Chatham Island snipe research and management trials, Rangatira/South East Island, April–May 2001

JULY 2001

Department of Conservation
Te Papa Atawhai

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Published by
Wellington Conservancy
Department of Conservation
Wellington, New Zealand

Cover photo: Adult female Chatham Island snipe feeding on mealworms in the aviary, 9 May 2001 (C. Miskelly).

This report was prepared for publication by DOC Science Publishing, Science & Research Unit Department of Conservation, Wellington; editing by Jaap Jasperse, layout by Lynette Clelland. Publication was approved by the Conservator, Wellington Conservancy, Department of Conservation, Wellington.

ISBN 0–478–22071–5

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EXECUTIVE SUMMARY

Chatham Island snipe, *Coenocorypha pusilla,* were studied on Rangatira/South East Island from 28 April to 12 May 2001. Two trials at keeping snipe in captivity were undertaken. The first (29 April – 8 May) involved holding two forced pairings of snipe in an aviary with separate flights to check social interactions, adaptation to captivity, and dietary preferences. All four birds thrived on cultured mealworms, *Tenebrio molitor*, but were reluctant to take artificial food. At the end of the trial the four birds were 6.3% lighter to 13.2% heavier than at first catch (mean 0.6% heavier). The second trial (8–11 May) involved holding 10 snipe of mixed ages and sexes in a single flight for 3 days, to observe social interactions and adaptation to captivity in a situation analogous to what would happen during an inter-island transfer of snipe. All 10 birds (which included the original four) thrived, and were on average 10.8% heavier than catch weight at the end of the trial. Only one bird was lighter than catch weight when released.

Comprehensive samples for checking disease were collected from 20 snipe, including the 10 captive birds on the day of their release. No pathogenic diseases were identified, and there was no apparent difference between captive and wild snipe in ectoparasite loadings or faecal bacteria. Blood samples for genetic analysis were collected from 11 snipe.

Night-time transects to count snipe along the main track to the summit were undertaken from 1 to 5 May 2001. Snipe densities were found to vary among Woolshed Bush (mean estimated density 10.4 adults/ha), Lower Summit Bush (8.3 adults/ha), and Upper Summit Bush (2.2 adults/ha). The density in Woolshed Bush was similar to that estimated by territory mapping in 1983/84. The total snipe population of the island was estimated at 1300 adults.

Additional notes on Chatham Island snipe breeding ecology and behaviour are presented.

1. Introduction

1.1 PREVIOUS MANAGEMENT AND RESEARCH ON CHATHAM ISLAND SNIPE

Chatham Island snipe, *Coenocorypha pusilla,* are currently confined to Rangatira/South East[1], Mangere, Little Mangere and Star Keys Islands in the Chatham Islands, although they are occasionally reported from Pitt Island (Higgins & Davies 1996). Until 1970, Chatham Island snipe were thought to be confined to Rangatira Island, where they had escaped predation by introduced cats, *Felis catus*, that are considered to have wiped out snipe on Pitt and Mangere Islands by about 1900. In 1970 the New Zealand Wildlife Service re-introduced Chatham Island snipe to Mangere Island (Bell 1974), where they have thrived, and from there have colonised Little Mangere Island (Higgins & Davies 1996).

The Wildlife Service and the Department of Conservation (DOC) twice attempted to hold Chatham Island snipe in captivity at Mt Bruce (National Wildlife Centre files, and Don Merton pers. comm.). In October and December 1983, 21 eggs were taken from Rangatira. Although most eggs hatched, the chicks survived for a maximum of only 14 days. In March 1988, five adult and three juvenile snipe from Rangatira were taken to Mt Bruce: six of these birds died within 23 days of arrival. The two remaining birds were force-fed for 4 months as artificial food was rejected. One died in October 1988 and the other survived until January 1989 (10 months). The main cause of mortality in both trials was thought to be the fungal pathogen *Aspergillus*, but it is likely that the underlying cause was malnutrition due to the difficulty of maintaining an adequate supply of live food for the birds. Overcrowding may also have contributed to mortality.

The only previous intensive field study of Chatham Island snipe was undertaken on Rangatira Island by C. Miskelly from November 1983 to January 1984, and in July 1986 (Miskelly 1987a & b, 1990a & b, 1999a). These studies focused on breeding ecology and behaviour (especially aerial displaying), and detailed comparisons were made with Snares Island snipe, *Coenocorypha aucklandica huegeli*, which were being studied concurrently. Additional information on Chatham Island snipe collected at this time was included in Higgins & Davies (1996).

1.2 BACKGROUND TO THE 2001 CAPTIVITY TRIALS AND CENSUS

Interest in conservation management of snipe was rekindled in dramatic fashion in November 1997, when a relict population of a previously unknown form of snipe was discovered on tiny Jacquemart Island in the Campbell Island group (Miskelly 2000). Possibly as few as 10 snipe are surviving on Jacquemart Island,

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[1] Rangatira is also known as South East Island; only the former name will be used in the remainder of the report.

so there is an urgent need to develop management techniques on other snipe before risking any direct management of Campbell Island snipe, *Coenocorypha* sp. Although DOC intends to eradicate Norway rats, *Rattus norvegicus,* from Campbell Island in 2001, there is a genuine risk that any attempt to directly transfer snipe from Jacquemart Island to Campbell Island will result in the extinction of this critically endangered bird. The main concern is that the birds might disperse widely on 11 268 ha Campbell Island, and die out without reproducing. Clearly, there is a need to build up the numbers of Campbell Island snipe before they are reintroduced to Campbell Island.

A Snipe Recovery Group was formed in 1998; it recommended that captive breeding trials be undertaken with Chatham Island snipe in order to develop techniques that had potential for application to Campbell Island snipe. A proposal to transfer Chatham Island snipe from Rangatira to the National Wildlife Centre (Mt Bruce) was considered by the Chatham Island Conservation Board on several occasions in 1999. The Board declined to support the proposal, citing concern over whether the birds could adjust to captivity, whether there were sufficient birds on Rangatira to sustain removal of six birds and 12 eggs, and also philosophical concern at endemic Chatham Island birds leaving the Chatham Islands. However, in August 1999 the Board requested that DOC undertake a census of snipe on Rangatira to compare with results from 1983–84, and also to undertake a trial at holding snipe in captivity on the island. This captivity trial was intended to check whether issues of bird health and nutrition raised by the 1983 and 1988 trials could be resolved using modern food supplies and husbandry techniques.

1.3 BACKGROUND TO DISEASE SAMPLING AND GENETIC SAMPLING

In recent years there has been increasing concern at the vulnerability of endemic Chatham Island birds to any new disease organisms that may reach the islands. This is particularly so for species that have passed through severe genetic bottlenecks (e.g. black robin, *Petroica traversi,* and shore plover, *Thinornis novaeseelandiae*), where there may be insufficient genetic variation remaining to allow some birds to survive exposure to a new pathogen. This issue was brought to the fore when DOC was asked to approve transfer of captive-reared brown teal to the Chatham Islands. Similar concerns have been raised in the event of snipe being taken to Mt Bruce for captive breeding and subsequently returned to the Chatham Islands.

DOC is currently funding a study of what avian disease organisms are present on the Chatham Islands, in order to guide management decisions on future bird transfers there. The opportunity was taken to collect baseline disease samples from Chatham Island snipe on Rangatira as part of this wider study, but also to provide specific information on disease levels in snipe that may be relevant to any future close-order management of snipe. These samples also had the potential to provide information on whether the 10 snipe held in captivity were under stress, as stressed birds are more likely to excrete pathogens that they already carry than are free-living birds.

Snipe are considered to be a good indicator species for pathogen presence on the Chatham Islands, as their foraging on the forest floor brings them into contact with large numbers of several migratory seabird species that, between them, forage all over the Pacific basin in the non-breeding season.

The blood samples collected from 11 snipe are intended to be used as part of a comprehensive study of genetic and taxonomic diversity of *Coenocorypha* snipe; the study is likely to include description of the recently discovered Campbell Island snipe as a new species or subspecies.

2. Methods

All the research reported here was undertaken by the authors on Rangatira, 28 April – 12 May 2001.

2.1 CAPTIVITY TRIALS

2.1.1 The aviary

A 'tunnel-house' aviary had been erected on the edge of woolshed bush, near the hut before our arrival (Fig. 1, see p. 27). The aviary was 9 m long, 4 m wide and 1.8 m high, and was divided into two flights by an internal partition. The single exterior door opened into the 'front flight', which was 5 m long. The internal door opened into the 'rear flight', which was 4 m long. The aviary had been erected over a flat area of rank grass and *Muehlenbeckia*. While much of this vegetation had been flattened, there was still considerable cover available for snipe in the two flights. This existing cover was augmented with a few *Carex* clumps and logs on 29 April 2001 (Fig. 2, see p. 27). In addition, two 'rain shelters' were placed in each flight, using nest boxes prefabricated for Chatham petrel, *Pterodroma axillaris*. Three shallow trays were dug into each flight to allow presentation of food and water.

The aviary was dismantled at the end of the trials on 11 May 2001.

2.1.2 Food items and presentation

Some natural food was discovered in the aviary during excavations, including scarabaeid (grass grub) larvae, weevil larvae, tenebrionid (darkling beetle) larvae and a cicada nymph. No earthworms or amphipods were noted.

The main food provided for snipe in the aviaries was cultured mealworm larvae, *Tenebrio molitor*, plus smaller numbers of cultured earthworms (usually cut to lengths manageable by the birds). Considerable effort was made to prevent these organisms escaping into the soil. Food was presented on small trays set within larger trays, which contained most 'escapees' (Fig. 3, see p. 28). At the conclusion of the trials, the site of each food tray was excavated to a depth of 30 cm and diameter of 50 cm, and the removed soil dumped in the sea. A few mealworms were found at the ground surface during this process, but no earthworms or mealworms were noted in the soil.

Other food items presented to captive snipe were steak strips, Go-cat® biscuit crumble, and Wombaroo® insectivore mix. The Wombaroo insectivore mix was mixed with ox heart mince and water to a sloppy consistency. The Go-cat biscuit crumble was blended to a dry powder, soaked in water and then blended again to form a moist crumble. Mealworms and severed earthworms were then presented on or within the artificial food mixes. Initially, the shallow trays were covered with a thin layer of soil to entice snipe to probe in them. Attempts to get snipe to eat artificial food included forming 'worms' out of moistened Go-cat crumble or Wombaroo powder. Steak strips were also coated in dry Wombaroo and Go-cat (Fig. 4, see p. 28). In addition, mealworms were concealed in tubes containing Go-cat crumble and Wombaroo and ox heart mix, so that snipe would be forced to ingest more of the artificial food while seeking mealworms. Once snipe were routinely using feed trays, all trays containing mealworms and earthworms were periodically removed to encourage snipe to consume artificial food.

2.1.3 Catching and handling snipe

Snipe were caught at night using a spot-light or headlamp and a handnet. Birds were placed in cloth bags and taken to the hut for measuring and plumage assessment. In order to age and sex birds for the aviary trials, standard measurements were taken (weight, bill length, tarsus length, mid toe and claw length, wing length and tail length) and descriptions taken of leg colour, bill colour, tail feather wear (Miskelly 1987a), primary covert markings, and the amount of contrast between dark and light markings on the dorsal plumage (Table 1; Appendix 1). Although no single character can be considered diagnostic, in combination these characters can allow most Chatham Island snipe to be assigned to age and sex classes.

Any downy young caught were weighed and measured as above (except wing and tail length if plumage was insufficiently developed), and their hatch dates calculated using the growth equations from Miskelly (1999a).

TABLE 1. CHARACTER STATES USED TO ASSIGN CHATHAM ISLAND SNIPE TO AGE AND SEX CLASSES. 'HAKAWAI' REFERS TO UNUSUAL TAIL FEATHER WEAR ATTRIBUTED TO MECHANICAL DAMAGE DURING NOCTURNAL AERIAL DISPLAYING (MISKELLY 1987a).

CHARACTER	ADULT MALE	JUVENILE MALE	ADULT FEMALE	JUVENILE FEMALE
Weight (g)	69–85	60–81	68–94	60–81
Bill length (mm)	40–48	40–46	43–49	40–46
Leg colour	Yellowish	Olive-yellow or olive-grey	Olive or olive-yellow	Olive
Colour of bill base	Brown	Greyish	Brown	Greyish
Tail wear	Often 'Hakawai'	Not worn	Rarely 'Hakawai'	Not worn
Primary coverts	No markings	Usually unmarked	Usually slightly mottled on inner web	Usually slightly mottled on inner web
Dorsal markings	Strong contrast	Dull, little contrast	Intermediate contrast	Dull, little contrast

For the first captive trial, only adult snipe not accompanied by dependent young were retained. For the second trial we deliberately selected two parent-chick pairs (with fully-feathered young) and an independent juvenile plus a roughly equal sex ratio of adult birds. Any birds caught that did not match the predetermined age and sex mix were released. All birds placed in the aviaries were given a single Darvic® 'D' size wrap-around colour band. As only 10 birds were kept in the aviary, five colours × two legs allowed sufficient combinations for all birds to be individually identifiable. In addition, the six birds caught only for the second trial were marked on the nape with Twink®. All leg bands were removed before snipe were released to the wild at the end of the second trial.

2.1.4 Monitoring condition of birds in the aviary

Snipe were handled as little as possible once placed in the aviary. Health and condition of the birds were assessed by observing behaviour, and by remote monitoring weight using a Mettler Toledo electronic balance and hand-held Psion data logger. Once snipe had learned to feed from feed trays, all but one feed tray would be removed during weighing sessions. The electronic scales were placed in an excavation in the flight, and the single feed tray placed on top and tared to 0.0 g. Instantaneous weights were recorded for any snipe that stood on the feed tray.

Only one bird had to be captured during a trial. On day 5 of the first trial, a male (Green left) that was rarely seen feeding was provisionally weighed at 60 g, 17.8% below his capture weight. He weighed 68 g when caught the following morning (7% below capture weight) before being placed inside a small cage supplied with a feed tray containing abundant mealworms. After 6 hours he had regained 2 g and was released back into the aviary. This bird subsequently used feed trays more regularly.

All ten snipe used for the captive trials were caught, weighed and disease sampled (see Section 2.2) before release. Disease samples from these birds compared with identical samples collected from 10 'wild' snipe could potentially reveal whether the captive birds were exhibiting any stress-related pathological conditions.

2.1.5 Behavioural observations of snipe in the aviary

Most behavioural observations of the captive snipe were made by a single observer sitting within the aviary, next to the internal partition with the internal door slightly open. When using the electronic balance, the observer would sit in the opposite flight from the balance, with the data logger cable passing through the internal door. A board was placed across the bottom of the open door to prevent snipe walking between the two flights. We do not consider that our presence when seated in the aviary affected the birds, which often foraged within a metre of us.

Two methods were used to record behaviour of snipe in the aviary: time-budget sampling, and focal animal sampling. During most observation sessions, we attempted to record what every bird was doing instantaneously every 5 minutes. A code system was developed to allow rapid scoring of behaviour of up to 10 birds at a time (Appendix 2). Analysis of time-budget samples focused on how behaviour differed between birds before and after they learned to use the feed trays. Many rare behaviours were either not recorded during the instantaneous 5-minute sampling intervals, or were lumped together for analysis.

Any birds that were active between (or during) 5-min time-budget sampling times were the focus of focal animal behaviour sampling, where all actions were recorded continuously using the same behaviour coding system presented in Appendix 2. Focal animal sampling was used to interpret rare behaviours, and to provide qualitative descriptions of how the birds were foraging and interacting.

2.1.6 First captive trial (four birds for 8–9 days)

The first trial was designed to model the scenario of two 'pairs' of snipe being taken into captivity to establish a captive breeding programme. We deliberately caught birds from different locations to ensure that existing pairs were not placed in a flight together (i.e. modelling a 'worst-case' scenario of only unrelated birds being caught to start a captive breeding programme). The first three birds were caught on the night of 29 April 2001; an adult male and an adult female were placed in the rear flight, and an adult male was placed in the front flight. A second adult female was caught and placed in the front flight on the night of 30 April 2001. The trial was terminated on 8 May 2001.

2.1.7 Second captive trial (10 birds for 3 days)

The second trial was designed to model the scenario of a snipe transfer between islands, when potentially 20–30 snipe could be held for 2–3 days in an aviary until conditions allowed transport to the release site. On 8 May 2001 additional cover and feed trays were added to the 4 × 4 m rear flight, and the 'pair' of adult snipe in the front flight was caught and moved in to the rear flight, to join the other 'pair'. On the night of 8 May, six additional snipe were placed in the rear flight; these birds comprised an adult male with a fully-feathered male chick, an adult female with a fully-feathered female chick, an independent juvenile male and an adult female. Therefore, the rear flight then contained three adult male snipe, four adult females, two juvenile males and a juvenile female. The trial was terminated on 11 May 2001.

2.2 DISEASE SAMPLING

Comprehensive wildlife health assessments were completed for 20 snipe, including the 10 captive snipe immediately before their release on 11 May 2001. The 10 other snipe sampled were caught on the evenings of 9 May (4 birds), 10 May (5) and 11 May (1). All birds were weighed and measured, and searched for visible abnormalities or lesions (none found). Nine sets of samples were collected from each bird:

Mycoplasma

Sterile paediatric swab dipped in transport medium, sample from choanal slit in palate, tip of swab left in transport medium, transport medium kept chilled before and after sampling.

Pasteurella

Sterile paediatric swab, sample from choanal slit, entire swab stored in charcoal medium.

Avian influenza and paramyxoviruses (including Newcastle's disease)

Sterile paediatric swab dipped in transport medium, sample from cloaca, tip of swab left in transport medium, transport medium kept chilled before and after sampling.

Chlamydia

Sterile paediatric swab dipped in transport medium, sample from cloaca, tip of swab swirled in transport medium then discarded, transport medium kept chilled before and after sampling.

Salmonella/Yersinia/Campylobacter

Sterile paediatric swab, sample from cloaca, entire swab stored in charcoal medium.

Blood smear to assess parasites and general blood cell counts

Blood collected from brachial (wing) vein (see Section 2.3 Genetic sampling). Sample collected with either a hypodermic syringe, or capillary tube after the vein was pricked with a sterile needle. Two smears made for each bird, air-dried, then fixed in 100% methanol, washed in filtered water and air dried again.

Faecal smear to check for gram-staining bacteria

Sterile swab dipped in fresh faeces, smeared on glass slide, slide then heat-fixed by passing through butane flame for 5 seconds.

Faecal sample to assess presence of *Heterakis*, *Capillaria*, strongyles, ascarids, *Giardia*, coccidia or their eggs

Sample collected with sterile swab and stored in equivalent volume of 5% formalin solution.

Ectoparasites

Any ectoparasites seen during disease sampling were collected with forceps and stored in 70% ethanol.

Detailed sampling methodology is given in Jakob-Hoff (1999). All birds were marked with Twink before release to ensure none was sampled twice.

2.3 GENETIC SAMPLING

Following initial attempts to collect blood from the medial tarsal (leg) vein, all genetic samples were collected from the brachial (wing) vein with a sterile 26 gauge needle. Although the brachial vein was easy to locate, it was difficult to collect blood using this method, and so most samples were much less than the 0.1 ml sought. Blood samples were collected from 11 snipe, and stored in roughly twice the volume of 99% ethanol (i.e. stored sample was intended to be 30% blood, 70% ethanol). Samples were kept chilled after collection.

At the time of writing, these samples are in storage for future analysis, and so are not discussed further here.

2.4 CENSUS

Nocturnal transects to estimate snipe abundance were undertaken by CM each night from 1 to 5 May 2001. Weather conditions were mild and dry each night, and either calm or with light northerly winds. The transects began at the front landing sign, and covered about 1.5 km of the main summit track, up to the fork to east and west summits. The transects were divided into three sections: Woolshed Bush (front landing to lower edge of Skua Gully, excluding woolshed clearing; 480 m), Lower Summit Bush (upper edge of Skua Gully to 'ST 116' marker; 530 m), and Upper Summit Bush ('ST 116' to summit fork; 550 m). The three transects were counted both on the way up (starting 2005–2040 hours, finishing 2123–2154 hours) and the way down (starting 2150–2219 hours, finishing 2305–2336 hours). The transects were walked at a slow pace (average 1433 m/h) while searching both sides of the track with a hand-held 12 volt halogen spotlight. All snipe seen within 10 m of the track were recorded and their age class and social groupings noted. Calling birds were not recorded unless subsequently seen. Dependent young accompanied by an adult were recorded separately (i.e. the count was of adult snipe and independent juveniles). There was a 18–27-min gap between the uphill and downhill transects each night.

Due to dense vegetation, logs, rocks and uneven ground, it was estimated that only about half of the transect area was sampled effectively. Although snipe were counted in a 20-m wide swathe, the effective swathe width used to calculate densities was estimated to be 10 m. While this effectively doubles the observed density, using actual figures would grossly underestimate snipe densities, as many birds would have been overlooked.

2.5 BEHAVIOURAL OBSERVATIONS OF WILD SNIPE

Notes were kept by CM on all wild snipe seen, focusing on habitat use, social groupings and vocalisations.

3. Results

3.1 CAPTIVE TRIALS

All 10 snipe adjusted well to captivity, and were released in good condition 3–12 days later. Each bird took from less than 11 h to over 58 h to learn to forage from the feed trays, and there was a tendency for adult males to be slow learners (Table 2).

The behaviour of all snipe changed significantly after they learned to forage at the feed trays (Fig. 5, see pp. 29, 30; Appendix 2). When first observed in the aviary, snipe were active up to 79% of the time (mean 28%) as they searched the aviary for food. After they found the feed trays, the typical pattern was for birds to become less active (mean 16%), as they fed in short bursts at the trays, then roosted (mainly out of sight) for long periods. The changed behaviour of seven birds is summarised in Fig. 5, O & P (note that the three other birds started foraging from feed trays too soon to allow collection of 'before' samples).

TABLE 2. MAXIMUM TIMES TAKEN FOR INDIVIDUAL SNIPE TO LEARN TO FORAGE FROM FEED TRAYS IN THE AVIARY. NOTE THAT SOME INDIVIDUALS HAD APPARENTLY ALREADY DISCOVERED THE FEED TRAYS BEFORE THE FIRST OBSERVATION SESSION THE MORNING AFTER THEIR CAPTURE.

BAND COMBINATION	AGE	SEX	MAX. TIME TO START USING FEED TRAYS (h)
Red left	Adult	Male	58.5
Green left	Adult	Male	42.5
Blue right	Adult	Male	36.8
Blue left	Juvenile	Male	12.0
Yellow right	Juvenile	Male	12.0
White left	Adult	Female	10.25
Yellow left	Adult	Female	17.25
Green right	Adult	Female	13.0
Red right	Adult	Female	16.3
White right	Juvenile	Female	13.0

Once all birds had learned to feed at the trays, there were still consistent differences in behaviour between individuals (examples in Fig. 5) and sex/age classes (Fig. 6, see p. 31). Adult males tended to spend less time active (mean 8%) than either adult females (mean 25%) or juveniles (mean 26%). This may reflect different metabolic requirements, as female snipe are larger than males, and the juveniles had not completed their development.

The body weights of snipe fluctuated markedly with their foraging success. One male (Green) in the first trial rarely visited feed trays and got down as low as 60 g (17.8% less than capture weight) the day before he was temporarily caged to force him to use feed trays. This bird subsequently exceeded his capture weight (Fig. 7). Most birds lost condition during the day following capture, before they learned how to find and use the feed trays (Fig. 8). Seven birds lost an average of 4.2% of their bodyweight in the first day (range –12.6% to +9.2%). This weight loss was rapidly regained if birds were allowed unlimited access to mealworms, as was the case throughout the second trial (Fig. 8). However, during the first trial, snipe were 'encouraged' to eat artificial foods by removing all live food for intervals of various lengths during parts of Days 5–9, resulting in these birds remaining close to their capture weights (Fig. 7). At the end of this trial, these four birds averaged 0.6% heavier than capture weight (actual values –6.3%, –2.3%, –2.1% and +13.2%). These same four birds were then used as part of the second trial (Days 9–12 in Fig. 7), when their weights increased rapidly due to the *ad libitum* supply of mealworms.

None of the snipe chose to eat artificial food if mealworms or earthworms were present in the feed trays. Snipe showed no interest in consuming the Go-cat crumble or Wombaroo and ox heart mix in/on which live food was presented, nor did they eat the moistened Go-cat or Wombaroo 'worms' (Fig. 4). However, plain steak strips and steak strips coated in either dry Go-cat or Wombaroo were consumed if left in the feed trays overnight in the absence of live food. For example, on the night of 6–7 May, 39 steak strips were consumed by the four birds then in the aviary. There was no way of knowing whether all four ate the strips, but as the strips were divided evenly between the two flights, at least two birds must have consumed them. On 7 May the snipe showed a preference for Go-cat-coated strips presented on the Wombaroo and ox heart mix (30/40 consumed) rather than the converse (9/40 consumed). All other similar trials

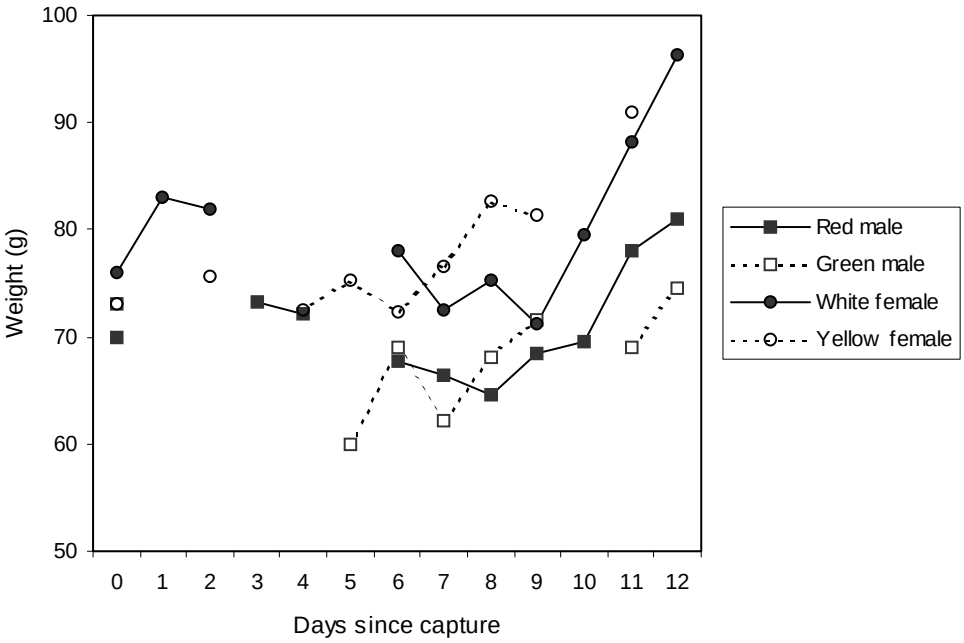

Figure 7. Fluctuations in bodyweight of the first four Chatham Island snipe taken into captivity. Weights remained close to or below capture weight during attempts to get the birds to eat artificial food (Days 5–9), but increased rapidly when the birds had access to *ad libitum* mealworms (Days 9–12).

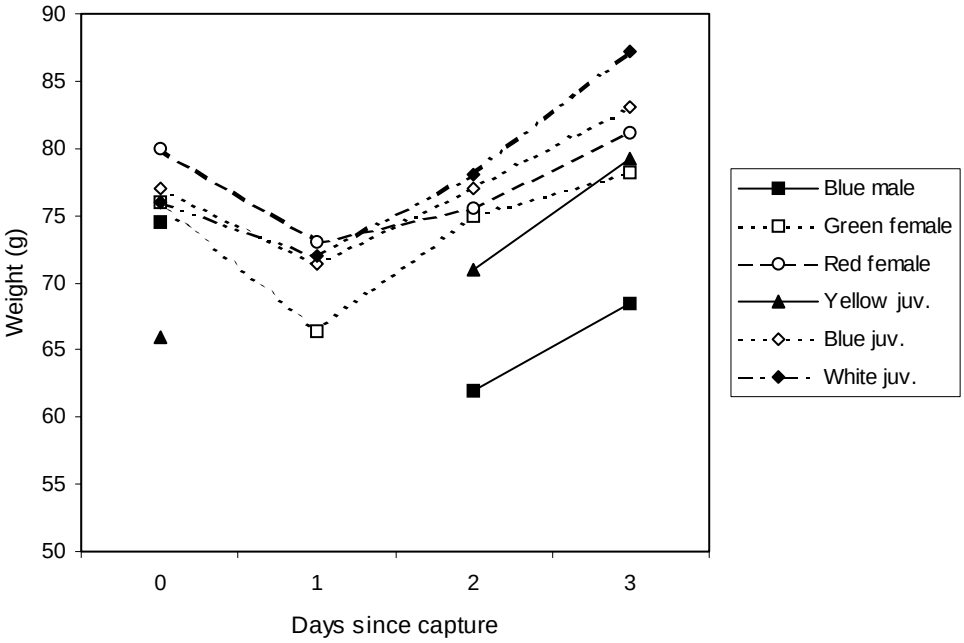

Figure 8. Fluctuations in bodyweight of the last six Chatham Island snipe taken into captivity. All six gained weight rapidly once they learned to forage from feed trays. The only bird released at below capture weight (Blue male) did not learn to use feed trays until Day 2.

were confounded by rain washing coatings off. Most meat strips left overnight in the second trial were also consumed, but again it was not possible to identify which or how many birds were involved.

At the end of the second trial, nine of the 10 birds were heavier than their capture weight (mean increase 10.8%; Table 3 and Figs 7 and 8). The one bird still underweight (Blue male) was the last bird to learn to use the feed trays, and was clearly gaining weight rapidly at the end of the trial (Fig. 8).

Snipe in the aviary generally exhibited similar behaviours to that of wild snipe. Some birds initially showed pacing behaviour along the sides of the aviary, but this ceased once they had discovered the feed trays. Two males occasionally flew up to the aviary roof on the day after capture, but this also ceased subsequently.

TABLE 3. CAPTURE WEIGHTS AND RELEASE WEIGHTS FOR THE 10 CHATHAM ISLAND SNIPE HELD IN CAPTIVITY.

BAND COMBINATION	AGE	SEX	TIME IN AVIARY (days)	CAPTURE WEIGHT (g)	RELEASE WEIGHT (g)	PERCENTAGE CHANGE
Red left	Adult	Male	12	70.0	81.0	15.7
Green left	Adult	Male	12	73.0	74.6	2.1
Blue right	Adult	Male	3	74.5	68.4	-8.2
Blue left	Juvenile	Male	3	77.0	83.0	7.8
Yellow right	Juvenile	Male	3	66.0	79.2	20.0
White left	Adult	Female	12	76.0	96.4	26.8
Yellow left	Adult	Female	11	73.0	91.0	24.7
Green right	Adult	Female	3	76.0	78.2	2.9
Red right	Adult	Female	3	80.0	81.2	1.5
White right	Juvenile	Female	3	76.0	87.2	14.7

The only birds seen to vocalise in the aviary (other than Distress Calls; see below) were three of the four adult females, and two of the three juveniles. The females gave contact calls ('Soft Call' of Higgins & Davies 1996) up to 10.5% of the time, but did not seem to be directing these at birds sharing the flight with them. The two juveniles gave 'Chick Calls' (Higgins & Davies 1996) until they had learned to use the feed trays. One juvenile (White) directed these begging calls at any other snipe that it approached, although mainly to its mother (Green). Both the juvenile and its mother discovered the feed trays simultaneously, after which all begging behaviour ceased, and the two birds no longer associated.

Two of the three birds then in the aviary gave '*chep*' alarm calls (Higgins & Davies 1996) when the second female was placed in the aviary at night on 30 April. As one bird also fluttered against the aviary mesh, no further nocturnal visits were made to the aviary other than to add the six extra snipe on 8 May.

One bird in the second trial (Red female), 'bobbed' frequently, dipping its body while standing still, and keeping its head motionless. At least three other birds were seen to 'bob' occasionally (Red male, Yellow female, Blue juvenile). This behaviour is rarely seen in wild snipe, but is thought to occur when birds are anxious about the close presence of an observer.

At least three birds (including two juveniles) used the water trays for bathing. This contrasts with observations by CM during 540 days of fieldwork between 1982 and 1992, when neither Chatham Island snipe nor Snares Island snipe, *Coenocorypha aucklandica huegeli,* were seen to bathe.

There was little evidence of overt aggression among the captive snipe, even when 10 birds were confined to 16 m^2 for 3 days. Most birds did not like other snipe approaching closer than 10 cm, and this led to some brief skirmishes at feed trays and favoured roost sites.

During the 'low-density' first trial, seven aggressive interactions were noted (six in one flight). Most were brief tussles at food trays, and on four occasions birds gave 'Distress Calls' (see Higgins & Davies 1996). On two occasions it was the Red male that called, but on the other two occasions (one per flight) the birds were under cover.

In the 'high-density' second trial, 20 aggressive interactions were observed during 590 min of observations (mean rate = one every half hour). These aggressive interactions comprised 8 Distress Calls (Yellow juvenile × 2, Red male, Green female, Yellow female, White female, Red female and one unseen bird) and 12 fights (Table 4). In the most extreme interactions (n = 5), the aggressor pecked the victim and removed a feather. Such fights are extremely rare among wild snipe (only seen when a prebreeding male tried to usurp a territorial male: Miskelly 1999b).

The aggressor in seven of the 12 fights seen was the White female, which had been resident in the flight for 9 days at the start of the second trial. The victim in half of the fights was the White juvenile, which persisted in begging from other snipe until it learned to use the feed trays.

TABLE 4. FIGHTS OBSERVED DURING THE SECOND CAPTIVE TRIAL, WHEN 10 SNIPE WERE HELD IN A 16 m^2 AVIARY FOR 3 DAYS. ALL FIGHTS WERE VERY BRIEF AND DID NOT RESULT IN NOTICEABLE INJURY OR DISTRESS.

TYPE OF INTERACTION	AGGRESSOR	VICTIM
Attack	White female	White juvenile
	White female	White juvenile
	White female	Blue juvenile
	White female	Yellow female
	Green female	Yellow juvenile
Attack with 'distress calling'	Red male	White juvenile
	Yellow juvenile	White juvenile
Attack with feather plucking	White female	White juvenile
	White female	Blue juvenile
	White female	Yellow juvenile
	Yellow juvenile	Red female
	Yellow juvenile	White juvenile

3.2 DISEASE SAMPLING

Few disease organisms or parasites were detected in the snipe. The *Mycoplasma* samples were unable to be cultured due to bacterial contamination. No evidence of *Salmonella*, *Yersinia*, *Campylobacter*, *Pasteurella*, *Chlamydia,* avian influenza or paramyxoviruses (including Newcastle's disease) was found. One bird (not captive) had 400 ascarid eggs per gram faecal matter, but no birds showed evidence of carrying *Heterakis*, *Capillaria*, strongyles, *Giardia* or coccidia. All 20 faecal smears had small or moderate numbers of gram-positive cocci, 12 had gram-positive rods (11 small numbers, 1 moderate), and 7 had small numbers of gram-negative rods (Table 5). There was no evidence for these faecal bacteria being more prevalent among the 10 captive birds.

The snipe-specific louse *Quadraceps coenocoryphae* Timmermann, 1955 was removed from three captive birds. One wild snipe had an immature tick (*Ixodes* sp.) and another had an adult flea (a female *Parapsyllus mangarensis* Smit, 1979).

TABLE 5. PREVALENCE OF GRAM-STAINING BACTERIA IN SNIPE FAECAL SAMPLES.

	WILD SNIPE		CAPTIVE SNIPE	
NUMBERS OF BACTERIA	SMALL	MODERATE	SMALL	MODERATE
Gram-positive cocci	8	2	9	1
Gram-positive rods	5	1	6	
Gram-negative rods	4		3	

3.3 CENSUS

The 5 nights of counts produced remarkably consistent results, with 19–23 adult snipe seen each night (Table 6). The counts also showed consistent, marked differences in encounter rates between the three transects. When converted to the estimated area covered by the transects, the counts revealed that snipe densities averaged 4.6 times higher in Woolshed Bush than in the Upper Summit transect (Table 7).

Densities were not accurately estimated for non-forested habitats. Anecdotal observations from the transects indicated that the ecotone between the forest and *Muehlenbeckia* vinelands held the highest densities of snipe. This was supported by one 200 m 'transect' through *Muehlenbeckia* on 4 May 2001, when three snipe were flushed (equates to roughly 38/ha). We used the maximum forest density (10 birds/ha) to estimate numbers in the vinelands (Table 7), although we recognise that this is likely to be an underestimate. The only snipe density available for grass and sedgeland on Rangatira is the 2 pairs/ha suggested in Higgins & Davies (1996). Using these figures, we suggest a ballpark total adult snipe population on Rangatira of 1300 birds.

TABLE 6. RESULTS OF 5 NIGHTS OF TRANSECT COUNTS FOR SNIPE ON RANGATIRA, 1–5 MAY 2001. UPHILL AND DOWNHILL COUNTS COMBINED FOR EACH NIGHT.

	1 MAY	2 MAY	3 MAY	4 MAY	5 MAY	MEAN
Woolshed Bush (2 × 460 m)	12	10	10	6	9	9.4
Lower Summit (2 × 530 m)	7	8	9	12	8	8.8
Upper Summit (2 × 550 m)	2	1	4	3	2	2.4
Total (2 × 1540 m)	21	19	23	21	19	20.6

TABLE 7. ESTIMATED NUMBER OF ADULT SNIPE ON RANGATIRA, MAY 2001.

	AREA SAMPLED (ha)	MEAN ADULT SNIPE DENSITY (birds/ha)	ESTIMATED TOTAL AREA (ha)	ESTIMATED ADULT SNIPE POPULATION	95% CONFIDENCE LIMITS
Woolshed Bush	4.6	10.2	25	255	181–329
Lower Summit	5.3	8.3	50	415	303–527
Upper Summit	5.5	2.2	25	55	16–94
Total forest	**15.4**	**6.9**	**100**	**725**	**500–950**
Muehlenbeckia	–	c.10	50	500	–
Grass and sedge	–	c.4	25	100	–
Total	–	**6.9**	**175**	**1300**	–

3.4 BEHAVIOUR OF WILD SNIPE

A total of 238 snipe sightings was recorded by CM from 28 April to 8 May 2001. Most sightings (71%) were of single adults or independent juveniles, however 25 parent-chick pairs were seen (i.e. about 12% of adults were accompanied by young). Nearly all chicks seen were fully feathered, or had only a trace of down on the nape, but two much younger chicks were caught. One caught on 29 April was estimated to be 22 days old (est. hatch 7 April), and a completely downy chick caught on 5 May was estimated to be 8 days old (est. hatch 27 April).

During a total of 36 hours and 40 minutes of night-time searches (including the transects), 204 adult snipe and 22 dependent chicks were seen (mean encounter rate 5.6 adult snipe per hour).

No courting pairs were seen, but loose flocks of snipe ('*chep* clusters') were often encountered at night. During the transects, groups of (usually unseen) snipe often gave the '*chep*' alarm call (Higgins & Davies 1996) at CM's presence, and this was by far the most common snipe call heard during April–May 2001. On 2 May an adult snipe was watched in the spotlight beam while giving the *chep* call—the only time CM observed this on either the Chatham Islands or the Snares Islands. The call was given while the bird was walking, with the bill closed and in the usual angled-down position (cf. male territorial call given by a stationary bird with bill open and nearly horizontal). The term '*chep* cluster' was used to describe loose aggregations of 3–6+ snipe giving contagious *chep* alarm calls within an area of less than 400 m^2. Following completion of the transects, several *chep* clusters were seen, including: 4 seen plus at least 1 heard within 15 m of each other; 3 adults within 3 m of each other; 2 of a group of 3 seen; 4 of a group of at least 6 seen (1 of the 2 heard was a chick); 1 flushed plus 4 others '*chepped*' within 20 m of each other. A *chep* cluster caught near the hut on 8 May comprised 2 adult males, 2 adult females and 2 juvenile males (1 adult male and a juvenile were a parent-chick pair). On 4 May a dependent chick that was still giving the typical chick call (Higgins & Davies 1996) was also heard to give the *chep* call.

Very few territorial male calls were heard, and these were heard only at dusk or at night. At least six birds were heard giving the low-intensity '*trerk trerk*' call ('Loud call' of Higgins & Davies 1996), including two calling to each other at night on 5 May. Three birds were heard giving the higher intensity '*queeyoo*' call on the ground (two at dusk on 8 May).

Aerial displaying was heard on the nights of 1, 2, 3 and 5 May, which were calm and clear. The most frequent call was '*chep*' (at least 8 birds). No full hakawai displays (Miskelly 1987a & 1990b) were heard, but the vocal component of the display ('*queeyoo*') was heard given by birds in flight at night on 2 May (3 birds), 3 May (1 bird) and 5 May (1 bird). It is likely that the bird heard on 3 and 5 May was the same as one heard on 2 May, as these calls came from the same site at the western end of Skua Gully. Of the 15 adult snipe handled and measured, 5 had the broken tail feathers thought to be caused by hakawai non-vocal displaying (Miskelly 1987a): 4 of 7 males, and 1 of 7 females (Appendix 1: note that one adult could not be sexed).

A final unusual sighting was of a snipe fast asleep in the spotlight beam at 2310 hours on 3 May. While snipe often sleep during the daytime, this was the first time CM had encountered a snipe asleep at night in 173 nights of field work on the Snares Islands, Chatham Islands and Antipodes Island.

4. Discussion

4.1 CAPTIVE TRIALS

Chatham Island snipe readily adapted to captivity in both the low-density and high-density trials. The main factor influencing behaviour and condition was the length of time individual birds took to learn to forage from the feed trays (up to 58 h). Activity levels were a good cue to whether snipe were getting enough food, with well-fed snipe typically roosting for 74–92% of daylight hours.

The two forced pairings in the first trial showed that snipe readily tolerated the presence of 'unrelated' snipe in the same aviary, but there was no evidence that a pair bond formed in either flight. However, there was also no evidence of pair bonds among wild snipe seen in April–May 2001. We consider that the higher aggression levels (6 interactions vs 1) in the 16 m^2 flight compared with the 20 m^2 flight was due to individual differences rather than being an effect of limited space, especially as most interactions occurred at the feed trays.

Although none of the captive snipe showed a preference for artificial food, the amount of steak strips (both coated and uncoated) consumed in the trials gives encouragement that the proportion of live food could be decreased over time. This is important both for economic reasons (cultured live food is expensive) and to ensure that captive snipe receive all the nutrients necessary to maintain good health and to breed successfully.

The second trial showed that large numbers of snipe can be held together for periods of a few days, although the rate of aggressive interactions was considerably higher than in the low density first trial. We suggest that groups of snipe held in aviaries for transfer should not be held at densities higher than the 1.6 m^2 per bird used in the second trial, and that abundant cover and feed trays be provided (as most fights occurred at the three feed trays used in our trial). Although none of the attacks caused apparent injury to any snipe, the heightened levels of stress may make the birds more susceptible to pathogens such as *Aspergillus*.

The most aggressive bird in the second trial was an adult female that had been resident in the flight for 9 days. We suggest that, in the event of a transfer, it would be preferable to place all the snipe into the aviary as quickly as possible to reduce the chance of any birds acting territorially.

If snipe are to be taken into captivity as part of a captive breeding programme or for translocation, they should be held in an aviary *in situ* until all the birds are using feed trays and have regained their capture weight. If any individual takes more than 2 days to learn to use feed trays, it should be caged for a day until it has learned to do so, and released back to the wild if it fails to gain weight while caged.

4.2 CENSUS

The density of snipe estimated by transects in Woolshed Bush in May 2001 (10.2 adults/ha) was very similar to the 11.2 adults/ha estimated there by territory mapping in 1983/84 (Miskelly 1990a). However, it must be recognised that the method used here (and especially the correction factor for birds assumed to be obscured by vegetation and surface topography) is not as accurate as territory mapping of colour-banded birds. This is by far the highest density of any snipe species known anywhere in the world (with the exception of the Snares Islands, where snipe densities are only marginally lower than at Rangatira: Tuck 1972, Miskelly 1990a). However, the lower density of snipe found in the Upper Summit bush in May 2001 meant that the estimated total population of snipe on Rangatira (1300 adults) was lower than the 700–800 pairs given in Higgins & Davies (1996). Whereas it was previously assumed that snipe occurred at densities of c. 5.6 pairs/ha throughout all forested areas on Rangatira, we now know that this is not the case.

The transect census method developed in this trial is easily repeatable, and should be trialed for at least 3 nights by other observers and at other times of the year to determine whether it yields consistent results.

4.3 BEHAVIOUR OF WILD SNIPE

The 2000/01 breeding season was a very prolonged one, based on the number of parent-chick pairs observed in April–May 2001, and especially the capture of two downy chicks. The previous latest published record for Chatham Island snipe breeding was a bird incubating on 7 April 1990 (Miskelly 1999a). However, Bruce McKinley recorded seeing a small downy chick on 4 May 2000 in the wildlife observations log on Rangatira. This chick was probably similar in age to the *c*.8 day-old chick caught on 5 May 2001.

The absence of courting pairs of adult snipe, and the few territorial calls heard indicated that breeding had probably ceased by the end of April 2001. However, the occurrence of aerial displaying on 3 nights in early May was of interest. The function of the 'hakawai' aerial display and the related '*queeyoo*' aerial display remain unknown. It is unlikely that these displays are directly related to advertising or defending a territory, as

1. Aerial displaying has been heard in every month except April, August and September (Miskelly 1990b), and
2. On average, each snipe territory in Woolshed Bush is only c. 0.2 ha in extent, and therefore about 60 m in diameter.

Any bird flying fast enough to perform the non-vocal hakawai aerial display would need to fly a circuit considerably larger than its territory.

The capture of a definite female with hakawai worn tail feathers on 8 May 2001 confirmed that the hakawai display is not performed exclusively by males.

5. Conclusions and recommendations

The authors suggest that:

- Based on the husbandry techniques described here, a limited captive-breeding programme for snipe should be initiated (preferably at the National Wildlife Centre, Mt Bruce) to develop techniques that could be applied to the critically endangered Campbell Island snipe.
- The snipe population on Rangatira is sufficiently robust that removal of up to 12 adults and 12 eggs per year would have negligible impact.
- Any snipe captured for a captive breeding programme should be held in an aviary *in situ* until they are known to be foraging from feed trays and have regained their capture weight.
- *Ad libitum* mealworms is a sufficient diet to maintain captive snipe in good condition for periods of at least 12 days.
- Further effort should be made to get captive snipe to consume artificial food.
- Groups of snipe held before transfer to new islands/sites should have at least 1.6 m^2 of aviary floor per bird, and the aviaries should be furnished with abundant cover and feed trays.
- The census method here developed for snipe on Rangatira should be trialed by other observers and at other times of the year.
- If the census method described in this report proves to yield consistent results, a monitoring programme should be developed to allow assessment of the snipe population on Rangatira.

6. Acknowledgements

This research was undertaken to answer specific questions raised by the Chatham Island Conservation Board. The captivity trial was funded by a grant from the Alice Hilda Robertson bequest fund, which also funded purchase of the electronic balance used in the aviary trials. We thank Hilary Aikman, Maria Pasco and Mike Thorsen for assistance with logistics and organising of the project. We are also indebted to Helen Gummer, Nio Mana and Andrew Smart for selecting and clearing the aviary site, and to Daryl Eason, Jane Haxton and Allen van Dijk for the superb job they did of erecting the aviary before we arrived. Christine Reed provided invaluable advice and assistance with the disease sampling project. Helen Gummer, Jane Haxton, Mike Thorsen and Allen van Dijk provided much assistance, good company and excellent food during our fortnight on Rangatira. Ricardo Palma and Professor Bob Pilgrim identified the snipe ectoparasites. Thanks also to Carolyn and Justin for holding the fort at home in our absence.

This manuscript benefited from comments received from Denise Fastier, Jaap Jasperse and Christine Reed.

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APPENDIX 1. MEASUREMENTS OF CHATHAM ISLAND SNIPE HANDLED ON RANGATIRA ISLAND 28 APRIL – 11 MAY 2001.

ID	DATE	AGE	SEX	WEIGHT	BILL	TARSUS	MTC	WING	TAIL	LEG COLOUR	HAKAWAI	1° COVERTS	COMMENTS
17	29/4/01	Adult	Male	70.0	44.2	23.9	30.3	100	33.4	Yellow	Yes	Clean	Aviary (R-) 1° moult: $N^2 4^1 1^1 O^6$
18	29/4/01	Adult	Male	73.0	43.8	23.2	30.7	100	31.5	Brown-yellow	Yes	Clean	Aviary (G-) 1° moult: $N^6 4^1 3^1 O^2$
21	29/4/01	Adult	Male	72.0	42.6	23.4	32.4	97	33.1	Yellowish	No	Clean	Released
23	30/4/01	Adult	Male	70.0	43.4	22.5	29.8	98	31.7	Green-yellow	No	Clean	Released 1° moult: $N^6 3^2 O^2$
25	8/5/01	Adult	Male	74.0	45.8	23.6	31.3	101	33.8	Yellowish	No	Clean	Released
10	8/5/01	Adult	Male	74.5	45.7	23.4	30.3	98	33.9	Yellow	Yes	Clean	Aviary (-B) 1° moult: $N^2 4^1 2^1 O^6$
04	9/5/01	Adult	Male	74.5	43.8	22.4	30.4	99	33.5	Yellow	Yes	Clean	
Adult male mean				**72.6**	**44.2**	**23.2**	**30.7**	**99.0**	**33.0**				
19	29/4/01	Adult	Female	76.0	44.9	24.1	31.2	99	33.4	Green-yellow	No	Slight mottled	Aviary (W-) 1° moult: O^{10}
16	30/4/01	Adult	Female	73.0	47.2	23.8	31.0	98	30.3	Green-yellow	No	Mottled	Aviary (Y-) 1° moult: O^{10}
15	8/5/01	Adult	Female	81.2	46.9	24.0	31.9	100	33.4	Olive	No	Mottled	Aviary (-R) 1° moult: N^{10}
26	8/5/01	Adult	Female	79.0	47.2	23.8	31.4	100.5	34.4	Olive-yellow	No	Clean	Released
13	8/5/01	Adult	Female	76.0	47.6	24.1	31.8	99.5	34.1	Olive	Yes	Slight mottled	Aviary (-G) 1° moult: O^{10}
03	9/5/01	Adult	Female	71.0	47.5	23.9	31.2	99	32.9	Olive	No	Mottled	
09	10/5/01	Adult	Female	71.5	44.7	23.1	29.4	97	33.5	Olive	No	Faint mottled	
Adult female mean				**75.4**	**46.6**	**23.8**	**31.1**	**99.0**	**33.1**				
20	11/5/01	Adult	?	78.5	43.6	22.4	30.5	102	34.2	Olive-yellow	No	Faint mottled	1° moult: O^{10}
14	8/5/01	Juv.	Male	66.0	45.5	23.6	30.1	95	33.8	Olive	No	Clean	Aviary (-Y) Both ad. & ch. calls
11	8/5/01	Juv.	Male	77.0	41.8	24.1	30.7	99	33.9	Olive-grey	No	Clean	Aviary (B-) Parent = -B (#10)
01	9/5/01	Juv.	Male	79.0	45.3	23.2	32.2	100	33.8	Olive-yellow	No	Clean	
05	10/5/01	Juv.	Male	72.0	45.2	24.0	31.1	101	34.2	Olive	No	Clean	
08	10/5/01	Juv.	Male	61.0	42.7	25.6	31.7	97	30.5	Olive	No	Clean	
Juvenile male mean				**71.0**	**44.1**	**24.1**	**31.2**	**98.4**	**33.2**				
12	8/5/01	Juv.	Female	76.0	44.1	24.4	31.5	102	33.3	Olive	No	Faint mottled	Aviary (-W) Parent = -G (#13)
02	9/5/01	Juv.	Female	66.5	40.6	23.1	29.4	99	32.7	Olive	No	Light mottled	With parent
07	10/5/01	Juv.	Female	75.5	45.8	24.4	31.9	103	32.4	Olive	No	Slight mottled	
Juvenile female mean				**72.7**	**43.5**	**24.0**	**30.9**	**101.3**	**32.8**				
06	10/5/01	Chick	?	67.0	39.5	22.7	28.1	97	31.8	Olive	No	Slight mottled	Down on frons
22	30/4/01	Chick	?	42.0	32.1	22.3	27.6	73	-	Olive	No	Clean	c. 22 d. old. Down on head & rump
24	5/5/01	Chick	?	21.8	18.4	18.0	25.3	-	-	Grey	-	-	c.8 d. old. Totally downy

ID = reference number used for disease sampling and genetic sampling. Disease samples were collected from all IDs numbered 1–20, and genetic samples were collected from IDs 1, 3–7, 10, 13, 16, 17 and 20. All measurements are in millimetres, except weight (grams). MTC = mid toe and claw. 'Hakawai' refers to distinctive tail feather wear thought to be caused by aerial displaying (Miskelly 1987a). '1° coverts' refers to whether there was any mottling on the inner web of the greater primary coverts (a character that aids sexing). Under 'Comments', band combinations used for aviary birds are given in parentheses. '1° moult' gives standard scoring system to describe state of moult of primary flight feathers where: O = an old feather, 1 = feather missing or in sheath, 2 = feather less than one-third grown, 3 = feather one-third to two-thirds grown, 4 = feather more than two-thirds grown, and N = new feather. Superscripts give the number of feathers in each category, numbered from the innermost primary outwards to the tenth primary.

APPENDIX 2. SUMMARY OF 5-MINUTE INSTANTANEOUS BEHAVIOURAL OBSERVATIONS OF CAPTIVE SNIPE ON RANGATIRA ISLAND, 29 APRIL – 10 MAY 2001.

BIRD	TOTAL OBS.	INACTIVE			ACTIVE				CALL
		OOS	ROOST	PREEN	WALK	PROBE	FEED	FLY	
1. Before feed									
Red male	101	48.5	2.0	0	5.0	43.6	0	1.0	0
Green male	96	99.0	0	0	1.0	0	0	0	0
Blue male	55	78.2	1.8	1.8	7.3	9.1	0	1.8	0
Yellow female	41	68.3	0	0	7.3	24.3	0	0	0
Green female	21	19.0	28.6	0	14.3	38.1	0	0	0
Red female	24	91.7	8.3	0	0	0	0	0	0
White juv.	19+14	0	10.5	10.5	36.8	42.1	0	0	73.7
Total before feed	**357+14**	**67.5**	**3.6**	**0.8**	**6.4**	**21.0**	**0**	**0.6**	**3.9**
2. Males after feed									
Red male	300	84.0	6.7	0	1.0	3.7	4.7	0	0
Green male	300	93.0	2.7	0	0.7	2.3	1.3	0	0
Blue male	46	67.4	6.5	0	0	15.2	10.9	0	0
Total male after feed	**646**	**87.0**	**4.8**	**0**	**0.8**	**3.9**	**3.6**	**0**	**0**
3. Females after feed									
White female	396+24	54.8	23.2	1.0	4.3	7.1	9.6	0	6.1
Yellow female	306+32	70.3	10.8	0.7	2.0	7.2	9.2	0	10.5
Green female	82	63.4	14.6	1.2	0	3.7	17.1	0	0
Red female	79+2	67.1	15.2	0	1.3	6.3	10.1	0	2.5
Total female after feed	**863+58**	**62.2**	**17.3**	**0.8**	**2.8**	**6.7**	**10.2**	**0**	**6.7**
4. Juveniles after feed									
Blue juv.	93	51.6	10.8	2.2	9.7	5.4	20.4	0	0
Yellow juv.	92+1	75.0	8.7	1.1	2.2	1.1	12.0	0	1.1
White juv.	82+3	58.5	12.2	2.4	4.9	4.9	17.1	0	3.7
Total juvenile after feed	**267+4**	**61.8**	**10.5**	**1.9**	**5.6**	**3.7**	**16.4**	**0**	**1.5**
Total for all birds after feed	**1776+62**	**71.2**	**11.7**	**0.7**	**2.5**	**5.2**	**8.7**	**0**	**3.5**

'Total obs.' = total number of instantaneous 5-minute behaviour observations for that individual or group of individuals. 'Before feed' = before birds learned to forage from feed trays. 'After feed' = after birds learned to forage from feed trays. 'OOS' = out of sight; 'Roost' included sleeping and inactive; 'Preen' included bathing and stretching; 'Probe' = probe soil; 'Feed' = feed from trays; 'Fly' included fluttering at ground level. Calling was not an exclusive behaviour – i.e. all calling birds were also scored in one of the other behaviour categories, which were mutually exclusive. The number of observations where a bird was calling is given after a '+' in the Total obs. column. All calls by adult females were contact calls, all calls by juveniles were chick calls (Higgins & Davies 1996). None of the adult males called during the instantaneous behaviour sampling. All measurements (apart from 'Total obs') are percentage of the total for that individual or group of individuals.

Figure 1. Snipe aviary on Rangatira, 29 April 2001 (C. Miskelly).

Figure 2. Karen Barlow installing the electronic balance in the rear flight of the snipe aviary, 29 April 2001 (C. Miskelly).

Figure 3. Adult female Chatham Island snipe (left) and adult male (right) on a feed tray in the aviary, 9 May 2001 (C. Miskelly).

Figure 4. Snipe smorgasbord. Clockwise from top left: steak strips, Wombaroo 'worms', Go-cat 'worms', steak strips coated in Wombaroo, earthworm segments, and steak strips coated in Go-cat (K. Barlow).

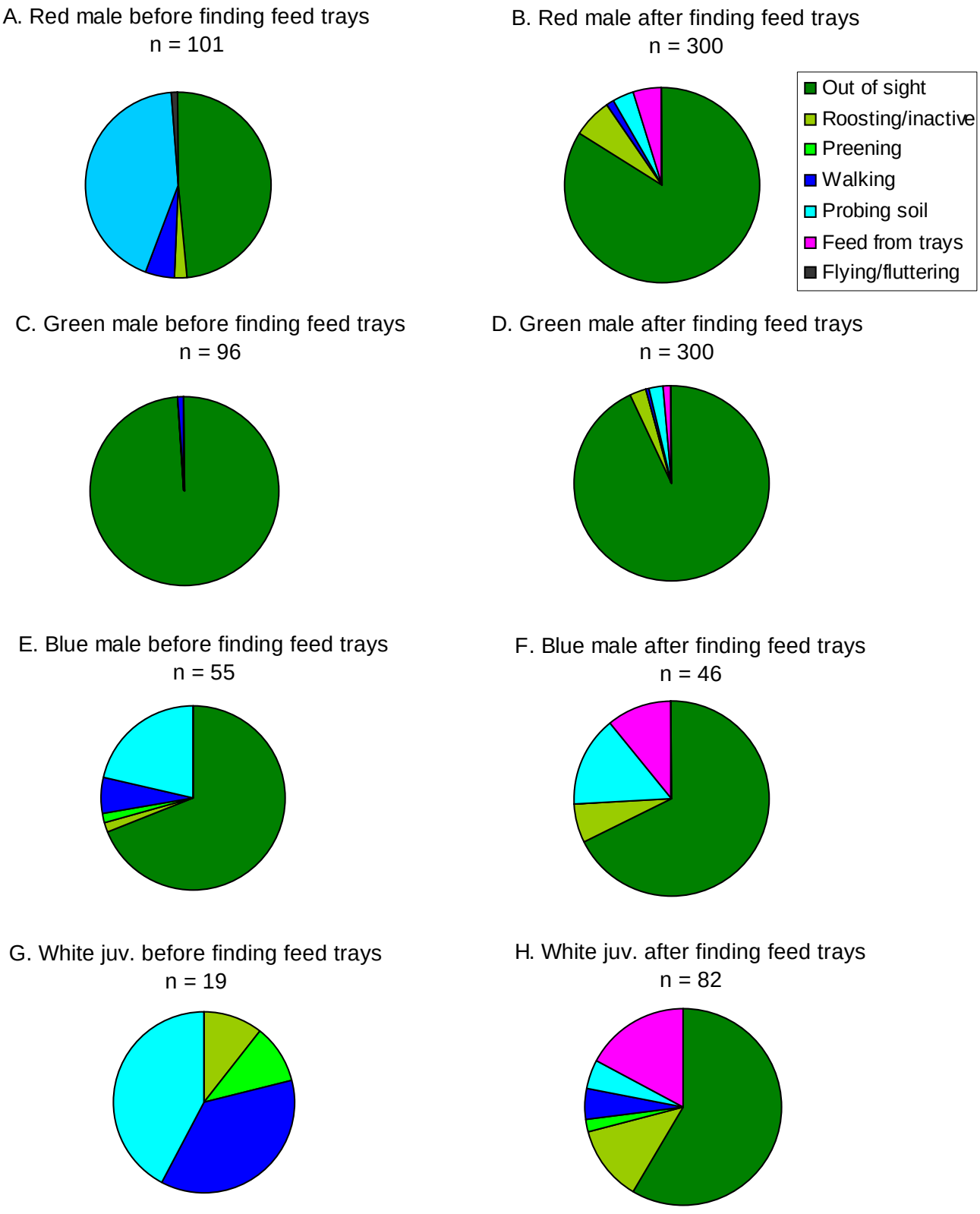
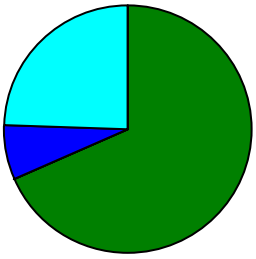
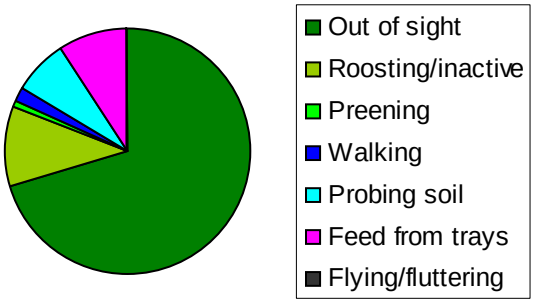


Figure 5. Differences in activity budgets of captive Chatham Island snipe before and after learning to forage from feed trays. Behaviour categories are described in Appendix 2. All birds changed their behaviour significantly after they learned to use the feed trays (χ^2 test, $P < 0.001$ for all comparisons except Blue right (male), where $P < 0.01$).

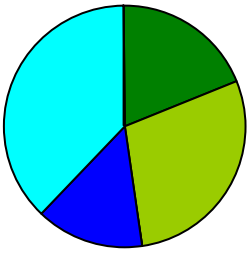
I. Yellow female before finding feeding trays
n = 41



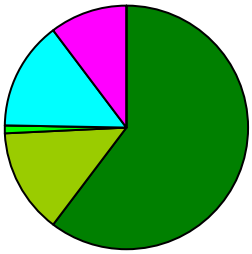
J. Yellow female after finding feed trays
n = 306



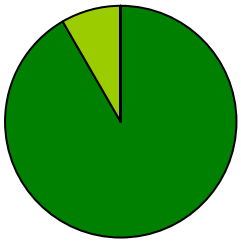
K. Green female before finding feed trays
n = 21



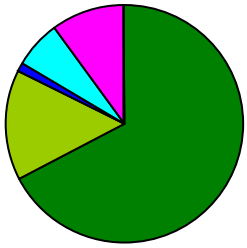
L. Green female after finding feed trays
n = 82



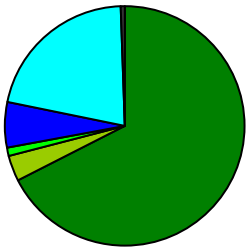
M. Red female before finding feed trays
n = 24



N. Red female after finding feed trays
n = 79



O. Total observations before using feed trays
n = 357 (7 birds)



P. Total observations after finding feed trays
n = 1776 (10 birds)

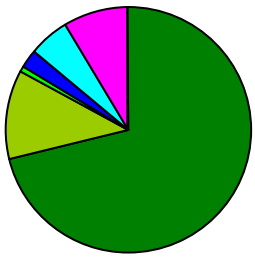


Figure 5 *continued*.

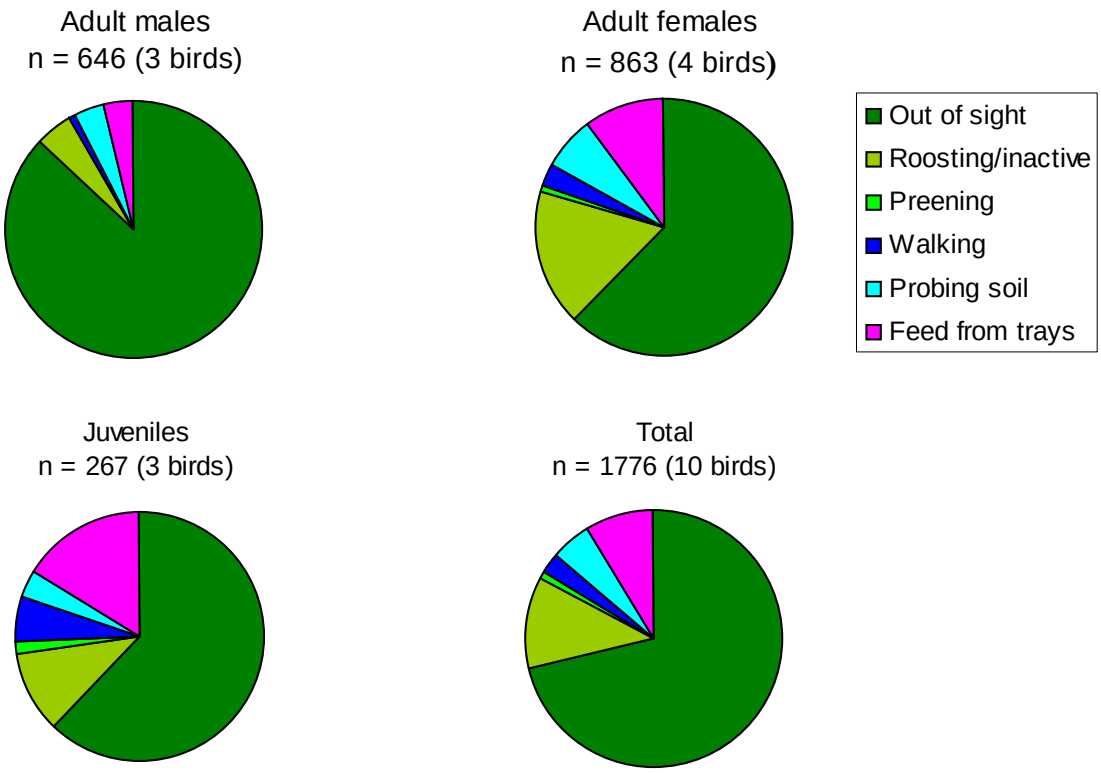


Figure 6. Differences in activity budgets of different age and sex classes of captive Chatham Island snipe after they learned to forage from feed trays. Behaviour categories are described in Appendix 2. The difference between adult male behaviour and behaviour of both other age/sex classes was highly significant (χ^2 test, $P < 0.001$). The difference between adult female and juvenile behaviour was also significant (χ^2 test, $P < 0.05$).