

Breeding biology of little shags (*Phalacrocorax melanoleucos*) at Lindale, Wellington

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Abstract The breeding of little shags at the Lindale Tourist Complex, Wellington, was studied during the 1997/98 and 1998/99 seasons. Breeding at the site first occurred in spring 1993 when a single pair was present. By 1999, the breeding population had increased to about 44 pairs. The breeding season extended over eight months (August to March), with a successful breeding cycle taking about 11 weeks (courtship and nest-building one week, incubation four weeks, chick rearing six weeks). Breeding success was high, with 79% of nesting attempts resulting in young leaving the nest. The productivity of successful nesting attempts differed significantly between the two seasons; 1.5 young per nest in 1997/98 and 2.1 in 1998/99.

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INTRODUCTION

The little shag (*Phalacrocorax melanoleucos*) ranges from New Zealand to Indonesia, New Caledonia, New Guinea, Solomon Islands, Australia and Tasmania (Turbott 1990). The subspecies *brevirostris* is restricted to New Zealand and is relatively common, breeding from North Cape to Stewart Island (Turbott 1990). It inhabits coastal and inland habitats, foraging in coastal waters, estuaries, lakes, ponds, streams and rivers (Matthews 1984; Bull *et al.* 1985), generally in waters less than three metres deep (Stonehouse 1967).

Given that the species is widespread and fairly common in Australasia, it is surprising that much of its breeding biology remains unknown. For example, there is no information about the laying interval between eggs, incubation activities or nestling-rearing activities

(Marchant & Higgins 1990; Johnsgard 1993). In New Zealand, most little shag colonies are at sheltered locations, such as lakes, ponds, swamps and islets (Matthews 1984), and sometimes the species breeds with other *Phalacrocorax* species. Nests are usually in trees over water but occasionally on *Carex* bushes, emergent snags or maimais (waterfowl shooters' hides). From studies at three North Island sites (Sibson & Davenport 1956; Matthews 1984; Taylor 1987), it seems that the species has a fairly regular breeding cycle. Building and refurbishing of nests begins in late July, and eggs are laid from August to February, with a peak in October-November. Although the young of early nesters disperse from colonies in November, the rearing of young extends into April, probably as a result of late nests and some pairs re-nesting after failed first attempts (Taylor 1987).

In this paper we report on the timing of breeding, nesting success and productivity of little shags at Lindale, Wellington. Our aim in studying this colony was to

determine whether the timing of their breeding season was the same as reported for other colonies in New Zealand. Also, we were interested in how the timing of nesting related to the monthly counts of the species in Wellington Harbour (Robertson 1992), where peak numbers are present in autumn and winter, and few remain during spring and summer. As a result of our observations, we were able to quantify shag nesting success and productivity.

STUDY AREA AND METHODS

Lindale Tourist Complex (40°54'S, 175°01'E) is situated about 2 km north of Paraparaumu, beside State Highway 1. Within the grounds of the complex are two ponds, referred to as north and south ponds. Each pond is about 0.5 ha and encompasses an island planted with willows (*Salix* spp.). It was on these willows of both islands that the little shags nested.

The study at Lindale was carried out during the 1997/98 and 1998/99 breeding seasons. Observations began in May 1997 with weekly visits to determine whether birds were occupying nests during the day. Once nesting began in August, visits were made one to five times weekly until nesting finished in March 1998. Monthly visits were made during the non-breeding season of April-June 1998, followed by one to four times weekly during the subsequent breeding season of July 1998 to March 1999. Observations were made using 8 x 30 binoculars and/or 20x telescope from sites about the ponds. The location, predominant activity of the occupants (courtship, nest-building, incubation, nestling rearing), and the number and estimated age of nestlings were recorded during each visit for each nest. We did not approach nests closely to determine clutch size or hatching success as it may have resulted in desertion of some nests.

The computer package, SigmaStat, was used to carry out statistical analyses. Because the productivity data were not normally distributed, the Mann-Whitney Rank Sum test was used to test for differences in productivity between seasons.

RESULTS

Colony expansion

The ponds were created and the willows planted in 1985 with the development of the Lindale complex. Alan Tennyson (pers. comm.) first saw little shags nesting at the site on 7 November 1993, when one occupied nest was evident. On 24 October 1994, he found six occupied

nests, and about six nests on 13 January 1996. Assuming that a pair of little shags is able to rear only one brood each breeding season, we estimated that 20-23 pairs nested at Lindale in 1997/98, and about 44 pairs the following season.

Extent of breeding season

In the 1997/98 season, nest occupancy was first noticed on 21 August (the previous visit having been on 12 August), and by November, 21 occupied nests were evident (Fig. 1). All these nests were at the south pond. Observations later in the season during windy weather that occasionally moved the willow foliage aside revealed that there were at least another three nests. No new nests were built during November, but six were built in December, two of which were in willows of the north pond. The last nestlings left the nest in early March. Thus the breeding season extended over six and a half months, and 27 nesting attempts were monitored.

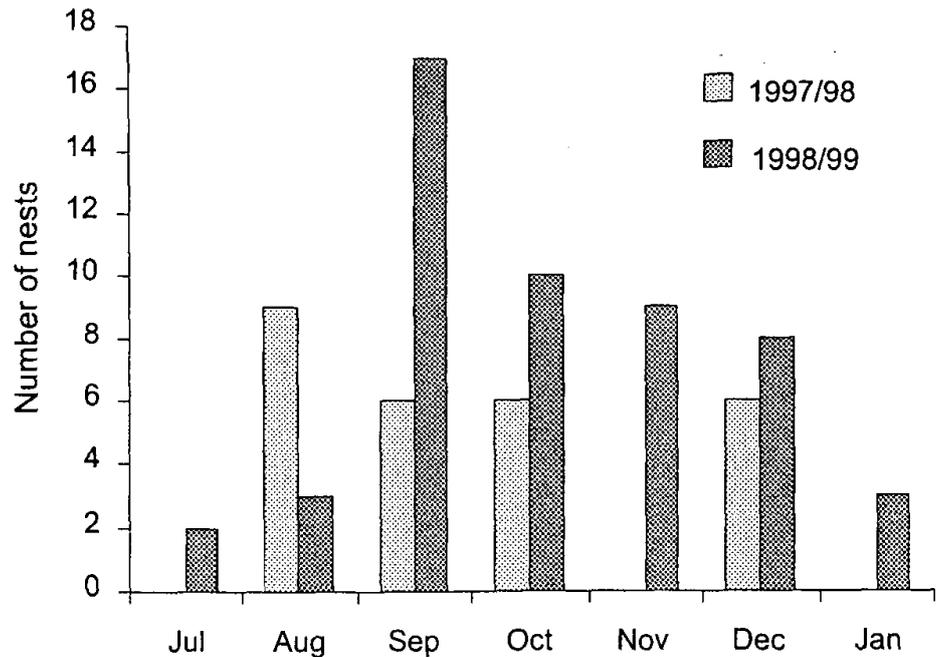
Nest occupancy began at the colony during late July in the 1998/99 season (Fig. 1). Thirteen nests were refurbished or built in the willows of the south pond, all during late July to mid September. In early September, pairs started nest-building in the willows of the north pond, several nests being built each month during October-December, and the last during mid January. In total, 38 nests were built at the north pond, one of which was used twice after a failed nesting. The last nestling left its nest in late March, thus the season extended over eight months, and 52 nesting attempts were monitored.

The durations of 36 successful nesting attempts during the 1998/99 season were determined to the nearest week. Approximately one week was required for courtship and nest-building, four weeks for incubation, and the rest for chick rearing to the stage whereby the chicks left the nest and its immediate vicinity. Most broods were five (28%, $n=36$) or six (53%) weeks of age when they left the nest, but a few were seven (14%) or eight (5%) weeks old. As no nestlings were banded, we were unable to determine when they first flew and when they left the colony.

Breeding success

A nesting attempt was deemed to have been successful if at least one fully feathered nestling was seen on or beside a nest. During the 1997/98 season, 20 (83.3%) of the 24 nesting attempts were successful. This was not significantly different from the 1998/99 result when 40 (76.9%) of the 52 attempts were successful ($\chi^2 = 0.112$,

Fig. 1 Number of nests initiated each month by little shags (*Phalacrocorax melanoleucos*) at Lindale during the 1997/98 and 1998/99 breeding seasons.



$P = 0.738$; with Yates' correction). Overall, 60 (78.9%) of the 76 nesting attempts monitored during the two breeding seasons were successful. Of the 16 nesting attempts that failed, 14 did so during incubation and the others during chick-rearing; the reasons for the failures are unknown. There were three cases of presumed prolonged incubation, one during the 1997/98 season, and two during 1998/99. Normal incubation lasts about four weeks (see above) but these three nests were occupied for 14, 16, and 21 weeks before being abandoned.

Table 1 Percentage of little shag broods of various sizes (sample size in parentheses) at nest leaving and failed nesting attempts at Lindale.

Season failed	Brood size				
	0	1	2	3	4
1997/98	16.7 (4)	50.0 (12)	20.8 (5)	12.5 (3)	-(0)
1998/99	23.1 (12)	21.2 (11)	25.0 (13)	28.8 (15)	1.9 (1)

Productivity

Considering all nests, 1.3 young per nest fledged in 1997/98 ($n = 24$) and 1.6 in 1998/99 ($n = 52$). This difference is not significant (Mann-Whitney Rank Sum test, $P = 0.213$). Of the successful nests, significantly fewer young per nest fledged in 1997/98 ($\bar{x} = 1.5$, $n = 20$) than in 1998/99 ($\bar{x} = 2.1$, $n = 40$) (Mann-Whitney Rank Sum

test, $P = 0.017$). Brood size at nest-leaving varied from one to four nestlings, with one-chick broods being most common in 1997/98, and three-chick broods in the following season (Table 1).

DISCUSSION

Colony expansion

Since little shags began breeding at Lindale in 1993, the colony has expanded rapidly. Initially this expansion was probably entirely as a result of immigration, but whether this was the case over the past two seasons is unknown. Two other colonies of the little shag are known in the Wellington region. On 9 October 1997, the colony located near the head of Pauatahanui Inlet (24.5 km south of Lindale) consisted of 23 occupied nests (RGP pers. obs.), but no further observations have been made. The other colony was at Lake Puketewhaino, near the mouth of the Waikanae River (3 km northwest of Lindale) and it consisted of 2-3 nests on 4 September 1994 (A.J. Tennyson pers. comm.). From observations in November 1992 (9 nests) and January 1993 (6 nests) (AJT pers. comm.), it is possible that some pairs abandoned this colony in favour of breeding at Lindale. However, the few nests seen at the Puketewhaino colony in September 1994 may have been because it was early in the season.

The increase in number of pairs nesting at Lindale during 1993-99 (1-44 pairs) may not match the trend in numbers of individuals using Wellington Harbour during autumn-winter. There was a significant increase in

numbers of little shags about the harbour between the surveys of 1975-77 and 1986-88 (Robertson 1992). However, preliminary results from a repeat harbour survey started in July 1998 suggest that little shag numbers are similar to those of the 1986-88 survey (D. Batcheler pers. comm.). The increase in the little shag population of the Wellington region during the past 25 years may relate to a change in attitude by waterfowl hunters and trout fishers towards shags resulting in fewer shags being shot. It is also possible that improved water quality (less effluent being piped into harbours and estuaries) and fewer large predatory fish (greater fishing pressure by commercial and recreational fishers on fish stocks) may have resulted in greater densities of little shag prey.

Breeding season

The timing (late July or August to March-April) and duration (7-8 months) of the little shag breeding season at Lindale was much the same as that found in earlier studies at Auckland and the Manawatu. At Lake Pupuke, Auckland, little shags nested from late July to March during 1954-56 (Sibson & Davenport 1956). From observations over eight seasons (1977-84) of a Hobson Bay colony, breeding began in late July or August and usually ended in March-April, although in 1981 it continued into May (Taylor 1987). At Hamilton's and Sexton's Lagoons during 1981-83 the species bred from August to April (Matthews 1984). By comparison, little shags can be found breeding throughout the year in Australia; in southern Australia breeding occurs mainly in spring and summer, but in northern Australia it occurs mainly in autumn and winter (Marchant & Higgins 1990).

The nesting of little shags at Lindale (August-March) occurs when few such shags occur in Wellington Harbour (Robertson 1992). Numbers increase about the harbour during March-April, remain at a peak during May-August, and then decline through September-November. Thus, it seems that most little shags vacate the north Wellington colonies once breeding has been completed and, possibly, many disperse south to Wellington Harbour for the non-breeding season. Banding of shags would be required to prove if such movements do occur.

Breeding success

The breeding success of the Lindale shags (83% in 1997/98 and 77% in 1998/99) was greater than that for the species nesting at Hobson Bay, Auckland in 1977/78 (62.5% of 56 nests) and 1978/79 (41% of 78 completed nests) (Taylor 1979, 1987). The overall nesting success

at Lindale (79%, $n = 76$) was significantly greater than that at Hobson Bay (50%, $n = 134$) ($\chi^2 = 15.8$, d.f. = 1, $P < 0.0001$; with Yates' correction). The reasons that nesting attempts at Lindale failed were unknown, but at Hobson Bay nests fell apart during storms and desertions occurred during incubation (Taylor 1987). Of 67 eggs monitored at Sexton's Lagoon, only 34% hatched and survived beyond a week after hatching (Matthews 1984). The high failure rate at this colony resulted from many eggs not hatching (37%) and predation by Australasian harriers (*Circus approximans*) on eggs and chicks where nests were on a maimai. Such exposed nests were uncommon at Lindale, most being situated within the canopy of the willows. Harriers were seen flying about the willows at Lindale, but we did not see any attempted predations.

We assume that a change in diet or prey availability resulted in the difference in productivity of little shags at Lindale between the two breeding seasons, but neither aspect was studied. The productivity of 1.5 young per nest at Lindale for the two seasons combined was similar to the mean of 1.4 young per nest at Hobson Bay during 1977-79 (Taylor 1987).

Prolonged incubation has been noted previously in the little shag. Taylor (1979) described two instances of this phenomenon during the 1977/78 season when nesting continued for 14.3 and 17.6 weeks. The duration of 21 weeks presumed incubation of a clutch at Lindale is five times the usual incubation period of four weeks (Matthews 1984).

While our study has resulted in further knowledge about the breeding of little shags, much basic information remains undetermined. Given the poor tolerance of this species to regular nest inspections, future studies will probably need to involve remote video surveillance techniques to determine such aspects as the laying interval and hatching success.

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