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# Introduction

This conference was held at Ohakune, New Zealand, during 28-29 March 1998, in conjunction with an inaugural Bat Workers Workshop, and was organised by Brian Lloyd, Science & Research Unit, Department of Conservation, New Zealand. Ohakune is located in the central North Island, and is close to readily accessible of both species of New Zealand bats. These endemic bat species are the only terrestrial mammals in New Zealand, and are considered to be threatened, or vulnerable to extinction.

Considerable progress has been made in important areas of research on both species since the inaugural New Zealand Bat Conference was held in Wellington, in July 1995. At that time the two major research programs being conducted by Department of Conservation were at an early stage. In addition a variety of investigations on these bats or on closely related topics were being carried out by other researchers. Results from much of this work was presented at the Second New Zealand Bat Conference.

The results of two evolutionary studies were presented. These were: (1) an investigation into the relationship of short-tailed bats (*Mystatcina tuberculata*) to other bat species, and (2) a study of the genetic diversity found in both long-tailed (*Chalinlobus tuberculata*) and short-tailed bats.

The major research program on long-tailed bats has been carried out at Eglinton Valley, Fiordland (principal scientist: Colin O'Donnell). A series of papers presented results of investigations into social structure, roost use, home range and habitat use by long-tailed bats, as well as overlap of echolocation calls of short-tailed and long-tailed bats as recorded by automatic detector systems.

The focus of short-tailed bat research has been at Rangataua Forest, near Ohakune (principal researcher: Brian Lloyd). Results presented included:

- An evaluation of the impact on short-tailed bats of aerially distributed 1080 (sodium monofluoroacetate) for vertebrate pest control (short-tailed bats are considered to be at risk of secondary poisoning).
- Measurement of population size, roosting behaviour, home range and habitat use by short-tailed bats at Rangataua Forest.
- Preliminary analysis of call structure of both short-tailed and long-tailed bat's echolocation calls (using a bat detector) was also described.

Results of surveys for short-tailed bats in Central North Island, Waitaanga Forest in North Taranaki, and both short-tailed and long-tailed bats in Tararua Ranges were presented. A new automated bat detecting and counting system was described.

Research on captive management issues included short term captive maintenance of short-tailed bats on Codfish Is., induced torpor in Rangataua Forest short-tailed bats as a captive management strategy, and long term captive maintenance of short-tailed bats at Wellington Zoo. Further research was presented on torpor in long-tailed bats and the effect of roost disturbance on cave dwelling (Northern Hemisphere) bats.

Bat research in New Zealand has made a major contribution to the scientific knowledge of the two New Zealand bat species, which has, until now, been largely superficial. In addition, the information on distribution and habitat use of both bat species, and the non target impact of a commonly used vertebrate pest control method on short-tailed bats as well as captive management methods will prove useful to conservation managers.

Shirley McQueen

# Proceedings of the Second New Zealand Bat Conference, Ohakune, New Zealand, 28-29 March 1998

## EVOLUTIONARY AND GEOGRAPHIC ORIGIN OF SHORT-TAILED BATS

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DNA-hybridization comparisons among representatives of the major groups of Chiroptera were carried out to determine the position of the tailed bat, *Mystacina tuberculata*. The results confirmed the species affinity with the South American noctilionoid (or phylostomoid) group first suggested by an earlier serological study. The estimated timing of divergence from the noctilionoids is 54 myrbp, which is much earlier than the tentative estimate of 35 myrbp inferred from serology.

The estimated timing of divergence is too late for Mystacinidae ancestors to have been isolated on New Zealand before New Zealand separated from the rest of Gondwanaland, but is consistent with the distribution of the mystacinid common ancestor in South America, Australia, and Antarctica before the Australia separated from Antarctica. Mystacinidae probably diverged from the noctilionoid group when Australia separated from Antarctica. Fossil mystacinids have recently been identified in early and mid-Miocene deposits in Australia, indicating that Mystacinidae were resident in Australia at least 25-20 myrbp. Mystacinidae may therefore have arrived in New by dispersal across the Tasman Sea from Australia before extinction of the mystacinid lineage in Australia.

THE TAXONOMIC STATUS OF NEW ZEALAND BATS

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We were contracted, by the Department of Conservation, to collect genetic information on New Zealand's native bats. We were then to provide management recommendations to assist in the preservation of the genetic diversity found within populations of wild bats. Bat researchers and Department of Conservation staff collected a total of 389 tissue samples from twelve populations of both long- and short-tailed bats throughout New Zealand and sent them to Molecular Ecology Laboratory at Massey University. DNA analysis indicated that at least two distinct populations of long-tailed bat are present in New with a marked degree of genetic difference occurring between North Island and South Island samples. In the case of short-tailed bats, Little Barrier Island and Northland populations are genetically distinct from other mainland New Zealand short-tailed bats and from short-tailed bats on Codfish Island. Despite consistently clustering together in a range of phylogenetic analyses, populations of the larger mainland short-tailed bat were to differ genetically, with increasing geographic distance. The short-tailed bats on Codfish Island represent a genetically distinctive population. Molecular markers were located within the mitochondria1 DNA of long-and short-tailed bats to allow an individual of unknown origin to be reliably ascribed to a particular geographic region. Consequently in order to preserve this genetic diversity we recommend that these populations of native bat be given their separate conservation status. Also, the phylogenetic relationships within each family of native bat was reassessed and a new taxonomy for both long-and bats will be presented.

THE LARGE FOREST BAT *(Vespadelus darlingtoni)* ON LORD HOWE ISLAND

**Glenn Hoye**

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Surveys were undertaken over the past two summers to assess the occurrence of *Vespadelus darlingtoni* on Lord Howe Island and to investigate its ecology. Results of the two surveys will be presented.

HABITAT USE AND CALL OVERLAP BY BATS IN THE EGLINTON VALLEY AS REVEALED BY AUTOMATIC DETECTOR SYSTEMS

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We studied habitat use in long-tailed bats and short-tailed Bats *(Mystacina tuberculata)* in Fiordland during summer using automatic bat detection units. We placed pairs of units, one set on 27 kHz and one on 40 kHz, along 20 transects running perpendicular to the valley floor. We sampled red beech forest interior (>200 m from forest edge), silver beech forest (50-100 m from edge), roads through the forest, forest-grassland edge, and open grassland. Number of bat passes per hour per night were recorded and classified as either long or short-tailed bats, or as ambiguous. We identified 98% of calls to species, based on their pulse rate, loudness and call duration. Of 2927 long-tailed bat calls recorded at 40 kHz <1% were also recorded on adjacent units at 27 kHz. Of 666 short-tailed bat calls recorded at 27 kHz, 24% were also recorded at 40 kHz. The majority of short-tailed bat passes were detected in red beech with 13.7% in silver beech, 2.6% along roads, 0.9% on the forest edge, and 0.2% in grassland. In contrast, the majority of long-tailed bat passes were on the forest-grassland edge along roads through the forest open grassland with a small proportion within forest (red beech = 4.2%, silver beech = 11.1%).Both species were active throughout the nine hours of darkness, however, peak activity periods varied. Most short-tailed bat passes were recorded in the second hour after sunset and the three hours preceding dawn. In contrast, peak long-tailed bat activity was during the first two hours after sunset, with little activity in the colder hours towards dawn. Colder dusk and overnight minimum temperatures reduced activity levels of long-tailed bats significantly, but not short-tailed bats.

PROGRESS IN DETERMINING THE STATUS AND DISTRIBUTION OF SHORT-TAILED BATS IN CENTRAL NORTH ISLAND

**Brian Lloyd[1] and Tom Whiteford[2]**

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Comprehensive surveys for short-tailed bats *Mystacina tuberculata* using automated bat detecting systems have been undertaken in a number of central North Island forest areas with assistance from local Department of Conservation field staff. The bat detectors were set at 28 kHz, which is the optimum frequency for detecting short-tailed bats. Areas include: the Waitotara Conservation Area, Riariaki, Murmuru and Mangamingi Conservation Areas (in the valley), forest

along the Wanganui River from Pipiriki to the Mangatiti River, the lower stretches of the Manganuiateo, Waimarino Forest, the western slopes of Ruapehu, Rangataua Forest, Tongariro Forest, Waitaanga, Kaimanawa, and central Whirinaki. Dense populations of short-tailed bats have been found in central Waitotara, Rangataua, Waitaanga and central Whirinaki. Low-density populations were found in eastern Waitotara, Murumuru, Waimarino and the western slopes of Ruapehu. Preliminary results from Kaimanawa indicate there is a large population but the population's core area has not been located.

Although bat detectors set at 28 kHz are not as effective for detecting long-tailed bats Chalinolobus tuberculatus as those set at 40 kHz (only 60-70% of tailed bat call sequences detected at 40 kHz are detected at 28 kHz) the surveys provided information on the distribution of long-tailed bats. Long-tailed bats were detected in most areas High call rates were recorded in Rangataua Forest, the lower reaches of Mangatiti and Manganuiateo, and Waimarino Forest.

At Rangataua, Whirinaki and northern Waitaanga minimum population estimates of the short-tailed bat populations have been obtained by video counts of evening departures from large colonial roosts located by aerial radiotracking of radiotagged bats.

In order to determine whether the central North Island populations are discrete or comprise a metapopulation with dispersal between areas, genetic analysis will be undertaken on wing-biopsy samples from Waitotara, Rangataua, Waitaanga and Whirinaki.

Further field-work is planned for next summer.

## TARARUA FOREST PARK BAT SURVEY

**Alina Atkins**

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Between 8 December 1997 and 6 March 1998, a survey for short-tailed bats (*Mystacina tuberculata*) and long-tailed bats (*Chalinolobus tuberculatus*) was carried out in the Tararua Forest Park. Ten sites were surveyed using ten automatic bat monitors (ABMs) for a minimum of four "good weather" nights per site. All sites were within three kilometres of the forest edge, in a zone targeted for a 1080 poison operation. ADMs were placed at approximately 200 metre intervals along a transect at each site.

Over the duration of the survey, recordings were made on a total of 54 nights, and 422.5 'ABM nights" were obtained. Bats were recorded at four of the ten sites, and it is likely that all of these were long-tailed bats. All but one of the passes was recorded at 40 kHz. The maximum number of passes recorded on any night was seven, and the highest total number of passes recorded at a site was 26.

# PRELIMINARY OBSERVATIONS ON THE STRUCTURE OF THE ECHOLOCATION CALLS OF NEW ZEALAND BATS, DETERMINED WITH A PETTERSSON BAT DETECTOR

**Brian Lloyd**

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The D980 Pettersson bat detector is a broad band ultrasound detector, which can transform the entire ultrasonic frequency range of bat echolocation calls to the audible range by the time expansion method. Twelve second sequences of ultra sound are recorded digitally and played back at a lower speed, as an audible signal which preserves all the characteristics of the original signal. The transformed signal can be recorded on standard audio media for analysis.

Preliminary analysis has been undertaken on short-tailed bat *Mystacina tuberculata* calls recorded at Rangataua and long-tailed bat *Chalinilobus tuberculatus* calls recorded in Waimarino Forest. Both locations are in central North Island.

There was very little variation in the short-tailed bat calls. The calls are broad band calls with high pulse repetition rate and a low duty cycle, typical of bats hunting in cluttered situation. The calls have steeply descending frequencies and contain 4-8 harmonics. The first four harmonics are centred on 25, 50, 75 and 100 kHz, other, weaker, harmonics extend up to 200 kHz. The calls are short, 2 msec, and have an interpulse interval of 20 msec, which indicates an operational range of 3.2 m.

Variation in long-tailed bat calls resembles that found in many overseas bats that forage for flying insects in uncluttered environments. Three call types can be identified: search, approach and attack. Most common is the search call, which is a narrow band call centred around 40 kHz. The pulse is relatively long (10 msec) and the interpulse interval is 100 msec, indicating an operational range of The approach call is a steeply descending call sweeping through a broad frequency range from 100 to 30 kHz. The pulse length is shortened to c.3 msec and the interpulse interval is reduced to 20-40 msec. Finally the attack call, or feeding buzz, comprises steeply descending calls with rapid rate of frequency change and multiple harmonics centred around 30, 70, and 100 kHz. The pulse length is reduced to 1-2 msec and the interpulse interval declines to 4 msec, which indicate an operational range of <1m.

## A NEW AUTOMATED BAT DETECTING AND COUNTING SYSTEM

**Murray Douglas**

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The development of semi-automatic acoustic bat detectors in New Zealand has primarily focused around using the Stag Electronics Batbox III ultrasonic bat detector and sound switched Dictaphone tape recorders with talking time marking. The equipment has been widely used during research and management programmes on short-tailed and long-tailed bats. Improvements have been made to these systems by adding larger external power sources via power regulators, environmental housings, reducing power consumption and improving field life and analysis efficiency by adding a rain noise muting feature. During the use of these systems researchers have gained a greater knowledge of the variation in frequency used by the two bat species. The disadvantage of the present Bat Monitoring System is that it uses audio tape and this requires manual analysis later. Also, incorrect frequency setting can change the unit's sensitivity to bats or the ability for any later species discrimination from the tape recording.

A lower cost and power-efficient new fully automated bat detector is described. This device has dual frequency detectors, optional stereo audio output, micro-processor control, clock-calendar chip, long-term memory and some built in automatic species discrimination software. Data can be captured optionally to memory, displayed on LCD or downloaded to a portable computer for spread-sheet display and analysis. If successfully field tested, this design is presented as an alternative, and more flexible solution, to the existing Bat Monitoring System for improving survey efficiency in the near future.

## TORPOR IN LONG-TAILED BATS

**Peter Webb**

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Small, insectivorous bats such as the New Zealand long-tailed bat are renowned for their use of torpor as a mechanism for saving energy. During torpor body temperature falls to within a few degrees of the ambient thus negating the need to expend energy on thermoregulation. In February of this year I conducted a pilot study looking at the use of torpor in long-tailed bats in Fiordland. Nulliparous adult females and adult males were caught in flyways or at roost exits and maintained in captivity for up to 3 days during which they were fed each evening on Captive individuals remained euthermic (non-torpid) during the hours of darkness but entered torpor at dawn and in most cases remained torpid throughout the day. At 10°C energy expenditure when torpid was only about 2 % of that when euthermic. Periods of apnea were observed within minutes of bats entering torpor. A temperature-sensitive radio-transmitter fitted to a single adult male bat indicated that torpor was less prevalent in the wild but on any day could occur at any time, all day, or not at all. Torpor in this individual was noted in both solitary and communal (10-30 bats) roosts.

INDUCING TORPOR IN CAPTIVE SHORT -TAILED BATS

**Shirley McQueen[1] and Brian Lloyd[2]**

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Artificially inducing torpor in short-tailed bats (*Mystacina tuberculata*) was trialed as a possible management strategy for holding large numbers of bats in captivity (e.g. during eradication of rats on islands). These bats are known to naturally use periods of torpor to conserve energy during winter. Twenty short-tailed bats were captured in Rangataua Forest, Ohakune, and were held for 5 months during winter 1996. The bats were housed in a prepared room for about 5 weeks before, and between induced torpor bouts. Food provided was comprised principally of mealworms and a solution of honey in water, with additions of locusts, larvae of longhorn beetles, and moths and beetles caught in a light trap. Fresh water was provided daily. Torpor was induced holding bats in a box lined with bark and wood, and placing this in a moist refrigerator at $4^{o}$-$6^{o}$ C for periods ranging from 3 to 11 days. All but one bat gained weight during the early pre-torpor period and maintained or gained weight over the time from capture to release. During torpor bouts the average weight loss was 1-2 g, which was regained by all bats within 3 days post torpor. Three bats died during the captive period. One was thin at capture and failed to thrive. The others had completed the longest torpor period of 10 days and fed overnight, but were found dead with gut by gas. Results of postmortem inconclusive, but fermentation of honey water was suspected as a contributing factor. Torpor for periods of up to 7 days could be used as an effective management option to reduce time and feeding costs when housing large numbers of bats. However it is not suitable for thin or sick bats, and only mealworms and water should be provided on the first night after torpor bouts.

## SHORT-TERM CAPTIVE MAINTENANCE OF BATS ON WHENUA HOU IN WINTER

**Jane Sedgley**

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Following the successful eradication of weka (1984) and brush-tailed possum (1987) from Whenua Island the Department of Conservation intend to eradicate kiore in the winter of 1998 using aerially broadcast Talon 20P (brodifacoum). To ameliorate the risk of secondary poisoning to the resident short-tailed bat population up to 400 bats will be held in captivity on the Island for the duration of the poison operation. Between 12 June and 31 July 1996 a preliminary trial was conducted to develop captive management techniques necessary to hold a moderate number of bats in captivity in situ in winter and to successfully reintroduce them to the wild. Up to 36 bats were held in a large free flight enclosure for up to 41 days.

The bats responded well to captivity, quickly adapting to artificial food and roost sites. There was no bat mortality in any of the project stages and gained weight during captivity. On release ten bats were fitted with transmitters. Nine of these found communal roosts soon after release, inferring that captive bats integrated back into the wild bat population. Bat capture, video-monitoring of roosts and temperature transmitter work indicated that bats are very active on the Island in mid-winter, down to temperatures of from -1$^{o}$ to -2$^{o}$ C. Activity levels did vary, however, apparently in response to temperature and weather conditions. Based on the results collected during this project, it seems likely that large numbers of bats would be active during the period of a mid-winter eradication operation.

## KEEPING BATS IN CAPTIVITY AT WELLINGTON ZOO

**Serena Lockwood**

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Of the nine New Zealand short-tailed bats, (*Mystacina tuberculata*) taken off Codfish Island on December 1992, seven arrived safely at the zoo for captive research. The two bats that did not survive may have died from shock. The sex ratio of the remaining bats was three males and four females. The bats were quarantined for thirty days in a renovated bird aviary that was to be their future home.

The enclosure had been rewired with a finer gauge wire over the existing wire, to make it bat proof. The enclosure was planted up with native trees and shrubs and a sprinkler system installed to keep the enclosure alive with plants and insects. An ultra-violet light was also put in the enclosure to attract the night insects.

Banding trials, bait trials, roost-box design and activity at night, were all studied over a period of time. Records were taken daily to study the different trends of activity and food consumption over a period of time. Infra red cameras were used to monitor night-time activity of the bats. The cameras were linked to a video recorder and screen. Several babies were born over a period of five years but unfortunately none survived more than five months. In 1997 a nursery box was set up with an infrared camera and a video monitor to monitor for the first time, in captivity and in the wild, the activity inside a nursery roost.

## EFFECT OF ROOST DISTURBANCE ON CAVE DWELLING BATS

**Peter Webb**

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In the late 1980's the Nature Conservancy Council (then the UK equivalent of DOC) became worried about the amount of disturbance to bats hibernating in caves caused by the activities of an increasing number of amateur and professional bat workers. Hibernating bats have very low levels of energy expenditure and can thus survive for prolonged periods without feeding. Disturbance of bats during hibernation may cause arousal, increase their rate of energy expenditure, reduce the amount of time for which they can survive without feeding and thus increase winter mortality. We surveyed all registered bat workers in the UK to establish what they actually did in bat hibernacula and hence the sorts of disturbance to which hibernating bats were likely to be exposed. These disturbances could be divided up into tactile disturbance (where the bat was handled), and non-tactile disturbance (namely torch light, flash photography, warming of the cave air, speech, and other sounds). We then brought bats of 6 different species into captivity during winter, placed them in a fridge to them to enter hibernation and then subjected them to these various disturbances to see whether the bats would arouse. During this whole procedure we monitored the rate at which the bats consumed oxygen (and hence their energy expenditure). Of 206 non-tactile disturbances only 9 (4.4 %) resulted in an increase in energy expenditure with an average increase of 2.2 Joules per bat per disturbance (equivalent to a reduction in the amount of time the bat could survive without feeding of approximately 0.001 days). Of 19 tactile disturbances all 19 (100 %) resulted in an increase in energy expenditure with an average increase of 2038 Joules per bat per disturbance (equivalent to a reduction in the amount of time the bat could survive without feeding of approximately 0.853 days). The largest response to a tactile disturbance would have resulted in a reduction in the amount of time the bat could survive without feeding of approximately 4.3 days. We concluded that while disturbance caused by handling hibernating bats could have a major impact on over-winter mortality, disturbance caused by non-tactile activities was probably minor. Nevertheless any disturbance could have an impact and thus all disturbances of hibernating bats should be kept to a minimum.

EVALUATING THE IMPACT OF 1080 PEST CONTROL OPERATIONS ON SHORT -TAILED BATS

**Brian Lloyd[1] and Shirley McQueen[2]**

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The impact of an aerial 1080 operation on a population of short-tailed bats *Mystacina tuberculata* inhabiting Rangataua Forest, central North Island, was evaluated using several methods. Pollard baits with a 0.15% ww toxic loading were sown over 2,500 ha of forest using bait application rates of 3 kg and 5 kg per ha in August 1997.

During winter short-tailed bat activity is variable, periods of torpor lasting up to 10 days are interspersed with brief bursts of activity. This erratic activity pattern made it impossible to measure changes in the population size at the time of the 1080 operation. Population levels were therefore monitored during the summers before and after the 1080 operation. Minimum population estimates were obtained by counting evening departures from colonial roosts and activity levels were measured with automatic bat detectors. There was no indication of any decline in the population as a result of the 1080 operation.

The impact of 1080 was monitored directly during the 10 days following the operation by catching 269 bats as they arrived at a roost after foraging and holding them for 48 hours. None of the bats displayed any symptoms of 1080 intoxication, but it should be noted that the technique's sensitivity has not been resolved.

The range of nocturnal invertebrates which feed on baits in the bat's winter range was determined by both routine inspections and video surveillance of hand placed carrot and pollard baits. A wide variety of relatively large invertebrates (>4 mm long) fed on the baits, including weta (6 spp.), beetles (3 spp.), millipedes (2 spp), harvestmen (4 spp.) and amphipods. Many of these invertebrates are prey items for short-tailed bats.

Invertebrates were collected from toxic baits following the 1080 operation. Eight pooled samples comprising 68 individuals with a total weight of were assayed for 1080 content. Concentrations of 1080 varied from 14 to 130 µg/g (mean 52.8 µg/g). The LD50 for a short-tailed bat is likely to be less than 14 µg of 1080. This dose would be ingested in <0.3g of invertebrates containing 52.8 µg/g of 1080. It therefore seems probable that, although there was no measurable impact on the short-tailed bat population during this study, short-tailed bats, and other vertebrate insectivores, are vulnerable to secondary poisoning after aerial 1080 operations.

SOCIAL STRUCTURE IN A POPULATION OF LONG-TAILED BATS

**Colin F.J. O'Donnell**

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Population structure of the threatened long-tailed bat (*Chalinolobus tuberculata*) was studied in beech (*Nothofagus*) dominated temperate rain-forest in the lower Eglinton Valley, Fiordland over four summers, 1993-97. Radio-tracking of bats (n= 73) indicated that individual foraging ranges over-lapped considerably. However, a banding study revealed that apparently distinct, but cryptic, social groups existed. The bats almost always associated with some of their traditional roosting companions during the day, but mixed at foraging sites during the night. Three groups were studied in detail. Of 1886 captures in 65 harp-trapping sessions at communal roosts there were only 38 cases (2%) of individuals switching between groups. Switching only occurred for one night. Those switching were equally distributed amongst non-breeding females, pregnant females and males. Each group contained 147-182 marked individuals, with 35, 51 and 63 breeding females. Juveniles of both sexes returned to their natal group as one year olds. Additional information has been collected over summer Results raise questions about how bat populations are defined and have implications for recommend-ing best practice conservation management. Localised assemblages of bat populations linked through infrequent migration by a few individuals, implies that metapopulations exist. However, the long-tailed bat population did not conform to traditional 'source-sink' metapopulation models because the metapopulation occurred in homogeneous habitat extending over a large geo-graphic area. If long-tailed bat populations are characterised by local extinction of groups in some patches of forest, and colonisation of others, then loss of lowland forests could have had a significant impact on the persistence of populations in the past.

ROOST USE BY LONG-TAILED AND SHOT-TAILED BATS IN THE EGLINTON VALLEY, FIORDLAND

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In 1992 we began a broad ecological study of long-tailed bats in the red beech dominated forests of the Eglinton Valley, Fiordland. Since February 1997 this research has included a newly discovered sympatric short-tailed bat popula-tion. One facet of our investigation is a study of roosting behaviour, and in the last two years we have focussed more specifically on roost site selection.

During the summers of we radio-tracked 73 long-tailed hats to 304 day-roosts in 291 different trees. Ninety-five per cent of these roosts were located in mature open structured lowland forest and were within 500 m of the forest-grassland edge. We compared roost tree and roost cavity characteristics with those of 596 random trees and 187 random cavities. Bats preferentially roosted in trees that had significantly lower canopy closure, larger stem diameters, were taller, had larger trunk surface areas and greater numbers of cavities than available trees. In comparison with random cavities, roost cavities were higher from the ground, had relatively uncluttered entrances, relatively small entrance holes and internal dimensions, tended to have a vertical interior orientation (where height exceeded depth) and were dry. Preliminary analysis indicates unoccupied long-tailed bat roost cavities are more thermally stable than similar sized non-roost cavities.

Compared with long-tailed bats, recent results suggest that a greater proportion of short-tailed bats occupy trees that are at higher altitudes and a greater distance from the forest edge. Their roost cavities tend to be relatively closer to the ground, have larger entrances and greater internal height. Dataloggers used to measure temperature inside short-tailed bat roosts proved to be an excellent technique for monitoring roost occupancy.

## PRELIMINARY OBSERVATIONS OF POPULATION SIZE, HOME RANGE, AND HABITAT USE IN SHORT-TAILED BATS *(Mystacina* sp.) IN FIORDLAND, NEW ZEALAND

**Jenny Christiel[1], C.F.J. O'Donnell[2], J. Sedgeley[1] and W. Simpson[3]**

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Short-tailed bats (*Mystacina* sp.) were discovered in *Nothofagus*-dominant rainforest in the Eglinton Valley, Fiordland in February 1997, representing the first records of these bats in Fiordland since 1871. This paper presents preliminary observations of population size, habitat use, activity patterns, home range size, and movements. Compared to lesser short-tailed bats (*M. tuberculata*) on Codfish and Little Barrier Islands the Fiordland bats were heavier, had larger wings and smaller ears and were sexually dimorphic. In summer, roosting groups ranged from 107-470 individuals and the bats ranged over 130 km$^2$ of the valley. Pattern of activity and movements were similar on most nights. For example, on 10 of 12 nights a juvenile male flew down the valley from a roosting area. His nightly range averaged 16.0 km$^2$ (SD = 7.8, Range 10.4 - 25.0 km$^2$), traversing a 14 ± 2.3 km length of the valley. On two nights he flew 10-14 km to the north of the roosting area. Cluster analysis revealed that there were four separate areas within the range in which 80%of fixes were collected. These were probably foraging areas and they covered a much smaller area of the range (4.6 km$^2$). Most activity was within the red beech forest interior and into high altitude forest. There was less activity close to the forest edge, and few records in open grassland. Bats began emerging c. 20 minutes after sunset and were active at the roost sites throughout the night. Radio-tagged bats from a range of sex and age classes were all active for the majority of the night even during heavy rain.

ROOSTING BEHAVIOUR OF SHORT -TAILED BATS IN RANGATAUA FOREST

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Aerial radiotracking and video surveillance have been used to study the roosting behaviour of short-tailed bats Mystacina tuberculata in 100 $km^2$ of old growth *Nothofagus* forest in Rangataua Forest, central North Island.

During the last 3 years more than 30 large communal roosts have been discovered, all but two of the roosts were in large chimney like cavities within the main trunks of live *Nothofagus fusca*. Entrances of summer communal roost are usually at the bottom of the cavity, relatively large (>100 mm x 100 mm) and less than 5 m above the ground. Communal roosts may contain from a few hundred bats to more than 5,000 bats. All communal roosts appear to be traditional, most have been re-used, some several times usually at similar times each year.

During summer most bats roost in large communal roosts, frequently the entire population of c. 7,000 bats may be found occupying 2 or 3 roosts. Throughout the rest of the year many bats roost alone, usually in small cavities on the main trunks of *Nothofagus*, but also in other tree species, or in other situations, e.g. under flaking bark, or at the base of *Collospermum.*

Summer communal roosts are used for short periods, varying from a few days to 2 weeks. Although consecutive roosts can be more than 6 km apart most bats move between the roosts on the same night. Individuals appear to move freely between different occupied communal roosts and may also shift from roosting solitarily to roosting communally. Maternity roosts occur from late December to mid February. Lactating females often leave their offspring in the maternity roost and occupy communal roosts with other adult bats, sometimes 4-5 km from the maternity roost.

During winter the bats hibernate. Periods of torpor lasting up to 10 days are interspersed with brief periods of activity. Hibernating bats usually roost solitarily, but may roost communally.

MONITORING SHORT-TAILED BATS IN WAITAANGA FOREST, NORTH TARANAKI

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Work started at South Waitaanga and North Waitaanga in November 1996 by John Heaphy and Alina Atkins. Mist netting was carried out at various locations, 1 long-tailed and *17* short-tailed bats were captured. Transmitters were fitted to 8 short-tailed bats and 4 roosts were located, 2 communal and 2 single. All captured bats were measured, weighed and had biopsies taken. Bat droppings were also collected and analysed.

From November 1997 to March 1998 bat-work was continued by Bryan Williams. Five long-tailed and 10 short-tailed bats were mist-netted at North Waitaanga. Transmitters were fitted to 7 of the short-tailed bats. One new roost was located. Video footage was taken and bats counted. One hundred short-tailed bats were captured by harp-trap and biopsy samples collected. Special thanks to Brian Lloyd and Shirley McQueen for their expert assistance.

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