

## SHORT NOTE

# A survey of four shag species in the outer Queen Charlotte Sound, New Zealand

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There is increasing evidence that population dynamics of cormorants and shags have been subjected to the compounding effects of anthropogenic and natural pressures (Dias *et al.* 2012; Hamann *et al.* 2012; Crawford *et al.* 2014). Consequently, accurate knowledge of the distribution and abundance of these species can provide insight into ecosystem status (Bustnes *et al.* 2013; Fortin *et al.* 2013; Ridgway & Middel 2015), as well as important information for conservation management and threat mitigation (Lewison *et al.* 2012). Here, we report population and distribution data on four shag species within the outer Queen Charlotte Sound of New Zealand and evaluate changes in their distribution and abundance as a precursor to informing management of these species, and the Queen Charlotte Sound in general.

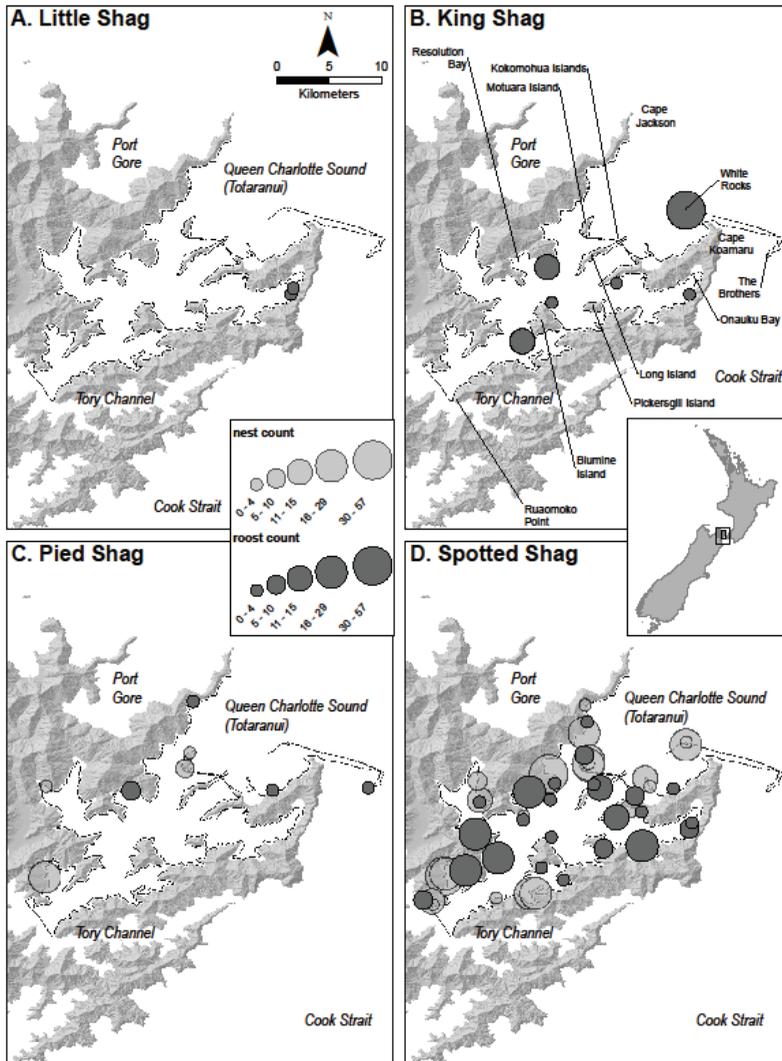
Nine of New Zealand's shag species are naturally uncommon, having restricted or disjunct distributions and/or small populations (Robertson *et al.* 2017), making them particularly susceptible to a range of threats including coastal development (e.g. Bell 2012; Urlich 2015), both commercial and recreational fisheries interactions (e.g. Abraham *et al.* 2010), predation by introduced pests, and changes in foraging and breeding success due to

climate change and/or anthropogenic disasters such as oil spills (Bell 2012; Battershill *et al.* 2013). Four species of shag breed in the Queen Charlotte Sound (Bell 2012; Robertson *et al.* 2017); the endemic king shag (*Leucocarbo carunculatus*) that is listed by New Zealand's Threat Classification Series as "Nationally Endangered" with a stable national population of 250–1,000 mature individuals; the smaller endemic spotted shag (*Strictocarbo punctatus*) that is listed as "Not Threatened" with an estimated stable population of >20,000 individuals; the pied shag (*Phalacrocorax varius varius*) that is listed as "Recovering" with an increasing population estimated at 6,400 breeding pairs (Bell 2013); and the little shag (*Phalacrocorax melanoleucos brevirostris*) that is classified as not threatened with a large, widespread and increasing population throughout New Zealand (Miskelly *et al.* 2008; Robertson *et al.* 2017).

On the 13<sup>th</sup> and 17<sup>th</sup> of November 2014, morning surveys from 0800 h – 1300 h quantified the size and location of shag colonies along the entire c. 320 km length of coastline of the outer Queen Charlotte Sound, from Cape Jackson to Ruaomoko Point to Cape Koamaru, including Blumine, Pickersgill, Long, Kokomohua, Motuara, and the Brothers Islands, as well as White Rock (see GPS tracks on Fig. 1). Observations were made from a 7 m aluminium boat, which was large enough to provide

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**Figure 1.** Number and size of nesting colonies and roosting sites of (A) little shag, (B) king shag, (C) pied shag and, (D) spotted shag in the outer Queen Charlotte Sound (Tataranui) in November 2014. Nesting colonies are those containing active nests with sitting birds or visible chicks and adults, and roosting sites are those not containing active nests. The dashed black line is the survey track.

a good observation platform for the sea conditions, but small enough to manoeuvre around the coast and offshore islands. The two survey days were clear with light sea chop and no swell. The land and islands were circumnavigated at about 5–10 knots and a distance of 10–50 m from the shore. The boat was stopped offshore of colonies to record location, identify individuals to species level, to distinguish between nesting colonies (those containing “active nests” defined as visible nest structures with sitting birds or visible chicks and adults) and roosting sites

(those not containing active nests), and to undertake counts. Colonies were identified as distinct if a distance of at least 100 m separated active nests. Shags were independently identified and counted by three people using binoculars. Where counts differed, they were averaged (the low numbers of shags at most sites meant that only the very largest colony was averaged with variation between observers being less than 5%). Survey track, locations, and size of each species nesting colonies or roosting sites are shown in

Figure 1. For spotted shags, across the entire survey, 151 active nests, and an additional 11 juveniles and 372 adults (not on nests) were sighted with 37 of these adults sighted on mussel farm areas (Fig. 1d). Average nesting colony size was 6.3 nests per colony (range 1–40). Seventy one percent of colonies had fewer than 10 active nests, and eight colonies were a single active nest.

For pied shags, 23 active nests, 17 adults (not on nests) and three juveniles were counted across the entire survey (Fig. 1c). For king shags, 82 adults and six juveniles were counted across six roosting sites, with the size of roosts ranging from 1–56 individuals (Fig. 1b). Three juvenile king shags were recorded roosting on mussel farm buoys. Five little shag adults were counted across a roosting site within a mussel farm area (Fig. 1a).

November is considered a good time for shag surveys as mid-November is a prime nesting time for pied and spotted shags, although it is outside the breeding period for king shags (Marchant & Higgins 1990; Schuckard 1994; Powlesland *et al.* 2008). The only other comparable survey undertaken in this area occurred at a similar time of year in 2006 (Bell 2012). Bell surveyed for all shag species in the area, except king shags, recording only pied, spotted, and little shags, as found here.

The spotted shag colony locations, bird numbers and average colony sizes we found in this survey were similar to those found by Bell in 2006 with breeding colonies of spotted shag associated with cliff habitat (Bell 2012).

We found four colonies of pied shags compared to Bell's six, all similar in number of birds. Pied shags have two peaks of breeding, during spring and autumn (Marchant & Higgins 1990), therefore counts in both surveys only indicate the size of the spring breeding population in this area, so a census of the entire breeding population would need additional counts in autumn. Nationally, pied shag colonies are thought to be increasing (Powlesland *et al.* 2008; Bell 2013; Robertson *et al.* 2017), although we found no evidence of this when comparing our results with those of Bell (2012). In addition to high numbers of nesting birds, our survey also found high numbers of roosting pied and spotted shags indicating the area is used extensively for roosting by these species.

Noting that our survey and the surveys by Bell (2012) were undertaken in the same season, we did not see any little shag nesting colonies. Our survey found only roosting little shags (on mussel farm buoys) and no nests, whereas Bell (2012) found two small nesting colonies. Future surveys may be able to determine if this reduction in the number of colonies indicates either declining numbers or shifting populations of little shags in the outer Queen Charlotte sounds.

Due to their low numbers, highly restricted distribution and Nationally Endangered threat status, there have been more comprehensive surveys of king shags in the Marlborough Sounds than any of the other species (Bell 2010; Schuckard *et al.* 2015, 2018). Our survey was outside of the breeding season for king shag and we found no active nests in the area surveyed. However, we did find three roosting sites with 13–56 adults (Fig. 1b.), as well as juveniles in the mussel farm area of Onauku Bay. One of the roosting sites identified in our study was in a location where king shags have not been recorded roosting; the northern headland of Resolution Bay, and one roosting site that has only been recognised as king shag site recently, the northern end of Blumine Island (Schuckard *et al.* 2018). It should be noted that time of day surveys are undertaken has a significant impact on numbers at roosts and this may be the reasons for differing locations and numbers between this survey and others.

This survey was not designed to estimate population size of any of the species surveyed, rather it was designed to compare distribution and observed numbers with other surveys such as Bell (2010, 2012). When compared to previous studies, there was no indication that number or distribution of any of the species surveyed is changing, with the exception of little shags, which appeared to show the loss or relocation outside the survey area of two small nesting colonies.

In the Marlborough Sounds, there are two compelling reasons to undertake surveys of shag species at regular intervals. The first is to monitor impacts and population trends of the Nationally Endangered king shag species particularly with changing pressures from mussel farming, other forms of aquaculture, recreational fishing, and coastal development, including changing land use such as forestry causing increased sediment runoff (Schuckard *et al.* 2015; Urlich 2015). The second is that elsewhere in New Zealand, increasing numbers of other shag species have led to increasing human-wildlife conflict with complaints about noise and nesting birds killing trees. Comparative surveys could help to quantify population trends and determine changes that may be occurring, and inform discussions on both of these issues. Colonial seabirds, such as shags, that occur in relatively clumped locations can be used as indicators for thresholds of impacts from human and naturally occurring changes in the coastal and marine environment. Use of New Zealand's coastal areas, including the Marlborough Sounds, is increasing, and this study and ongoing comparisons will assist with informing and guiding management, particularly for documents such as regional plans and species threat assessments.

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