

and the area covered. Morrison's data (Table 2) suggest that there has been a decline at Yates Point. The three later counts taken together neither support nor refute that conclusion.

John O'Groats - Yates Point, 20-21 August. No Tawaki were found from John O'Groats River to 1.5 km south of Yates Point, after which penguins were encountered in scattered small colonies to 200 m along the north side of the point, mostly within 20 m of the beach. To make the counts in Table 1 comparable, 19 nests and 33 birds found on the north side of the point were not included in the total for Heppelthwaite *et al*. Thus their complete total for Yates Point was 174 nests and 300 birds. Some clean eggs were seen, indicating that some birds had laid only recently.

At a creek 800 m north of Yates Point, 1 bird seen, 1 heard. 1.5 km from Yates Point is a small creek: 2 nests, 4 birds in forest behind the kiekie. Overnight camp at Professor Creek.

Professor Creek - Sydney Beach, 22 - 23 August. Beaches consisted of rounded boulders against truncated alluvial fans between steep forested spurs. 1 nest and 1 bird were found near a small creek half way between Professor Creek and Madagascar Beach (which is immediately south of Sydney Beach; Fig. 1). The survey was intensive from Professor Creek to Madagascar Beach.

DISCUSSION

The number of Tawaki nests for the entire region from Milford Sound south is about 850 nests (Studholme *et al*. 1994). This total includes an estimate of 100 nests for Stewart and the Southern Titi Is, and some adjustment for undercounting on Breaksea and the Shelter Is. To that total needs to be added the 871 nests recorded by DoC north of the Hope River, 389 reported here (or 481 if Eason's 1995 count on Yates Point is used), and an estimate of 150 nests on Open Bay Is (McLean & Russ 1991), for a total of 2,260 (2,352).

Numerous reviewers have requested comments on the accuracy and repeatability of the counts reported in the series of articles that constitute the complete survey of Fiordland Crested Penguins (see Literature Cited). Some have also requested validation and/or calibration of our counts. What we can offer is the following.

The counts represent a minimum estimate. Double counting of nests was unlikely as all recording was by one person who confirmed the location of each nest while the group moved steadily through the colony. Our emphasis on minimum disturbance meant that we did not double-count colonies (we walked through the colony once only). However, at some locations the terrain required us to walk back through the colony. It was rare to find previously unrecorded nests when this occurred.

Time, cost and logistic constraints meant that validation of the counting procedure was never a viable option. Rather, we focussed on using a simple procedure that was quickly learned by inexperienced personnel. This procedure should give comparable counts at different times and places as long as the surveying personnel do as we did: have one person assigned to record the count, move slowly as a band just once through the colony, and complete the count in 30-60 mins (for a colony of 10-20 nests spread

along a drainage channel). The discrepancy in counts between Eason and Heppelthwaite *et al.* in 1995 on Yates Point (Table 2) may seem an indication that the counting procedure has low repeatability. Working on his own, Eason spent about the same amount of time conducting the count as the four people making up Heppelthwaite *et al.*, yet he found 58% more nests. The discrepancy can be explained by three factors: 1.) weather: Eason's count was made in ideal conditions after a dry period, and he searched areas on the flax-covered flats that were rejected as "too wet" by Heppelthwaite *et al.*, who made their count in atrocious conditions; 2.) habitat structure. The nests at Yates Point are only loosely organised in colonies in large areas of dense scrub, including kiekie and flax that are virtually impenetrable; 3.) experience. Eason was more experienced at finding Tawaki nests than Heppelthwaite *et al.* were, and any difference in experience is most likely to affect the count in habitats such as at Yates Point.

We have not attempted to validate the counting technique, primarily because of the problem of disturbance. Minimising disturbance was always our highest priority, and validation requires repeated movement through a colony, preferably every time a new party begins work. Without validation, we cannot assess the level of confidence in the counts we provide and no estimate of variance can be attached to our population estimates. Logistically, validation would have been difficult even if the required disturbance was deemed acceptable, because of the number of people involved in the surveys. With respect to this survey, we can provide no solution to the validation issue. Future surveys would best be conducted by one small party that targets the areas we have identified as containing most penguins. Unfortunately, the scale of the enterprise makes such an exercise unlikely.

We only counted nests that were being used, except for a few occasions when a pair of birds were not clearly established at a nest site. Also, the methodology should have eliminated double counting. Thus our counts are much more likely to underestimate than overestimate the true total because some nests were presumably missed (particularly at sites like Yates Point), some small colonies and isolated nests have presumably not been found, and a few areas of coastline have not been visited. We consider it unlikely that >10% of nests are missed at colonies in habitat where counts are straightforward. We also consider it unlikely that we have missed >10% of the breeding locations for the species, or that we have missed any major breeding locations. For sites where counting is difficult (eg. Yates Point, the north side of Long Reef Point, some parts of Breaksea and Taumaka Is, parts of the coast south of Jackson Head) it is impossible to estimate how many nests were missed using currently available information.

As a first attempt at providing a final count of nests for the species, we assume undercounting by 20%, resulting in a final estimate of 2,712 (2,822) nests for the species annually. Realistically, it appears that there are 2,500-3,000 nests annually.

We believe that all the major nesting areas of Tawaki (>100 nests) have now been identified. These are, from south to north: Codfish I., Solander I., Breaksea and adjacent islands, Shelter Is (Doubtful Sound; D. Eason obtained higher counts there than the Southern Heritage/University counts reported in McLean and Russ 1991), Yates Point, Cascade Point and the coast north, Jackson's Head, the Open Bay Is,

and the coast south of the Paringa River. Additionally, there are good numbers of birds, approaching 100 nests, south of Hope River, south of Gorge River, and at Martins Bay. Many smaller isolated colonies have been identified.

Surveys are still required of the coastline between Sandrock Bluff and Gorge River, on Awarua Point (south side, near Crayfish Rock), between Madagascar Beach and Martins Bay, on the south coast of South I. east of Puysegur Point, and the west coast of Stewart I. including the Titi Is. In October, 1995, during a sampling trip throughout Fiordland to collect blood for a species-wide genetic survey, we located two previously unknown small colonies in Doubtful Sound and sign of two old colonies (now vacant) in Dusky Sound. Clearly, there will be other small colonies that we have not located in the southern fiords, but these are unlikely to yield large numbers of nests.

Although mainland Tawaki colonies tend to occur on points, there are some curious gaps in distribution along the mainland coastline. For example, few or no colonies were found between Gorge River and Awarua Point (where a colony remains to be confirmed), and the surveyed section between Martins Bay and Yates Point. Many drainage channels through forest occur in these areas suggesting that Tawaki are not limited by nesting habitat. More likely is that they are limited by unknown factors offshore, possibly compounded by problems onshore, such as predators. Whether Tawaki are subject to significant mortality from introduced predators is not known, although we have received anecdotal reports of adults and chicks being attacked by mustelids.

Many Tawaki are protected by virtue of their isolated and inaccessible nesting locations. However, with respect to management, the biggest area of concern is the coast north of Cascade Point where large concentrations of nests occur in areas accessible to people and dogs (people who take dogs to beaches usually have no interest in seeing penguins).

Increasing interest from tourists to see penguins is resulting in disturbance at a few accessible colonies, although it is not yet known if that disturbance will have any long-term impact. If the colonies fail, then the tourists will presumably go elsewhere. Thus, it would be better to manage frequently-visited colonies to balance the needs of penguins and tourists, than to have the colonies fail because disturbance levels are too high. Unfortunately, not enough information is available on tolerance of humans by Tawaki for informed management decisions to be made. DoC has begun a long-term monitoring programme designed to assess general population trends for Tawaki, information from the genetic survey will be available soon, and the species-wide survey provides a baseline for future analyses of abundance and distribution. However, the most immediate need is to ensure that the somewhat conflicting needs of tourism and protection are rationalised.

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The breeding population of Spotted Shags (*Stictocarbo punctatus punctatus*) on Banks Peninsula: 36 years later

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ABSTRACT

In 1960, a census of the Spotted Shag (*Stictocarbo punctatus punctatus*) population on Banks Peninsula found 9,787 breeding pairs (Turbott & Bell 1995). Here we report the results of a comparative census conducted on Banks Peninsula during the 1996 breeding season. Thirty-six years after the original census, the number of breeding pairs was found to have more than doubled to 22,123 pairs. We speculate that the population was formerly limited by food availability and that a reduction in fishing effort around Banks Peninsula, especially in the late 1980s, may have contributed to the observed growth in the shag breeding population.

KEYWORDS: population census, Spotted Shag, *Stictocarbo punctatus punctatus*, Banks Peninsula, New Zealand.

INTRODUCTION

The Spotted Shag (*Stictocarbo punctatus punctatus*) is endemic to New Zealand breeding along the coasts mainly of the South Island (Bull *et al.* 1985, Marchant & Higgins 1990). The total population has been estimated to be between 60,000 and 150,000 breeding pairs (Marchant & Higgins 1990). However, a count of occupied nests on Banks Peninsula by Turbott & Bell (1995) in 1960 seems to be the only systematic count of breeding Spotted Shags anywhere to date. Therefore, a repetition of this census after 36 years might give some indication of the general status of this New Zealand species.

Around Banks Peninsula (center at 43° 45'S, 173° E), Spotted Shags nest colonially on the cliffs from Sumner Head south to Birdlings Flat. Egg laying at Whitewash Head, Banks Peninsula began in mid-September and continued over a period of three to four weeks, followed by a month-long incubation period (Fenwick & Browne 1975). Spotted Shags off Kaikoura are reported to feed in deep water, usually within 10 nautical miles (approx. 18.5 km) of land (Stonehouse 1967). Around Banks Peninsula they are often seen foraging close to shore (pers. obs.).

METHODS

Survey techniques and timing were modelled after those used by Turbott & Bell (1995) in 1960. This is crucial to guarantee comparability between the two surveys (Harris & Forbes 1987). The timing of the census in late October to early November was intended to coincide with the incubation stage of the breeding cycle so that a tally of occupied nests should lead to a reasonable estimate of the size of the breeding population.