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New Zealand pipit (*Anthus n. novaeseelandiae*) nesting and breeding behaviour in urban Onerahi, Whangarei

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Abstract: Four New Zealand pipit nesting attempts were monitored in an urban wasteland field in Onerahi, Whangarei. A female laid two clutches in dense kikuyu (*Pennisetum clandestinum*) in October and December 2015 and fledged young from both clutches. Pipits were then absent from the site from February until late August 2016. The male reappeared and used the exact same home range, with a new female. This female laid two nests in the more open low gorse (*Ulex europaeus*) and aristea (*Aristea ecklonii*) cover in September and October 2016 but both nests were depredated at 3–5 and seven days after hatching, respectively. All three chicks, the female, and possibly the male were killed during the latter predation event. There were differences in adult behaviour throughout the breeding cycle. The female constructed the nest and undertook all the incubation. During the incubation period the male was only present at the nest site in the early morning and did not roost at the site each evening. The pair was present throughout the day after the chicks hatched. Pipits used more frequent calling rates when there was a perceived threat, and when that threat was near a nest.

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INTRODUCTION

The New Zealand pipit (*Anthus novaeseelandiae*) is considered to be part of a complex which includes Australian and New Guinean birds (Gill *et al.* 2010*).* New Zealand pipits increased in number as the land was converted to open habitats (Buller 1888; Guthrie-Smith 1927) but pipits have subsequently declined (Robertson *et al.* 2007; Beauchamp 2009) and are now absent from intensively farmed areas as well as some less intensively farmed areas. Pipits were absent from 1994–2004 (AJB *unpubl. data*; Robertson *et al.* 2007) in areas where they were formerly common (Garrick 1981), including the roads into Huiarua Station. This may have occurred because the habitat became too dry (Hamel 1972), or because there was significant and permanent loss of roadside breeding habitats during the 1983–1986 drought (Beauchamp 1997).

Pipit habitat requirements for nesting, nest site use, and the duration of nesting are not well studied in New Zealand. Anecdotal records from Kapiti Island at sea level, indicated that pipits bred over eight months (August–March) and had multiple clutches of 1–4 young (Wilkinson & Wilkinson 1952). Nests were constructed in open sites under or adjacent to tufts of vegetation or beside logs (Guthrie-Smith 1927; Higgins *et al*. 2006) or within or under dense grass at the end of short tunnels (Wilkinson & Wilkinson 1952; Higgins *et al*. 2006). In alpine Australia, Norment & Green (2004) found that all nest sites on alpine frost flats were placed below shrubs with entrances aligned away from predominant winds and that the most successful nests were in denser habitat.

Previous authors found that nests laid by

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adjacent pairs were on average 78.3 m (range 52–150 m, *n* = 24) apart (Norment & Green 2004). These authors suspected that their study included a polygamous group of a male and two females, and two clutches were incubated simultaneously by the females *c.* 9 m apart (Norment & Green 2004). The spacing between nests laid by the same pairs during the same season in other studies were 0.15–25 m apart (McEvey 1949, 1952; Higgens *et al.* 2006). The home ranges of pairs of pipits do not necessarily abut in New Zealand (Beauchamp 2013), and on Chatham Island home ranges are often >100 m apart (Beauchamp 2002).

On Kapiti Island incubation lasted about 14 days and the young fledged 14–16 days later (Wilkinson & Wilkinson 1952; Wilkinson 1957; Garrick 1985; Moon 1988). On the Snowy Mountains, Australia, incubation was 13.9 days (*SD* = 0.6, range 13–14.5), and the duration of nesting and pre-fledging averaged 27.5 days (Norment & Green 2004). The time between loss of a nest and relaying three eggs (which are usually laid a day apart) is as little as six days, and the time between fledging young and relaying was ≤14 days (Lord 1956; Norment & Green 2004).

Studies of Sprague's pipit (*Anthus spragueii*; Robins & Dale 1999), the American pipit (*A. rubescens*; Verbeek & Hendricks 1994) and the water pipit (*A. spinoletta*, Rauter & Reyer 1997) have found that the female does the nest building and all of the incubation. Where sexing has been possible, the division of labour in the New Zealand pipit is undescribed (Norment & Green 2004; Higgins *et al.* 2006).

Studies in New Zealand and Australia have found that pipits occupy breeding areas temporarily and then flock together in the late summer. These groups sometimes comprise both adults and the still dependent fledged young of the late clutches (Norment & Green 2004; Beauchamp 2009, 2013).

The late nest occupancy and post-fledging periods (weeks 2–4 after hatching) are considered to be the times when pipits are most vulnerable to predators (Guthrie-Smith 1927; Wilkinson & Wilkinson 1952; Beauchamp 2007) as the nestlings are noisy after feeding (Beauchamp 2007), and fledglings fly poorly (Wilkinson & Wilkinson 1952). I previously assessed where these risk periods were for pipits using 20 years of observations, but there was limited information on activities during incubation and nesting behaviour by chicks and parents, and I did not know the exact flight capability of young at fledging (Beauchamp 2009).

In this paper I describe the breeding performance and breeding behaviour during two breeding seasons at an urban site in Onerahi, Whangarei and then discuss how this relates to previous observations, habitat and threats to pipit in the Northland and other rural landscapes.

METHODS

Study area

The study area was a privately-owned fallow field (2.87 ha; Fig. 1) which between 2007–2015 regenerated to rank kikuyu (*Pennisetum clandestinum)*, watsonia (*Watsonia bulbillifera*), 0.3–3.0 m high gorse (*Ulex europaeus*), and 3–5 m high aristea (*Aristea ecklonii*; Fig. 1C). Three paths through the site were improved in 2014 to include mown grass and some bare ground, and a former 620 m² tip site was cleared and mown annually from November 2015 (Fig. 1C). The total field, including the tall gorse, was mown to the ground by a tractor in February 2016, but by the start of September 2016 the kikuyu and watsonia region had recovered to form a dense mat. However, the areas that had formerly been high gorse were 20 cm high gorse regrowth and aristea, or open bare ground.

The pipits' foraging home range included a church with a gravelled car park (305 m²), low-grassed street berms (0.4 ha), and a park (0.5 ha). The nearest open rural grassland was 370 m to the east (Fig. 1B).

Three domestic cats (*Felis catus*) roamed into the field, and a mature harrier (*Circus approximans*) with a light underwing patrolled the field. Three residents ran unleashed dogs (*Canis familiaris*) along the paths. No introduced mammalian predator control occurred in the field region.

Field observations

I observed four pipit nesting events during two breeding seasons on a piece of fallow urban land between 16 October 2015 and 3 November 2016 (Table 1, Figs 1 & 2). Monitoring was biased to the early morning and evening (69%, *n* = 80, Fig. 3) and confined to short periods to reduce observer impact on pair behaviour. The pipit pairs were visited during the pre-breeding (mean = 21 minutes, *SD* = 12, range 2–60, *n* = 43); incubation (mean = 18 minutes, *SD* = 11, range 2–22, *n* = 66); and nestling (mean = 35 mins, *SD* = 19, range 5–98, *n* = 41) phases of nests 1–4; and the fledgling phase of nests 1 and 2 (mean = 38 mins, *SD* = 23, range 7–108, *n* = 24).

Pipits were sexed using the male's protective behaviour (Beauchamp 2013), after which the bird's plumage was inspected to ascertain what the differences were between the sexes. The plumage of the first pair was similar, but the male had a lighter and slightly less speckled breast. The plumage of the male in the second pairing was similar to the first, but the female had more limited breast speckling and far lighter lower belly and flank than the female in the previous season. The sex of the second female was confirmed from inspection of the reproductive track of her depredated body at the end of the season. The male used exactly the same parts of the local environment each year

Table 1. Dates of the breeding period phases of the four New Zealand pipit (*Anthus n. novaeseelandiae*) breeding attempts at Onerahi, Whangarei. Phase start and end dates are provided, with the number of days on which data were collected indicated in parentheses.

Phase	Nest 1	Nest 2	Nest 3	Nest 4
Pre-incubation	15 Oct 2015 – 21 Oct 2015 (4)	3 Dec 2015 – 13 Dec 2015 (7)	4 Sep 2016 – 12 Sep 2016 (7)	2 Oct 2016 – 11 Oct 2016 (9)
Incubation	22 Oct 2015 – 6 Nov 2015 (4)	14 Dec 2015 – 27 Dec 2015 (9)	13 Sep 2016 – 26 Sep 2016 (4)	12 Oct 2016 – 26 Oct 2016 (13)
Nestlings	7 Nov 2015 – 20 Nov 2015 (10)	28 Dec 2015 – 12 Jan 2016 (12)	27 Sep 2016 – 1 Oct 2016 (3)	27 Oct 2016 – 3 Nov 2016 (6)
Fledglings	21 Nov 2015 – 2 Dec 2015 (8)	13 Jan 2016 – 23 Jan 2016 (9)	n/a	n/a

despite there being other sites within the region that were flown over but otherwise not used. These differences were interpreted as the same male with a different partner each season.

The pipit pairs were monitored by moving on foot throughout the site, but I never stopped closer than 4 m from the location of any known nest. I recorded the location of birds relative to fixed points, the calls given, the rate of *tjswee* and *tjswit* calls in relation to the proximity of the nest and the fledglings, the direction and location of foraging from the nest sites, and the time that the female spent away from nest 4 during incubation. Food delivery rates were recorded using Redfield 10x42 binoculars from a position 15–25 m from all nests. The activity of adult pipits was scored every 5 seconds for a maximum of 10 minutes, and the distance moved within these periods noted. Adult pipit calling rates were recorded separately when the pipits were within a radius of 10–50 m and 5–9 m of nest 2 to assess whether the rate changed with my proximity to the nest.

I could not access nests 1 and 2 laid in kikuyu without unnecessarily disturbing the nests and thus I only inspected nests 3 and 4 in more open habitat briefly when the pair was absent to establish the exact location of the nest and the number of eggs/chicks present.

RESULTS

Pair presence at the site

On 15 October 2015, two pipits fed together on one of the paths in a block of fallow land surrounded by urbanization (3 ha, Fig. 1B & 1C). The pair was subsequently seen on the street verges up to the church car park, but no courtship activity was observed. The first pair disappeared on 23 January 2016, the last day the fledgling of that season was seen (Table 1). A single bird was next seen near the church car park on 28 August 2016, and a pair was seen in the field on 4 September 2016. Pipits disappeared from the site on 3 November 2016 when the second brood of nestlings, the female, and maybe the male, were killed (Table 1; Fig 2). The pairs were only present when nesting and raising young (Fig. 2).

Pre-nesting and nest building

The first pair was found at the site seven days before incubation of nest 1 and eight days before incubation of nest 3. The time between the last sighting of young from nest 1 and the start of incubation at nest 2 was 12 days; and the time between the loss of nest 3 and the start of incubation at nest 4 was 11 days (Table 1).

During the pre-nesting phase the pair predominantly foraged together (Table 2). The movements were generally a slow stop-start walk covering an average of 5.2 m.min^{-1} (SD = 4.3, n = 6). Pipits preened on the ground or on elevated surfaces at the foraging sites (Table 3). Pipits were generally quieter in the pre-incubation period than in other phases of breeding (Table 3). The only time that the male was heard uttering a territorial song was on 11 December 2015 while he carried out an arched display flight over the former nest site (nest 1, Fig. 1C).

Table 2. Encounter rates of New Zealand pipit (*Anthus n. novaeseelandiae*) pair members in the breeding field at Onerahi during different phases of the breeding period.

Breeding phase	One adult detected	Pair detected	No adults detected	Proportion of visits that the pair was detected at the site(%)	Proportion of the overall visitation effort (%)
Pre-incubation	9	24	13	52.2	25.6
Incubation	41	18	10	26.1	38.3
Nestlings	21	19	1	46.3	22.8
Fledglings	7	12	5	50.0	13.3

Table 3. New Zealand pipit (*Anthus n. novaeseelandiae*) calls during breeding at Onerahi, Whangarei.

Period	**Proportion of visits that each call type was detected**				**Visits when pipits were detected (*n*)**	**Visits when any calls were detected (%)**
	tjwsit	*tjwsee*	*tzeer*	*pipit*		
Pre-incubation	2.2	11.4	2.2	2.2	44	26.7
Incubation	0.2	39.1	1.1	18.7	64	58.3
Nestlings	38.6	34.0	2.2	23.0	39	67.5
Fledglings	26.0	47.8	0	37.4	23	66.7

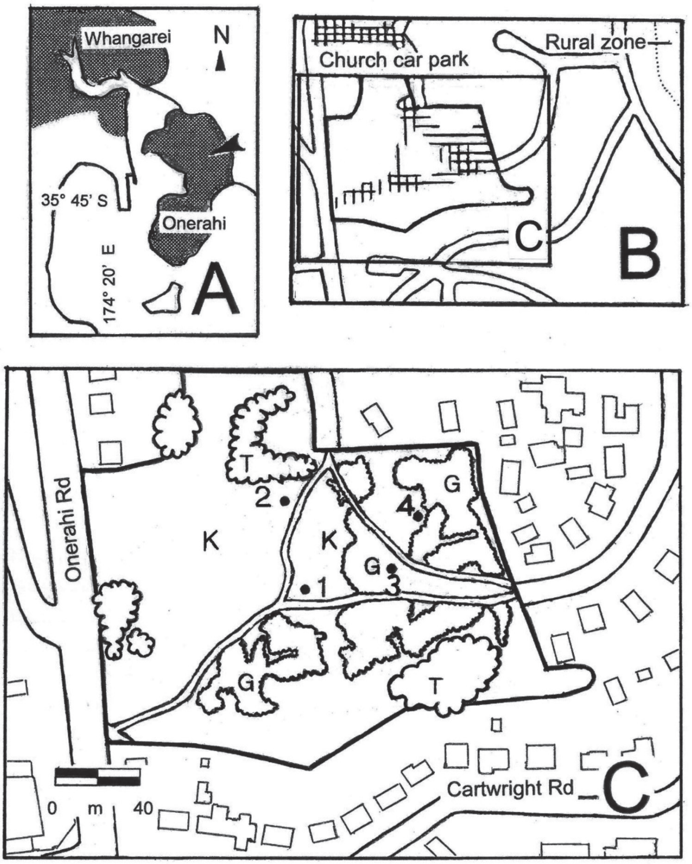

Figure 1. New Zealand pipit (*Anthus n. novaeseelandiae*) nest and foraging locations at Onerahi, Whangarei. A) Study site location in Onerahi. B) Adult foraging areas; hatched lines are the principal foraging areas in the field and surrounding street. C) Field sites in dark margin including • = nest location and number; G = gorse; T = trees; K = kikuyu and watsonia.

The first season's nests were 3.5 m and 3.2 m from the public track system, respectively, were 40 m apart and both were situated in 50–70 cm high dense kikuyu with watsonia (Fig. 1C). Neither nest could be accessed without compromising the protection of the dense habitat or altering the behaviour of the adults and consequently the nests were only investigated after the young had fledged. Nest 1 could not be located and nest 2 comprised a relatively limited grass bowl within the grass mat 200 mm above the ground and topped by kikuyu.

The second season's nests were 6 m and 8 m from formed paths, were 44 m apart, and both were located in open areas of gorse and aristea respectively (Fig. 1C). Nest 3 contained three eggs on 25 September 2016. The only nest building seen was between 0730 h and 1030 h on 9 October 2016, the day of the predicted laying of the first egg of a three-egg clutch in nest 4.

During the pre-incubation phase the first pair used at least six sites for night roosting together (Fig. 1C) and were absent from the site for five nights. The second pair was never detected roosting in the field in the pre-nesting phase and was seen leaving the site at twilight (*n* = 8 days of observations).

Incubation

At nests 3 and 4 the female did all of the incubation, and all afternoon and evening first encounters with pipits were with the foraging female (*n* = 11). At nest 4 the female foraged on average 6 (*SD* = 3.6, *n* = 13) times an hour and for between 2 and 9 minutes. The duration of these foraging periods increased as incubation progressed (Fig. 5).

During the incubation period the male was only found on-site before 1017 h and after 1700 h (*n* = 7 visits). The *tjwsee* call (Fig. 4) was given by the male while moving around the site, but not at the nest. The *tzeer* call was given by both sexes more often than during other parts of the breeding cycle, especially during low sweeps over the nest sites. The *tzeer* call was also uttered with the only period of song heard during the study (Table 3; Sonogram J in Higgins *et al.* 2006).

During the incubation period the male was only seen around sunset during three evenings and he only roosted on-site twice (*n* = 12 days of observation). On the 13th day of incubation of nest 2 the male appeared to be set to roost at the site, but 7 minutes before sunset he flew towards Limestone Island; a site that pipits use to roost (AJB *unpubl. data*).

Nestlings

After the nestlings hatched the male was detected more often at the site (Table 2). The female foraged for food for the young before the first hatched chick was dry and brooded the young until day six, and then intermittently thereafter. Most first encounters were of solitary adults walking and feeding (64%, *n* = 25; Table 4), and adults moved on average 55 m.min-1 (*SD* = 6.6, *n* = 11).

The pipits foraged within the site differently during each nesting attempt (Table 5). The foraging area used by the adults for nest 1 was more limited in size than that used in subsequent nesting attempts (Fig. 1B, Table 5). The foraging area used for nest 2 included the road verges (40% of observations) and

Table 4. New Zealand pipit (*Anthus n. novaeseelandiae*) behaviour during breeding phases at Onerahi, Whangarei.

Period	No. of five-second units	No. of days that data were collected	Behaviour category (%)					
			Dash & jump	Feed	Preen	Stand	Walk	Fly
Pre-incubation	553	3	2.4	13.7	15.6	20.6	46.1	0.5
Incubation	229	4	5.2	23.1	3.1	14.0	47.6	2.6
Nestlings	432	6	2.8	14.4	0.5	13.9	60.6	3.5
Fledglings	1,057	17	4.4	12.4	0.2	9.8	65.8	3.2

Table 5. Number of flights to urban berms and car parks and different field sites by New Zealand pipits (*Anthus n. novaeseelandiae*) after food delivery to nestlings at Onerahi, Whangarei.

Location	Nest 1	Nest 2	Nest 3	Nest 4	Total
Urban berms and car parks	3	19	4	7	33
Field sites					
Top clear soil and gorse	21	6	9	17	53
Lower rank grassland	1	8	2	4	15
Middle rank grassland gorse interface	0	13	5	18	36

especially the cracks along the concrete verge of the berms. The same non-field areas were used in both nesting seasons by all of the adult birds.

Food-delivery to the nests averaged 12.2 deliveries per hour (*SD* = 7.6, *n* = 9.5 hours of observation) and on-nest time averaged 6 seconds (*SD* = 4.6, *n* = 46). Parents delivered food equally to the nest ($\chi^2 = 2.96$, $P > 0.05$, $n = 57$), and the male was more cautious during food delivery and when I was within 25 m of the nest. After food delivery, only 24.6% (*n* = 17) of the flights from the nest were towards their foraging partner, and flights were generally to an area not used during their last food collection period (65%; $n = 75$; $\chi^2 = 9.72$, $df = 1$, $P<0.005$). Nestlings first called after food delivery at nests 1, 2 and 4, at eight, eight and seven days old, respectively. At nest 2, on day eight, nestlings called 50% (*n* = 8) of the time after adults delivered food (*n* = 46) in groups of calls of 7–9 MHz (Fig. 4). During the two days before I observed young (days 15 and 16), adults delivered food to sites up to 6 m from the nest, indicating that the young were already dispersed in the kikuyu.

The *tjwsee* (Fig. 4, 3-5 kHz) contact call (Beauchamp 2007) was given by both parents from the time that the eggs hatched, and was either uttered at the nest or within 50 m of the nest (88%, *n* = 50 deliveries). Parents called on average 18 (*SD* = 5.7, range 9.1–25.7, *n* = 12) times a minute from the top of the highest vegetation near the nest when intruders were 20–45 m from the nest; and on average 34.6 times (SD = 5.7 range 30–42, *n* = 3) a minute when intruders were closer than 20 m to the nest ($t = 4.667$, $df = 3$, $P<0.018$).

In the late nesting period, contact calls were also interspersed with single or groups of repeated *tzree* calls (Fig. 4).

Fledglings

Young pipits only fledged from nests 1 and 2 (Table 1, Fig. 2). Three fledglings from nest 1 were first seen at *c.* 15 days old on 21 November 2015. Their

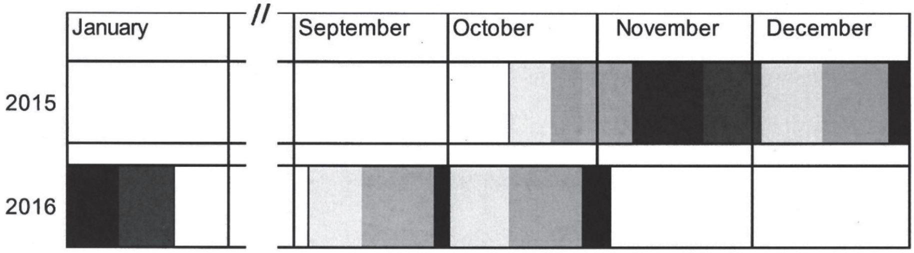

Figure 2. Detection and breeding of New Zealand pipits (*Anthus n. novaeseelandiae*) in 2015–2016 at Onerahi, Whangarei. light grey = nest building, medium grey = incubation, black = on nest, dark grey = fledged with parents.

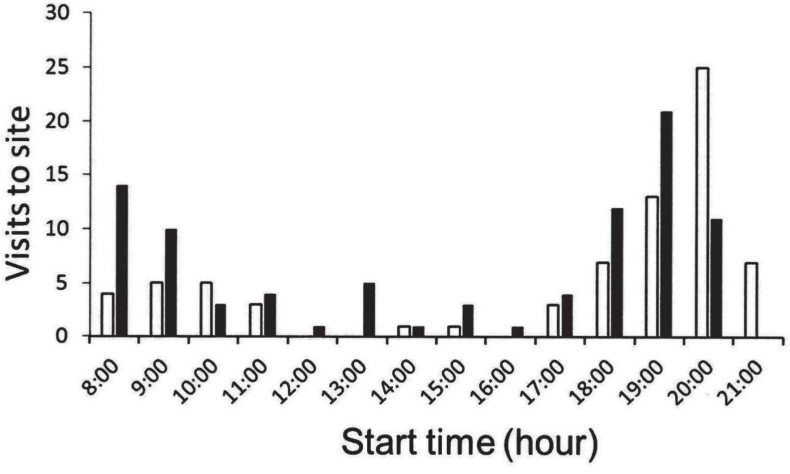

Figure 3. Observer arrival times at the New Zealand pipit (*Anthus n. novaeseelandiae*) study site at Onerahi, Whangarei. Open bars: nests 1 & 2 and closed bars: nests 3 & 4.

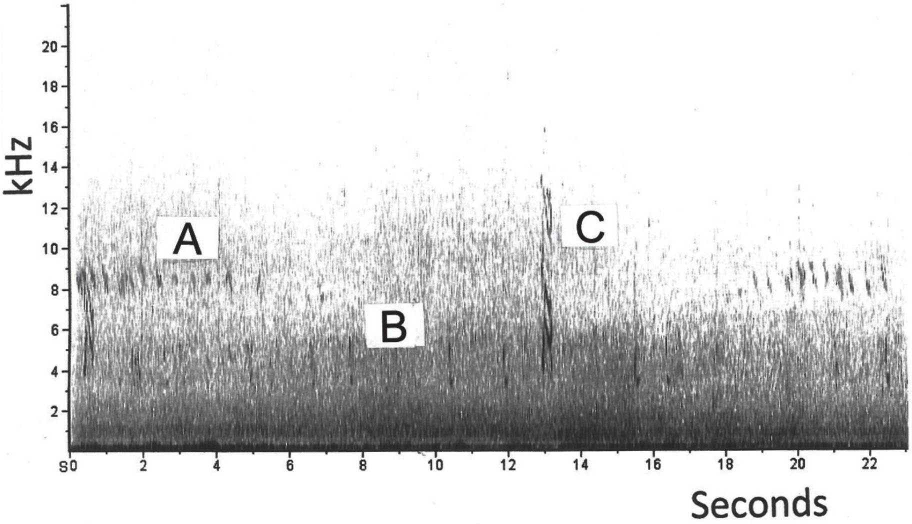

Figure 4. New Zealand pipit (*Anthus n. novaeseelandiae*) calls at the nest site. A: chick calls after adults leave the nest; B: *tjwsee* calls; C: *tzree* and inter-dispersed *tjwsee* calls

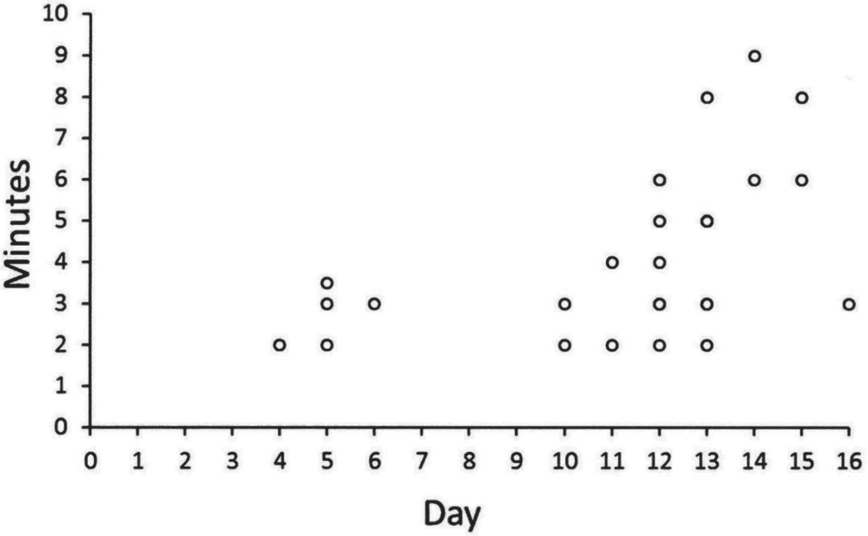

Figure 5. Duration of female New Zealand pipit (*Anthus n. novaeseelandiae*) foraging times when incubating nest 4 at Onerahi, Whangarei.

tails were half-grown and their flights of *c.* 35, *c.* 27 and *c.* 26 m, respectively, were in a straight line and their landings were clumsy when compared with adults. The last fledgling's tail was fully developed on 2 December 2015, when it was last seen with both parents (Fig. 1B). The *tjwsee* and *tjwiit* contact calls given to dependent young ceased on day 25 when at least one fledgling was still present at the site.

At nest 2, two young were seen on day 17 and three fledglings were seen at the eastern margin within 7 m of each other, and 80 m from the nest site, on day 20. The three young had tails that were half, two-thirds and almost fully developed. On discovery, each bird flew off in a different direction of *c.* 77 m, *c.* 37 m and >123 m, and then they either flew or walked back to the sites of initial detection. There, the fledglings were fed by adults coming in from the north and east outside of the field. On day

23 only one fledgling remained in the field. An adult flew directly to where the fledgling was located and fed it and later, when the fledgling had moved between visits, the adult circled the field calling for it. On day 24, during the hour before sunset, pipits were only seen at 1920 h when an adult and juvenile flew in from the north, landed near nest 2 and then departed 3 minutes later towards Limestone Island.

Predator interactions and pipit mortalities

Nestlings were lost from nest 3 at *c.* 4 days old and before any chick calling was heard. No remains were found on the nest that day and the nest was not damaged.

Cats were seen 15 times and pipits had six encounters with five different domestic cats during the 98 days of observations (mean 1 interaction per 4.5 h, n = 40.7 h), including three at locations where young pipits were fed. All encounters involved both adult pipits. The behaviour exhibited by the adult pipits indicated that they recognized cats as predators but that they did not utter any specific distress calls, like those used when harriers (n = 3 flyovers) were nearby. The pair initially remained motionless 1–2 m apart and 3–7 m from the cat before flying off. During one encounter within shrubland, where dependent young were nearby, the adults moved from the ground to perches above the cat giving *tjwsee* and *tzree* calls at a rate of >0.5 per second and enticed the cat to follow them from the site.

Nestlings were lost from nest 4 at seven days old, just after chick calling started. No remains were found on the nest and the nest was not damaged. The deceased adult female was found 2 m from the nest with a claw or beak puncture wound to the left pectoral muscle, and feathers missing from her abdomen, and tail. It is likely that the nestlings and both adults were lost at the same time as the male was never seen again. The cause of death was unknown. The most likely predator was a cat or a harrier but rats cannot be discounted. Hedgehogs and possums were unknown in the neighbourhood. The male may have just deserted the site as he did at the end of the previous breeding season.

DISCUSSION

Breeding biology differences

This study confirmed previous breeding phenology (Heather & Robertson 2015), that the habitat used by pipits for breeding was not used all year (Beauchamp 2013), and that the duration of the breeding season in New Zealand was similar to the 104 days recorded in alpine Australia (Norment & Green 2004). It also found that the nests constructed by the same pair in the same season were 42 and 40 m apart, which are consistent with the distances found in other studies (Higgins *et al*. 2006).

However, there were some differences as well. Some existing literature indicates that both sexes of the New Zealand pipit incubate (Wilkinson & Wilkinson 1952), but this is not consistent with the incubation behaviour in the genus *Anthus,* where only the female usually incubates (Tyler 2004). The female of the second pair in this study did the only nest building seen, and in all four nesting attempts females did all of the incubation and contributed an equal part to chick rearing. This study also found that the male was not near the nest or female during incubation after early morning and did not roost near the nest most evenings. The male's role appeared to be defence of the female before nesting, and defence and feeding of the young post-hatching (Beauchamp 2009, 2013). This differs from other studies of New Zealand pipit which suggest that the male is present all the time, and especially when there are threats to occupancy of that site or for the female from other pipits (McEvey 1949; Beauchamp 2002, 2013). These differences in sex-based roles during breeding may explain why one male could apparently defend two concurrent nesting females with nests situated 9 m apart in alpine areas of Australia (Norment & Green 2004). It would be quite easy for a male to defend two nearby nesting females if the females did all of the nest building and incubation and could do most of the chick feeding.

It is very likely that the male of both pairings in this study was the same as the pairs used exactly the same roadside areas despite there being considerably more habitat that could have been used. The sites used by the pairs included areas of the roadside which were outside of the field and not all that obvious as pipit habitat. The male also moved each season to and from sites to the north, the exact location of which could not be established. It is therefore likely that the male roamed over and defended a large area, and that the female only used a portion of that area (the urban field) for breeding.

It is possible that the widening and cutting of the grass tracks and the mowing of a former dump site in mid-2015 made the site more suitable for pipit foraging and nesting. The habitat created at Onerahi was similar to that in nearby grazed farmland, and which in Northland frequently has rank grassed road verges (Beauchamp 2007, 2013).

The field was mowed between the first and second seasons, but the dense kikuyu and watsonia were available in both seasons and low gorse and aristea vegetation replaced tall gorse in the second season. The weather and climate conditions were similar each year and there were no climatic reasons why in one season the nests would have been laid in the long grass and the other in low open gorse.

The main difference was the female partner and it appears that in 2015 the first female chose to use dense grassland for her two nests, while in 2016 the second female chose open low gorse habitats for her two nests. The male did not appear to know where nest 4 was situated during the hatching period and this suggests that the nest location and habitat were likely chosen by the female. Unlike water pipits, the male partner did not feed the female while she was incubating (Rauter & Reyer 1997).

Habitat, parent-chick calling and breeding success

At Onerahi the successful nest sites were in denser habitat, and the young pipits remained concealed in a complex habitat for *c.* 16 days. Fledglings were only seen when they could fly. The adults accompanied the young when they moved due to my disturbance; however, when young were disturbed while the adults were absent the young birds returned to their former sites. Consequently, high circular flights over the site to find young were rare, and the chick "*zhep*" calls frequently given by dispersed and half-tail developed pipits at Mangawhai on 31 October 2004 (Beauchamp 2007) was heard only once at Onerahi.

This study found that pairs used differential call rates to indicate the proximity of a threat to the nestlings. I reassessed calling rates from cassette tapes I recorded at Ormiston Road in 2001 to see whether similar call rate differences were evident (Beauchamp 2013). These differences existed, so I searched Ormiston Road on 25 February 2016 and located a nest and group of fledglings using the *tjwsee* calling and call rate as indicators of nest proximity. In hindsight, I concluded that adults were more reluctant to divulge the location of nests with young than I had previously assumed during work on Ormiston Road (Beauchamp 2013), and I needed to be >20 m away from, and out of direct view of the nest site before adults would visit nests.

Nesting success

The call rates at Onerahi, which were verified at Ormiston Road, suggest that adult pipits are capable of communicating warnings to their young at very densely vegetated nest sites, and that nestlings can emerge later and are better developed for flight in these sites. The extra protection offered by dense grassland could potentially lessen the risk of predation after leaving the nest and before leaving the natal area (Beauchamp 2007, 2013). The limited data collected during this study suggests that selection pressure at the nest may be acting against female pipits that build nests in open sites, and favour those nesting in very dense grassland. Consequently, the mainland pipit populations may be more likely to be located in areas where there are dense grassland nest sites including the road verges and forestry margins in places like Northland. During droughts, when the roadsides are grazed, or when roadside areas are mown, safe nesting sites may well be removed. This loss of nesting habitat alone may explain the loss of pipits in areas of the East Cape and the lack of pipits in the Waikato (Robertson *et al.* 2007).

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LITERATURE CITED

Beauchamp, A.J. 1997. The decline of the North Island Weka (*Gallirallus australis greyi*) in the East Cape and Opotiki Regions, North Island New Zealand. *Notornis 44*: 27–35.

Beauchamp, A.J. 2002. Chatham Island pipit (*Anthus novaeseelandiae chathamensis*) use of farm and fern land in spring *Notornis 49*: 45–48.

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

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

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

Buller, W.L. 1888. *A history of the birds of New Zealand*. London, The Author.

Garrick, A.S. 1981. Diet of pipits and skylarks at Huiarua Station, Tokomaru Bay, North Island, New Zealand. *New Zealand Journal of Ecology 4*: 106–114.

Garrick, A.S. 1985. Pipit *Anthus novaeseelandiae*. p. 270. *In*: *Readers Digest complete book of New Zealand birds.* Readers Digest, Sydney.

Gill, B.J.; Bell, B.D.; Chambers, G.K.; Medway, D.G. Palma, R.L.; Scofield, R.P.; Tennyson, A.J.D.: Worthy, T.H. 2010. *Checklist of the Birds of New Zealand, Norfolk and Macquarie Islands, and the Ross Dependency, Antarctica*. Ornithological Society of New Zealand. Te Papa Press, Wellington.

Guthrie-Smith, H. 1927. *Birds of Water, Wood, and Waste*. Wellington, Whitcombe & Tombs.

Hamel, J.B. 1972. Pipits, Skylarks and rainfall. *Notornis 19*: 20–25.

Heather, B.D.; Robertson, H.A. 2015. *The Field Guide to the Birds of New Zealand*. Auckland, Penguin Books.

Higgins, P.J.; Peter, J.M.; Cowling, S.J. (eds) 2006. *Handbook of Australian, New Zealand, and Antarctic birds. Vol. 7, Part B. Boatbill to starlings.* Anthus novaseelandiae *Australasian Pipit.* Pp. 1359–1389. Melbourne, Oxford University Press.

Lord, E.A.R, 1956. The birds of the Murphy's Creek district, southern Queensland**.** *Emu 56*: 100–128.

McEvey, A. 1949. Notes of the Australian pipit and its territory. *Emu 49*: 35–43.

McEvey, A. 1952. Further notes of the Australian pipit and its territory. *Emu 52*: 117–120.

Moon, G. 1988. *New Zealand Birds in Focus*. Weldon, New Zealand.

Norment, C.J: Green, K. 2004. Breeding ecology of Richard's pipit (*Anthus novaeseelandiae*) in the Snowy Mountains. *Emu 104:* 327–336.

Robertson, C.J.R.; Hyvönen, P; Fraser, M.J.; Pickard, C.R. 2007. *Atlas of bird Distribution in New Zealand 1999–2004.* Wellington, Ornithological Society of New Zealand.

Robbins, M.B.; Dale, B.C. 1999. Sprague's Pipit (*Anthus spragueii*). Pp. 1–16 *In*: Poole, A. & Gill, F. (eds). *The Birds of North America*, No. 439. Philadelphia, PA, The Academy of Natural Sciences, and Washington, D.C., The American Ornithologists' Union.

Rauter, C.; Reyer, H-U. 1997. Incubation pattern and foraging effort in the female water pipit *Anthus spinoletta*. *Ibis 139*: 441–446.

Tyler, S. 2004. Family Motacillidae (Pipits and Wagtails). *In*: del Hoyo, J.; Elliott, A.; Christie, D. *Handbook of the Birds of the World. Volume 9, Cotingas to Pipits and Wagtails*. Barcelona, Lynx Editions pp. 689–743.

Verbeek, N.A.M.; Hendricks, P. 1994. American Pipit (*Anthus rubescens*). Pp. 1-22 *In*: Poole, A. & Gill, F. (eds). *The Birds of North America*, No. 95. Philadelphia, Academy of Natural Sciences, and Washington DC, American Ornithologists' Union.

Wilkinson, A.K. 1957. *Kapiti Diary.* Masterton, The Masterton Printing Company.

Wilkinson, A.S.; Wilkinson, A. 1952. *Kapiti Bird Sanctuary.* Masterton, The Masterton Printing Company.