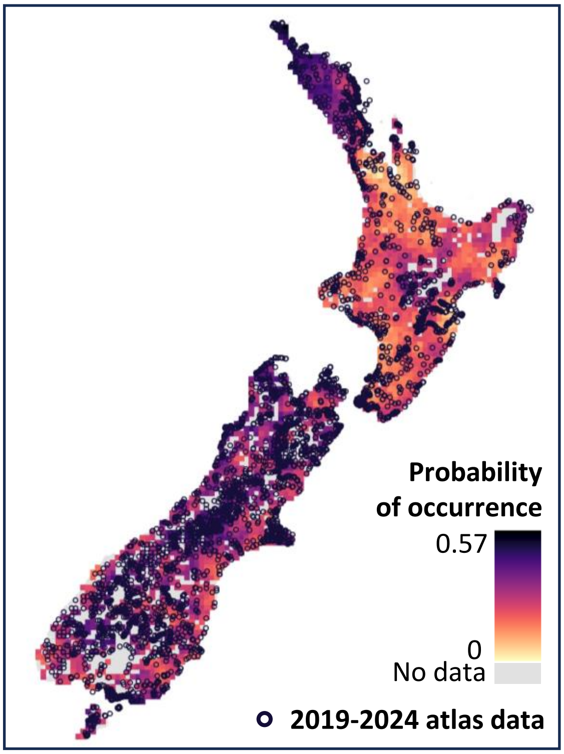
AT RISK DECLINING

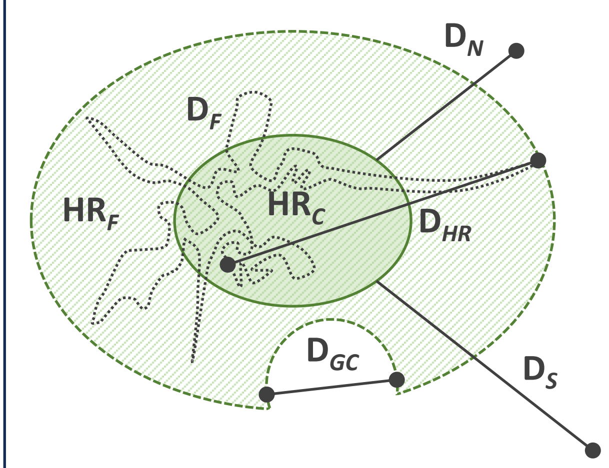
Pīhoihoi / New Zealand pipit

Anthus novaeseelandiae novaeseelandiae

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	3–4 ha
Foraging home range (HR_F)	unknown
Foraging dispersal (D_F)	unknown
Home range dispersal (D_{HR})	unknown
Natal dispersal (D_N)	unknown
Seasonal dispersal (D_S)	unknown
Gap-crossing (D_{GC})	800 km

Description

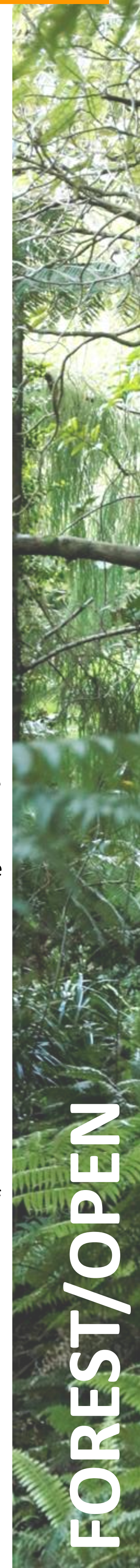
The pīhoihoi is an endemic songbird found throughout New Zealand, including the subantarctic and Chatham Islands. They occupy a broad range of native and modified open habitats, from coastal to alpine areas. Pīhoihoi have a brown upper body with wing feathers that have pale edging. Their breast is a pale cream with brown streaks, and white outer tail feathers are visible during flight. They can be mistaken for introduced skylarks *(Alauda arvensis),* which are similar in size and coloration, but pīhoihoi have more defined streaking and an upright posture. Pīhoihoi will also run away when approached, while sklyarks more often take flight. When walking, pīhoihoi display with a distinct tail-flicking motion.

Ecology

Despite being widespread, pīhoihoi have received limited scientific study. There is little information on their general ecology, habitat use, and threats. Pīhoihoi may have benefited from European settlement, with forest clearance and the expansion of rough, open, pastural habitats. Observations of flocks have become less common, possibly indicating a decline. Pīhoihoi are found in open habitats, emergent shrublands and fernlands, wetlands, lakes, sandy rivers, and coastal habitats, and even in high-elevation rocky alpine habitats. They are predominantly insectivorous, consuming flying insects such as butterflies, large flies, cicadas, and grasshoppers. Pīhoihoi remain in pairs during breeding (August–March), but form small flocks (<10 individuals) outside the breeding season. Nesting occurs on the ground or at the base of dense, low vegetation. Females appear to be the sole incubator, with males providing little support during incubation. Following hatching, both parents feed chicks and fledglings.

Pressures

Changes in grazing practices have been a major cause of population decline in pīhoihoi. These birds do well in heavily grazed sheep and cattle pasture habitats. Conversion to dairy grazing and forestry have reduced the quality of these open habitats. High levels of predation by endemic avian and introduced mammalian predators are also a pressure. Pīhoihoi persist well in modified habitats, but the loss of rough pasture and the urbanisation of open habitats may increase their sensitivity to predation. Cats are known nest predators, but a suite of predators probably affect pīhoihoi. Population growth on Campbell Island / Motu Ihupuku following rat eradication suggests rats are a key limiting factor. Drought, extreme weather, and the spread of invasive weeds contribute to habitat degradation and reduced food resources.



Dispersal

Before human arrival pīhoihoi may have been less common, relying on high mobility to disperse between open habitats in a predominantly forested landscape. They are highly mobile, as reflected by their widespread distribution across all islands in New Zealand. They are a flocking species and were commonly observed in large flocks of >40 birds up until the 1960s. Following breeding, pīhoihoi form mixed flocks of juveniles and adults. Fledglings are poor fliers but will disperse widely while still dependent on their parents. Breeding home ranges can extend up to 6 ha, and parents will often lose fledglings while foraging. There is very little information on seasonal dispersal movements.

Breeding pīhoihoi foraging in open alpine turf habitat on the central volcanic plateau, Tongariro.

Breeding habitat

Apart from a few observational studies of pīhoihoi in pastural habitat, there is very limited information on habitat requirements, particular in native habitats. Pīhoihoi quickly occupy open habitat after it is created. Breeding has mostly been observed in habitats with substantial bare ground, low-stature plants, and low-cropped vegetation. Breeding habitat can range from rough, ungrazed pasture (e.g. kikuyu), to dense wetland, fernland or low scrub vegetation, unmown road verges, coastal scrub and dune vegetation, and alpine tussock. Nests are constructed in the open, under or next to dense vegetation or logs that provide cover and protection from avian predators. Surveys at Te Ahu a Turanga highway project found that nests were consistently built on hillslopes in rank grass next to patches of bare earth. Breeding territories are temporarily occupied from August to March, and some individuals reuse the same breeding territories between years.

Coastal dune and foreshore foraging habitat, Whangarei.

Non-breeding habitat

Pīhoihoi occupy a diverse range of habitats throughout the year. They appear to undertake seasonal movements after breeding, leaving their breeding territories. They become highly mobile, foraging in pasture, low vegetation/crops, and bare habitats, often in small flocks (<10 individuals). In the central North Island pīhoihoi have been observed dispersing between alpine habitat to newly felled plantation habitats at lower elevations after the breeding season. They require partially open habitats for foraging and rarely enter dense vegetation. Sites are deserted or used less frequently after they become overgrown.

Breeding and foraging habitat in rank grass along the Te Ahu Turanga highway development, Manawatu.

Roosting and foraging habitat

Pīhoihoi appear to move throughout the landscape using different habitats in response to food availability. Rank grass and bare ground are important foraging habitat, along with earthworks and drains. Surveys in the Wellington region found foraging is most common on beaches and in rough pasture, where the birds forage in seaweed and vegetation to catch flying insects. High insecticide use may limit invertebrate resources and foraging habitat.

Key management actions

Key management actions include:

- grazing practices (e.g. mixed sheep & cattle grazing) that create open, well-grazed habitat with margins of denser vegetation of rank grass and rough pasture
- modifying mowing regimes and earthworks, and cordoning off nest areas (5 weeks), to avoid disturbance during August–March
- reduced mowing regimes along road margins to encourage denser rank grass habitat
- control of introduced predators, particularly cats, mustelids and rats – most pest control focuses on forest habitats, but predator control in urban environments, wetlands, dune systems, and rough pasture areas will benefit breeding success
- protection of wetlands, lake margins, dunes, and low, open scrub vegetation from development
- regulatory controls to reduce vehicle disturbance in foreshore and dune habitats
- restoration of low-lying coastal, wetland, and turf habitats
- regulatory controls to reduce the risk of cats and dogs in urban and rural habitats, particularly in coastal developments and subdivisions.

Knowledge gaps and challenges

There has been little scientific study done on pīhoihoi, which has resulted in very limited information on seasonal habitat use, distribution, dispersal, and conservation requirements. Pīhoihoi occupy habitats that have high overlap with human activities, making them challenging to manage. There have been no tracking studies of pīhoihoi, so while evidence suggests they have seasonal migration movements, there is no information on how far they disperse and which habitats they are dispersing between. Recent surveys from Te Ahu a Turanga have provided some guidance on the management of pīhoihoi habitat during developments: while destructive overall, earthworks can create temporary new areas of bare soil and rank grass, which are used for foraging and breeding. However, this makes them vulnerable to disturbance and direct mortality. Careful management of pīhoihoi habitat during developments is therefore needed to minimise any adverse effects.

Further reading

Beauchamp AJ 2007. Notes on New Zealand pipit (*Anthus n. novaeseelandiae*) home range, parental care, and the behaviour of dependent young. Notornis 54: 44–47(a) and 112–114.

Beauchamp AJ 2009. Distribution and habitat use by New Zealand pipits (*Anthus n. novaeseelandiae*) on the Volcanic Plateau. Notornis 56: 183–189.

Beauchamp AJ 2013. New Zealand pipit (*Anthus novaeseelandiae*) presence and breeding status using car and walk surveys near Whangarei, New Zealand. Notornis 60: 125–133.

Beauchamp AJ 2019. New Zealand pipit (*Anthus n. novaeseelandiae*) nesting and breeding behaviour in urban Onerahi, Whangarei. Notornis 66: 200–209.

Lovegrove T 1980. Birds of Auckland. Aukland, Wilson & Horton.

MacLeod CJ, Blackwell G, Moller H, Innes J, Powlesland R 2008. The forgotten 60%: bird ecology and management in New Zealand's agricultural landscape. New Zealand Journal of Ecology 32 (2): 240–255.

Thompson DR, Bearhop S, Ross B 2005. Spread of Australasian pipit (*Anthus novaeseelandia*) onto Campbell Island following eradication of Norway rats (*Rattus norvegicus*). Notornis 52: 43–46.

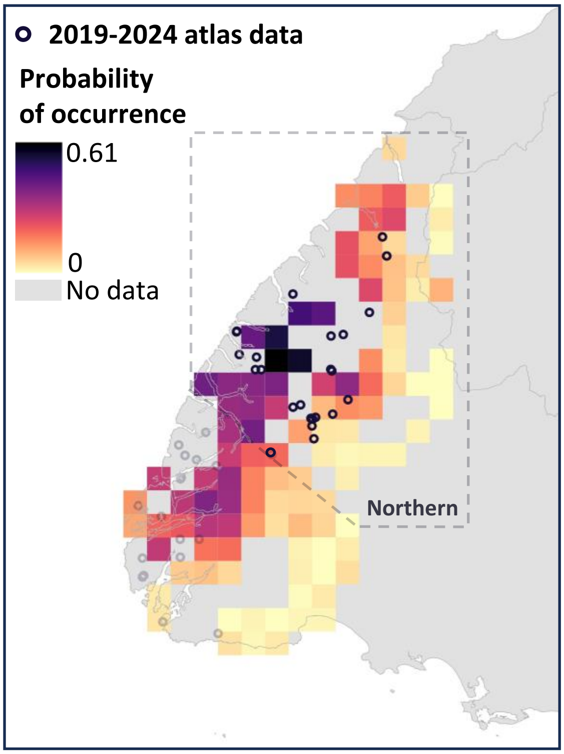
* Predicted distribution compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

NATIONALLY VULNERABLE

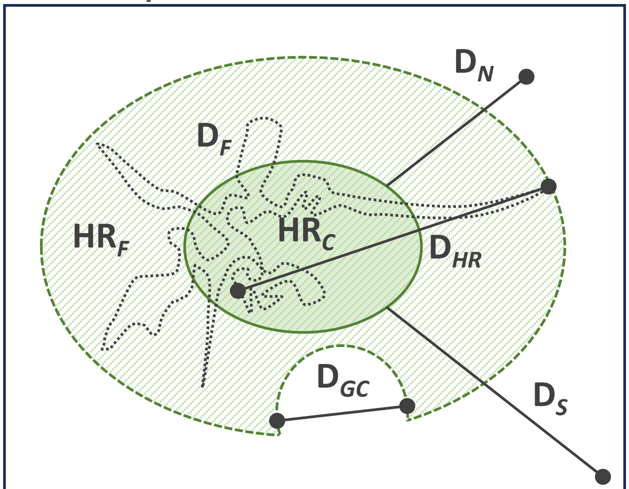
Northern Fiordland tokoeka / brown kiwi

***Apteryx australis* 'Northern Fiordland'**

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	mean: 51 ha
Foraging home range (HR_F)	unknown
Foraging dispersal (D_F)	unknown
Home range dispersal (D_{HR})	800 m
Natal dispersal (D_N)	min: 5 km(?)
Seasonal dispersal (D_S)	NA
Gap crossing (D_{GC})	unknown

Description

Fiordland tokoeka are one of the largest kiwi taxa. Their brown feathers have reddish-brown to dark brown streaking. Females can weigh up to 3.3 kg and are considerably larger than males (2.6 kg). Males and females can be distinguished by their calls: male calls are a series of high-pitched, ascending whistles, while females have lower-pitched, slower, hoarse guttural calls. The Fiordland tokoeka is one of two subspecies of tokoeka and, as its name suggests, is restricted to Fiordland. Within this subspecies genetic analysis shows that the taxon can be split into two genetically distinct populations around Wilmot Pass – between Doubtful sound and Lake Manapouri – resulting in two separate taxa for management purposes, northern and southern. The main populations of northern Fiordland tokoeka are found in the Clinton Valley, Murchison Mountains, and on Secretary Island.

Ecology

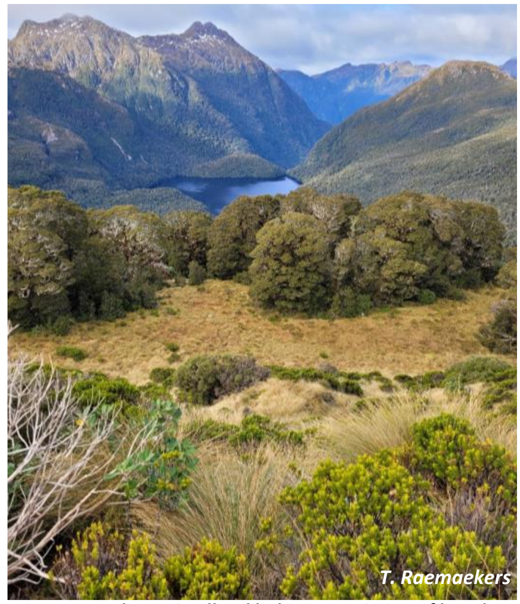
Fiordland tokoeka were historically widespread throughout Fiordland, and are still found in native forest, tussock grassland, and neighbouring farmland habitats. They are largely nocturnal, but daytime foraging has been observed, particularly in summer, when nights are shorter. Fiordland tokoeka are mostly insectivorous, consuming a range of invertebrates by probing the forest floor. They form monogamous pairs and can lay multiple single-egg clutches per season. Incubation is shared between males and females, and with previous chicks, which often remain and act as helpers. Weight varies considerably throughout the year, with minimum weights in summer following breeding. Longevity and age of maturity are unknown, but are likely to be high based on other similar kiwi species.

Pressures

Historical logging and habitat clearance in the eastern Southland have resulted in the current restricted distribution of Fiordland tokoeka. Like most kiwi, Fiordland tokoeka are vulnerable to introduced mammalian predators, particularly stoats (*Mustela erminea*) and feral cats (*Felis catus*). Stoats are the main threat to eggs and chicks, which leads to recruitment failure. Expansion of feral cats into Fiordland may add additional pressure, but cat populations are still fairly localised. Continuing population decline may reflect loss of genetic diversity in isolated populations.

Dispersal

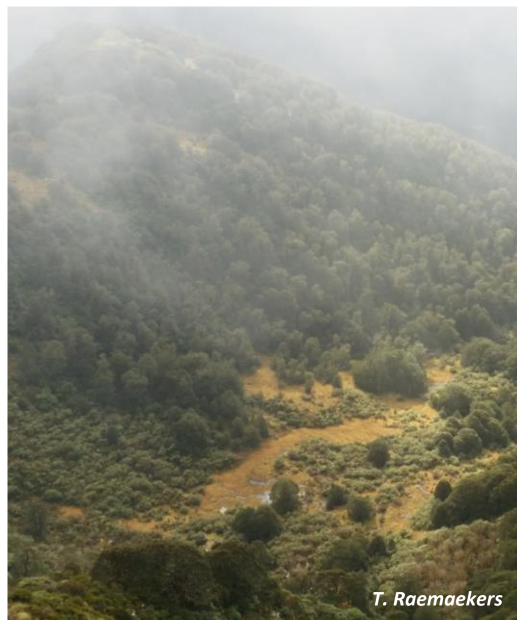
There is very limited information on dispersal for Fiordland tokoeka. They are strongly territorial, with non-overlapping territories that are defended against neighbours. Northern Fiordland tokoeka appear to have relatively large territories for kiwi, with an average territory size of 51 ha found in the Murchison Mountains. Young chicks will venture out of, and return to, the nest until they are a month or more old, after which they begin dispersing. Sub-adults have been found to disperse at least 5 km after fledging. Once territories are established, Fiordland tokoeka appear to be fairly sedentary, and yearly home range movements of 800 m are recorded. Gap-crossing ability is unknown, but their restricted distribution to native forest in Fiordland suggests low dispersal (or survival) in surrounding cleared agricultural areas. Northern Fiordland tokoeka naturally occur on Secretary island, although this is more likely to be the result of past lower sea levels.



Diverse southern Fiordland habitat consisting of beech-podocarp forest, scrub and tussock areas. Shy Lake, Fiordland

Breeding habitat

Fiordland tokoeka occupy a diverse range of habitats in Fiordland. They can be found from sea level to above the treeline, in beech and podocarp forest, tussock grasslands, shrublands, and coastal habitats. Pairs often reuse the same nesting sites across seasons, with some pairs using the same nest location every year. There have been few studies on the ecology of Fiordland tokoeka, so there is limited detail on their fine-scale habitat requirements.



Mixed beech forest, scrub and tussock high elevation breeding habitat, Fiordland.

Non-breeding habitat

Fiordland tokoeka establish permanent territories once mature. Juveniles may disperse further than breeding adults and use a wider variety of habitats, although there are very few data on this. Habitats with no mustelid control can be considered non-breeding habitat due to the high recruitment failure that occurs from chick predation by stoats. Territorial boundaries often follow natural features such as streams or bluffs.

Roosting and foraging habitat

Fiordland tokoeka use any natural cavity for roosting within their territory. During daytime they sleep in natural burrows under the roots of living trees, under thick vegetation, in rock crevices or inside hollow trees or logs. In general, kiwi (*Apteryx* spp.) have multiple shelters within their territory and often roost in a different location every day. Young chicks and sub-adults sometimes share a roost with their parents and will contribute to egg incubation. Fiordland Tokoeka forage by probing their beak into the soft ground, where they mostly prey on invertebrates, but they will also consume occasional berries and vegetation. Thick, mossy forest floors are often utilised for foraging. Foraging habitat is predominantly in forested or low scrub vegetation, but extends into open tussock areas at higher elevations.

Low elevation breeding habitat in mixed podocarp-beech rainforest, Fiordland.

Key management actions

Key management actions include:

- in situ management of stoats across large areas is essential for population recovery.
- predator control with trapping and toxins that reduces stoats down to very low numbers is necessary to protect nests and young chicks. Effective control of stoats to low or undetectable numbers is essential to allow for successful recruitment of juveniles into the breeding population.
- regular aerial 1080 application (e.g. every 3 years) is needed, along with predator control timed to follow mast seed events to knock down predator eruptions.
- short pulses of 1080 using ground bait stations may be used in long-term trapping areas to help target trap-shy predators.
- connectivity of safe habitat between fragmented populations should be increased through landscape-scale predator control and lowland forest revegetation.
- translocations to intensively controlled areas or islands could be used, but this is not considered the main focus for management.

Knowledge gaps and challenges

There is generally limited information on Fiordland tokoeka, with the taxon still considered to be in a 'research' phase. Until recently, the Northern Fiordland tokoeka had been the focus of most research, with the majority of studies carried out in the Clinton Valley and Murchison Mountains. Fiordland tokoeka have a broad distribution across Fiordland, but there is limited information on dispersal, connectivity, density, and overall metapopulation dynamics. A key challenge for Fiordland tokoeka is maintaining effective stoat control within the difficult Fiordland environment. As a consequence the majority of Fiordland tokoeka populations do not receive active conservation management. Monitoring of key populations shows high variability in productivity across years, despite control efforts. More research is needed to inform how inbreeding and small population dynamics may be affecting population trends. Low recruitment limits the ability for interventions such as translocations, because sourcing adults from remnant populations may exacerbate genetic and small-population challenges. Fiordland tokoeka have had the fewest translocation attempts of all kiwi taxa.

Further reading

Edmonds H 2005. Fiordland tokoeka productivity and chick survival study, Clinton Valley, Fiordland National Park, 2004/05. Te Anau, NZ, Department of Conservation.

Edmonds H 2012. Tokoeka monitoring Murchison Mountains 2011/2012. Te Anau, NZ, Department of Conservation.

Edmonds H 2015 Taxon plan for northern and southern Fiordland tokoeka (*Apteryx australis australis*): strategic plan for the recovery of northern and southern Fiordland tokoeka, for the period 2015–2025 and beyond. Wellington, NZ, Department of Conservation.

Germano J, Barlow S, Castro I, Colbourne R, Cox M, Gillies C, et al. 2018. Kiwi recovery plan 2018–2028, Mahere whakaora kiwi 2018–2028. Threatened Species Recovery Plan No. 64. Wellington, NZ, Department of Conservation.

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Tansell J, Edmonds HK, Roberston HA 2016. Landscape-scale trapping of stoats (*Mustela erminea*) benefits tokoeka (*Apteryx australis*) in the Murchison Mountains, Fiordland, New Zealand. Notornis 63: 1–8.

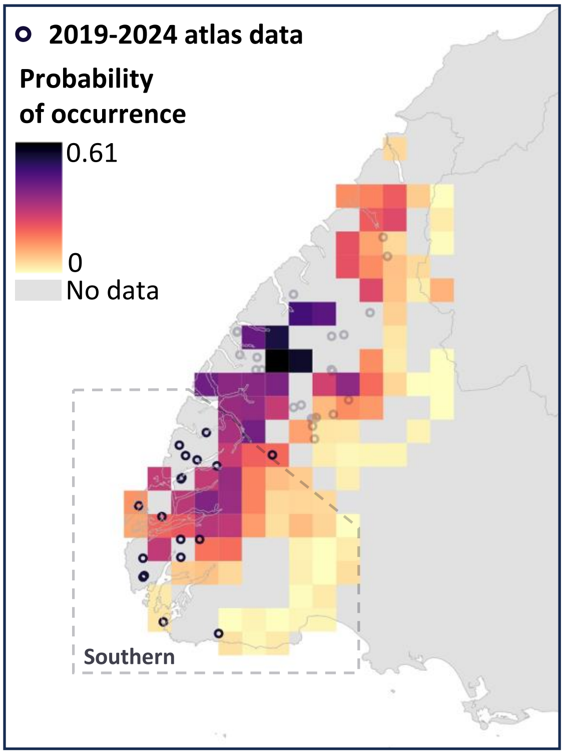
* Predicted distribution compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

NATIONALLY ENDANGERED

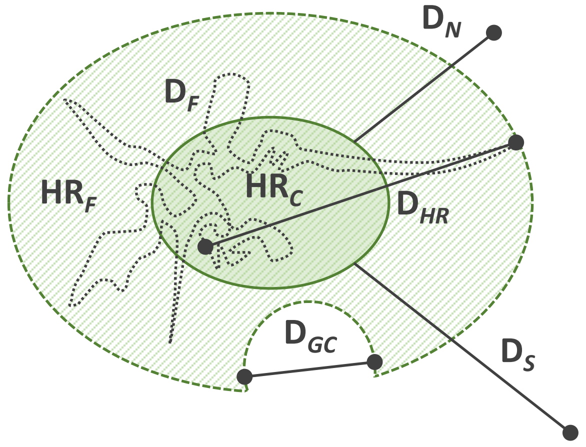
Southern Fiordland tokoeka / brown kiwi

Apteryx australis 'Southern Fiordland'

Predicted distribution*



Dispersal and movement metrics



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Ecology

Fiordland tokoeka were historically widespread throughout Fiordland, and are still found in native forest, tussock grassland, and neighbouring farmland habitats. They are largely nocturnal, but daytime foraging has been observed, particularly in summer, when nights are shorter. Fiordland tokoeka are mostly insectivorous, consuming a range of invertebrates by probing the forest floor. They form monogamous pairs and can lay multiple single-egg clutches per season. Incubation is shared between males and females, and with previous chicks, which often remain and act as helpers. Weight varies considerably throughout the year, with minimum weights in summer following breeding. Longevity and age of maturity are unknown, but are likely to be high based on other similar kiwi species.

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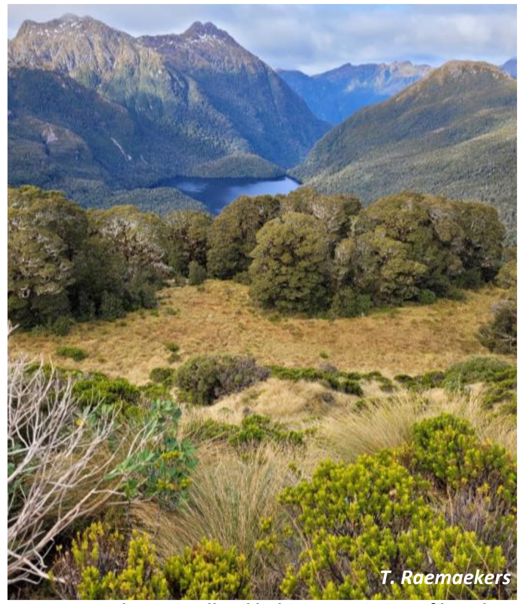

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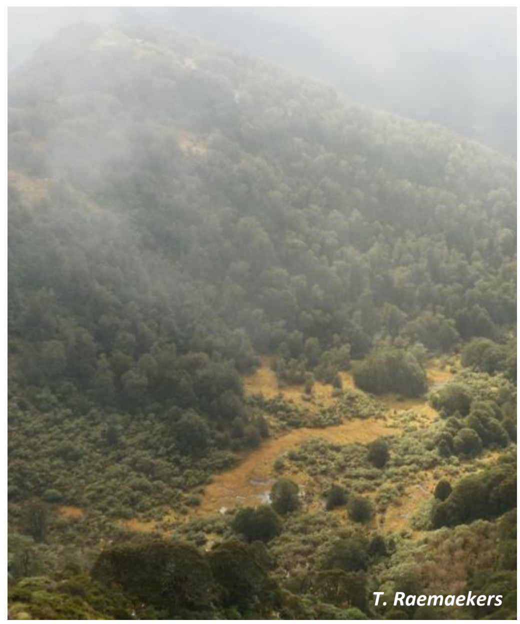

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Low elevation breeding habitat in mixed podocarp-beech rainforest, Fiordland.

FOREST/OPEN

Key management actions

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- connectivity of safe habitat between fragmented populations should be increased through landscape-scale predator control and lowland forest revegetation.
- translocations to intensively controlled areas or islands could be used, but this is not considered the main focus for management.

Knowledge gaps and challenges

There is generally limited information on Fiordland tokoeka, with the taxon still considered to be in a 'research' phase. Until recently, the Southern Fiordland tokoeka had little research focus, but an 8-year monitoring programme at Shy Lake has improved knowledge on this taxon. Fiordland tokoeka have a broad distribution across Fiordland, but there is limited information on dispersal, connectivity, density, and overall metapopulation dynamics. A key challenge for Fiordland tokoeka is maintaining effective stoat control within the difficult Fiordland environment. As a consequence the majority of Fiordland tokoeka populations do not receive active conservation management. Monitoring of key populations shows high variability in productivity across years, despite control efforts. More research is needed to inform how inbreeding and small population dynamics may be affecting population trends. Low recruitment limits the ability for interventions such as translocations, because sourcing adults from remnant populations may exacerbate genetic and small-population challenges. Fiordland tokoeka have had the fewest translocation attempts of all kiwi taxa.

Further reading

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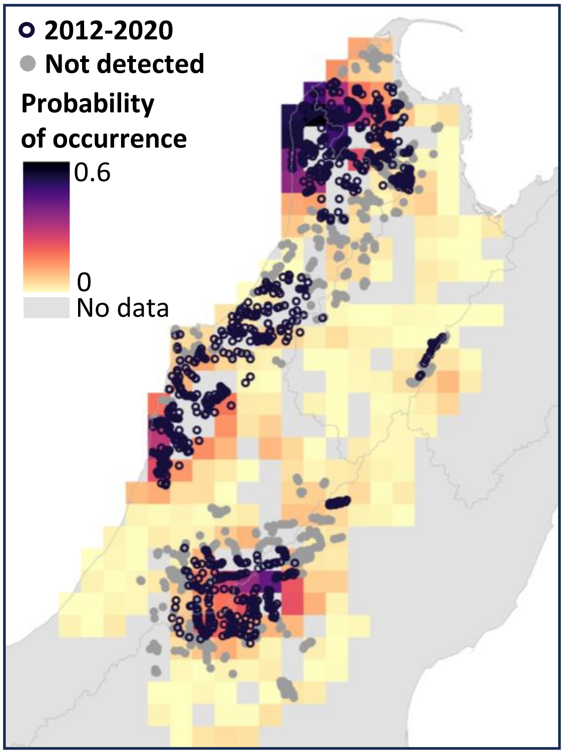
FOREST/OPEN

NATIONALLY VULNERABLE

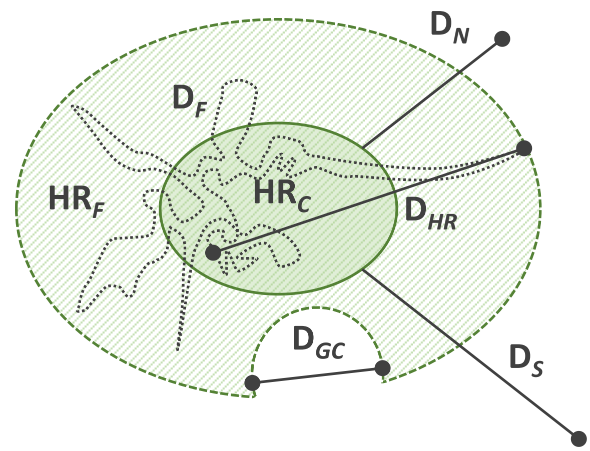
Roroa / Great spotted kiwi

Apteryx maxima

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	26–126 ha
Foraging home range (HR_F)	max: 475 ha
Foraging dispersal (D_F)	1,050–1,250 m
Home range dispersal (D_{HR})	357–722 m
Natal dispersal (D_N)	unknown
Seasonal dispersal (D_S)	NA
Gap crossing (D_{GC})	unknown

Description

Roroa / great spotted kiwi is one of the largest kiwi species. Females can weigh over 3.5 kg while males weigh up to 2.5 kg. They are greyish-brown in colour, with irregular banding and mottling on their feathers, which are dark brownish-black. They have a long, pale bill and robust feet that are dark to pale brown. Males and females can be distinguished by their calls, with males producing a high, shrill whistle while female calls are at a lower pitch with ascending whistles. Roroa are endemic to the South Island of New Zealand, and are restricted to four genetically distinct populations in Kahurangi National Park, north-west Nelson, Paparoa Range, and Arthur's Pass / Hurunui, with Kahurangi being the main stronghold.

Ecology

Roroa have contracted into small populations within their historical range, isolated by distance, and so have minimal geneflow. They mostly occur in high-rainfall, mountainous areas, and are habitat generalists, occupying a range of native forest, scrubland, and upland tussock grassland habitats. Roroa are nocturnal, and shelter in cavities or under vegetation during the day. They are a long-lived species, with an adult life expectancy of up to 57 years and a long generational interval. Their breeding productivity is very low: they lay a single egg per breeding event, and juveniles only become mature at 3–8 years. Egg incubation is shared, with males incubating during the day and shared incubation at night. Juveniles can remain with their parents for a long time, with records of young birds remaining for 4.5 years. These characteristics make roroa populations extremely sensitive to threats and slow to respond to management.

Pressures

Like most kiwi, roroa are vulnerable to introduced mammalian predators, particularly mustelids (stoats, *Mustela erminea*), feral cats (*Felis catus*), and dogs (*Canis lupus*). Adult roroa are vulnerable to dog and ferret (*Mustela furo*) predation, but stoat predation of chicks and juveniles is the main cause of recruitment failure. Incorrectly set leg-hold traps have been a common cause of injury in roroa. Historical logging and widespread forest clearance has contributed to the fragmentation and isolation of remaining populations, with limited gene flow. Their remnant distribution associated with high-rainfall mountainous areas may reflect relatively recent range contraction. Roroa are prone to nest disturbance and will readily abandon nests in the early stages of incubation if disturbed. Weka are known to predate eggs and harass nesting individuals, contributing to nest failure.

Dispersal

Roroa are flightless and highly territorial. Breeding pairs defend permanent home ranges of up to 126 ha. Mean territory size varies between populations and across years, but is generally between 30 and 70 ha. Once established, general movement is fairly low, with most birds moving 1–1.2 km per night. Juveniles remain within their natal range for up to 4.5 years before dispersing. Little information exists for natal dispersal, but a female has been recorded dispersing 2 km to establish a territory. Post-release monitoring of translocated roroa has found dispersal between 2 and 10 km from the release site, with a maximum recorded dispersal distance of 17 km prior to settlement. Some individuals can take a long time to establish territories, with one translocated bird in Kahurangi National Park taking 878 days to settle. Gap-crossing ability is unknown, but given the high fragmentation and genetic isolation of populations it is likely to be low.

Beech dominated forest breeding habitat, Kahurangi National Park.

Breeding habitat

Little is known about the habitat use of roroa, but studies suggest they are largely confined to forest habitats, from sea level to the treeline. Breeding habitat appears to be mostly beech and podocarp-dominated high-elevation forest. In the Nelson region breeding habitat is dominated by silver beech (*Lophozonia menziesii*) and red beech (*Fuscopoa fusca*) at lower elevations, and by mountain beech (*F. solandri var. cliffortioides*) at higher altitudes. Breeding territories extent across the treeline, where *Olearia*, *Dracophyllum*, and *Veronica* scrubland and *Chionochloa* tussock habitats are also used. Nesting occurs in natural cavities, generally under tree boles or root plates, as well as in hollow logs, rock caves or other natural underground cavities.

High elevation forest habitat bordered by tussock and scrubland used for breeding. Kahurangi National Park

Non-breeding habitat

Roroa establish permanent territories once mature. Juvenile roroa probably disperse further than breeding adults and may use a wider variety of habitats, although there are very few data on this. Habitats with no mustelid control can be considered non-breeding habitat due to the high recruitment failure that occurs from chick predation by stoats.

Roosting & foraging habitat

Roroa will use the same natural cavities for nesting and roosting. During the daytime they sleep in natural holes under the roots of living trees, in hollows under thick vegetation, or inside hollow logs. In general, kiwi (*Apteryx* spp.) can have up to 100 shelters within their territory and will generally roost in a different location every day. Young chicks and sub-adults are known to share a roost with their parents. While remaining in their natal territory, sub-adults will commonly roost close to parents, with over half of monitored birds found roosting within 50 m of their parents. Roroa forage by probing their beak into the ground, where they forage on a wide range of invertebrates, fruits, berries, and leaves within the leaf litter.

Low elevation rainforest habitat, Kahurangi National Park.

Key management actions

Key management actions include:

- in situ management of mustelids across large areas is essential for population recovery.
- predator control with trapping and toxins to reduce stoats to very low numbers is necessary to protect breeding adults and chicks. Effective control of stoats (e.g. <0.01 stoats per hectare) can be adequate for restoring recruitment of juveniles into breeding populations.
- continued dog control, permitting, regulations, and signage to ensure roroa habitat remains dog free are all recommended.
- the 'Roroa Species plan 2019–2029' should be used to assess production and development applications that are within or adjacent to roroa habitat.
- connectivity of safe habitat should be increased between fragmented populations through landscape-scale predator control and lowland forest revegetation.
- regular aerial 1080 application (e.g. every 3 years) is essential, along with predator control timed to follow mast seed events to knock down predator eruptions
- short pulses of 1080 using ground bait stations can be used in long-term trapping areas to help target trap-shy predators.
- wild-to-wild translocation of adult roroa can be a used to establish new populations into predator-controlled habitat, but this is not considered a priority management tool. If translocations are undertaken, birds should be moved within neighbourhood units, no more than 20 km from source, to maintain genetic diversity across the populations.

Knowledge gaps and challenges

Until recently roroa was one of the least-studied kiwi species, with less conservation management. As a consequence the population is still in decline. Overall there is limited information on their ecology, habitat requirements, threats, and management. However, recent surveys and monitoring of birds have provided new information to inform management. In situ, large-scale 1080 control is currently the key recommended tool for effective management, but predator control in the mountainous habitats that roroa occupy can be challenging. Limited predator-controlled habitat and the importance of wild adult birds has meant only four translocation projects have been undertaken since 2004. The long generation interval of roroa means management and recovery can be slow, and so support for sustainable, long-term projects is needed.

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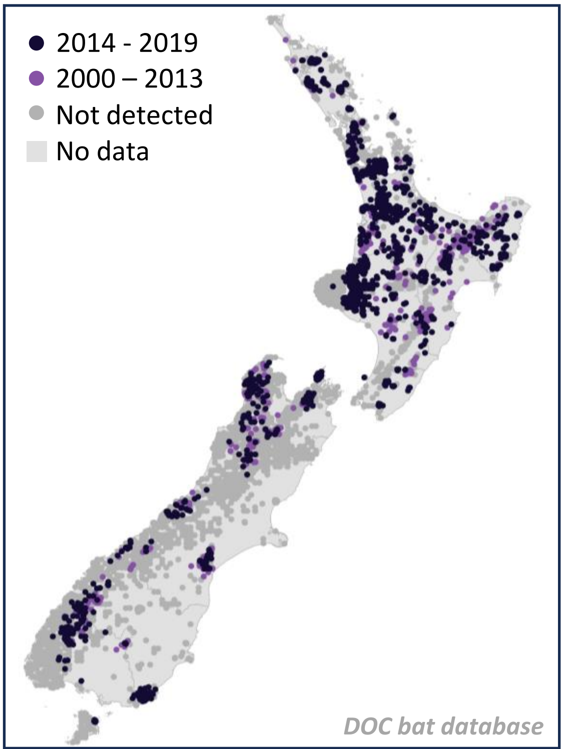
* Predicted distribution is compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and survey data from 2012-2010 from Toy & Toy (2022) which includes acoustic detections, incidental detections and non-detections.

NATIONALLY CRITICAL

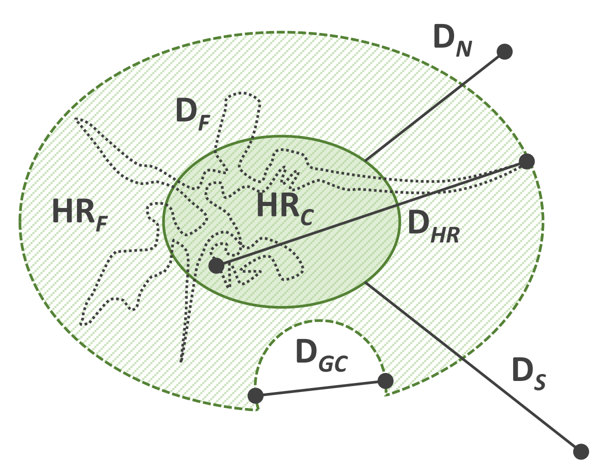
Pekapeka / Long-tailed bat

Chalinolobus tuberculatus

Observations 2000-2019



Dispersal and movement metrics



Core home range (HR_C)	230–2,000 ha
Foraging home range (HR_F)	max: 6,000 ha
Foraging dispersal (D_F)	unknown
Home range dispersal (D_{HR})	max: 25 km
Natal dispersal (N_D)	unknown
Seasonal dispersal (D_S)	unknown
Gap crossing (D_{GC})	min: 1 km

Description

Long-tailed pekapeka are one of two endemic micro-bat species in New Zealand. They are smaller than short-tailed pekapeka, weighing between 8.5 and 12.3 g. The long-tailed pekapeka can be distinguished by its tail, which is almost as long as its head and body and has a large, V-shaped membrane extending past the back legs. Adult females are a chestnut brown colour, while males and juveniles are dark brown with blackish heads. Pekapeka are nocturnal and moderately fast flying. They can be distinguished from birds when flying due to their typical bat silhouette and distinctive, sharp flight patterns.

Ecology

Long-tailed pekapeka are widely distributed throughout New Zealand. They are found across all the main islands and also on many predator-reduced offshore islands, including Aotea / Great Barrier Island, Hauturu-o-Toi / Little Barrier Island, and Kapiti Island. Long-tailed pekapeka are rare or absent across much of the eastern South Island and lower North Island. They are mostly insectivorous, their diet consisting of a wide variety of aerial, aquatic, and terrestrial invertebrates. During summer they roost in large colonies. In colder months, pekapeka enter a torpor state (semi-hibernation), whereby they remain in roosts with limited activity. The breeding season occurs in autumn and summer, with mating in autumn and pups born in summer. Long-tailed pekapeka move between roost sites as a group often – sometimes daily – during summer. Therefore, large areas of habitat with abundant roost sites are critical. They are mostly associated with mature native forest habitats, but are also found in modified plantation forestry, and in modified agricultural habitats with large, standing trees.

Pressures

Clearance of large, old-growth forest and predation by introduced mammalian predators have been the main contributors to a decline in pekapeka. Key ongoing pressures include predation and competition, and habitat degradation and disturbance. They are extremely vulnerable to mustelids and rats throughout the year. Cats and possums are also known predators. Introduced species (e.g. sparrows, wasps) compete for roosts. Selective logging of mature native forest as well as large-scale felling of plantation forests reduces habitat quality. Housing, roading, and infrastructure developments that remove native forest and large roosting trees are also a threat. Wind farms pose a collision risk to pekapeka due to their interference with echolocation. Climate change and its impact on mast dynamics are other threats.

Dispersal

Long-tailed pekapeka are highly mobile and have very large home ranges that vary depending on their age and sex, and the season. Colonies in Fiordland have been found to disperse over 11,700 ha, but individual home ranges tend to average between 237 and 2,006 ha. The largest individual home range recorded in Fiordland was 5,629 ha. Long-tailed pekapeka are strong fliers and can fly between 10 and 25 km between roosts and foraging grounds. Overall dispersal from colonies has been found to cover over 15,000 ha. Long-tailed pekapeka commonly disperse along streams and open corridors between forest habitats.

High quality southern breeding habitat, Eglington Valley.

Breeding habitat

Long-tailed pekapeka breeding habitat is usually found in unmodified native forest, but can also consist of plantation forestry, scrublands, and farmland where large, standing trees for roosting are present. In northern habitat, communal roosts are more often found in old-growth kauri forest. The availability of large roosting cavities is a key component of breeding habitat. Breeding habitat also requires large, connected areas of habitat to provide enough roost trees for roost-switching. Thick-walled tree cavities are necessary for adequate thermoregulation of maternal roosts.

Expansive area of mature, unmodified podocarp forest breeding habitat, Pureora Forest.

Foraging habitat

Long-tailed pekapeka are able to persist in small forest patches in urban environments as long as there are vegetated corridors. Their activity decreases with housing and street light density. Foraging habitat is generally associated with forest edges and riparian corridors. However, they also forage over regenerating scrub, open pasture, orchards, dwellings, and urban roadsides. Long-tailed pekapeka appear to use linear landscape features such as streams, gullies or roads to assist with their foraging. In these edge habitats foraging activity peaks just after sunset. Foraging is linked to invertebrate abundance, with increased activity during warm, humid evenings.

Roosting habitat

Long-tailed pekapeka roost in cavities in a variety of large, mature trees; dead, standing trees; exotic forestry; or limestone caves and crevices. In modified habitats they will also roost under bridges and in farm buildings. In Fiordland, roost trees are mostly found in beech (*Fuscospora*) species. In Northland, long-tailed pekapeka have been observed roosting in kauri (*Agathis australis*), while in podocarp/broadleaf forests they will roost in a range of canopy trees that have >50 cm diameter at breast height. Cavities are usually located high in trees, averaging 15–17 m above the ground. In native forest, roost trees are often found close to streams and in gullies. Unlike short-tailed pekapeka, roost switching occurs frequently, and there is very little reuse of roosts. In Fiordland a 3-year study recorded 300 different roost sites being used. In modified habitats with limited roost sites reuse of roosts is more common.

Roosting habitat with large mature trees, Whanganui.

Key management actions

Given the long-term importance of roost trees, the protection of individual roost trees from felling and urban development is crucial. Other key management actions include:

- habitat protection in frequently used foraging areas, including reduced disturbance of waterways and gullies from development and river engineering
- protection of dead spars during harvesting of forestry, to protect roosts and promote the persistence of populations in modified landscapes
- riparian planting along streams and waterways
- predator control that maintains low levels of a suite of mammalian predators (including rats, mustelids, possums and cats) – predator control that only targets individual predator species can result in mesopredator release and produce negative outcomes for pekapeka, particularly in mast years
- cat control and regulations in urban and modified areas where pekapeka roost
- predator control strategies that minimise the risk of secondary poisoning
- continued protection and restoration of large tracts of healthy forest and waterways to minimise the potential impacts of climate change on food availability and temperature stress
- modified street lighting design on urban fringes to reduce light pollution and impacts on foraging.

Knowledge gaps and challenges

Studying pekapeka dispersal is challenging due to their small size and high mobility. Determining the distribution and location of suitable roosting trees is critical to their successful management. However, because these bats switch roost frequently, temporal variation in distribution makes it difficult to estimate population trends and identify areas for management. There is also uncertainty about how emerging pressures such as climate change and wind farm developments will affect them. Long-tailed pekapeka are probably less gap limited than short-tailed pekapeka, although maximum gap-crossing abilities have yet to be established. A key challenge for the conservation of pekapeka is that management actions are largely restricted to in situ management of existing populations. There has been no success in establishing new populations of pekapeka through conservation translocations: experimental translocations have shown that translocations are currently not a viable management technique. Protection of existing populations, and their habitat, is therefore key to ensuring their long-term persistence.

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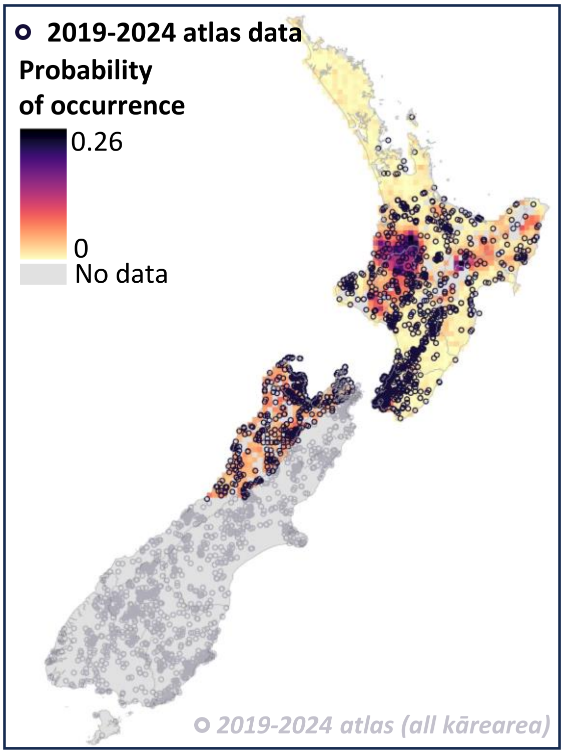
NATIONALLY INCREASING

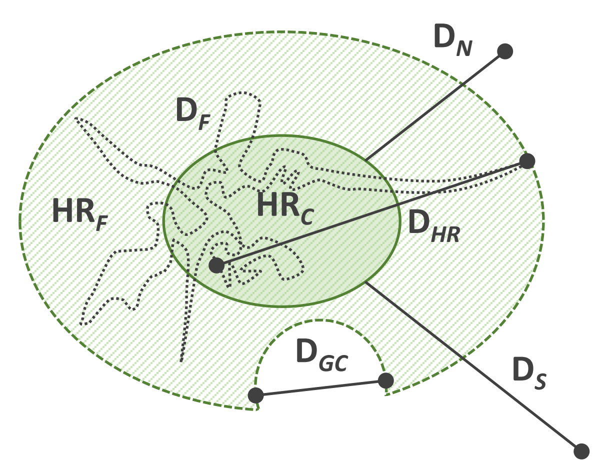
Kārearea / Bush falcon

Falco novaeseelandiae ferox

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	900 ha
Foraging home range (HR_F)	4,000–60,000 ha
Foraging dispersal (D_F)	mean: 4 km
Home range dispersal (D_{HR})	max: 10 km
Natal dispersal (D_N)	1–35 km
Seasonal dispersal (D_S)	NA
Gap crossing (D_{GC})	500 km

Description

The kārearea is a small falcon and the only endemic raptor in New Zealand. It is mostly brown, with white flecks, a cream breast, and a reddish-brown undertail. Kārearea have long wings, which look pointed and curved when diving but spread when gliding. During flight they beat their wings rapidly, giving them a distinctive flight style compared to kāhu / Australasian harriers (*Circus approximans*). Kārearea make a loud, piercing call during flight. Females are much larger and more richly coloured than males. Adults can be distinguished by their yellow legs, dark coloration, and strong, flecked patterning. Juveniles have pale grey legs and are more uniform in colour. The bush kārearea is the smallest and darkest of the three subspecies.

Ecology

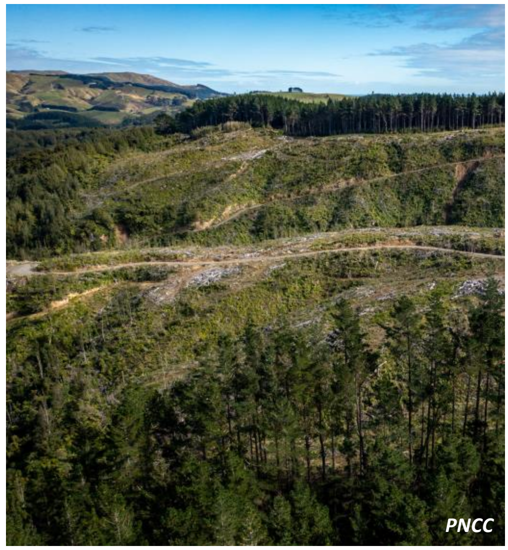
The kārearea is widespread but rare throughout New Zealand. The bush kārearea has disappeared from northern New Zealand, and is only found south of Waikato (37° latitude) in the North Island and in forested areas of the West Coast and Nelson regions. The population of bush kārearea is estimated to be only 1,300 pairs. They predominantly occur in native and exotic forests, but are sometimes found in tussock grassland, farmland, and urban areas. Kārearea are predatory and mainly feed on live prey. Their diet mostly consists of medium-sized birds, but they also hunt small mammals, depending on prey abundance. Juveniles are also known to prey on larger invertebrates. Nesting occurs in trees/epiphytes, or on the ground on cliff ledges, bare slips or rocky outcrops. Breeding occurs from October to December. Clutches are up to four eggs, and incubation lasts for a month and is shared by both parents. Kārearea have a long fledgling period of up to 14 weeks.

Pressures

Historical decline in bush kārearea has been linked to forest clearance following European settlement, as well as introduced mammalian predators, persecution, and pesticide use. Ongoing habitat disturbance and degradation affect prey abundance. During breeding, kārearea are vulnerable to introduced mammalian predators, with nests and fledglings particularly vulnerable. Predator control can benefit them, but it can also lead to secondary poisoning. Expansive clear-cutting of plantation forests that reduces edge habitats and increases open patch size reduces habitat quality and foraging ability. Competition with introduced species such as the Australian magpie (*Gymnorhina tibicen*) can also be a concern.

Dispersal

Kārearea are a highly mobile species but establish relatively sedentary home ranges throughout the year. Adult kārearea nest in the same sites between years. Core home range sizes vary from 600 to 7,500 ha. In plantation forests research has recorded average core home ranges of 1,500 ha, with a high degree of overlap among individuals. Home range sizes can be smaller (600–900 ha) in high-quality habitat that has increased edges and many small, open patches. However, foraging home ranges can be large. A multi-year satellite tracking study of a female bush kārearea recorded dispersal across 60,000 ha. After fledging, juveniles are very mobile. Increased sightings of juvenile kārearea is often observed in autumn, when dispersing individuals use a wider range of habitats. Although juveniles may roam further, natal dispersal averages 9 km, with territories established within 1–35 km of natal territories. Kārearea are not gap limited, and data from southern falcons show dispersal of 270 km between subantarctic islands.



Breeding habitat consisting of a mosaic of mature native forest, exotic pine and young scrub. Turitea Reserve

Breeding habitat

Breeding habitat consists of a mosaic of open habitat and edges of mature exotic and native forest. The presence of mature trees in open patches is the key feature for suitable kārearea breeding habitat. In exotic plantations nesting occurs in open regenerating patches (e.g. <3-year-old vegetation), no more than 200 m from the edge of mature forest. In native forest, nesting generally occurs in epiphytes in large, emergent trees. Native forests have much lower densities of nesting and hunting habitat, and so much larger areas are needed to support healthy breeding populations. Research suggests that forestry and agricultural habitats may have improved breeding success and foraging opportunities compared to natural habitats. Open patches provide important habitat for hunting and feeding, and for courtship displays. Highly mixed landscapes of open agricultural areas, native scrub, and mature forest that have a high edge density provide optimal landscapes for breeding.

Small podocarp forest remnant breeding habitat within rural landscape, Rangitikei.

Non-breeding habitat

Bush kārearea generally use the same habitat year-round, but non-breeding individuals may have more expansive home ranges across more uniform habitats, with reduced edge habitat. Unpaired individuals will still hunt and roost in open patches.

Roosting and foraging habitat

Hunting occurs predominantly in open habitat, although bush kārearea have been observed hunting under the canopy as well. Open habitat along forest edges provides ideal hunting habitat, with a high diversity and abundance of prey. Pine plantations have a higher abundance of exotic passerine birds, making them a resource-rich habitat compared to indigenous forests. Pine plantations are therefore a key habitat type for bush kārearea, and suitable harvesting practices benefit hunting opportunities and prey abundance.

Native breeding habitat with tall emergent nesting trees. Central Plateau

Key management actions

Key management actions include:

- protection of large, emergent trees used for nesting
- harvesting protocols in exotic plantations that ensure open patches (0–3-year-old stands) are <400 ha in size, irregularly shaped, and retain small stands of mature pine to maintain edge habitats
- plantations that have a mosaic of smaller, unevenly aged forest stands to promote smaller-scale harvesting regimes and maintain high edge density
- retention of stands of mature trees along edges of open habitat, particularly in steeper terrain
- pest control for mustelids, possums, cats, and hedgehogs in native, forestry, and agricultural habitats
- designing of wind farms developments to reduce/avoid felling of large standing trees, collision risk, and construction during the breeding season
- kārearea-friendly powerline design, which includes insulated transformers and lightning arrestors
- translocations, while not a key management tool, can be successful in reintroducing or supplementing populations in modified landscapes
- provision of artificial perches and nesting sites in agricultural landscapes, which can help foraging and breeding, reduce predation risk, and improve ecosystems services provided by kārearea.

Knowledge gaps and challenges

A few tracking studies have provided valuable detailed data on dispersal and habitat use. However, studies have focused on forestry and agricultural areas and are generally constrained to small sample sizes. These studies have shown marked differences in dispersal and home ranges across sex and age. For example, tracking of five bush kārearea showed widely different home ranges, ranging from 4,000 to 60,000 ha. So while some data are available, extrapolation across populations is difficult. Bush kārearea survive well in modified habitats, which may be contributing to range expansion. Wind turbines might pose an increasing threat to bush kārearea, but there is little information on how much of a collision risk they pose. Research that monitors bush kārearea populations around such developments is needed to help mitigate these adverse effects.

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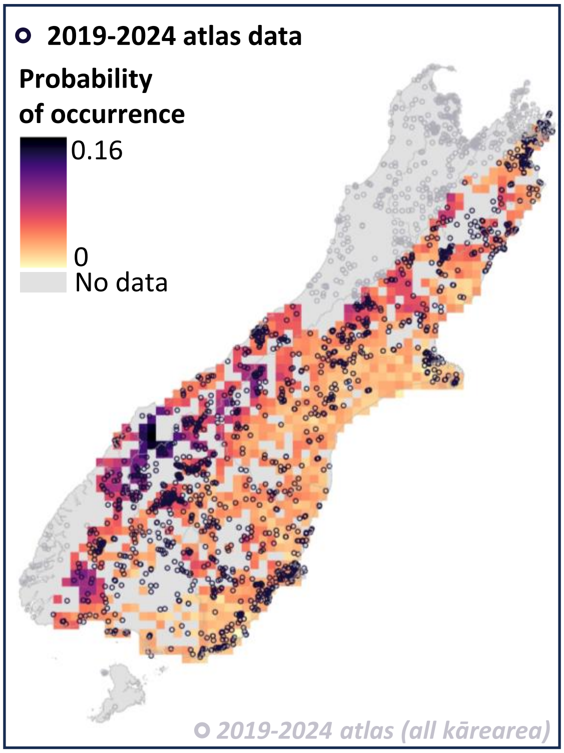
* Predicted distribution is compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

NATIONALLY VULNERABLE

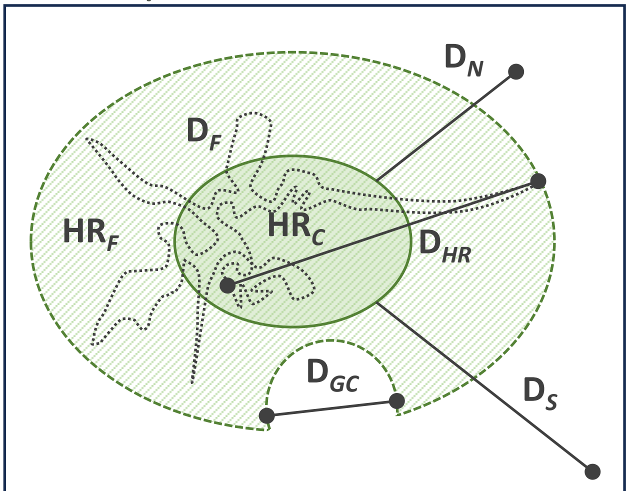
Kārearea / Eastern falcon

Falco novaeseelandiae novaeseelandiae

Predicted distribution*



Dispersal and movement metrics



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Gap crossing (D_{GC})	500 km

Description

The kārearea is a small falcon and the only endemic raptor in New Zealand. It is mostly brown, with white flecks, a cream breast, and a reddish-brown undertail. Kārearea have long wings, which look pointed and curved when diving but spread when gliding. During flight they beat their wings rapidly, giving them a distinctive flight style compared to kāhu / Australasian harriers (*Circus approximans*). Kārearea make a loud, piercing call during flight. Females are much larger and more richly coloured than males. Adults can be distinguished by their yellow legs, dark coloration, and strong, flecked patterning. Juveniles have pale grey legs and are more uniform in colour. Kārearea are divided into three geographical forms based on habitat association. The eastern kārearea is the largest and palest of the three forms.

Ecology

The kārearea is widespread but rare throughout New Zealand. Eastern kārearea are mostly found east of the Southern Alps in open, drier habitats, but extend from coast to coast in the central South Island. These birds are predatory and predominantly feed on live prey. Their diet mostly consists of medium-sized birds, but they also hunt small mammals, depending on prey abundance. Juveniles are also known to prey on larger invertebrates. Eastern Kārearea mostly nest on the ground, on cliff ledges, bare slips or rocky outcrops. Breeding occurs from October to December. Clutches are up to four eggs, and incubation lasts for a month and is shared by both parents. Kārearea have a long fledgling period of up to 14 weeks.

Pressures

Historical decline in kārearea is associated with habitat clearance, introduced mammalian predators, persecution, and pesticide use. Drought, habitat degradation, and clearance are key ongoing pressures for eastern kārearea. Breeding surveys indicate relatively good nesting success, suggesting the main pressures are affecting adult survival and recruitment. Electrocution from powerlines is a common cause of mortality for eastern kārearea in modified environments. Conversion of tussock grasslands and scrub habitats into pasture and forestry reduces breeding and foraging habitat. As predators, kārearea may be sensitive to secondary poisoning, but evidence on this is limited. Competition with introduced species such as the Australian magpie (*Gymnorhina tibicen*) also occurs. Drought may be contributing to reduced habitat quality. Collison with wind turbines is a new, emerging pressure.

FOREST/OPEN

Dispersal

Kārearea are a highly mobile species but establish relatively sedentary home ranges throughout the year. Adult birds nest in the same sites between years. Core home range sizes vary from 600 to 7,500 ha. Eastern kārearea tend to have smaller home ranges averaging 1,400 ha. In plantation forests research has recorded average core home ranges of 1,500 ha, with a high degree of overlap among individuals. Home range sizes can be smaller (600–900 ha) in high-quality habitat with increased edges and numerous, small, open patches. However, foraging home ranges can be large. A multi-year satellite tracking study of a female bush kārearea recorded dispersal across 60,000 ha. After fledging, juveniles are more mobile. Increased sightings of kārearea in autumn are mostly of dispersing juveniles. Natal dispersal averages 9 km, with territories established within 1–35 km of natal territories. Fledglings are poor fliers and remain close to nest sites until 10 weeks. Once mature, kārearea are not gap limited. Data from southern kārearea show dispersal of 270 km between subantarctic islands.

Breeding habitat of mixed open and high altitude scrub and forest vegetation, Aoraki/Mt Cook Village.

Breeding habitat

Eastern kārearea occupy a range of open, modified, and native habitats across the South Island. Native, unmodified habitats appear to be preferred for breeding, including open tussock, native riparian edges, and native forests. However, successful breeding also occurs in modified plantation forest, agricultural environments (e.g. high-country farms, vineyards), and dry, open, mixed-use habitats. Steep terrain provides good hunting conditions and natural protection from predators. Availability of water may be an important feature of breeding habitat, with some evidence that nesting locations near water (e.g. steep-sided valleys overlooking streams) are preferred. The intensive monoculture of vineyards in the Marlborough area, with a high abundance of introduced bird species, is associated with increased breeding success.

Breeding and foraging habitat in high country tussock and modified regenerating scrub habitat, Lake Ohau.

Non-breeding habitat

Kārearea have permanent territories once mature, so breeding and non-breeding habitats are similar. Eastern kārearea breed less in pine plantations compared to bush kārearea and have lower nesting success in native hill country. Food and water availability are key limiting factors on kārearea density. Habitats with a low abundance of small avian prey species are used less by breeding pairs. Juveniles spend more time in low scrub and forest habitats before dispersing into more open areas.

Roosting & foraging habitat on steep cliff ledge surrounded by mixed open and modified vegetation, Canterbury.

Roosting and foraging habitat

Studies of eastern kārearea in modified sheep farming areas have shown that foraging home ranges are mostly undefended, with high territory overlap. Eastern kārearea hunt in relatively open habitats, with introduced avian prey the main component of their diet. Open and modified areas with a high abundance of small, introduced birds are important foraging habitat. Kārearea use large, emergent trees, modified structures, and cliff ledges as perches, which provide good vantage points for foraging.

Key management actions

Key management actions include:

- protection of scrub, open tussock habitats, and mature forest with large, emergent trees, particularly around steep valleys and water courses
- harvesting protocols in exotic plantations that ensure open patches (0–3-year-old stands) are <400 ha in size, irregularly shaped, and retain small stands of mature pine to maintain edge habitats
- plantations that have a mosaic of smaller, unevenly aged forest stands to promote smaller-scale harvesting regimes and maintain high edge density
- pest control for mustelids, cats, and hedgehogs
- designing wind farms to reduce/avoid the felling of large, standing trees, collision risk, and construction during the breeding season
- kārearea-friendly powerline design, which includes insulated transformers and lightning arrestors
- provision of artificial perches and nesting sites in agricultural landscapes, which can help foraging and reduce predation risk, and also improve ecosystems services provided by karearea.

Knowledge gaps and challenges

Most studies of kārearea are of bush kārearea, resulting in few detailed dispersal and habitat studies of southern and eastern kārearea. Despite being widespread, observations of eastern kārearea are rare, making data on distribution, population trends and habitat preferences sparse. Inferences can be made from bush kārearea, although given that kārearea are distinguished by geographical habitat use, inferences may be limited. Some studies are available for eastern kārearea, but they focus on modified agricultural habitats and are constrained by small sample sizes. Data on eastern kārearea in native-dominated systems are limited. There is also limited information on key pressures and management options. Eastern kārearea have been found to have higher breeding success than other forms, suggesting key pressures may have a greater impact on adults.

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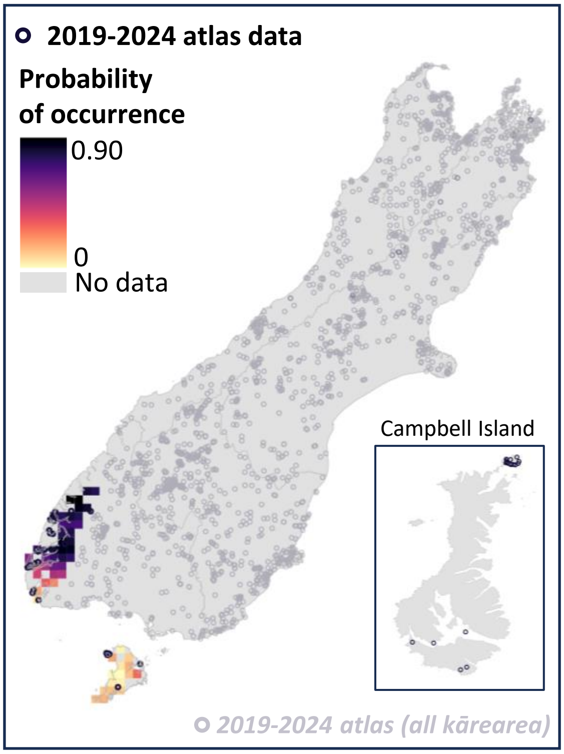
* Predicted distribution is compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

NATIONALLY ENDANGERED

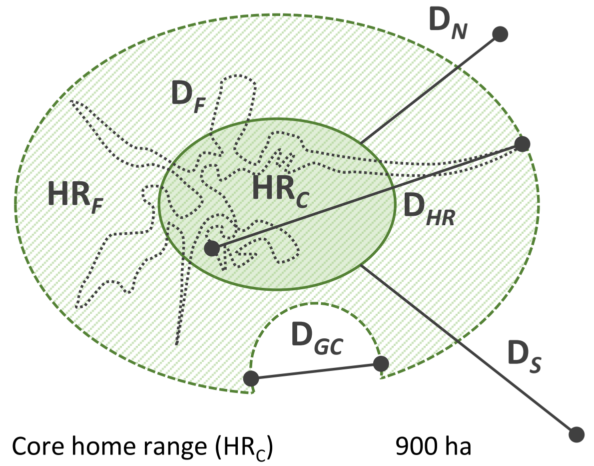
Kārearea / Southern falcon

Falco novaeseelandiae **'southern'**

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	900 ha
Foraging home range (HR_F)	4,000–60,000 ha
Foraging dispersal (D_F)	mean: 4 km
Home range dispersal (D_{HR})	max: 10 km
Natal dispersal (D_N)	1–35 km
Seasonal dispersal (D_S)	NA
Gap crossing (D_{GC})	500 km

(Inferred from other kārearea studies)

Description

The kārearea is a small falcon and the only endemic raptor in New Zealand. It is mostly brown, with white flecks, a cream breast, and a reddish-brown undertail. Kārearea have long wings, which look pointed and curved when diving but spread when gliding. During flight they beat their wings rapidly, giving them a distinctive flight style compared to kāhu / Australasian harriers (*Circus approximans*). Kārearea make a loud, piercing whistle during flight. Females are much larger and more richly coloured than males. Adults can be distinguished by their yellow legs, dark coloration, and strong flecked patterning. Juveniles have pale grey legs and are more uniform in colour. The southern kārearea is intermediate in size and coloration of the three forms.

Ecology

The kārearea is widespread but rare throughout New Zealand, but the southern kārearea is the rarest of the three forms. It is found mostly in Fiordland, with rare observations on Stewart Island / Rakiura, but has been found as far south as the subantarctic islands. They are mainly found in native forests, but are also recorded in open tussock grassland and in herb fields on the subantarctic islands. Kārearea are predatory and predominantly feed on live prey. Their diet mostly consists of medium-sized birds, but they also hunt small mammals, depending on prey abundance. Seabirds may be a key part of the diet of southern kārearea. Juveniles are also known to prey on larger invertebrates. Nesting occurs in trees/epiphytes, or on the ground on cliff ledges, bare slips or rocky outcrops. Breeding occurs from October to December. Clutches are up to four eggs, and incubation lasts for a month and is shared by both parents. Kārearea have a long fledgling period of up to 14 weeks.

Pressures

Pressures are less known for southern kārearea. Historical forest clearance in eastern Southland following European settlement may have contributed to their current distribution. Introduced mammalian predators are likely to be the key ongoing pressure. Predation and degradation of marine habitats may be affecting key seabird prey species. During breeding, ground-nesting kārearea are vulnerable to introduced mammalian predators. Predator control benefits kārearea, but may also result in secondary poisoning.

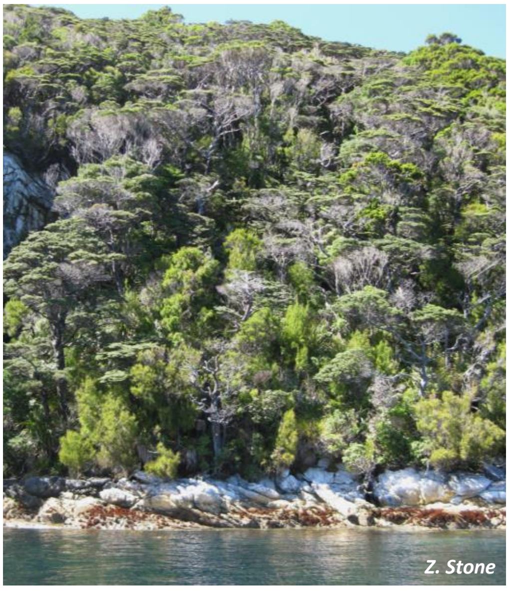
Dispersal

Kārearea are a highly mobile species but establish relatively sedentary home ranges throughout the year. Adult kārearea nest in the same sites between years. Core home range sizes range from 600 to 7,500 ha. Home ranges may be smaller (600–900 ha) in high-quality habitat that has increased edges and numerous, small, open patches. Foraging home ranges can be large. There are very few dispersal data on southern kārearea specifically. Most records of southern kārearea on Stewart Island / Rakiura are from winter, which may be from dispersing individuals or larger foraging home ranges. While juvenile kārearea disperse further, natal dispersal averages 9 km, with territories established within 1–35 km of natal territories. Kārearea are not gap limited: southern kārearea have colonised the subantarctic islands (470 km), and fossil evidence has been found on the Chatham Islands (800 km).

Mixed beech, rata and podocarp forest breeding habitat, Anchor Island.

Breeding habitat

Southern kārearea are mainly found in coastal Fiordland. There is very limited information on these birds, so most information on habitat is inferred from other kārearea taxa. Kārearea breeding habitat usually consists of a mosaic of open habitat and the edges of mature native forest. The presence of mature trees in open patches is the key feature of kārearea breeding habitat. Few records of nests exist for southern karearea, although nests have been found under low rātā (*Metrosideros*) forest in the subantarctic. In native forest, bush kārearea usually nest in epiphytes in large, emergent trees. Native forests have much lower densities of nesting and hunting habitat, so much larger areas of native forest are needed to support healthy breeding populations. In Fiordland, the mosaic of mature coastal forest and tussock subalpine open habitats may be a key feature of breeding habitat. Nesting preferences for southern kārearea are unknown.



Coastal breeding and foraging habitat, Anchor Island.

Non-breeding habitat

Habitat preferences for southern kārearea are unknown. They generally use the same habitat year-round, but home ranges expand in more uniform habitats that have reduced edge habitat for hunting. Unpaired individuals will still hunt and roost in open patches.

Roosting & foraging habitat

Data on foraging and roosting preference are extremely limited. Seabirds may be an important component of southern kārearea diet, with multiple observations of hunting under the dense forest canopies for ground-burrowing seabirds. Given the dominance of native vegetation in Fiordland, roosting and foraging habitat may be more forest based. However, coastal margins, subalpine tussocks, and turf areas may provide important open areas for hunting. Other kārearea generally hunt in open habitat along forest edges.

Rata dominated breeding forest habitat on the subantarctics, Enderby Island.

Key management actions

Key management actions include:

- protection of scrub and open tussock habitats, especially around steep valleys and streams
- retention of stands of mature trees around the edges of developments, particularly in high-elevation areas (e.g. upper parts of gullies)
- pest control for mustelids, cats, and hedgehogs
- designing wind farms to reduce/avoid the clearance of standing trees, collision risk, and construction during the breeding season
- kārearea-friendly powerline design, which includes insulated transformers and lightning arrestors
- translocation into well-managed agricultural areas to reintroduce or supplement populations
- provision of artificial perches and nesting sites in agricultural landscapes, which can help foraging and reduce predation risk.

Knowledge gaps and challenges

There are very few data on southern kārearea. They are rare, and there are few observations of these birds in Fiordland. Most of the information on dispersal, pressures, habitat use, and management presented here is inferred from work on other kārearea taxa. This results in considerable uncertainty regarding key pressures and the management needed to protect these birds. The taxonomic status of southern kārearea is solely based on the geographical distribution of the Fiordland population. Considering this association with coastal Fiordland habitat, there mya be important differences in habitat preferences, foraging, and breeding requirements that have yet to be determined. Taxonomic research is urgently needed to define this taxon, its range and population size. General ecological research is also vital for identifying differences in ecology, pressures, and management.

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Thomas B, Minot EO, Holland JD 2010. Home range and habitat use of the New Zealand Falcon (*Falco novaeseelandiae*) within a plantation forest: a satellite tracking study. International Journal of Ecology article ID 829702.

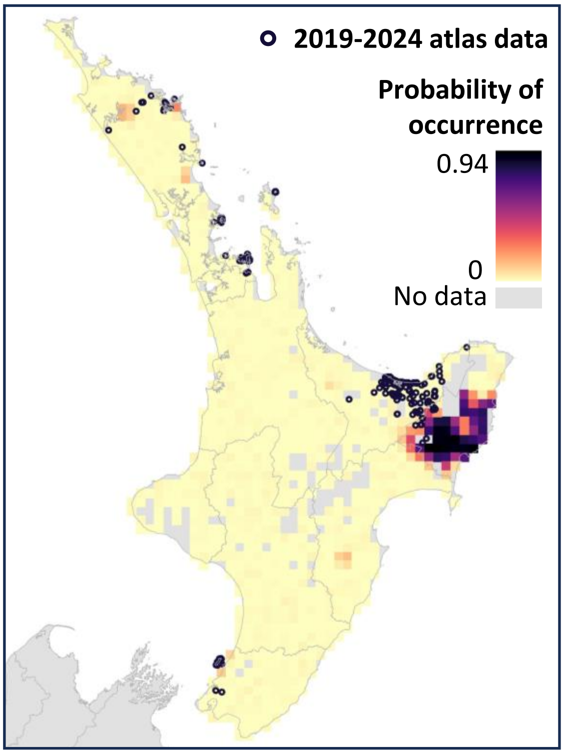
* Predicted distribution compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

AT RISK
RELICT

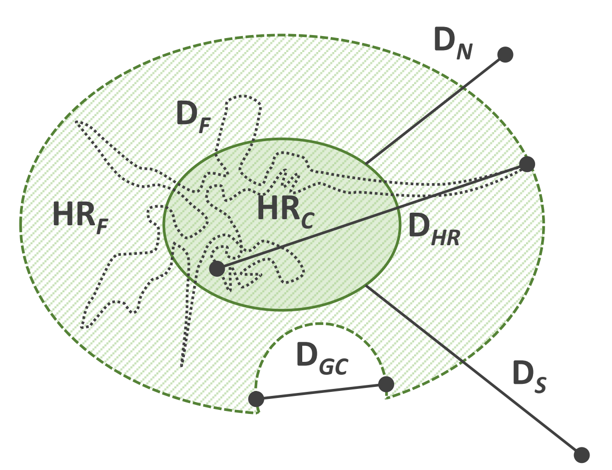
North Island weka

Gallirallus australis greyi

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	0.65–1 ha
Foraging home range (HR_F)	mean: 3–10 ha
Foraging dispersal (D_F)	max: 940 m
Home range dispersal (D_{HR})	6–10 km
Natal dispersal (D_N)	min: 1.5–5 km
Seasonal dispersal (D_S)	90 km
Gap crossing (D_{GC})	min: 1 km (water)

Description

The North Island weka is an endemic subspecies of weka found in the North Island of New Zealand. It is a large, flightless rail with grey and brown feathers with black speckles. Juveniles (<5 months) can be distinguished from adults by their brown eyes, which turn red as they age. North Island weka can be inquisitive and interact with people. However, they can also be quite cryptic and often remain under cover. Their distinctive loud calls are most commonly heard at dawn and dusk.

Ecology

North Island weka were formerly found across a range of forested, scrub, and wetland habitats throughout the North Island. They are now highly restricted in distribution, with a remaining stronghold in the eastern Bay of Plenty, along with scattered translocated populations located around the North Island. Dry conditions in Gisborne have caused a recent range shift towards the Bay of Plenty. An introduced hybrid population (with South Island weka) occurs on Kapiti Island. North Island weka are omnivorous, consuming a wide variety of fruits, invertebrates, and vertebrates (e.g. lizards, birds, rodents). They are a key native predator of invertebrates, reptiles, and ground-nesting birds. This predatory nature has contributed to human conflict regarding livestock and to historical persecution, and more recent hesitation in conservation actions. Because of their size they are important seed dispersers for many large-fruited species such as miro (Prumnopitys ferruginea) and hīnau (Elaeocarpus dentatus), and they play an important role in influencing forest composition. North Island weka breed mostly year-round, with peak breeding during summer. Both parents incubate eggs and brood chicks for a week after hatching.

Pressures

North Island weka experienced significant decline following European settlement due to habitat loss and the large-scale release of ferrets. Human interaction is also a threat – including hunting, predation by pets, and vehicle strike. Continued habitat degradation and introduced mammalian predators are key causes of ongoing decline. North Island weka are particularly vulnerable to ferrets, dogs, and cats. They are highly sensitive to changes in food availability and habitat disturbance: increased drought and reduced food availability are responsible for range contraction and high mortality. Predator control operations can cause secondary poisoning, and incorrect trap type and placement can cause harm or mortality.

Dispersal

Despite being flightless, weka are highly mobile and have been recorded naturally showing up in isolated habitats or on islands (North Island weka can swim at least 1 km). Home ranges tend to shift with food availability. Males have larger home ranges then females or juveniles: tracking of weka on the East Cape found median home range sizes of 10.6 ha for males and 3.5 ha for females. Juveniles sometimes remain close to their parents' home range, with low immediate natal dispersal. When pushed out, natal dispersal of 1.5–5 km has been recorded. Recorded dispersal distances may be biased by island data because the birds are restricted in their dispersal ability. Land gap-crossing distance is unknown, but individuals can disperse widely, especially following translocation to unfamiliar habitat. One escapee during a translocation was found having dispersed 72 km across rural Auckland. Recent range shift from Gisborne to Bay of Plenty suggests potential seasonal dispersal of 90 km to follow resources. Translocations with soft releases can reduce dispersal, with individuals staying within 6 km of the release site. Dispersal data may be biased by the fragmented nature of North Island habitats, and larger home ranges in males may be from male-biased populations. Weka living closer to humans may also have reduced dispersal and home ranges.

High quality coastal broadleaf forest breeding habitat, Kapiti Island.

Breeding habitat

North Island weka appear to prefer forested habitats such as native forest and/or exotic plantation, but can be found in highly mixed rural habitats as well. These birds are fairly sedentary once a territory has been established. High-quality breeding habitat would include mature, diverse, native forest with good pest control to allow for successful breeding. Their habitat use can also be fairly diverse, and breeding home ranges can include grazed and ungrazed native forest, scrubland, and pasture, where there may be minimal understorey regeneration as well as highly modified vegetation near urban areas. Nesting relies on dense vegetation such as grasses or sedges for cover.

Foraging habitat around open seabird nesting areas within coastal broadleaf forest habitat, Kapiti Island.

Non-breeding habitat

Once territories are established North Island weka rarely leave them, even if poor environmental conditions affect habitat quality. As a result, they are highly sensitive to in situ habitat disturbance and resource fluctuations.

Roosting and foraging habitat

As a ground-dwelling, omnivorous predator North Island weka forage in the leaf litter or understorey vegetation. They spend most of their time undercover, under dense scrubland, rough pasture or forest. Drought strongly affects food resources, and so foraging habitat tends to require good ground cover to retain soil moisture. They remain within defined territories, meaning that non-breeding and foraging habitat are consistent with breeding habitat. Dense thickets of weeds (e.g. blackberry, gorse) and scrubland provide important foraging habitats in rural settings.

Mixed coastal non-breeding habitat of modified rough pasture and regenerating scrub, Whangarei heads.

FOREST/OPEN

Key management actions

Key management actions include:

- mammalian pest control, particularly of ferrets, cats and dogs – the complete disparity in ferret and North Island weka distributions suggests that ferret elimination (0% density) is needed
- weka-proof traps and appropriate poison and baits to avoid harm or mortality from pest control operations; self-resetting traps need to be >1 m above the ground
- improving the connectivity of safe, resilient habitat in rural settings, which may include riparian planting and reduced grazing intensity to promote scrub regeneration, wetlands, and dense vegetation.
- protection and restoration of native forest, wetlands, and regenerating scrub habitats, particularly in higher-rainfall areas, to improve habitat condition and resilience to extreme weather
- revegetation of cleared areas with native scrub to increase habitat and food availability and allow for home range shifts with changing climatic conditions
- increased public awareness and engagement to reduce human interaction pressures
- regulatory controls to limit dogs and cats in urban and rural habitats.
- North Island weka are often excluded from conservation interventions such as translocations. However, translocations into high-rainfall, mustelid- and dog-free habitats are critical to their recovery.

Knowledge gaps & challenges

Compared to southern weka, North Island weka are very shy, making monitoring difficult. Despite behaviours that allow them to survive in modified habitats, they are still declining and are highly threatened. There has been very limited research on North Island weka, and most information is based on small sample sizes and translocated populations. They have received limited conservation attention, resulting in some uncertainty about best practice and effective management. While ferret control is thought to be a key management tool, the degree to which additional predator control is needed and the extent to which other pressures are limiting population recovery are unknown. For example, drought significantly affects food availability and habitat quality. Climate change appears to be a significant threat to North Island weka persistence, making management challenging. The restricted distribution of North Island weka means there is limited information on habitat preferences and breeding success in unmodified, connected landscapes.

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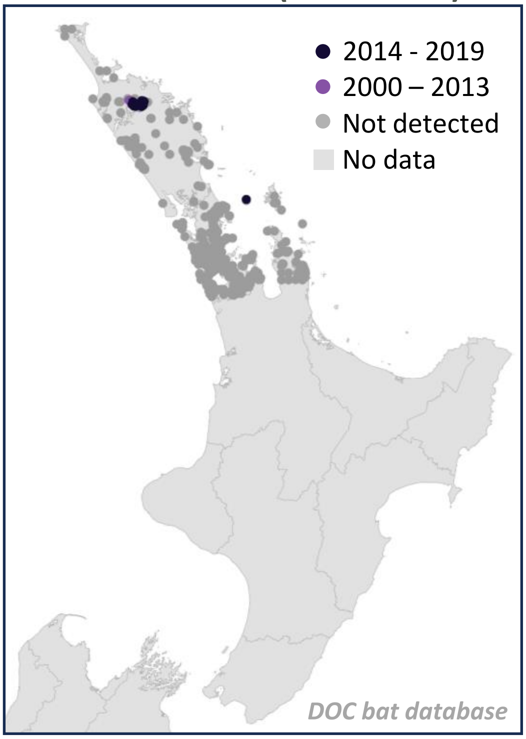
* Predicted distribution compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

Pekapeka / Northern short-tailed bat

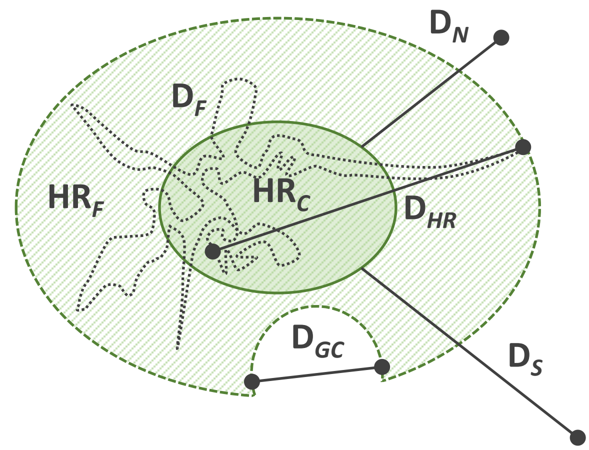
NATIONALLY ENDANGERED

Mystacina tuberculata aupourica

Observations (2000-2019)



Dispersal and movement metrics



Core home range (HR_C)	150 ha(?)
Foraging home range (HR_F)	10,000 ha
Foraging dispersal (D_F)	unknown
Home range dispersal (D_{HR})	<5 km(?)
Natal dispersal (N_D)	unknown
Seasonal dispersal (D_S)	unknown
Gap crossing (D_{GC})	<1 km(?)

Description

Short-tailed pekapeka (also known as lesser short-tailed bats) are one of two endemic microbat species in New Zealand. They are larger than long-tailed pekapeka but still weigh less than 15 g. Short-tailed pekapeka are a brown-grey colour, and have large, distinctive, pointed ears and a free tail that is shorter than their back legs. These bats are nocturnal, and can be distinguished from birds when flying due to their typical bat silhouette and distinctive, sharp flight patterns. Short-tailed pekapeka are classified into three subspecies based on geographical distribution. The northern subspecies is the rarest, having only been recorded at isolated sites in Northland and on Hauturu-o-Toi / Little Barrier Island in the Hauraki Gulf.

Ecology

Northern pekapeka are found only in mature, dense, kauri-dominated forests. They may once have occurred on the Coromandel Peninsula, with a historical record dating from 1900. Pekapeka roost communally in tree hollows and also in solitary roosts. They have a lek breeding system, whereby males attract females with song displays. During colder months pekapeka enter a torpor state (semi-hibernation), when they remain in roosts with limited activity. Breeding occurs in summer and autumn. They are omnivorous, but invertebrates make up the majority of their diet. Pekapeka are one of the few bats capable of foraging on the forest floor, where they dive under leaf litter looking for invertebrates. They also catch prey through aerial hawking, or gleaning items off vegetation. Pekapeka consume nectar and are important pollinators of a range of plant species, including *Dactylanthus taylorii* (Nationally Vulnerable).

Pressures

Historical clearance and burn-off of large old-growth kauri forest and predation by introduced mammalian predators have been the main contributors to range contraction in pekapeka throughout New Zealand. Rats, possums, mustelids, and cats are all known predators. Mustelids and cats, in particular, are significant predators of pekapeka. Secondary poisoning by anticoagulant toxins can result in increased mortality if applied incorrectly due to pekapeka's omnivorous diet and terrestrial foraging behaviour. Fragmentation has probably hindered their ability to recolonise habitat, resulting in isolated populations that may be more sensitive to environmental change.

Dispersal

In general, pekapeka are a highly mobile species with large home range sizes that vary among individuals. Dispersal information on northern pekapeka is limited, but inferences can be made from other subspecies. Central pekapeka disperse less then southern pekapeka; given that northern pekapeka are highly restricted in distribution, their dispersal may also be limited. Pekapeka regularly disperse between roosts, and consecutive roost locations can be 10–11 km apart. Foraging home ranges for central pekapeka containing multiple roost locations can spread across 10,000 ha. These foraging home ranges often contain multiple clusters of concentrated activity, which pekapeka regularly commute between – presumably key foraging resources. The core activity areas can be much smaller, with some studies suggesting core home ranges of < 150 ha. Colony roosts are usually found within these core areas, but solitary roosts are more often spread across the larger foraging range. Home ranges and dispersal patterns are probably driven by seasonal food availability. Radio-tracking studies in the Central Plateau suggest that gap crossing may be limited to <1 km.

Coastal forest foraging habitat, Hauturu-o-toi/Little Barrier Island.

Breeding habitat

The breeding habitat of northern pekapeka comprises intact, mature kauri (*Agathis australis*) forest that can provide numerous large trees for roosting and high-quality foraging habitat. The largest old-growth trees within the forest interior are preferentially selected for roosting. Maternity roosts at Ōmahuta Forest have been found in treefalls and rotting logs. Thick-walled tree cavities are necessary for adequate thermoregulation of maternal roosts. These roosts are usually located within the forest interior, away from edge habitat. Breeding habitat needs to be large enough to allow for the frequent roost-switching behaviour observed in pekapeka, and is generally high in understorey complexity.

High quality, mature, coastal kauri breeding habitat, Hauturu-o-toi/Little Barrier Island.

Foraging habitat

Pekapeka foraging habitat includes a range of native and modified forest types. On Hauturu-o-toi / Little Barrier Island pekapeka forage on the coastal fringe, especially during peak flowering periods. *Metrosideros* spp. and *Collospermum* are important for foraging resources during summer and autumn. While preferring forest interiors, pekapeka will also forage over open pasture adjacent to forest edges. Males and juveniles appear to have larger foraging home ranges due to a more varied diet, which supports energetic demands of lek breeding displays (males) and naïve foraging strategies (juveniles). Most foraging habitat is found within close proximity of colony roosts.

Coastal regenerating and edge foraging habitat, Hauturu-o-toi/Little Barrier Island

Roosting habitat

Pekapeka predominantly roost in native tree cavities in mature forest throughout the year and show seasonal patterns in roost selection. Large, standing trees with thick bark, such as kauri or rātā spp. >25 m high and 1 m diameter at breast height (DBH), are preferred roost locations, particularly for communal roosts. Communal roosting is more common in summer and solitary roosting more common in winter. Solitary roosts can be found in smaller trees (30–40 cm DBH), and can have denser vegetation surrounding the cavity opening compared to communal roosts. Pekapeka have been recording using the same roost trees for over 10 years.

Key management actions

Key management actions include:

- maintaining predator-free habitat on Hauturu-o-Toi / Littler Barrier Island, which is crucial to the survival of this critical population
- intensive predator control that maintains low levels of a suite of mammalian predators (including rats, mustelids, possums, and cats) in Northland kauri forest habitats
- protection of old-growth kauri and coastal broadleaf forests from clearance and disturbance
- cat control, and increased awareness and regulation of cats in rural areas where pekapeka roost, which can reduce predation pressure
- kauri dieback mitigation strategies to reduce the spread of the disease and protect old-growth kauri forest habitats
- predator control strategies that minimise the risk of secondary poisoning
- protection of dead spars on forest margins and in modified areas, which may help protect roost habitat and promote the persistence of populations within modified landscapes.
- Given the long-term importance of roost trees, protection of individual roost trees from felling and urban development is crucial.

Knowledge gaps & challenges

As with most mobile fauna, pekapeka present a challenge for studying dispersal due to their small size, high mobility, and restricted distribution. The particularly restricted distribution of northern pekapeka makes this even more challenging. Pekapeka are difficult to detect, so the current recorded distribution may be under-represented, limiting inferences that can be made about their wider habitat use and preferences. The very limited data available for northern pekapeka means that most information on pressures and dispersal is based on other pekapeka populations. Given their preference for forest interiors and margins the ability of pekapeka to cross large habitat gaps may be limited, but maximum gap-crossing abilities have yet to be established. A key challenge for the conservation of pekapeka is that management actions are largely restricted to in situ management of existing populations. There has been no success in establishing new populations of pekapeka through conservation translocations, so the protection of existing populations and their habitat is key to ensuring their long-term persistence.

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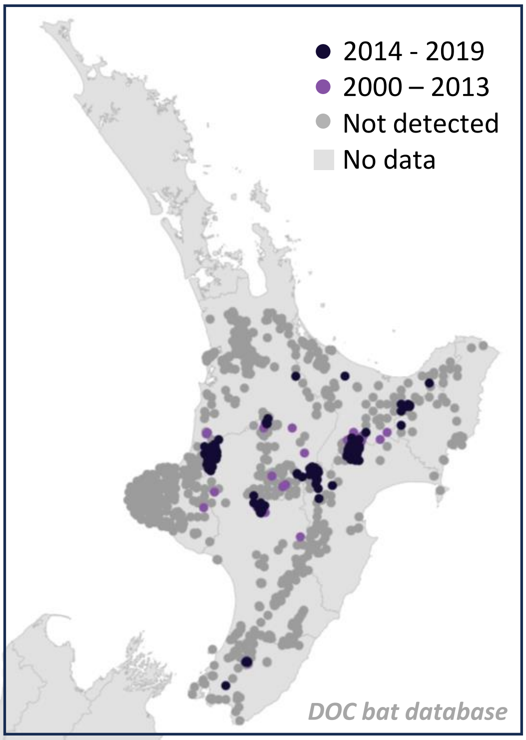
AT RISK DECLINING

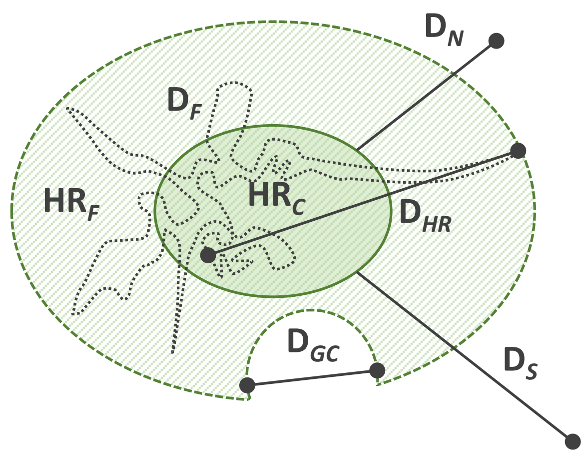
Pekapeka / Central short-tailed bat

Mystacina tuberculata rhyacobia

Observations (2000-2019)



Dispersal and movement metrics



Core home range (HR_C)	150 ha(?)
Foraging home range (HR_F)	10,000 ha
Foraging dispersal (D_F)	unknown
Home range dispersal (D_{HR})	10–11 km(?)
Natal dispersal (N_D)	unknown
Seasonal dispersal (D_S)	unknown
Gap crossing (D_{GC})	<1 km(?)

Description

Pekapeka (also called lesser short-tailed bats) are one of two endemic micro-bat species in New Zealand. They are larger than long-tailed pekapeka but still weigh less than 15 g. Short-tailed pekapeka are a brown-grey colour, and have large, distinctive, pointed ears and a free tail that is shorter than their back legs. Pekapeka are nocturnal, and can be distinguished from birds when flying due to their typical bat silhouette and distinctive, sharp flight patterns. Short-tailed pekapeka are distributed across three distinct management units, separated into northern, central, and southern taxa. The central short-tailed pekapeka is mostly found across the central areas of the North Island.

Ecology

Pekapeka distribution is highly restricted to large remnants of mature, dense, native forest. The central subspecies is the most widespread, found across Taranaki, the Central Plateau, and East Cape, along with a small remnant colony in Wellington. Pekapeka roost in tree hollows communally and also in solitary roosts. They have a lek breeding system, whereby males attract females with song displays. During colder months pekapeka enter a torpor state (semi-hibernation), when they remain in roosts with limited activity. Breeding occurs in summer and autumn. They are omnivorous, with invertebrates making up the majority of their diet. Pekapeka are one of the few bats capable of foraging on the forest floor, where they dive under leaf litter looking for invertebrates. They also catch prey through aerial hawking, or gleaning items off vegetation. Pekapeka consume nectar and are important pollinators of a range of plant species, including *Dactylanthus taylorii* (Nationally Vulnerable).

Pressures

Historical clearance of large, old-growth forest and predation by introduced mammalian predators have been the main contributors to range contraction in pekapeka throughout New Zealand. Rats, possums, mustelids, and cats are all known predators. Mustelids and cats, in particular, are significant predators of pekapeka. Secondary poisoning by anticoagulant toxins can result in increased mortality if applied incorrectly due to pekapeka's omnivorous diet and terrestrial foraging behaviour. Fragmentation has probably hindered the ability of pekapeka to recolonise habitat, resulting in isolated populations that may be more sensitive to environmental change.

Dispersal

In general, pekapeka are a highly mobile species with large home range sizes that vary across regions and among individuals. Dispersal patterns of the central pekapeka appear to be less than those observed for other populations, particularly compared to southern pekapeka. However, this is based on limited research, and their true movement patterns are probably larger than recorded. Pekapeka regularly disperse between roosts, with consecutive roost locations up to 10–11 km apart. Foraging home ranges at Rangataua Forest, which contains multiple roost locations, were spread across 10,000 ha. Foraging home ranges often contain multiple clusters of concentrated activity, which pekapeka regularly commute between – presumably key foraging resources. These core activity areas can be much smaller, with some studies suggesting core home ranges of <150 ha. Colony roosts are usually found within these core areas, but solitary roosts are more often spread across the larger foraging range. Home ranges and dispersal patterns are probably driven by seasonal food availability. Radio-tracking studies in the Central Plateau suggest that gap crossing may be limited to <1 km.

High quality breeding habitat in Whirinaki.

Breeding habitat

Breeding habitat comprises large tracts of mature native forest that can provide numerous large trees for roosting and high-quality foraging. Species composition of breeding habitat is not crucial, but the presence of large trees is essential. The largest old-growth trees within the forest interior are preferentially selected for roosting locations. Maternity roosts are more commonly located within the forest interior away from edge habitat. Thick-walled tree cavities are necessary for adequate thermoregulation of maternal roosts. In addition, breeding habitat needs to be large enough to allow for the frequent roost-switching behaviour observed in pekapeka. Breeding habitat usually has high understorey complexity, but modified native forests with browsing damage may still support breeding colonies.

Foraging habitat

Foraging habitat can include a wider range of coastal and modified forest types. Pekapeka often use exotic forestry plantations for foraging, and while preferring forest interiors will also forage over open pasture adjacent to forest edges. Males and juveniles appear to have larger foraging home ranges due to a more varied diet, which supports energetic demands of lek breeding displays (males) and naïve foraging strategies (juveniles). Most foraging habitat is within close proximity of colonial roosts.

Example of large colony roost tree with low cavity opening, Ruapheu.

Roosting habitat

Pekapeka predominantly roost in native tree cavities in mature forest throughout the year and show seasonal patterns in roost selection. Large standing trees with thick bark, such as tōtara or rātā spp. >25 m high and 1 m diameter at breast height (DBH), are preferred roost locations, particularly for communal roosts. Communal roosting is more common in summer, and solitary roosting more common in winter. Solitary roosts can be found in smaller trees (30–40 cm DBH), and can have denser vegetation surrounding the cavity opening compared to communal roosts. Pekapeka have been recorded using the same roost trees for over 10 years.

Key management actions

Key management actions include:

- intensive predator control to maintain low levels of a suite of mammalian predators (including rats, mustelids, possums and cats) is necessary for the survival of pekapeka. Predator control that only targets an individual species can cause mesopredator release and result in negative outcomes, particularly in mast years.
- cat control, and increased awareness of and regulations for domestic cats in urban and modified areas where pekapeka roost, can reduce predation pressure.
- predator control strategies that minimise the risk of secondary poisoning are essential.
- protection of dead spars during harvesting of exotic plantations may help preserve roost habitat and promote the persistence of populations in modified landscapes.
- habitat protection is necessary within frequently used foraging areas.
- continued protection of large tracts of healthy forest with high-quality foraging habitat and roosts will help minimise the potential impacts of climate change on food availability and temperature stress.
- given the long-term importance of roost trees, protection of individual roost trees from felling and urban development is crucial.

Knowledge gaps and challenges

As with most mobile fauna, studying pekapeka dispersal is challenging due to their small size, high mobility, and restricted distribution. Pekapeka are difficult to detect, so their current recorded distribution may be under-represented, limiting inferences about wider habitat use and preferences. Based on their preference for forest interiors and margins, the ability of pekapeka to cross large habitat gaps may be limited, but maximum gap-crossing abilities have yet to be established. This affects managers' ability to predict the spread of individuals from existing populations. A key challenge for the conservation of pekapeka is that management actions are largely restricted to in situ management of existing populations. There has been no success in establishing new populations of pekapeka through conservation translocations, so the protection of existing populations, and their habitat, is key to ensuring their long-term persistence.

Further Reading

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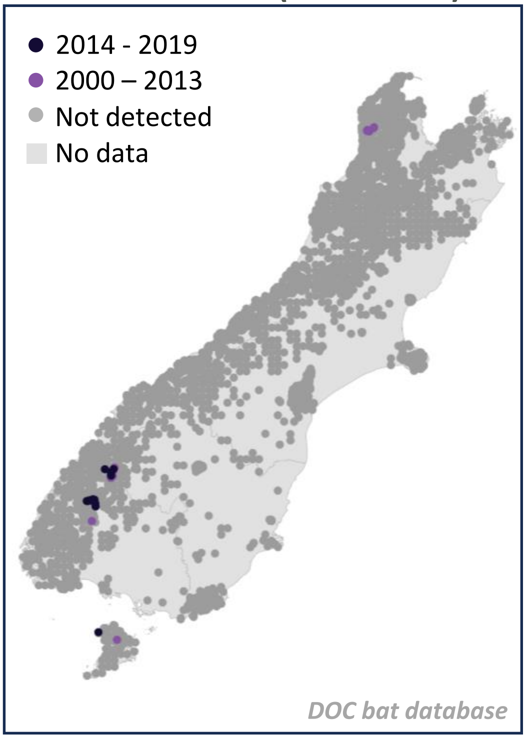
AT RISK RECOVERING

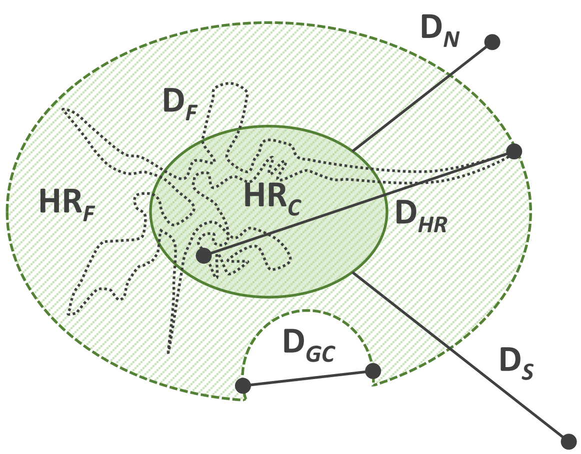
Pekapeka / Southern short-tailed bat

Mystacina tuberculata rhyacobia

Observations (2000-2019)



Dispersal and movement metrics



Core home range (HR_C)	60 ha
Foraging home range (HR_F)	max: 4,300 ha
Foraging dispersal (D_F)	6–41 km
Home range dispersal (D_{HR})	<5 km(?)
Natal dispersal (D_N)	unknown
Seasonal dispersal (D_S)	unknown
Gap crossing (D_{GC})	<1 km(?)

Description

The short-tailed pekapeka (also known as the lesser short-tailed bat) is one of two endemic microbat species in New Zealand. They are larger than long-tailed pekapeka but still weigh less than 15 g. Short-tailed pekapeka are a brown-grey colour, and have large, distinctive, pointed ears and a free tail that is shorter than their back legs. These bats are nocturnal, and can be distinguished from birds when flying due to their typical bat silhouette and distinctive, sharp flight patterns. Short-tailed pekapeka are classified into three subspecies based on geographical distribution. The southern form is found only on Codfish Island / Whenua Hou and Fiordland.

Ecology

The distribution of pekapeka is tightly restricted to large remnants of mature, dense, native forest. The southern subspecies is now only known from three locations in Southland, but historically would have been found more widely throughout the South Island. These bats roost in tree hollows communally and also in solitary roosts. They have a lek breeding system, whereby males attract females with song displays. During colder months they enter a torpor state (semi-hibernation), when they remain in roosts with limited activity. Breeding occurs in summer and autumn. They are omnivorous, with invertebrates making up the majority of their diet. Pekapeka are one of the few bats capable of foraging on the forest floor, where they dive under leaf litter looking for invertebrates. They also catch prey through aerial hawking, or gleaning items off vegetation. Pekapeka consume nectar and are important pollinators of a range of plant species.

Pressures

Historical clearance of large, old-growth forest and predation by introduced mammalian predators have been the main contributors to range contraction in pekapeka throughout New Zealand. Rats, possums, mustelids, and cats are all known predators. Mustelids and cats, in particular, are significant predators of pekapeka. Southern pekapeka are more affected by irruptive predator–prey dynamics associated with southern forest habitats. Although rare, secondary poisoning by anticoagulant toxins can cause mortality if applied incorrectly, due to pekapeka's omnivorous diet and terrestrial foraging behaviour. Fragmentation has probably hindered the ability of pekapeka to recolonise habitat, resulting in isolated populations that may be more sensitive to environmental change.

Dispersal

Generally, pekapeka are a highly mobile species with large home range sizes that vary among individuals. While there have been some tracking studies done in Fiordland, dispersal information is generally limited. Pekapeka mostly disperse through forest, making dispersal limited in fragmented habitats. Southern pekapeka appear to have larger colonial home ranges than other taxa, which can be up to 14,000 ha. They regularly disperse between roosts, and consecutive roost locations can be 10–11 km apart. Individual foraging home ranges for southern pekapeka, containing multiple roost locations, have been recorded up to 4,285 ha. Foraging home ranges often contain multiple clusters of concentrated activity, which pekapeka regularly commute between – presumably key foraging resources. These core activity areas can be much smaller. Tracking of Fiordland pekapeka identified core home ranges of under 270 ha, averaging only 62 ha. Colony roosts are usually found within these core areas, with solitary roosts more often found spread across a larger foraging range. Home ranges and dispersal are probably driven by seasonal food availability. Radio-tracking studies of central pekapeka suggest that gap crossing may be limited to under 1 km.

Breeding habitat in lowland beech forest, Eglington Valley.

Breeding habitat

In Fiordland, breeding habitat comprises intact, lowland southern beech forest (*Fuscospora* and *Lophozonia*), which can provide numerous large trees for roosting and high-quality foraging habitat. The largest old-growth trees within the forest interior are preferentially selected for roosting. Maternity roosts are generally found in large beech trees and are usually located within the forest interior, away from edge habitat. Thick-walled tree cavities are necessary for adequate thermoregulation of maternal roosts. Breeding habitat needs to be large enough to allow for the frequent roost-switching behaviour observed in pekapeka, and is generally high in understorey complexity.

Interior forest foraging and breeding habitat, Whenua Hou / Codfish Island

Foraging habitat

Southern pekapeka preferentially forage in mature, red beech-dominated forest interiors. This habitat is usually found on lower slopes or in valleys, and often results in long home ranges and movements following valley systems. Most foraging occurs >100–200 m from the forest edge. Pekapeka will also occasionally forage along roadsides and pasture edges. Males and juveniles appear to have larger foraging home ranges due to a more varied diet, which supports energetic demands of lek breeding displays (males) and naïve foraging strategies (juveniles). Most foraging habitat is within close proximity of colonial roosts.

Roosting habitat

Pekapeka predominantly roost in native tree cavities in mature beech forest throughout the year and show seasonal patterns in roost selection. Large, standing trees with thick bark, >25 m high and 1 m diameter at breast height (DBH), are preferred roost locations, particularly for communal roosts. Communal roosting is more common in summer and solitary roosting more common in winter. Solitary roosts can be found in smaller trees (30–40 cm DBH), and can have denser vegetation surrounding the cavity opening compared to communal roosts. Pekapeka have been recorded using the same roost trees for over 10 years.

Breeding habitat on Whenua Hou / Codfish Island.

Key management actions

Key management actions for pekapeka include:

- maintaining a predator-free habitat on Codfish Island / Whenua Hou
- intensive predator control that maintains low levels (e.g. < 5% tracking) of a suite of mammalian predators (including rats, mustelids, possums, and cats) in southern beech forest habitats
- protection of old-growth southern beech forest from clearance and disturbance
- cat control, and increased awareness of and regulations for cats in rural habitats where pekapeka roost, to reduce predation pressure
- predator control strategies that minimise the risk of secondary poisoning
- protection of dead spars on forest margins and in modified areas, which may help protect roost habitat and promote the persistence of populations within modified habitat.

Given the long-term importance of roost trees, protection of individual roost trees from felling and development is crucial.

Knowledge gaps & challenges

As with most mobile fauna, studying pekapeka dispersal is challenging due to their small size, high mobility, and restricted distribution. The restricted distribution of southern pekapeka to small islands and Fiordland makes this even more challenging. Pekapeka are difficult to detect, so the current recorded distribution may be under-represented, limiting inferences about wider habitat use and preferences. There are very limited data for southern pekapeka, so most information on pressures and dispersal is based on other pekapeka populations. Based on their preference for forest interiors and margins, the ability of pekapeka to cross large habitat gaps may be limited, but maximum gap-crossing abilities have yet to be established. A key challenge for the conservation of pekapeka is that management actions are largely restricted to in situ management of existing populations. There has been no success in establishing new pekapeka populations through conservation translocations, so the protection of existing populations and their habitat is key to ensuring long-term persistence.

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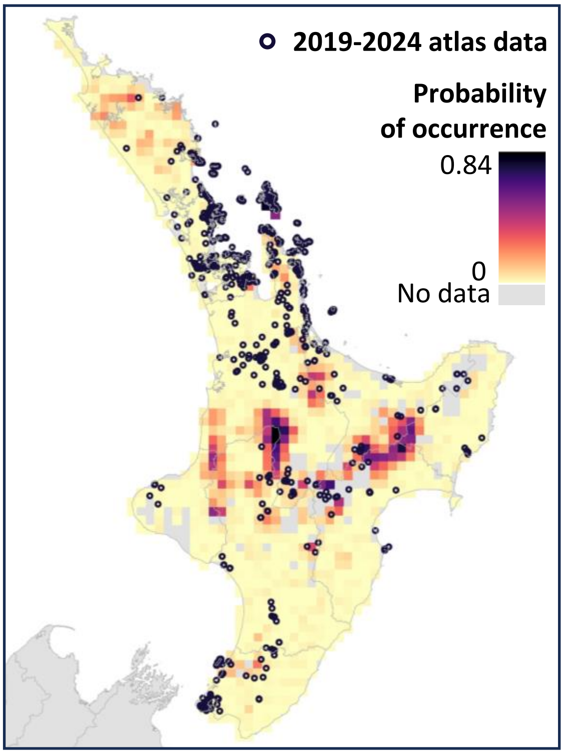
AT RISK RECOVERING

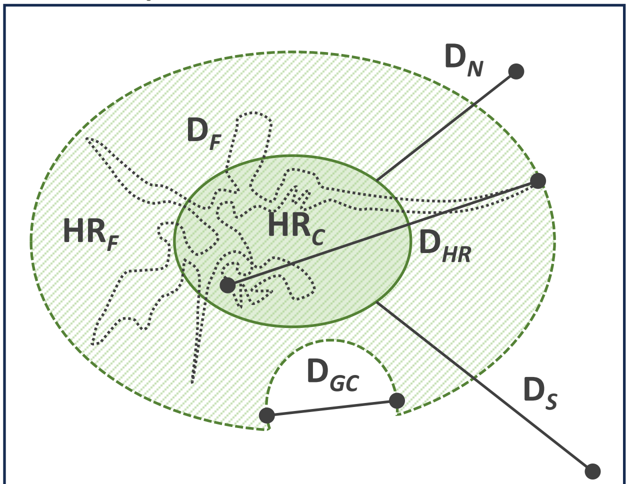
North Island kākā

Nestor meridionalis septentrionalis

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	15–50 ha
Foraging home range (HR_F)	125 ha
Foraging dispersal (D_F)	40–45 km
Home range dispersal (D_{HR})	max: 400 km
Natal dispersal (D_N)	unknown
Seasonal dispersal (D_S)	180 km
Gap crossing (D_{GC})	min: 25 km

Description

The North Island kākā is a large, brown parrot found in the North Island of New Zealand. Adults have a crimson/red belly and undertail with a red-orange underwing. Juveniles have a yellow base to their lower bill, and yellow skin around their nostrils and eyes for their first year. These features make them easily identifiable from other exotic and native parrots found in the North Island, along with their distinct loud, melodic calls. Kākā presence can also be identified by their bark-stripping habit in larger trees.

Ecology

North Island kākā can be found in lowland forests throughout the North Island of New Zealand, but population strongholds exist around the central North Island and Aotea / Great Barrier Island. Successful reintroduction to Zealandia has resulted in increased kākā in the Wellington Region, especially in urban areas, where kākā commonly forage in gardens and street trees. Kākā are sequential feeders, moving throughout the landscape and feeding on a variety of food resources, including seeds, fruit, nectar, sap, honeydew, and tree-dwelling (especially wood-boring) invertebrates. Breeding is episodic and strongly related to food supply, with increased breeding in masting years. Food comprises both native and exotic resources, with exotic vegetation particularly important in modified habitats. Sap can be an important food source for females. Kākā are cavity nesters, and females are the sole incubator, with the male feeding the female during the incubation period. They require mature vegetation with large tree cavities for nesting. Fledglings have an extended period of parental care, only becoming fully independent after 5–6 months.

Pressures

Historical fragmentation and habitat clearance probably contributed to historical patterns of range contraction. However, kākā are also highly sensitive to introduced mammalian predators, particularly stoats (*Mustela erminea*) and possums (*Trichosurus vulpecula*). Due to their cavity-nesting behaviour female kākā and chicks are extremely vulnerable to predation in the nest, resulting in considerably skewed sex ratios in populations without adequate pest control. Diet overlap with possums may also contribute to reduced kākā populations where possum densities are high. Window strike, poisonous exotics (e.g. *Rhododenron* spp.) and feeding by the public may also affect kākā in modified habitats.

Dispersal

Kākā are highly mobile. North Island kākā have variable home range sizes throughout the North Island, depending on habitat. Compared to South Island kākā, they appear to have smaller home ranges of <125 ha, with core home ranges averaging between 15 and 50 ha. Kākā have larger home ranges in beech-dominated habitats than in broadleaf forests. However, they undertake significant seasonal dispersal, which is driven by food availability, and may be more common among individuals residing in poor-quality habitats. During seasonal movements North Island kākā can disperse over 180 km and cross considerable habitat gaps of >25 km. Radio-tracking in the Waikato discovered seasonal movement between the Waikato and the Hauraki Gulf. This research suggested that juveniles and females may be more likely to undertake these large seasonal movements. Established adults become more sedentary, with reduced dispersal and more permanent occupation in mature, high-quality forest habitat. North Island kākā have recolonised mainland areas adjacent to island populations.

Nest tree in high quality breeding habitat (broadleaf coastal forest) on Aotea/Great Barrier Island.

Breeding habitat

Kākā nest in the trunks of live or dead canopy and emergent trees. Breeding habitat requires large areas of mature forest with sufficient large trees that have a diameter at breast height >600 mm and natural cavities of >50 mm width and 300 mm depth. Nesting begins in spring, from October to November. Various native forest types are preferred for establishing home ranges (e.g. beech, coastal broadleaf or mixed podocarp forests). Exotic vegetation and small forest fragments are also used during the breeding season for foraging.

Non-breeding winter habitat used by kākā in rural Waikato consisting of riparian totara forest remnants and exotic gardens.

Non-breeding habitat

Before establishing home ranges young kākā utilise a variety of non-breeding habitat. In modified landscapes, non-breeding habitat can include smaller fragments of native or exotic vegetation. This means identifying and managing non-breeding habitat at a landscape scale can be difficult.

Roosting and foraging habitat

In high-quality breeding habitat foraging will occur within home ranges. In poorer-quality vegetation or modified landscapes, use of foraging habitat can be highly seasonal and wide ranging. Kākā predominantly feed in the upper vegetation storey, and foraging habitat will follow the availability of key food resources throughout the year: nectar in spring/summer, fruit in autumn/winter, and sap in late winter. Because of this, foraging ranges can be large when key podocarp resources are less abundant. Exotic trees and supplementary food stations may be more important in modified landscapes or during limited resource availability. In particular, exotic conifers and eucalypt species appear to provide important sap resources for female kākā. Tracking in the Waikato suggests that individual trees and small wind breaks are sought out for foraging. Supplementary feeding in reserves can help reduce foraging movements and assist in post-release monitoring.

Japanese Cedar hedge used for foraging and roosting.

Key management actions

Key management actions include:

- Intensive predator control, particularly for mustelids and possums, that maintains <5% tracking rates during all stages of breeding (including up to 3-4 months post-fledging) is necessary for successful breeding.
- Aerial 1080 operations during mast seeding years, particularly in beech-dominated habitats, are needed to reduce the effects of increased predator abundance.
- New populations can be established with translocations into intensively managed areas.
- Pest management in modified habitats may support the survival of dispersing juveniles and improve recruitment/establishment of new populations.
- Avoidance of planting and removal of poisonous exotic species (e.g. Rhododendron) in foraging habitats is recommended.
- Improved public engagement and awareness of North Island kākā may mitigate these pressures, and can contribute to improved habitat quality at a landscape scale.

Knowledge gaps and challenges

Kākā can be difficult to study given their high mobility, intelligence, inquisitive and destructive nature. Data capture of cross-regional patterns of landscape-level dispersal is still limited, but advances in tracking have provided a good understanding of dispersal and habitat selection within regions. Research has shown that North Island kākā movement is highly individual, with considerable variation in home range sizes, seasonal foraging patterns, and habitat use between individuals. Natal dispersal for kākā remains largely unknown. Based on research there is now a reasonable understanding of diet, breeding patterns, productivity, mast dynamics, dispersal, and adaptability to habitats and environmental changes. The recent success of reintroductions and population growth in North Island kākā suggest that pressures and management data may be sufficient for informing conservation.

Further reading

Charles KE, Linklater WL 2014. Selection of trees for sap-foraging by a native New Zealand parrot, the Kaka (*Nestor meridionalis*), in an urban landscape. Emu – Austral Ornithology 114(4): 317–325.

Dussex N, Sainsbury J, Moorhouse R, Jamieson IG, Robertson BC 2015. Evidence for Bergmann's rule and not allopatric subspeciation in the threatened kaka (*Nestor meridionalis*). Journal of Heredity 106: 679–691.

Forrest SW, Rodríguez-Recio M, Seddon PJ 2024. Home range and dynamic space use reveals age-related differences in risk exposure for reintroduced parrots. Conservation Science and Practice 6(5): e13119.

Greene TC, Powlesland RG, Dilks PJ, Moran L 2004. Research summary and options for conservation of kaka (*Nestor meridionalis*). DOC Science Internal Series 178. Wellington, Department of Conservation.

Innes J, Miskelly CM, Armstrong DP, Fitzgerald N, Parker KA, Stone ZL 2022. Movements and habitat connectivity of New Zealand forest birds. New Zealand Journal of Ecology 46(2): 1–21.

Leech TJ, Gormley AM, Seddon PJ 2008. Estimating the minimum viable population size of kaka (*Nestor meridionalis*), a potential surrogate species in New Zealand lowland forest. Biological Conservation 141(3): 681–691.

O'Donnell CFJ, Dilks PJ 1994. Foods and foraging of forest birds in temperate rainforest, South Westland, New Zealand. New Zealand Journal of Ecology 18: 87–107.

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Recio MR, Payne K, Seddon PJ 2016. Emblematic forest dwellers reintroduced into cities: resource selection by translocated juvenile kaka. Current Zoology 62(1): 15–22.

Walker S, Monks A 2018. Estimates of local occupancy for native land birds from the New Zealand bird atlases. Notornis 65(4): 223–236.

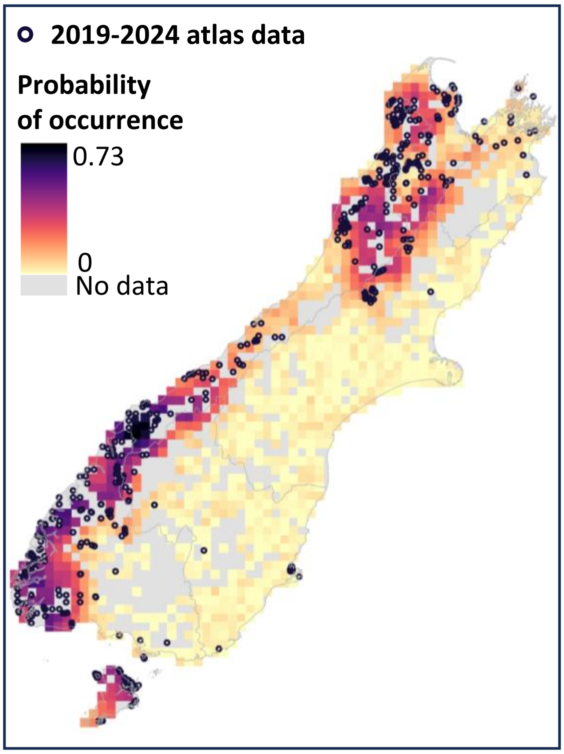
* Predicted distribution compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

NATIONALLY VULNERABLE

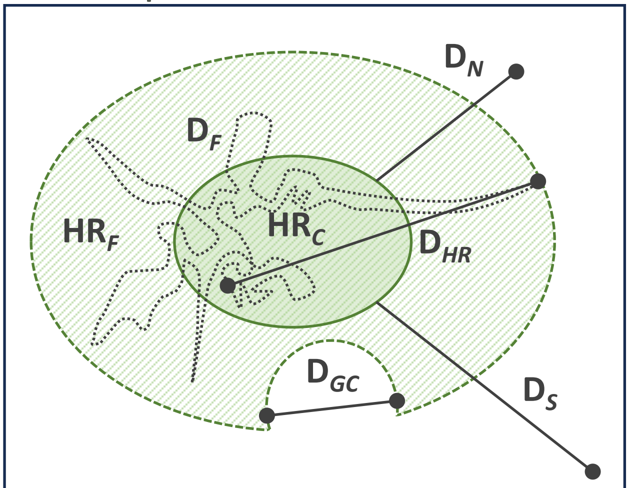
South Island kākā

Nestor meridionalis meridionalis

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	30–1,000 ha
Foraging home range (HR_F)	1,600 ha
Foraging dispersal (D_F)	20–25 km
Home range dispersal (D_{HR})	max: 400 km
Natal dispersal (D_N)	unknown
Seasonal dispersal (D_S)	180 km
Gap crossing (D_{GC})	min: 25 km

Description

The South Island kākā is a large, brown parrot endemic to the South Island of New Zealand. They are larger and brighter than North Island kākā, with a deep crimson underbelly/undertail, a red-orange underwing, and a pale grey crown. Juveniles have a yellow base to their lower bill, and yellow skin around their nostrils and eyes for their first year. They may be mistaken for kea (*Nestor notabilis*), but their size, brown plumage, distinct calls, and non-alpine distribution help distinguish them.

Ecology

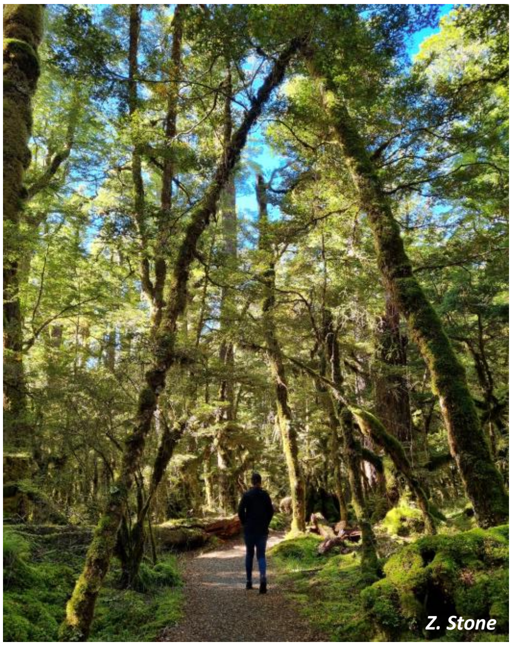
South Island kākā are found in mature forest habitats. They were abundant throughout the South Island in the 1800s, but have since declined. South Island kākā are more commonly found in low-high elevation forests along the West Coast and Tasman regions, Fiordland, and Stewart Island / Rakiura. They are extremely rare east of the Southern Alps. Successful reintroduction of South Island kākā to sanctuaries such as Orokonui and Abel Tasman National Park have expanded their range. These birds are sequential specialist feeders, moving seasonally between food resources as they become available. They are omnivorous, with a varied diet that includes invertebrates, nectar, fruits, seeds and sap. Breeding is episodic and strongly related to food supply, with successful breeding associated with mast years. South Island kākā are cavity nesters, and females are the sole incubator, with the male feeding the female during the incubation. They require mature vegetation with large tree cavities for nesting. Fledglings have an extended period of parental care, only becoming fully independent after 5–6 months.

Pressures

Historical fragmentation, habitat clearance, and the introduction of predators during early European settlement were significant causes of historical decline in South Island kākā, particularly in eastern regions. These birds are highly sensitive to introduced mammalian predators, particularly stoats (*Mustela erminea*) and possums (*Trichosurus vulpecula*). Due to their cavity-nesting behaviour, females and chicks are vulnerable to predation in the nest, resulting in considerably skewed sex ratios in populations without adequate pest control. Diet overlap with possums may also contribute to reduced kākā populations where possum densities are high. Logging during forestry activity may threaten their survival in modified environments.

Dispersal

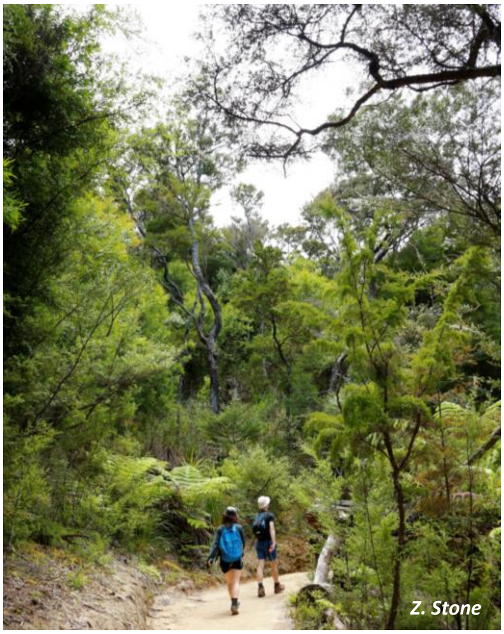
South Island kākā are a highly mobile species, making them difficult to research and resulting in few dispersal studies. They appear to have larger home ranges than North Island kākā. Male home ranges as large as 1,600 ha have been recorded in Nelson Lakes National Park, and females have been recorded dispersing over 20 km. Monitoring of reintroduced South Island kākā at Orokonui Sanctuary revealed that home range areas varies considerably, ranging from 34 to 1,000 ha. Younger individuals tend to disperse further and have a much larger average home range (600 ha), while older individuals appear more sedentary, with smaller home ranges averaging 100 ha. South Island kākā undertake significant seasonal dispersal, driven by food availability. During seasonal movements they can disperse considerable distances tracking resources, and can cross large habitat gaps of over 25 km.



Low elevation breeding habitat in beech dominated forest, Fiordland.

Breeding habitat

South Island kākā nest in the trunks of live canopy and emergent trees. Breeding habitat requires large areas of mature lowland forest habitat with sufficient large live trees that have a diameter at breast height of over 600 mm, and large natural cavities of roughly 50 mm width and 300 mm depth. Nesting begins in spring and continues from October to November. Native forest is preferred for establishing home ranges, but exotic vegetation and small forest fragments can be used during the breeding season for foraging.



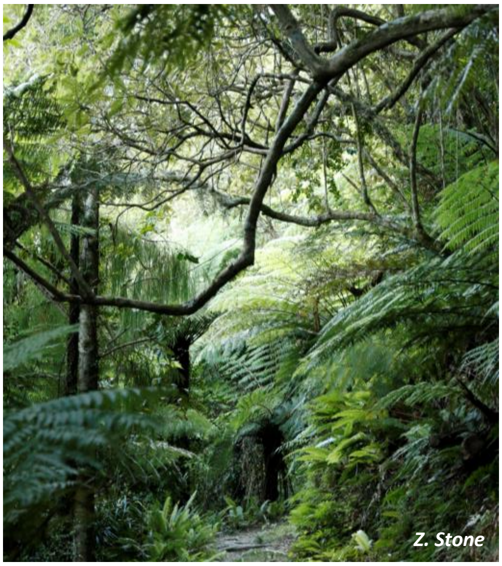
Coastal beech forest habitat found in Abel Tasman National Park.

Non-breeding habitat

Before establishing home ranges, young South Island kākā utilise a wider variety of habitats. There have been rare observations of these birds showing up in modified habitats such as Christchurch surrounds or Oamaru. However, compared to North Island Kākā, southern kākā seem to be less likely to use this lower-quality habitat.

Roosting and foraging habitat

In high-quality breeding habitat, foraging will occur within the home ranges of breeding habitat. In poorer-quality habitat or non-masting podocarp forests, foraging may be more wide ranging. South Island Kākā mainly feed in the upper vegetation storey, and foraging habitat follows the availability of key food resources throughout the year: nectar in spring/summer, fruit in autumn/winter, and sap in late winter. Because of this, foraging ranges can be large when key podocarp resources are less abundant. There is little evidence that South Island kākā forage in exotic vegetation, except for reintroduced birds from Orokonui. In beech-dominated forest honeydew may be consumed throughout the year.



Temperate rainforest habitat of the West Coast, Franz Joseph.

Key management actions

Key management actions include:

- intensive predator control (particularly for mustelids and possums) that maintains under 5% tracking rates during all stages of breeding, including up to 3 to 4 months post-fledging, is necessary for successful breeding.
- large-scale aerial 1080 operations in response to mast seeding years are particularly important for the survival of South Island kākā.
- large, old-growth trees in native and exotic forests need protecting to maintain nesting sites.
- forest habitat in eastern regions of the South Island should be restored.
- wasp (Vespula spp.) control may reduce competition for honeydew and contribute to improved breeding success.
- new populations in intensively managed habitat can be established with translocations.
- pest management within modified habitats may support the survival of dispersing juveniles and improve the recruitment/establishment of new populations.
- Improved public engagement with, and awareness of, South Island kākā may mediate these pressures and contribute to improved habitat quality at a landscape scale.

Knowledge gaps and challenges

South Island kākā can be difficult to study given their high mobility, intelligence, inquisitive and destructive nature. Data capturing cross-regional patterns of landscape-level dispersal are still limited, but advances in tracking have provided a good understanding of dispersal and habitat selection within regions. Natal dispersal for juvenile birds remains unknown. Based on research, there is now a reasonable understanding of diet, breeding patterns, productivity, mast dynamics, dispersal, and adaptability to habitats and environmental changes. Pressure and management data may be sufficient for informing conservation. The dependence of South Island kākā on large areas of remote forest habitats makes large-scale 1080 operations challenging.

Further reading

Charles KE, Linklater WL 2014. Selection of trees for sap-foraging by a native New Zealand parrot, the Kaka (*Nestor meridionalis*), in an urban landscape. Emu – Austral Ornithology 114(4): 317–325.

Dussex N, Sainsbury J, Moorhouse R, Jamieson IG, Robertson BC 2015. Evidence for Bergmann's rule and not allopatric subspeciation in the threatened kaka (*Nestor meridionalis*). Journal of Heredity 106: 679–691.

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Walker S, Monks A 2018. Estimates of local occupancy for native land birds from the New Zealand bird atlases. Notornis 65(4): 223–236.

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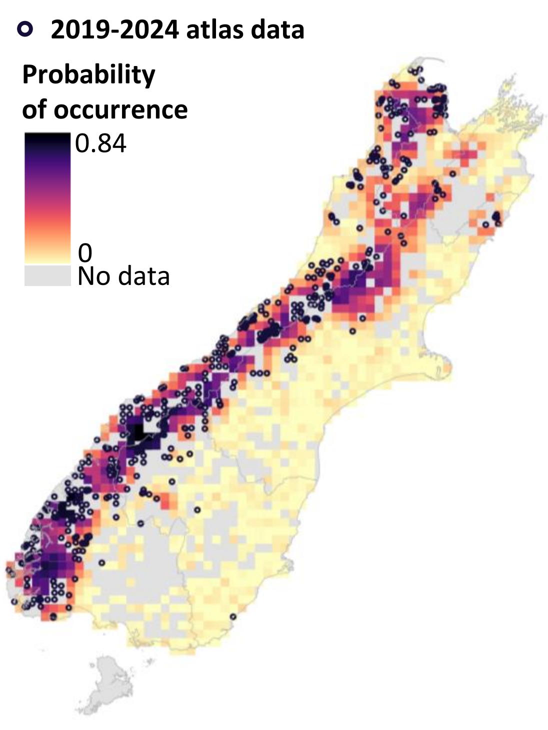
NATIONALLY ENDANGERED

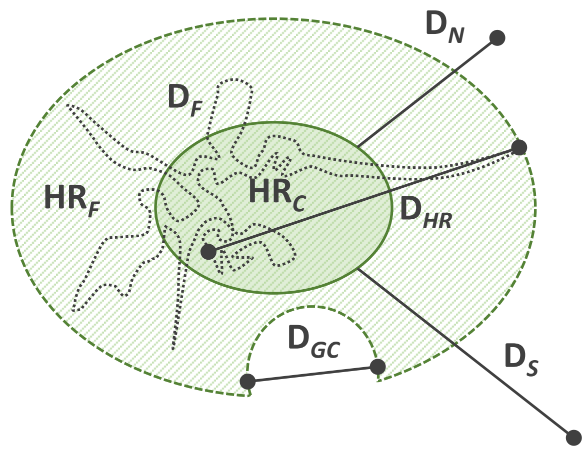
Kea

Nestor notabilis

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	300–1,000 ha(?)
Foraging home range (HR_F)	unknown
Foraging dispersal (D_F)	5 km
Home range dispersal (D_{HR})	unknown
Natal dispersal (D_N)	max: 500 km
Seasonal dispersal (D_S)	NA
Gap crossing (D_{GC})	unknown

Description

Kea are endemic to New Zealand and are only one of two parrots in the world that use alpine habitats. They are large and olive green, with blue-green flight feathers and scarlet underwings. Juveniles can be distinguished from adults by their yellow eyelids and ceres (skin around the nostrils and beak), and paler crown feathers. Female kea are smaller than males and have smaller bills. These birds are intelligent, opportunistic omnivores. As such, they exhibit a complex array of behavioural traits, reflecting a complex social structure and enabling safe exploration and exploitation of novel resources. Localised interactions between kea and humans can result from this, sometimes with detrimental consequences. Kea have special cultural significance to Ngāi Tahu.

Ecology

Kea are widely distributed across montane areas of the South Island. Several aspects of their ecology make population size difficult to estimate. Kea are mostly found in montane or upland habitats, including alpine grasslands, subalpine scrublands, native forest, bare rock, and scree habitats. They are mostly ground-based – nesting, roosting, and foraging on the ground. Kea are omnivorous, consuming a wide variety of foods including fruits, vegetative material, nectar, flowers, seeds invertebrates, and small vertebrates. They are also important seed dispersers for alpine plants. Breeding occurs once a year, with nesting, chick rearing, and fledging taking up to 4 months. During nesting the male will feed the female, who then provisions the chicks until they reach fledging stage. Juveniles can remain with parents for up to 8 weeks prior to independence.

Pressures

Between the 1860s and 1970s an estimated 150,000 kea were culled. Following protection in 1986 they are still experiencing ongoing decline, particularly in north-eastern areas. Key pressures include predation by introduced mammalian predators, lead poisoning, and human conflict. Due to their ground-dwelling habit introduced mammalian predators are a key threat, particularly mustelids and feral cats. Kea can be extremely vulnerable to the irruptive predator dynamics associated with mast seed years, particularly in north-eastern high country, where rodent prey becomes scarce and excess predators are forced to switch prey. Their inquisitive nature can lead kea to accidents and poisoning from lead-containing materials. Pest control devices such as possum traps and poison bats can cause mortality when used without attention to kea risk. Habituated kea near settled areas have a reduced fear of humans and hazardous materials, making them more vulnerable to these threats.

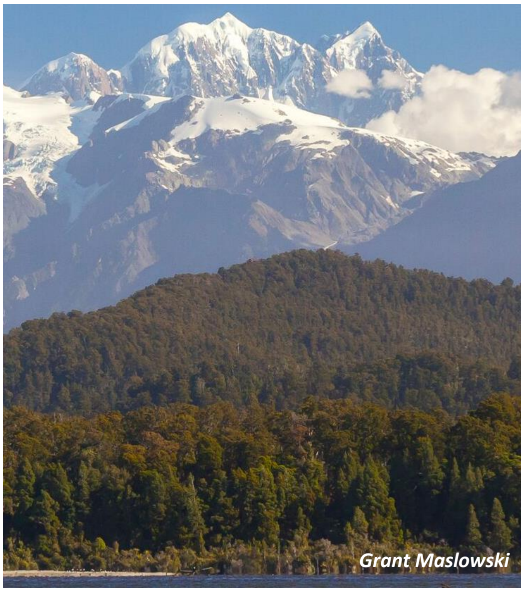
Dispersal

Kea are difficult to study due to their sparse, patchy distribution in rugged terrain, their often cryptic behaviour, and their high mobility. They frequently move between forest and alpine habitats. Home ranges vary depending on habitat quality, but can be as large as 1,000 ha. Home range size is not well studied, but the available information suggests it varies greatly depending on life stage and breeding status. Home ranges in native forest may be smaller (300 ha) compared to those in exotic plantations (1,000 ha). Daily foraging movements of 5 km have been recorded. Kea also undergo considerable natal dispersal. Juveniles initially forage within 6–40 km of their natal territories, then congregate in loose flocks and can disperse widely for up to 5 years before forming breeding pairs. Though limited data are available, tracking studies have recorded natal dispersal of 100–500 km. Once paired, kea become more sedentary. During nesting female kea remain relatively close, foraging up to 1.5 km from the nest location, usually in forest habitat. Adult males may forage further to human-occupied areas within 3 km of their nesting sites.

Beech forest breeding habitat and alpine foraging habitat, Kahurangi National Park

Breeding habitat

Breeding habitat is usually found within forest. West of the Southern Alps kea breed in predominantly podocarp and mixed podocarp/beech rainforest. In the east, breeding habitat mostly consists of dry, montane, pure beech forest. Some individuals also breed in lower-elevation rainforest at sea level, or in exotic plantation forests. Kea nest on the ground using natural crevices or tree root hollows. During nesting, territories contract to forested areas.



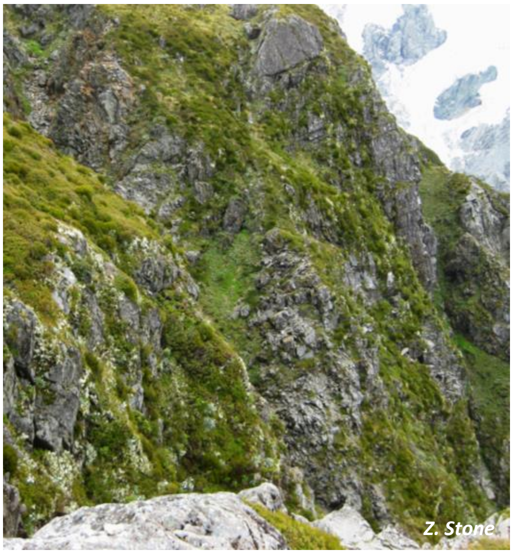
Lowland podocarp breeding habitat in front of non-breeding, foraging alpine habitat. Okarito.

Non-breeding habitat

Kea have seasonal variability in habitat selection due to the extreme conditions experienced in alpine areas. During winter they are more common in lower-elevation forest. In summer they roam more widely, particularly non-breeding juveniles. Juveniles and sub-adults are frequently found in flocks above or below the treeline in native forest and alpine ecosystems, and sometimes in exotic forestry or human settlements.

Roosting and foraging habitat

Foraging occurs across a wide range of habitats, from lowland podocarp and mixed podocarp/beech forests to upland rātā forests, forestry, subalpine scrub, and alpine tussock and scree habitats. Foraging and roosting habitat selection may be learned behaviours, with older kea found to use a wider range of habitats and food resources then juveniles. Foraging habitat also includes exotic pine plantations and pasture farmland. Kea living near humans forage more often on human food. Kea disperse between forest and open alpine areas in response to resource availability. Open alpine habitats are used for foraging fruit and vegetative material, while invertebrates are consumed more in forests. The larger bill size of males may be from more diverse foraging during breeding.



Alpine herb field foraging habitat. Aoraki, Mt Cook

Key management actions

Key management actions include:

- control of introduced mammalian predators, particularly mustelids and feral cats, across both breeding and non-breeding/foraging habitats
- large-scale pest control operations during irruptive peaks following mast years, which are particularly important for improving survival and breeding success in kea
- appropriate application of poisons and traps (e.g. kea proof traps)
- removal of lead-containing building materials (e.g. nails and flashings) in kea habitats
- protection of high-elevation rainforest, and subalpine and alpine habitats
- reducing access to human food sources to reduce the spread of accidents, poisoning, or negative behavioural conditioning
- public engagement to reduce feeding and human-mediated mortality.

Note that captive breeding and translocations are currently not considered necessary and/or appropriate management tools

Knowledge gaps and challenges

A key limitation to managing kea is the uncertainty regarding population abundance and trends. Since kea are patchily distributed, disperse widely, occupy difficult terrain, and often visit human settlements, accurate population estimates are hard to determine. Dispersal information is also severely limited, with little known about their movement, ecology, and habitat selection. Improved understanding of the relative importance of habitat used for foraging and breeding under increasing environmental variability is also needed. While difficult to implement, large-scale predator control has proven to be an effective management tool for improving breeding and survival.

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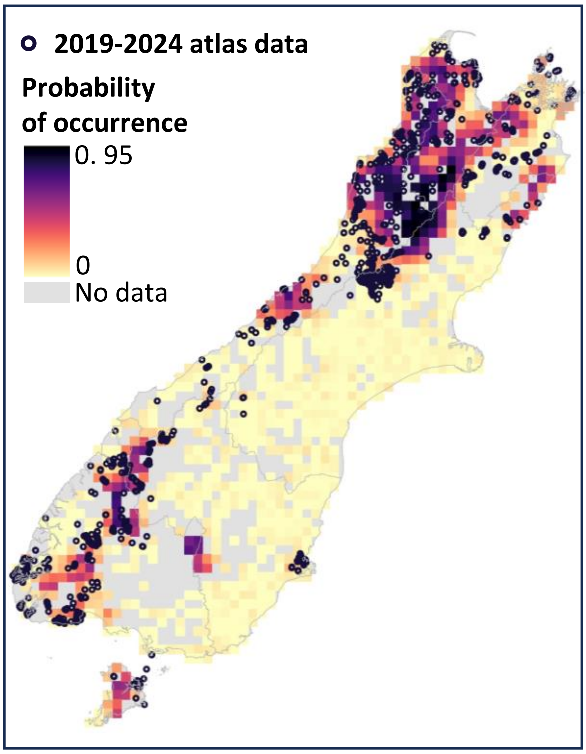
* Predicted distribution compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

AT RISK DECLINING

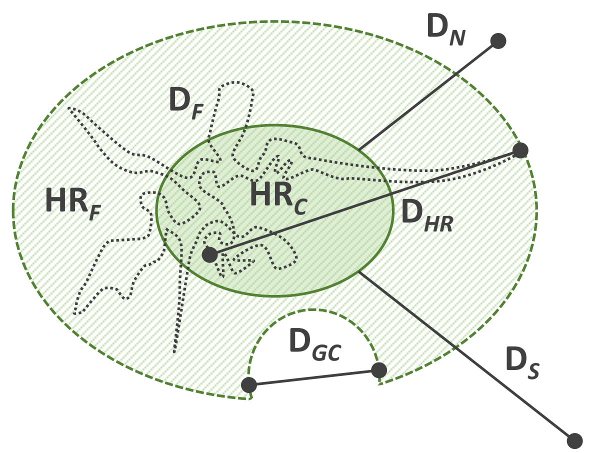
Kakaruai / South Island robin

Petroica australis

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	0.2–6 ha
Foraging home range (HR_F)	0.2–6 ha
Foraging dispersal (D_F)	unknown
Home range dispersal (D_{HR})	250 m
Natal dispersal (D_N)	max: 16 km
Seasonal dispersal (D_S)	NA
Gap crossing (D_{GC})	max: 1.7 km

Description

Kakaruai are small, grey songbirds. Adult males have a darker grey-black head and upper body, and an obvious white chest and belly. Adult females are generally a lighter grey colour and have a smaller, less distinct white chest. Adult birds often flare white feathers above the base of the beak, generally when agitated.

Ecology

The kakaruai is an insectivorous, passerine species endemic to the South Island of New Zealand. Kakaruai were probably abundant throughout most of the forested South Island habitats but are now most prevalent in the north and along the West Coast. Robins found on Stewart Island / Rakiura are considered a separate subspecies (*Petroica australis rakiura*). Kakaruai mainly forage on the forest floor and predominantly occupy lowland mature forests, but they also occur in scrub or modified habitats such as exotic pine plantations. These birds form monogamous pairs, and males defend permanent territories from which they rarely move once established. Females are the sole incubator of nests, which contributes to high nest failures and female mortality during the breeding season.

Pressures

Kakaruai are vulnerable to predation by invasive mammalian predators, especially rats (*Rattus* spp.) and stoats (*Mustela erminea*), which may have more impact in southern habitats. Adult female survival is strongly affected by rats due to predation on the nest. Fragmentation of habitat contributes to poor dispersal and recolonisation of forest fragments. Sensitivity to predation is higher during the breeding season, when adult female survival, nest success, and juvenile recruitment are highly dependent on predator control. Poor habitat quality can also influence breeding success. Lower nesting success has been found in kanuka *(Kunzea* spp.*)* / scrub-dominated native vegetation.

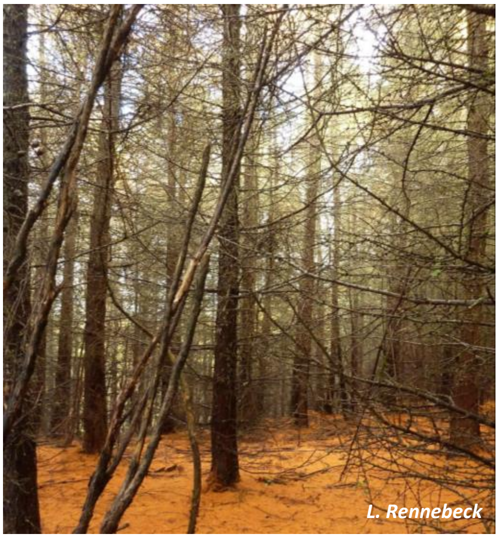
Dispersal

Kakaruai are reluctant to cross habitat gaps of >100 m on the mainland, but they may more readily disperse across water gaps to recolonise islands. In Dusky Sound, for instance, kakaruai have recolonised islands up to 1.7 km away following reintroduction. In the North Island, toutouwai (North Island robins, *Petroica longipes*) have frequently been detected dispersing up to 20 km in connected habitat. Few records exist for kakaruai, but natal dispersal of up to 16 km has been detected in Stewart Island / Rakiura robins. Dispersal is usually greatest in juveniles, with natal dispersal (dispersal away from hatching territory) occurring 4–6 weeks after fledging during summer/autumn. Following dispersal, permanent territories are established and are strongly defended by males. Home range sizes vary depending on habitat quality and population density. In high-density sites (e.g. fenced sanctuaries or islands), territories range between 0.2 and 0.6 ha. In low-density populations, territories spread more widely and can be as large as 6 ha.

High quality breeding habitat in mature podocarp forest with mammalian predator eradicated, Fiordland.

Breeding habitat

Breeding habitat usually consists of mature forest vegetation, but kakaruai can also breed in plantation pine forest, and younger forest and scrub habitat. Compared to toutouwai / North Island robins, breeding success can be higher in exotic plantations compared to native forest or scrub habitats. In lowland habitat kakaruai have flexible nesting requirements, but may have some preference for edge habitat. Research on Stewart Island / Rakiura and toutouwai / North Island robins has found territory establishment associated with forest edges. Breeding activity occurs during July–January. To be effective breeding habitat, predator control that can maintain <5% rat tracking index (RTI) is generally needed to support female survival, successful nesting, and fledgling and juvenile recruitment.



Breeding habitat in exotic plantation dominated Douglas fir, Silver Peaks, Dunedin.

Non-breeding habitat

Because kakaruai form permanent territories, habitat use remains largely the same throughout the year. However, during non-breeding periods (February–June) pairs are less likely to remain close and may spread across more of their home range. Dispersal beyond the established home range may also be more common, especially by unpaired individuals. Kakaruai will disperse through most vegetation >2 m in height, including forest, exotic plantation, scrub, or mixed vegetation classes. Breeding territories are less likely to be established in these types of habitat. Without adequate rat control, breeding habitat will become male biased and will not support successful nesting.

Potential breeding habitat in kanuka dominated regenerating scrub, Silver Stream. High rat abundance has led to male bias and poor nesting success.

Roosting and foraging habitat

Kakaruai are insectivorous and mostly forage on the forest floor, with vegetation structure having a strong influence on habitat selection. On Stewart Island / Rakiura, edge habitat with reduced stem density, <50% vegetation cover, and minimal moss cover are preferred for foraging. Territory selection may be strongly influenced by resource availability rather than specific nesting requirements. High ungulate presence may degrade understorey and leaf litter quality, affecting food availability and therefore home range size and nesting success.

Key management actions

Key management actions include:

- predator control, particularly of rats to a minimum of <20% RTI, is needed to protect kakaruai populations. However, an RTI of <5% during the breeding season is probably necessary for successful recruitment, particularly in connected sites.
- frequent aerial 1080 application in lowland forest (3-year intervals) is probably needed to support long-term rat suppression and improve nesting success.
- higher-altitude forest (>500 m) may have greater benefits from using aerial 1080 due to slower rat recovery.
- restoration planting to connect fragmented habitat, and protection of regenerating scrub, may improve connectivity and natural recolonisation of unoccupied habitats.
- translocations to predator-controlled sites can re-establish populations.
- control of introduced herbivores may improve breeding success in heavily browsed habitats.

Knowledge gaps and challenges

Despite higher levels of research on the toutouwai / North Island robin, studies on kakaruai are still more limited. Some inferences can be made from studies of toutouwai / North Island robins and Stewart Island / Rakiura robins. More recent studies of kakaruai at Orokonui Ecosantuary – Te Korowai o Mihiwaka have monitored dispersal. However, as a reintroduced population occupying lower-quality habitat, data from these studies may not represent other populations. For example, kakaruai may have a greater propensity for dispersal, particularly crossing habitat gaps, as demonstrated by frequent movement between islands in Fiordland. The impact of understorey browsing on habitat selection and resource availability is less understood, particularly in beech-dominated habitats.

Further reading

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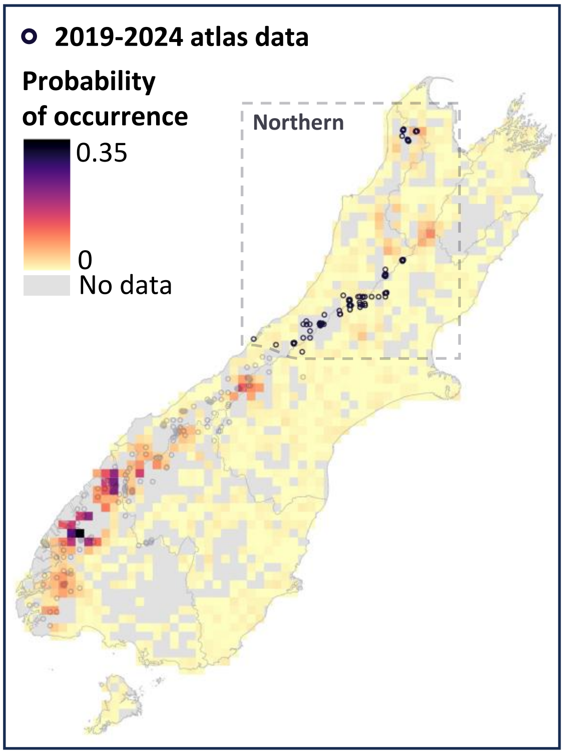
* Predicted distribution compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

NATIONALLY CRITICAL

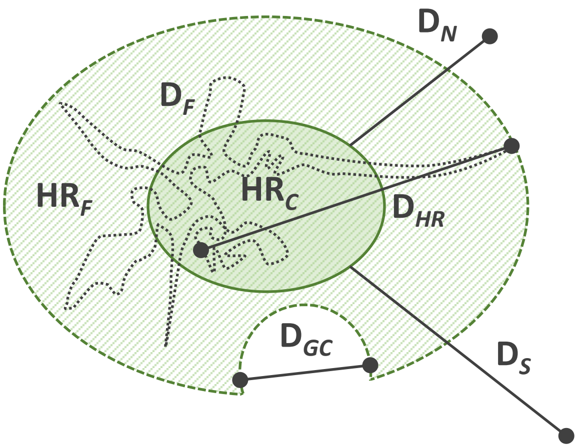
Pīwauwau / Northern Rock wren

Xenicus gilviventris 'northern'

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	0.6–4.2 ha
Foraging home range (HR_F)	unknown
Foraging dispersal (D_F)	unknown
Home range dispersal (D_{HR})	unknown
Natal dispersal (N_D)	500 m
Seasonal dispersal (D_S)	NA
Gap crossing (D_{GC})	unknown

Description

Pīwauwau/rock wrens are small, alpine passerines and are one of only two remaining species within the endemic New Zealand wren family (Acanthisittidae). They are small, weighing only 16–20 g, and have a short tail, rounded wings, and long legs and toes. Males are olive green on top, with brown underneath and yellow streaks on the side. Females are similar, but slightly more uniform in colour, mostly olive green-brown on top and pale brown below. They have a distinctive bobbing and wing-flicking movement, often preferring to hop along the ground rather than fly. Pīwauwau are separated into two distinct genetic lineages - southern and northern. The northern population is found in the West Coast and Nelson regions, northwards from Aoraki / Mt Cook up to Northern Kahurangi National Park.

Ecology

Northern pīwauwau are patchily found above the treeline in subalpine/alpine habitats across the West Coast and Nelson regions. They can be found between 700 and 2,900 m elevation. Pīwauwau are predominantly insectivorous and largely ground dwelling, with limited flight ability. These birds eat a range of invertebrate species, which they mostly forage for on the ground. They form monogamous pairs that maintain permanent territories across seasons. Breeding occurs in the warmer months (spring/summer), when nests are constructed in small holes or crevices and can contain one to five eggs.

Pressures

Due to their ground-dwelling nature and reliance on patchy alpine habitats, pīwauwau are highly sensitive to introduced mammalian predators, particularly stoats (*Mustela erminea*) and mice (*Mus musculus*). These predators are a significant seasonal pressure through egg and chick predation during the breeding season. Irruptive mast events in lower-elevation forests also effect predator abundance in alpine habitats. Given their dependence on subalpine and alpine habitats, climate change, and its interactive effect on predation is an increasing threat. Climate change may increase the fragmentation of alpine habitats, and northern pīwauwau may be particularly sensitive to this. Rats (Rattus spp.) are generally absent from alpine areas, but climate change may increase invasion from lower elevations. An increased severity and frequency of extreme weather events in alpine habitats may also have an impact on survival and breeding success, with unseasonal snow storms known to result in high mortality of adults of nests.

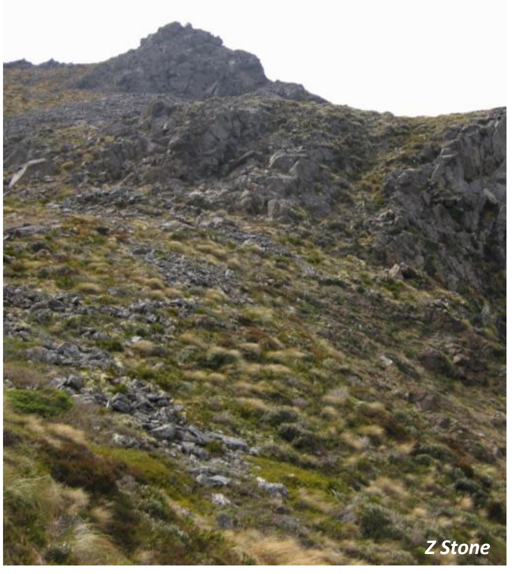
Dispersal

Because of their small size, cryptic nature, and difficult alpine habitat there is very little information on the dispersal patterns of pīwauwau. A study of southern pīwauwau in the Murchison Mountains found that they maintain permanent territories ranging from 0.6 to 4.2 ha (mean 1.4 ha). Territories vary little between seasons. Natal dispersal is also fairly limited, with most juveniles establishing territories within 500 m of their parents. Despite this apparent low dispersal, genetic analyses suggest that long-distance dispersal events may be common, with evidence of gene flow occurring across 70 km. Long-distance dispersal may be female biased, with higher relatedness found in males of occupied sites. Genetics suggest that dispersal is more limited in northern pīwauwau, with high fragmentation and limited connectivity between populations.

Subalpine shrubland and boulderfield breeding habitat, Arthurs Pass.

Breeding habitat

Pīwauwau are the only avian taxon that lives and breeds exclusively above the treeline in New Zealand. Breeding habitat comprises low alpine and subalpine shrubland, herb fields, scree slopes, boulder fields, and rocky bluffs. Territories are mostly found in boulder fields and talus (scree) slopes, interspersed with subalpine scrub and patchy tussock grasslands that are found at 700–1,100 m elevation. Nests are constructed in crevices on the ground among scree slopes and boulder fields, or on cliffs. They are fully enclosed, with thickly lined walls to buffer against the alpine conditions. Nesting can occur during periods of snow, but severe snow storms probably affect nest survival.



Alpine tussock and boulder breeding habitat, Kahurangi National Park

Non-breeding habitat

Because pīwauwau occupy permanent territories, breeding and non-breeding habitat are the same, with birds remaining above the treeline for the entire year. There have been occasional records of birds at slightly lower elevations in valley floors, and in unoccupied alpine areas, which indicates that some foraging and dispersal may occur beyond the usual territorial areas. Pīwauwau over-winter in the alpine zone, with no evidence that they migrate to lower elevations during winter.

Roosting and foraging habitat

Pīwauwau are relatively sedentary, with roosting and foraging occurring within core territories. Nests are mainly found behind vegetation in cracks in bluffs, and most are located on steep cliff bluffs that are difficult to access. The extent of foraging habitat is relatively unknown, especially in winter, when invertebrate and fruit resources are scarce. Given their small territories and sedentary nature, foraging is probably dependent on fine-scale habitat quality. Most foraging observations have been recorded during the breeding season, when individuals remain relatively close to their nests (within 100–200 m). Patterns of winter habitat use are unknown. It is suspected that pīwauwau may enter a shallow state of torpor during colder months, with reduced activity, and may even hibernate.

Alpine herbfield and scree breeding habitat, Aoraki/Mt Cook.

Key management

Key management actions include:

- predator control should target stoats using ground trapping and/or aerial 1080 application that extends into alpine habitat above the treeline.
- because stoats do not permanently occupy alpine habitats, predator control in adjacent lower-elevation forested habitat can reduce mustelid abundance in surrounding habitats and decrease migration into alpine habitat during warmer months.
- traps or toxins should be deployed around nesting cliffs as well as in flatter, more accessible boulder fields.
- predator control should be timed in relation to irruptive mast dynamics (i.e. shortly after a masting event).
- predator control between known populations to create protected corridors may help improve survival of dispersing individuals and support gene flow.
- the large home range of stoats means that single individuals can have a strong impact on a pīwauwau population. Therefore, effective predator control that eliminates stoats is probably necessary for pīwauwau recovery.
- translocation of pīwauwau to Secretary Island suggests this could be a successful management tool, but there are limited suitable alpine sites available for release.

Knowledge gaps and challenges

Monitoring of pīwauwau is challenging, and detection rates at occupied sites are generally very low. This has meant that baseline estimates of population size and trends are extremely difficult. Access issues, as well as their difficult environment and terrain, also make research challenging. As a result there have been very few studies on the general ecology of pīwauwau, and what is known is often based on small sample sizes and biased towards warmer seasons when access is possible. Despite this, predator control has been shown to improve survival and breeding success, although effective predator control in the alpine zone is extremely challenging. In addition, there is very limited information on how climate change will affect alpine habitats and interactions between pressures.

Further reading

Little L, King CM, O'Donnel CFJ 2017. Behaviour of stoats (*Mustela erminea*) raiding the nests of rock wrens (*Xenicus gilviventris*) in alpine New Zealand. Notornis 64: 124–135.

Michelsen-Heath S 1989. The breeding biology of the rock wren, *Xenicus gilviventris*, in the Murchison Mountains, Fiordland National Park, New Zealand. Unpublished MSc thesis, University of Otago, Dunedin, NZ.

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Rawlence TE 2019. The efficacy of aerial 1080 poison applied on a landscape scale to control alpine predators and the reproductive response of rock wren (*Xenicus gilviventris*). Unpublished MSc thesis, University of Otago, Dunedin, NZ.

Rawlence TE, Squire KN 2024. Survival of rock wrens (*Xenicus gilviventris*) using radio-tags, through an aerial 1080 pest control operation. New Zealand Journal of Ecology 48(1): 5374.

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Weston KA, Taylor SS, Roberston BC 2016. Identifying populations for management: fine-scale population structure in the New Zealand alpine rock wren (*Xenicus gilviventris*). Conservation Genetics 17: 691–701.

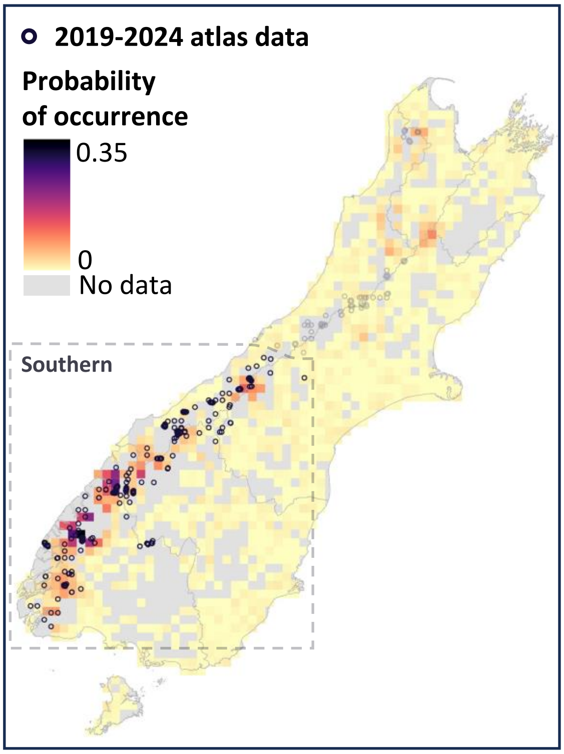
* Predicted distribution compiled from 1999-2004 occupancy modelling (Monks and Walkers, 2018) and additional 2019-2024 NZ bird atlas data that does not overlap with 1999-2004 survey grid or where occupancy was predicted at <0.2.

NATIONALLY ENDANGERED

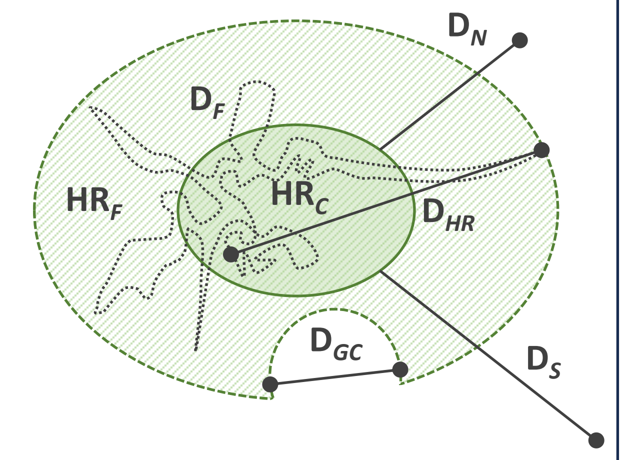
Pīwauwau/Southern rock wren

Xenicus gilviventris 'southern'

Predicted distribution*



Dispersal and movement metrics



Core home range (HR_C)	0.6–4.2 ha
Foraging home range (HR_F)	unknown
Foraging dispersal (D_F)	unknown
Home range dispersal (D_{HR})	unknown
Natal dispersal (N_D)	500 m
Seasonal dispersal (D_S)	NA
Gap crossing (D_{GC})	unknown

Description

Pīwauwau/rock wrens are small, alpine passerines and are one of only two remaining species within the endemic New Zealand wren family (Acanthisittidae). They are small, weighing only 16–20 g, and have a short tail, rounded wings, and long legs and toes. Males are olive green on top, with brown underneath and yellow streaks on the side. Females are similar, but slightly more uniform in colour, mostly olive green-brown on top and pale brown below. They have a distinctive bobbing and wing-flicking movement, often preferring to hop along the ground rather than fly. Pīwauwau are separated into two distinct genetic lineages - southern and northern. The southern population occurs south of Aoraki / Mt Cook mostly within the Southern Alps of Southland and Otago regions.

Ecology

Southern pīwauwau are widely – but patchily – found above the treeline in subalpine/alpine habitats across Southland, Otago, and the West Coast. They can be found between 700 and 2,900 m elevation. Pīwauwau are predominantly insectivorous and largely ground dwelling, with limited flight ability. These birds eat a range of invertebrate species, which they mostly forage for on the ground. They form monogamous pairs that maintain permanent territories across seasons. Breeding occurs in the warmer months (spring/summer), when nests are constructed in small holes or crevices and can contain one to five eggs.

Pressures

Due to their ground-dwelling nature and reliance on patchy alpine habitats, pīwauwau are highly sensitive to introduced mammalian predators, particularly stoats (*Mustela erminea*) and mice (*Mus musculus*). These predators are a significant seasonal pressure through egg and chick predation during the breeding season. Irruptive mast events in lower-elevation forests also effect predator abundance in alpine habitats. Given their dependence on subalpine and alpine habitats, climate change, and its interactive effect on predation is an increasing threat. Climate change may increase the fragmentation of alpine habitats. Rats (*Rattus* spp.) are generally absent from alpine areas, but climate change may increase invasion from lower elevations. An increased severity and frequency of extreme weather events in alpine habitats may also have an impact on survival and breeding success, with unseasonal snow storms known to result in high mortality of adults of nests.

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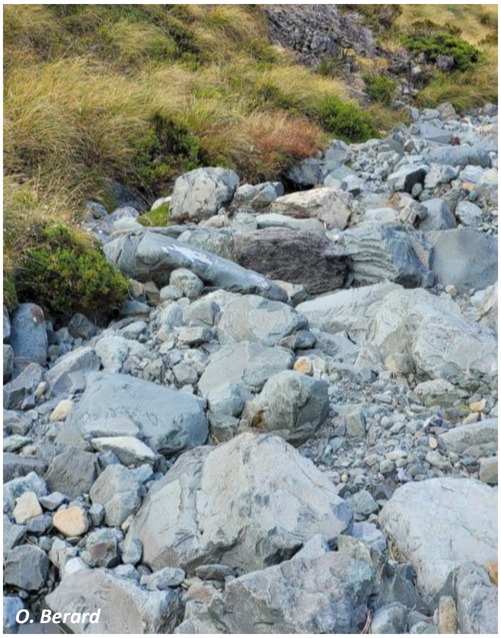
Subalpine shrubland and boulderfield breeding habitat of Northern pīwauwau, Arthurs Pass.

Breeding habitat

Pīwauwau are the only avian taxon that lives and breeds exclusively above the treeline in New Zealand. Breeding habitat comprises low alpine and subalpine shrubland, herb fields, scree slopes, boulder fields, and rocky bluffs. Territories are mostly found in boulder fields and talus (scree) slopes, interspersed with subalpine scrub and patchy tussock grasslands that are found at 700–1,100 m elevation. Nests are constructed in crevices on the ground among scree slopes and boulder fields, or on cliffs. They are fully enclosed, with thickly lined walls to buffer against the alpine conditions. Nesting can occur during periods of snow, but severe snow storms probably affect nest survival.



Southern Pīwauwau breeding habitat of scree, boulders, subalpine scrub and tussock habitat, Steele Saddle, Otago.

Non-breeding habitat

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