murupara Office, pers. comm.), there is no intensive predator control throughout most of the species' range and populations are considered to be declining. Furthermore, colonies in the Maruia, Pureora and Whareorino forests appear to be continuing to decline despite intensive management (L. Bridgman, DOC, pers. comm.; M. Pryde, unpubl. data). Long-tailed bat colonies have large ranges, and radio-tracking studies are revealing that some predator control areas are not large enough to protect bats roosting throughout the area that is used by their entire colony (e.g. Pelorus and Pureora forests; Dennis 2022a; M. Pryde, unpubl. data).

Although new surveys for long-tailed bats regularly obtain new records and the species appears to be widespread, the health and survival of these populations is unknown, and the colonies that are found appear to be small (e.g. Griffiths et al. 2021; Dennis 2022b). Long-tailed bats are also highly mobile, with straight-line distances between roosts and foraging grounds of 10 km to > 25 km. Single colonies range over more than 150 km^2, and the same bats can be recorded across a wide range, even in one night, which can give a false sense of abundance (O'Donnell 2001; Davidson-Watts Ecology (Pacific) Ltd 2019). However, this mobility cannot be interpreted as an ability to move and adapt to new roosting sites because colonies show strong roost site fidelity, needing to return to their traditional roosting areas each morning (O'Donnell & Sedgeley 2006). We have assumed that long-tailed bat populations are declining at a similar rate across the species' range, largely because unmonitored populations are exposed to the same or worse threats as populations at monitored sites.

4.1.2 Northern lesser short-tailed bat (*Mystacina tuberculata aupourica*)

The northern lesser short-tailed bat is one of three subspecies of lesser short-tailed bat. It is largely represented by only one secure population on predator-free Te Hauturu-o-Toi/Little Barrier Island, where the population is thought to number > 2000 bats. A small remnant of the previously extensive Ōmahuta–Puketī population was rediscovered in 2019, but only c. 300 bats are present and the subspecies is likely declining without predator management over most of its range (C. Vestena, DOC Pewhairangi/Bay of Islands Office, pers. comm.). Surveys in recent years have failed to find these bats in two other forest blocks where they had previously been observed (Warawara and Waipoua).

4.1.3 Central lesser short-tailed bat (*Mystacina tuberculata rhyacobia*)

Found in the central North Island, the central lesser short-tailed bat is the most widespread and numerous subspecies of lesser short-tailed bat. The sum of the most recent roost counts at five managed sites exceeded 15 000 bats, and predator management at several key sites in Whirinaki, Pureora and Rangataua is likely maintaining or increasing numbers. The annual

survival of adult females in the Pureora predator control area is >80%, but the status of other populations with recent records in Raukūmara, North Taranaki and Kaimanawa is unknown. There are no recent records for populations on the Mamaku Plateau and in Whanganui National Park, although lesser short-tailed bat populations may persist in these areas. Extensive surveys in the Tararua Range indicate that lesser short-tailed bats may now be locally extinct there.

4.1.4 Southern lesser short-tailed bat (*Mystacina tuberculata tuberculata*)

The southern lesser short-tailed bat has been reduced to just three known populations in the South Island, which remain localised and vulnerable. Recent surveys following a series of rat irruptions have failed to find these bats in the Ōpārara Basin (M. Pryde, unpubl. data), where they were last recorded in the mid-2000s. One population in the Eglinton valley has increased from c. 300 to >4000 individuals following c. 15 years of intensive predator control (R. Jackson, DOC Te Anau Area Office, pers. comm.). However, maintaining this gain is dependent on predator management being sustained and remaining effective (Edmonds et al. 2017). A second population on Codfish Island/Whenua Hou is thought to be stable following the eradication of rats from the island in 1998. However, this observation is anecdotal because no monitoring has been undertaken since the eradication, and the status of this population is dependent on maintaining effective island biosecurity systems and monitoring so that pests do not reinvade. A third population that has only recently been discovered in the Murchison Mountains appears to be very small (c. 300 bats) and is likely declining (Jackson 2020).

4.1.5 Greater short-tailed bat (*Mystacina robusta*)

Greater short-tailed bats were last seen on Taukihepa/Big South Cape Island in the southern Tītī/Muttonbird Islands in 1967 following an invasion by rats (O'Donnell et al. 2010). However, short-tailed bat-like calls were recorded on Putauhina Island in 1999 following anecdotal sightings of bats after the commencement of systematic rat eradications on the islands. Anecdotal reports have continued, but the presence of bats has not been confirmed after a series of brief trips to the islands between 1999 and 2017. It was previously thought that lesser short-tailed bats were also present on the southern Tītī/Muttonbird Islands. However, recent DNA analyses have shown that historic specimens from this location were all greater short-tailed bats despite their relatively small body sizes (Oldfield 2020).

4.1.6 Little red flying fox (*Pteropus scapulatus*)

Sightings of little red flying foxes, an Australian species, have been restricted to one confirmed record of vagrants in Hamilton in 1927–1929 (O'Donnell et al. 2010).

4.2 Assessments

Taxa were assessed according to the criteria of Townsend et al. (2008) and have been grouped in Table 2 by conservation status and then alphabetically by scientific name. The IUCN category is listed alongside the NZTCS listing. Data Deficient appears at the top of the list. Categories are then ordered by degree of loss, with Threatened at the top and Non-resident Native at the bottom. Brief descriptions of the NZTCS categories and criteria for assessments are provided in section 4.3. See Townsend et al. (2008), Michel (2021) and Rolfe et al. (2021) for details.

The full data for the assessments listed in Table 2 can be viewed and downloaded at https://nztcs.org.nz/reports/1082.

Table 2. Conservation status of all known bat taxa in Aotearoa New Zealand.

Qualifiers are abbreviated as follow: CD = Conservation Dependent, CI = Climate Impact, CR = Conservation Research Needed, OL = One Location, PD = Partial Decline, PF = Population Fragmentation, RR = Range Restricted. Further details about each of these can be found at https://nztcs.org.nz.

NAME AND AUTHORITY	COMMON NAME	FAMILY	CRITERIA	QUALIFIERS	STATUS CHANGE
DATA DEFICIENT (1)					
Mystacina robusta Dwyer, 1962 IUCN: Critically Endangered (Possibly Extinct) D, ver 3.1, 2021	greater short-tailed bat	Mystacinidae		OL	No change
THREATENED (3)					
NATIONALLY CRITICAL (1)					
Chalinolobus tuberculatus Forster, 1844 IUCN: Critically Endangered A2ace, ver 3.1, 2021	long-tailed bat	Vespertilionidae	C	CI, CD, CR, PF	No change
NATIONALLY VULNERABLE (1)					
Mystacina tuberculata aupourica Hill & Daniel, 1985 IUCN: Mystacina tuberculata, Vulnerable A4bce, ver 3.1, 2021	northern lesser short-tailed bat	Mystacinidae	C(1)	CI, CD, CR, PD, PF, RR	No change
NATIONALLY INCREASING (1)					
Mystacina tuberculata tuberculata Gray, 1843 IUCN: *Mystacina tuberculata*, Vulnerable A4bce, ver 3.1, 2021	southern lesser short-tailed bat	Mystacinidae		CI, CD, CR, PF	No change
AT RISK (1)					
DECLINING (1)					
Mystacina tuberculata rhyacobia Hill & Daniel, 1985 IUCN: *Mystacina tuberculata*, Vulnerable A4bce, ver 3.1, 2021	central lesser short-tailed bat	Mystacinidae	B(1)	CI, CD, CR	No change
NON-RESIDENT NATIVE (1)					
VAGRANT (1)					
Pteropus scapulatus Peters, 1862 IUCN: Least Concern, ver 3.1, 2016	little red flying fox	Pteropodidae			No change

4.3 NZTCS categories, criteria and qualifiers

Full details of the criteria and qualifiers included in Table 2 can be found in Rolfe et al. (2021). Summary definitions for the categories are presented below.

Data Deficient

Taxa that cannot be assessed due to a lack of current information about their distribution and abundance. It is hoped that listing such taxa will stimulate research to find out the true category (for a fuller definition, see Townsend et al. (2008)).

Threatened

Taxa that meet the criteria specified by Townsend et al. (2008) for the categories Nationally Critical, Nationally Endangered and Nationally Vulnerable.

NATIONALLY CRITICAL

A – very small population (natural or unnatural)

A(1) < 250 mature individuals

A(2) ≤ 2 sub-populations, ≤ 200 mature individuals in the larger sub-population

A(3) Total area of occupancy ≤ 1 ha (0.01 km^2)

B – small population with a high ongoing or forecast decline of 50–70%

B(1) 250–1000 mature individuals

B(2) ≤ 5 sub-populations, ≤ 300 mature individuals in the largest sub-population

B(3) Total area of occupancy ≤ 10 ha (0.1 km^2)

C – population (irrespective of size or number of sub-populations) with a very high ongoing or forecast decline of > 70%

C Predicted decline > 70%

NATIONALLY ENDANGERED

A – small population that has a low to high ongoing or forecast decline of 10–50%

A(1) 250–1000 mature individuals

A(2) ≤ 5 sub-populations, ≤ 300 mature individuals in the largest sub-population

A(3) Total area of occupancy ≤ 10 ha (0.1 km^2)

B – small, stable population (unnatural)

B(1) 250–1000 mature individuals

B(2) ≤ 5 sub-populations, ≤ 300 mature individuals in the largest sub-population

B(3) Total area of occupancy ≤ 10 ha (0.1 km^2)

C – moderate population and high ongoing or forecast decline of 50–70%

C(1) 1000–5000 mature individuals

C(2) ≤ 15 sub-populations, ≤ 500 mature individuals in the largest sub-population

C(3) Total area of occupancy ≤ 100 ha (1 km^2)

NATIONALLY VULNERABLE

A – small population (unnatural), increasing >10%

A(1) 250–1000 mature individuals

A(2) ≤5 sub-populations, ≤300 mature individuals in the largest sub-population

A(3) Total area of occupancy ≤10 ha (0.1 km^2)

B – moderate population (unnatural), stable ±10%

B(1) 1000–5000 mature individuals

B(2) ≤15 sub-populations, ≤500 mature individuals in the largest sub-population

B(3) Total area of occupancy ≤100 ha (1 km^2)

C – moderate population and population trend that has a low to high ongoing or forecast decline of 10–50%

C(1) 1000–5000 mature individuals

C(2) ≤15 sub-populations, ≤500 mature individuals in the largest sub-population

C(3) Total area of occupancy ≤100 ha (1 km^2)

D – moderate to large population and moderate to high ongoing or forecast decline of 30–70%

D(1) 5000–20 000 mature individuals

D(2) ≤15 sub-populations, ≤1000 mature individuals in the largest sub-population

D(3) Total area of occupancy ≤1000 ha (10 km^2)

E – large population and high ongoing or forecast decline of 50–70%

E(1) 20 000–100 000 mature individuals

E(2) Total area of occupancy ≤10 000 ha (100 km^2)

NATIONALLY INCREASING

This is a new name and category for At Risk – Recovering A of Townsend et al. (2008).

Taxa that have undergone a documented decline within the last 1000 years to a population size of 1000–5000 mature individuals or a total area of occupancy of ≤100 ha (1 km^2) and now have an ongoing or predicted increase of >10% in the total population or area of occupancy, taken over the longer of the next 10 years or three generations.

Taxa that are increasing but have a population size of <1000 mature individuals (or a total area of occupancy of <10 ha) are listed in one of the other Threatened categories, depending on their population size (for more details, see Townsend et al. (2008)).

At Risk

DECLINING

A – moderate to large population and low ongoing or forecast decline of 10–30%

A(1) 5000–20 000 mature individuals

A(2) Total area of occupancy ≤1000 ha (10 km^2)

B – large population and low to moderate ongoing or forecast decline of 10–50%

B(1) 20 000–100 000 mature individuals

B(2) Total area of occupancy ≤10 000 ha (100 km^2)

C – very large population and low to high ongoing or forecast decline of 10–70%

C(1) >100 000 mature individuals

C(2) Total area of occupancy >10 000 ha (100 km^2)

RELICT

Taxa that have undergone a documented decline within the last 1000 years and now occupy <10% of their former range and meet one of the following criteria:

A 5000–20 000 mature individuals; population stable (±10%)

B >20 000 mature individuals; population stable or increasing at >10%

The range of a relictual taxon takes into account the area currently occupied as a ratio of its former extent. Relict can also include taxa that exist as reintroduced and self-sustaining populations within or outside their former known range (for more details, see Townsend et al. (2008)).

NATURALLY UNCOMMON

Taxa whose distributions are confined to a specific geographical area or which occur within naturally small and widely scattered populations, where these distributions are not the result of human disturbance.

Not Threatened

Resident native taxa that have large, stable populations.

Introduced and Naturalised

Taxa that have become naturalised in the wild after being deliberately or accidentally introduced into Aotearoa New Zealand by human agency.

Non-resident Native

Taxa whose natural presence in Aotearoa New Zealand is either discontinuous (Migrant) or sporadic or temporary (Vagrant), or which have succeeded in recently (since 1950) establishing a resident breeding population (Coloniser).

MIGRANT

Taxa that predictably and cyclically visit Aotearoa New Zealand as part of their normal life cycle (a minimum of 15 individuals known or presumed to visit per annum) but do not breed here.

VAGRANT

Taxa whose occurrences, though natural, are sporadic and typically transitory, or migrants with fewer than 15 individuals visiting Aotearoa New Zealand per annum.

COLONISER

Taxa that would otherwise trigger Threatened or At Risk categories because of their small population sizes, have arrived in Aotearoa New Zealand without help from humans and have been successfully reproducing in the wild only since 1950.

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6. References

Alexander, J. 2001: Ecology of long-tailed bats *Chalinolobus tuberculatus* (Forster, 1844) in the Waitakere Ranges: implications for monitoring. Unpublished MSc thesis, Lincoln University, Lincoln.

Arnett, E.B.; Baerwald, E.F. 2013: Impacts of wind energy development on bats: implications for conservation. Pp. 435–456 in Adams, R.A.; Pedersen, S.C. (Eds): Bat evolution, ecology, and conservation. Springer New York.

Baerwald, E.F.; D'Amours, G.H.; Klug, B.J.; Barclay, R.M.R. 2008: Barotrauma is a significant cause of bat fatalities at wind turbines. *Current Biology 18*: 695–696.

Barclay, R.M.R.; Baerwald, E.F.; Gruver, J.C. 2007: Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. *Canadian Journal of Zoology 85*: 381–387.

Borkin, K.M.; O'Donnell, C.F.J.; 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*: 3537–3548.

Bradshaw, R.E.; Bellgard, S.E.; Black, A.; Burns, B.R.; Gerth, M.L.; McDougal, R.L.; Scott, P.M.; Waipara, N.W.; Weir, B.S.; Williams, N.M.; Winkworth, R.C. 2020: *Phytophthora agathidicida*: research progress, cultural perspectives and knowledge gaps in the control and management of kauri dieback in New Zealand. *Plant Pathology 69*: 3–16.

Colchero, F.; Jones, O.; Conde, D.A.; Hodgson, D.; Zajitschek, F.; Schmidt, B.R.; Malo, A.F.; Alberts, S.C.; Becker, P.H.; Bouwhuis, S.; Bronikowski, A.M.; De Vleeschouwer, K.M.; Delahay, R.J.; Dummermuth, S.; Fernández-Duque, E.; Frisenvænge, J.; Hesselsøe, M.; Larson, S.; Lemaître, J.-F.; McDonald, J.; Miller, D.A.; O'Donnell, C.; Packer, C.; Raboy, B.E.; Reading, C.J.; Wapstra, E.; Weimerskirch, H.; While, G.M.; Baudisch, A.; Flatt, T.; Coulson, T.; Gaillard, J.-M. 2019: The diversity of population responses to environmental change. *Ecology Letters 22*: 342–353. doi:10.1111/ele.13195

Cryan, P.M.; Barclay, R.M.R. 2009: Causes of bat fatalities at wind turbines: hypotheses and predictions. *Journal of Mammalogy 90*: 1330–1340.

Cryan, P.M.; Gorresen, P.M.; Hein, C.D.; Schirmacher, M.R.; Diehl, R.H.; Huso, M.M.; Hayman, D.T.; Fricker, P.D.; Bonaccorso, F.J.; Johnson, D.H. 2014: Behavior of bats at wind turbines. *PNAS 111(42)*: 15126–15131.

Daniel, M.J. 1979: The New Zealand short-tailed bat, *Mystacina tuberculata*; a review of present knowledge. *New Zealand Journal of Zoology 6*: 357–370.

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

Dennis, G. 2019: Minimising non-target impacts of anticoagulant rodenticide use for a highly susceptible species, the New Zealand lesser short-tailed bat (*Mystacina tuberculata*). Unpublished PhD thesis, Massey University, Palmerston North. 234 p.

Dennis, G. 2022a: Long-tailed bat (*Chalinolobus tuberculatus*) monitoring in the Pelorus catchment, Season 3: 2020–2021. A report for the Royal Forest and Bird Protection Society, Wellington.

Dennis, G. 2022b: Long-tailed bat (*Chalinolobus tuberculatus*) monitoring in the Pelorus catchment, Season 4: 2021–2022. A report for the Royal Forest and Bird Protection Society, Wellington.

Dennis, G.C.; Gartrell, B.D. 2015: Nontarget mortality of New Zealand lesser short-tailed bats (*Mystacina tuberculata*) caused by diphacinone. *Journal of Wildlife Diseases 51*: 177–186.

Edmonds, H.; Pryde, M.; O'Donnell, C.F.J. 2017: Survival of PIT-tagged lesser short-tailed bats (*Mystacina tuberculata*) through a pest control operation using an aerial application of the toxin 1080. *New Zealand Journal of Ecology 41*: 186–192.

Griffiths, K.; More; J. Quinell, A. 2021: Ngā Pekapeka o Ngā Motu Rākau o Ruataniwha: Protecting and enhancing long-tailed bat populations in Central Hawke's Bay. Assessment of colonies and roosting sites in Makaretu and Tukituki areas over two summers. December 2019 to February 2021. The Conservation Company, Waipawa.

Grodsky, S.M.; Behr, M.J.; Gendler, A.; Drake, D.; Dieterle, B.D.; Rudd, R.J.; Walrath, N.L. 2011: Investigating the causes of death for wind-turbine-associated bat fatalities. *Journal of Mammalogy 92*: 917–925.

Hitchmough, R. (comp.) 2002: New Zealand Threat Classification System lists—2002. *Threatened Species Occasional Publication 23*. Department of Conservation, Wellington. 210 p. www.doc.govt.nz/documents/science-and-technical/tsop23.pdf

Hitchmough, R.; Bull, L.; Cromarty, P. 2007: New Zealand Threat Classification System lists 2005. Department of Conservation, Wellington. 194 p. www.doc.govt.nz/nz-threat-classification-system-lists-2005

Jackson, B. 2020: Murchison Mountains lesser short-tailed bat monitoring. Department of Conservation, Te Anau (unpublished report).

Michel, P. 2021: Amendment to the New Zealand Threat Classification System manual 2008: revised categories 2021. Department of Conservation, Wellington. 5 p. www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs-amendment-revised-categories-2021.pdf

Molloy, J.; Bell, B.; Clout, M.; de Lange, P.; Gibbs, G.; Given, D.; Norton, D.; Smith, N.; Stephens, T. 2002: Classifying species according to threat of extinction. A system for New Zealand. *Threatened Species Occasional Publication 22*. Department of Conservation, Wellington. 26 p. www.doc.govt.nz/globalassets/documents/science-and-technical/tsop22.pdf

O'Donnell, C.F.J. 2001: Home range and use of space by *Chalinolobus tuberculatus*, a temperate rainforest bat from New Zealand. *Journal of Zoology (London) 253*: 253–264.

O'Donnell, C.F.J. 2014: Statement of evidence of Colin Francis John O'Donnell for the Director General of Conservation. In the matter of the Resource Management Act 1991 and in the matter of the Notice of Requirements from NZTA and Hamilton City Council for designations to construct, operate and maintain the Southern Links Roading Network. Department of Conservation, Hamilton.

O'Donnell, C.F.J.; Borkin, K.M. 2021: *Chalinolobus tuberculatus*. Pp. 96–107 in King, C.M.; Forsyth, D.M. (Eds): The handbook of New Zealand mammals. 3rd edn. CSIRO Publishing, Melbourne.

O'Donnell, C.F.J.; Borkin, K.M.; Christie, J.E.; Lloyd, B.; Parsons, S.; Hitchmough, R.A. 2018: Conservation status of New Zealand bats, 2017. *New Zealand Threat Classification Series 21*. Department of Conservation, Wellington. 4 p. www.doc.govt.nz/Documents/science-and-technical/nztcs21.pdf

O'Donnell, C.F.J.; Christie, J.E.; Hitchmough, R.A.; Lloyd, B.; Parsons, S. 2010: The conservation status of New Zealand bats, 2009. *New Zealand Journal of Zoology 37*: 297–311. doi:10.1080/03014223.2010.513395

O'Donnell, C.F.J.; Christie, J.E.; Lloyd, B.; Parsons, S. 2013: The conservation status of New Zealand bats, 2012. *New Zealand Threat Classification Series 6*. Department of Conservation, Wellington. 8 p.

O'Donnell, C.F.J.; Edmonds, H.; Hoare, J.M. 2011: Survival of PIT-tagged lesser short-tailed bats (*Mystacina tuberculata*) through a pest control operation using the toxin pindone in bait stations. *New Zealand Journal of Ecology 35*: 30–43.

O'Donnell, C.F.J.; Sedgeley, J.A. 2006: Causes and consequences of tree-cavity roosting in a temperate bat, *Chalinolobus tuberculatus*, from New Zealand. Pp. 308–328 in Zubaid, A.; McCracken, G.F.; Kunz, T.H. (Eds): Functional and evolutionary biology of bats. Oxford University Press, New York.

Oldfield, I.F. 2020: Historical genetic diversity of the greater short-tailed bat (*Mystacina robusta*). Unpublished Master of International Nature Conservation thesis, Lincoln University, New Zealand, and Georg-August-Universität Göttingen, Germany.

Pacifici, M.; Santini, L.; Di Marco, M.; Baisero, D.; Francucci; L.; Grottolo Marasini, G.; Visconti, P.; Rondinini, C. 2013: Data from: Generation length of mammals, Dryad, Dataset. Available at http://doi.org/10.5061/dryad.gd0m3, version 1.0 (last updated on 27 August 2013). Resource ID: 10.5061/dryad.gd0m3; Data Paper ID: doi:10.3897/natureconservation.5.5734

Pryde, M.A. 2022: Statement of evidence of Moira Anne Pryde for the Director General of Conservation/ Te tumuaki ahurei submission 38 FS013 – Bat ecology. In the matter of the Resource Management Act 1991 and in the matter of Proposed Plan Change 5 – Peacocke Structure Plan by Hamilton District Council. Department of Conservation, Hamilton.

Pryde, M.A.; Lettink, M.; O'Donnell, C.F.J. 2006: Survivorship in two populations of long-tailed bats (*Chalinolobus tuberculatus*) in New Zealand. *New Zealand Journal of Zoology 33*: 85–89.

Pryde, M.A.; O'Donnell, C.F.J.; Barker, R.J. 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.

Richardson, S.J.; Allen, R.B.; Whitehead, D.; Carswell, F.E.; Ruscoe, W.A.; Platt, K.H. 2005: Climate and net carbon availability determine temporal patterns of seed production by Nothofagus. *Ecology 86*: 972–981.

Rolfe, J.; Makan, T.; Tait, A. 2021: Supplement to the New Zealand Threat Classification System manual 2008: new qualifiers and amendments to qualifier definitions, 2021. Department of Conservation, Wellington. 7 p. www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs-supplement-2021.pdf

Roscioni, F.; Russo, D.; Di Febbraro, M.; Frate, L.; Carrnaza, M.L.; Loy, A. 2013: Regional scale modelling of the cumulative impact of wind farms on bats. *Biodiversity and Conservation 22*: 1821–1835.

Thurley, T. 2021: Statement of evidence of Tertia Thurley for the Director General of Conservation. In the matter of the Resource Management Act 1991 and the matter of an application by Tilt Renewables Limited (RM200234) to construct, operate and maintain up to 19 wind turbines within a defined project envelope on the property at 379 Maitahi Road, Omamari legally described as Lot 1 DP 201886. Department of Conservation, Whangarei.

Thurley, T. 2022: Statement of evidence of Tertia Thurley for the Director General of Conservation. Bats. 26 April 2022. Before the Environment Court, Auckland in the matter of an appeal under section 120 of the under the Resource Management Act 1991 and the matter of an application by Waste Management New Zealand Ltd for resource consents to construct and operate a new regional landfill at 1232, State Highway 1, Wayby Valley. Department of Conservation, Hamilton.

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. 35 p. www.doc.govt.nz/globalassets/documents/science-and-technical/sap244.pdf

Walker, S.; Monks, A.; Innes, J. 2019: Thermal squeeze will exacerbate declines in New Zealand's endemic forest birds. *Biological Conservation 237*: 166–174.

Zhang, Z.; Liu, X.; Zhao, D.; Post, S.; Chen, J. in press: Overview of the development and application of wind energy in New Zealand. *Energy and Built Environment*. https://doi.org/10.1016/j.enbenv.2022.06.009