CAVITY NESTING IN STITCHBIRDS AND THE USE OF ARTIFICIAL NEST SITES

By GRETCHEN RASCH

ABSTRACT

Cavity nesting by Stitchbirds *(Notiomystis cincta)* was studied on Little Barrier Island by adding artificial nest sites (boxes) in a breeding habitat. The addition of boxes was a test of the theory that the number of breeding pairs of cavity nesting species is limited by the availability of suitable holes for nest sites. Site limitation is also said to prevent males of these species from taking more than one mate. This theory was tested by placing some boxes close to natural nest sites and other boxes. Results showed that the number of breeding Stitchbirds was not necessarily limited by the availability of sites, and that lack of sites did not restrict male birds to monogamy. The boxes could be a useful management tool for enhancing this rare species.

INTRODUCTION

The Stitchbird *(Notiomystis cincta)* is one of only two species of honeyeater (family Meliphagidae) to use tree cavities as nest sites. (The other species is the nearly extinct Hawaiian honeyeater, the Kauai O'o *Moho braccatus.*) This habit of nesting in tree holes is interesting from both evolutionary and ecological viewpoints (Rasch 1985b). Furthermore, this behaviour can be manipulated for the benefit of the species by the use of artificial nest sites. With this in mind, I began an experiment in 1984 to study cavity-nesting behaviour in Stitchbirds and the effect of adding nest boxes.

The first objective of the experiment was to develop an artificial nest box which Stitchbirds would accept. If Stitchbirds would use them, artificial nest sites could be a useful management tool for establishing Stitchbirds on other sites, especially those with young, regenerating forest, which often lacks trees with natural cavities.

Artificially increasing the number of breeding pairs of Stitchbirds was the second objective. I wanted to test the theory that the breeding density of cavity-nesting species is limited by the availability of nest sites. The survival of nestlings is significantly greater in species that use cavity nests than in species that use open nests (Nice 1957, Lack 1968). Evolutionary theory suggests that birds should prefer cavity nests if using these sites increases their breeding success. Yet open-nesting species generally outnumber cavity-nesting species in forests. It has been said that the breeding density (i.e. nesting pairs per hectare) is limited by the number of suitable cavities available, and therefore open nesting allows greater numbers to breed (von Haartman 1957, van Balen *et al.* 1982). In a large number of studies the addition of artificial nest sites to breeding areas has resulted in increases in the breeding density of cavity nesters, thus showing that site limitation often occurs (von Haartman 1957, Enemar & Sjostrand 1972, Slagsvold 1975, Brush 1983, Herlugson 1983, Nilsson 1984). Often the increase is quite dramatic. Hogstadt (1975) reported a ten-fold increase in the number of cavity-nesting pairs per hectare after nest boxes were added. If Stitchbirds are limited by the availability of nest sites, the addition of nest boxes should increase the number of breeding pairs.

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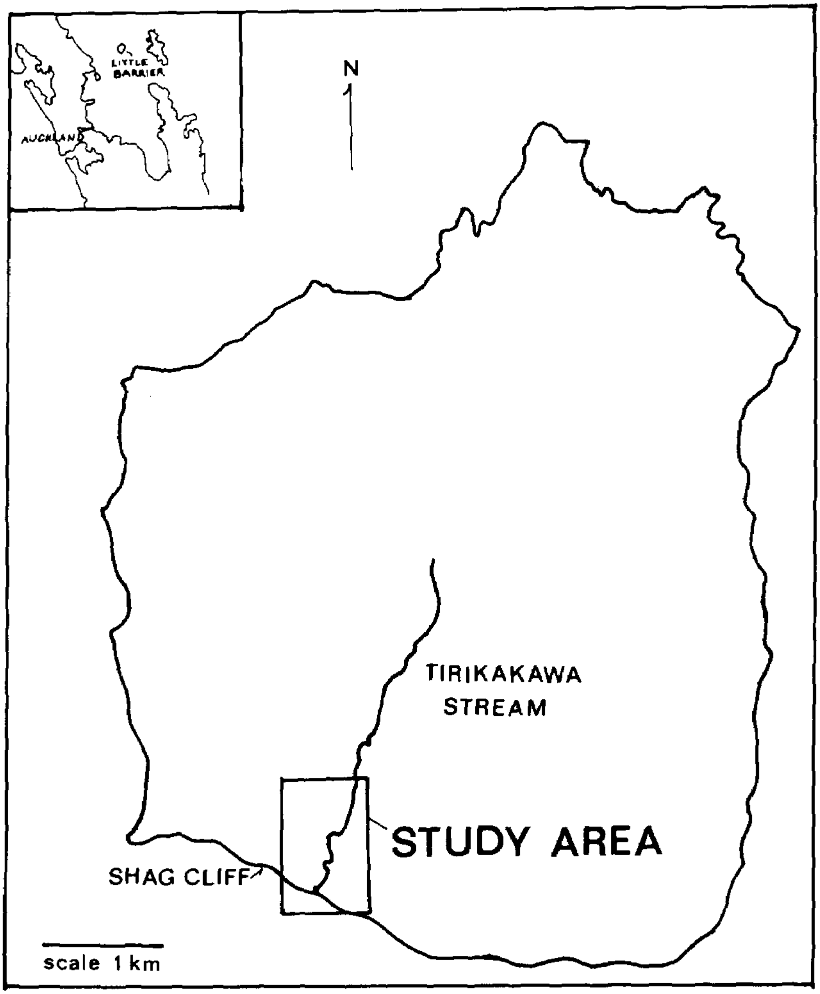

FIGURE 1 — Location of the study site in the Tirikakawa Valley, Little Barrier Island

The third objective was to find out whether the normally monogamous Stitchbird could become polygamous (take more than one mate), given the right conditions. The theory of natural selection states that individuals increase their chances of genetic survival by maximising their reproductive output (Alcock 1984). That is, the more offspring an animal has, the greater the possibility of its genetic line being represented in future generations. Therefore multiple matings (polygamy) is one way for an individual to promote the survival of its genotype.

As members of the opposite sex are limited in number, there is competition among members of the same sex for potential mates (Krebs & Davies 1981). In species in which only female birds incubate the eggs, males have a greater opportunity to take extra mates. Males are monogamous only when they are prevented from taking additional mates because competition is too great, or because survival of the clutch depends on both parents caring for the young (Emlen & Oring 1977). In cavity-nesting species, where owning a nest hole is a prerequisite to mating, monogamy may result because males can defend only one nest site at a time if nest sites are limited (Wittenberger & Tilson 1980). Only male Stitchbirds were considered in this experiment because the females are committed to nest building, laying, and incubation (Rasch 1985a). My hypothesis was that, if nest boxes were added close to natural sites (and to one another), male Stitchbirds could defend more than one site and therefore take more than one mate.

METHODS

Stitchbirds live only on Little Barrier Island (36° 12'S, 175° 7'E) in the Hauraki Gulf, except for small numbers recently released on Hen, Cuvier, and Kapiti Islands. The study site on Little Barrier included the Tirikakawa Valley and the Shag Cliff area (Figure 1). Elevation was from sea level to 150 m a.s.l. The study site was divided into three areas (Figure 2). Area I included the Shag Cliff and the first 250 m (from the valley mouth, upstream) of the Tirikakawa Valley. Forest cover of this 3 ha area was predominantly kanuka (*Kunzea ericoides*) forest. Area II was a 2.8 ha area over the next 250-550 m upstream from Area I. This was a transition zone between kanuka and rata/tawa (*Metrosideros* spp./*Beilschmiedia tawa*) forest. Area III was 550-1300 m from the valley mouth and covered 5.5 ha. The canopy in this area was rata/tawa.

Puriri (*Vitex lucens*) and pohutukawa (*Metrosideros excelsa*) trees grew along the cliff and the stream. Stitchbirds most often use cavities in these two species as nest sites. Stitchbirds are secondary cavity nesters. That is, they use already existing holes in old or diseased trees and do not excavate new ones. The birds often re-use the nests in following years (Rasch 1985a).

When I began the nest box experiment, I knew the locations of eight natural nest sites in Area I and Area III. Three nest sites were in Area I and four were in Area III. During the experiment I found two more natural sites (site B and site C) in Area I. No natural nest sites were found in Area II. Nest sites were found by careful observation of Stitchbird behaviour. Males conspicuously defend nest sites with loud singing to attract mates, and are in constant attention at the site during incubation. During the nestling period, parent birds feed the young 2-7 times per hour and can be observed as they enter and leave the nest (Rasch 1985a).

Twenty nest boxes were constructed to measurements made from natural sites (Figure 3). One feature of Stitchbird nests is that the actual nest cavity is an average distance of 280 mm above the outside entrance. This "tunnel" from entrance to nest was incorporated into the nest box design. I hoped that this would discourage other cavity-nesters on Little Barrier from using the boxes; the Saddleback *(Philesturnus carunculatus)*, Rifleman (*Acanthisitta*

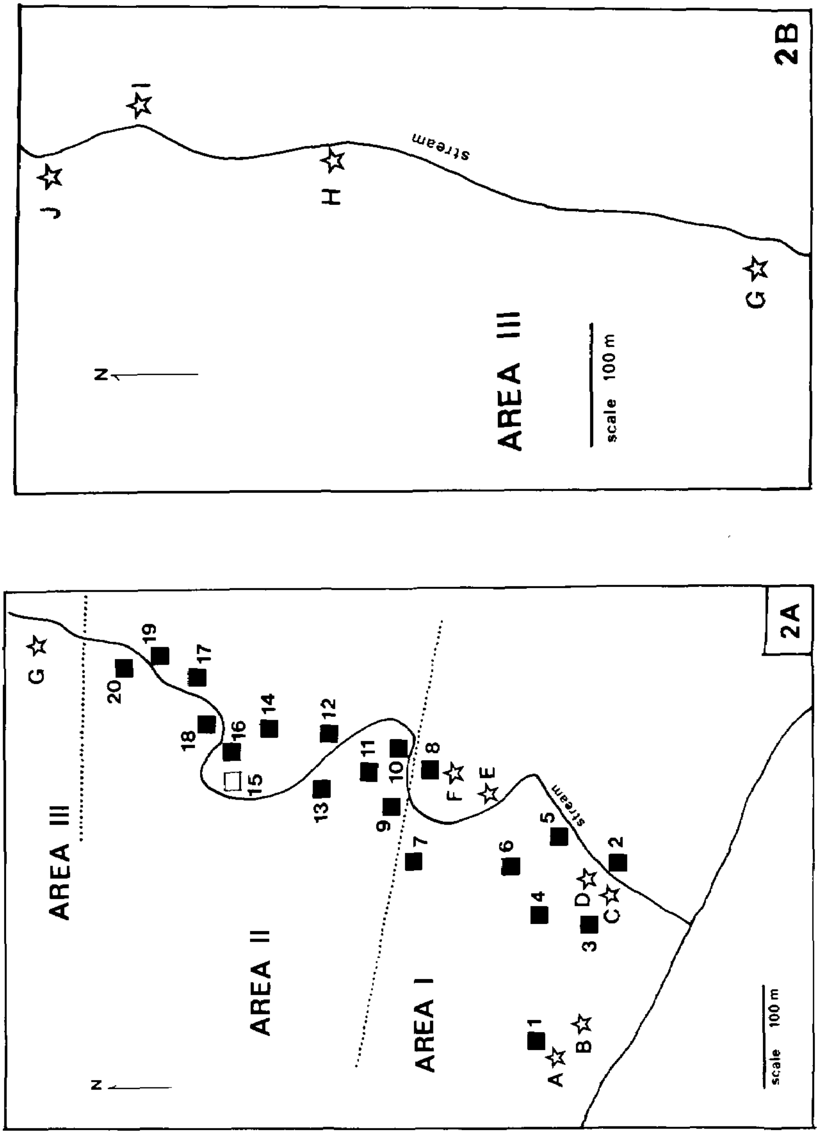

FIGURE 2 — Location of natural nest sites and of boxes in the study area. Map B is the northern continuation of Map A. ☆ = natural site. ■ = box. Box 15 is shown by an open square as it was destroyed in 1985

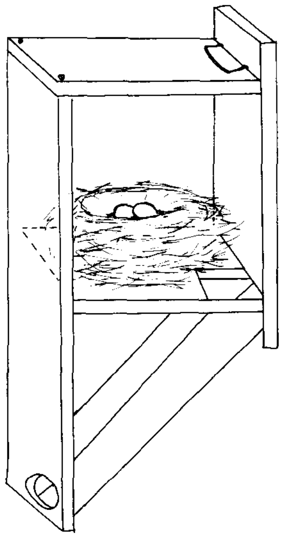

FIGURE 3 — Stitchbird nest box, cutaway view. The nest "cavity" measures 15 cm × 20 cm × 20 cm (width × length × height). The tunnel is 24 cm long (approximately)

chloris), Kakariki (*Cyanoramphus* spp.), and New Zealand Kingfisher (*Halcyon sancta*). The boxes were built of 2.5 cm tanalised pine. The tops were hinged at the back and fastened with screws so that I could easily remove them to see inside the box.

Eight boxes were put up in Area I and 12 in Area II (Figure 2). The boxes were erected in August 1984, before the breeding season, which begins some time from September to November. Boxes were placed 2-5 m up in various species of tree, the height being limited by the ladder. Aspect was not taken into account, except that no opening faced downstream into the prevailing breeze.

Boxes in Area I were there to increase the density of nest sites available in a known breeding habitat. The boxes were erected in Area II to test whether Stitchbirds had not been nesting in this area because of the lack of natural nest sites. No boxes were erected in Area III, as a control to monitor any natural increases in breeding density. Since the habitat varied between areas, density changes may have been related to habitat type. Therefore the control area was not ideal.

To test the hypothesis that availability of nest sites was limiting the potential for polygamy in male Stitchbirds, four boxes (numbers 1,2,6 and 8) were placed within 5 m of known natural nest sites. Six boxes (numbers 12,13,15,16,17, and 18) were within 10 m of another box.

During the breeding season each box and natural site was watched for at least one hour per trip. After the breeding season, boxes were opened and checked for nests. From the size of the nests and eggshell remains the nests could be identified as Stitchbird nests.

Monitoring effort varied from year to year. Observation was nearly daily in the summers of 1983-1984 and 1986-1987, several visits to the island were made in 1982-1983 and 1984-1985, and only two visits, one during and one after the breeding season, were made in 1985-1986.

RESULTS

No nest boxes were used by Stitchbirds during the first breeding season that the boxes were available (summer 1984-1985). Singing by male Stitchbirds was conspicuous in the valley as the boxes were being set up, and so the Stitchbirds may have already chosen nest sites. Therefore in Table 1, the 1984-1985 summer was considered along with 1982 and 1983 as being a summer before the addition of boxes.

Two boxes (numbers 8 and 9) were used as nest sites in 1985-1986, and two other boxes (numbers 7 and 13) were used in 1986-1987 (Table 1). There was no increase in the number of nests used in any one year within the entire nest box area (both Area I and Area II). The number of nests used per year did not exceed past records in Area I, but Stitchbirds nested for the first time in Area II because of their using the boxes. There was a decline in active nests in Area III.

If the experimental areas (Areas I and II) are considered together, the average number of nest sites used was 2 per year before the boxes were added and 3 per year afterwards. For the control (Area III), the average was 2.3 nests per year before boxes, and 0.5 nests afterwards. A chi-square test indicates that the change in the ratio between the two areas was not significant ($x^2 = 1.91$, df = 1, p = 0.10) (Parker 1979).

I may have missed nests in Area III in 1985-1986 because of my limited observation effort. During my only breeding season visit, I did see a pair of Stitchbirds at site J but could not confirm actual nesting.

I did not observe any male Stitchbirds defending more than one nest or more than one female. Nest site F and Box 8, less than 1 m apart on the same tree, were both used but not in the same year.

There appeared to be a trend for the birds to select the higher boxes. Whereas the mean height for all boxes was 3.2 m (SE = 0.19, range = 1-5 m, n = 19), the mean height of the four boxes used by Stitchbirds was 3.5 m (SE = 0.29, range = 3-4). The mean height for natural sites was 5.0 m (SE = 0.92, range = 1-10 m, n = 10). These differences in height were tested by the Mann-Whitney U test (Runyon 1977), but there were no significant differences between the average heights (Table 2). No other cavity-nesting bird species were found nesting in the artificial sites, although cave wetas (*Gymnoplectron* sp.) and geckos (*Hoplodactylus pacificus*) used them extensively.

The nests in boxes 7 and 8 failed at an early stage. No activity by adult Stitchbirds was detected at these sites during the breeding season. On examining the boxes during the following autumn, I found three dead nestlings in each box and one well-developed dead nestling in box 9.

The boxes remained in good condition, except for box 15, which was knocked down by a falling branch in the winter of 1985.

TABLE 1 — Nest sites used by Stitchbirds in the Tirikakawa Valley, 1982-1987. 'Site' refers to natural sites.

	Season used				
	1982-1983	1983-1984	1984-1985	1985-1986	1986-1987
Boxes	NA	NA	NA	up	up
1) Experiment					
Area 1 (3 ha)					
Site A	.	x	.	.	.
Site B	.	.	.	x	x
Site C	x	.	.	.	.
Site D	.	x	.	.	.
Boxes 1-6	.	.	.	.	.
Site E	x	x	.	.	.
Box 7	.	.	.	.	x
Site F	.	.	x	.	.
Box 8	.	.	.	x	.
Area II (2.8 ha)					
Box 9	.	.	.	x	.
Boxes 10-12	.	.	.	.	.
Box 13	.	.	.	.	x
Box 14-20	.	.	.	.	.
Total sites used in Areas I and II	2	3	1	3	3
2) Control					
Area III (5.5 ha)					
Site G	.	x	x	.	.
Site H	.	x	x	.	.
Site I	x	.	.	.	.
Site J	.	x	x	.	x
Total sites used in Area III	1	3	3	0	1

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TABLE 2 — Mann-Whitney 'U' test for differences in means among natural nest sites, boxes and boxes used

Comparison	U	U'
Nest sites and boxes	63	127
Nest sites and boxes used	15	25
Boxes and boxes used	29	47

At $p = 0.10$, these values were not significant (Table H, Runyon 1977).

DISCUSSION

Stitchbirds use of nest boxes: This experiment showed that nest boxes have excellent potenial as a management tool for Sticthbirds. The birds used the boxes despite the abundance of natural sites. In a similar study, Eastern Bluebirds *(Sialia sialis)* actually preferred artifical sites over natural sites (Pinkowski) 1979).

The nest boxes also served to provide exclusive sites for Stitchbirds alone. The nest boxes could prevent aggressive introduced cavity nesters such as the Indian Myna *(Acridotherses tristis)* or the European Starling *(Sturnus vulgaris)* from taking over Stitchbird nesting habitat.

The failure of two nests in boxes may have been due to overheating or inadequate ventilation. Consequently, at the end of the 1986-87 breeding season, I drilled holes into the sides of the boxes to increase the circulation of air. The boxes will be monitored over the next few breeding seasons to see whether nest sucess increases.

Sire limitation and breeding density: The number of natural sites that were discovered may partly depend on the amount of effort spent looking for these nests. I made only one week-long visit during the breeding season of 1985-86 and found only one natural site. My failure to notice Stitchbird activity around unsucessful nests in nest boxes indicates that incomplete nesting attempts in natural sites may go completely undetected.

Even so, it would appear that nest boxes did not cause a large increase in the number of Stitchbirds nesting in the experimental area. The appearance of Stitchbird nests in the previously unused Area II indicates that sites were a limited resource in this area.

As breeding density did not increase in Area I, and as the number of nests in Area II was well below the number of boxes available, it would appear that other factors are limiting the numbers of pairs nesting there. Food may be the limiting resource (Rasch 1985b). Northern Hemishere studies on nest boxes have used insectivorous birsd as their experimental subjects (e.g. Enemar & Sjostrand 1972, Slagsvold 1975, Pinkowski 1979, van Balen *et al.* 1982, Brush 1983, Nilsson 1984). Perhaps insects are more consistently abundant the the nectar and fruit which Stitchbirds feed on.

Why the use of natural sites decreased in Area II is unknown. The more diverse tawa forest in Area III would appear to be better habtit than the transitional kanuka/tawa forest of Area II. As the boxes used by Stitchbirds in Area II were not those nearest to Area III, birds were more likely moving from Area I and not from Area III. The use of Area II and the drop in use of Area III may therefore be unrelated events.

Therefore nest sites availability does not always limit the breeding density of Stitchbirds. Brush (1983) reported similar variability in the effects of adding nest boxes in his study of cavity nesters along the Colorado River. He suggested that the dramatic increases of cavity nesters in other studies (e.g. Hogstadt 1975) was a result of using heavily modified forests as study sites.

Polygamy: It is also unlikely that the lack of nest sites was a factor in preventing polygamy in Stitchbirds. From the large number of unmated males present, the sex ratio seemed to be biased towards males. Female aggression towards other female Stitchbirds (Rasch 1985a) may prevent males from taking additional mates (Wittenberger & Tilson 1980). Polygamy may occur only in populations where the sex ratio is heavily biased towards females.

A transfer population of Stitchbirds illustrates this hypothesis in reverse. Only one female and 17 male Stitchbirds were left on Cuvier Island in November 1986 after transfers from Little Barrier in 1982 and 1985. Because of the number of males at the only nest site, it was impossible for the territory owner (banded for recognition) to keep the other males away from his nest and female (pers. obs.). It appeared that other males were attempting to copulate with the female. Multiple fathers of a single clutch are not unknown in normally monogamous passerines (Ford 1983) and may have occurred at this Stitchbird nest.

Although the sample sizes in this experiment were too small to support definte conclusions about theories on cavity-nesting, I did show that Stitchbirds will use artificial nest sites. With an improvement in design, nest boxes could be useful in promoting the induction of Stitchbirds to rehabilitated sites (such as Tiritiri Matangi Island) where the re-established forest is too young to provide natural nest sites.

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SHORT NOTE

Mummified moa remains from Mt Owen, northwest Nelson

Discovery: During the Christmas period 1986-87, members of the New Zealand Speleological Society were in northwest Nelson at Mt Owen, a marble mountain with well-developed karst features and many caves. On 7 January 1987, several cavers were excavating a route through a debris choke to link two caves, when they saw some moa remains. As muscle and skin tissues still adhered to the bones, Paul Wopereis spoke to me by radio.

This discovery was greeted with tremendous excitement at the National Museum of New Zealand because mummified remains of moas are very rare (10 previous records). On 8 January, J. A. Bartle, M. Strange and I went to the expedition's camp at Lake Bulmer on Mt Owen to examine the discovery for the National Museum.

The site: The mummified remains were found in Blowhole Cave where it connects with Whalesmouth Cavern, grid reference S26 c 934 947. The site is 1160 m a.s.l., which is about 100 m below the upper limit of forest and about 716 m below the summit of Mt Owen (1876 m).

The bones and tissues were disarticulated, scattered vertically through 2 m of rockfall debris. The tissue was attached only to those bones which were within the area swept by a strong draught of air between the two caves. Bones not in the draught had no tissue and were damp, and so the tissue had been preserved mainly by the drying effect of this air flow.

Skeletal remains: From characters outlined by Worthy (1988) the remains were identified as one *Megalapteryx didinus* (Owen). As the bones were fairly disassociated, several elements are lost, but those present include: right side of mandible; vertebrae including the atlas, axis, 10 cervical and 2 thoracic vertebrae; 5 thoracic ribs, 5 sternal ribs; left and right (LR) coracoid-scapulae; pelvis; LR tibiotarsi; LR fibulae; LR tarsometatarsi; complete complement of left phalanges, 9 R phalanges. A left femur found 10 m away from the other remains is regarded as belonging to this bird. Many tracheal rings were also present. The remains are now in the National Museum of New Zealand (catalogue number S 23808).

Tissue remains: Best preserved was the tarsometatarus and associated toes of the left foot (Fig. 1, 2). The pads and dorsal scales are present, although the horny claws of the terminal phalanges are missing. Much muscle tissue has been preserved on this tarsometatarus, but a large piece, showing scutes and feather pits, had become separated from the bone at the tibiotarsal