



## Population assessment during the non-breeding season of King Shag in the Marlborough Sounds, February 2020.



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April 2020

## **Citation:**

This report should be cited as:

Bell, M.; Frost, P.G.; Melville, D.S. 2020. Population assessment during the non-breeding season of King Shag in the Marlborough Sounds, February 2020. Unpublished Technical Report to New Zealand King Salmon.

Cover image: Imagery from a section of the Duffers Reef colony from the sea, February 2020, © Dan Burgin

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## 1. INTRODUCTION

In April 2014, New Zealand King Salmon was granted resource consent to establish new salmon farms in the Waitata Reach and Richmond Bay. One condition of this consent required the company to develop and implement a King Shag Management Plan to ensure that the establishment and operation of the new salmon farms do not result in a reduction in the King Shag population in the Marlborough Sounds, especially at Duffers Reef (Schuckard 2015). As recommended by Schuckard (2015), the management plan was reviewed after 3 years and a new one adopted in 2019 (Bell 2019a).

One provision of the first King Shag Management Plan required the population to be censused by aerial survey at least once every three years (Schuckard 2015). If either the overall population, or the Duffers Reef roost site, are found to have declined by >3% per annum over this interval, then aerial surveys must be undertaken annually.

A base-line aerial survey carried out in February 2015 recorded 834 King Shag at nine sites throughout the Marlborough Sounds (Schuckard 2018). The survey was repeated in February 2018, when 633 King Shag were counted at ten sites (Schuckard 2018). As this represented an 8.7% per annum reduction in numbers between the two surveys, New Zealand King Salmon initiated annual surveys as required by the management plan. A survey in January 2019 found 789 birds (Bell et al. 2019). Despite the increase, this number still represented a 1.5% per annum reduction since early 2015 (Bell et al. 2019).

Given the fluctuations in King Shag numbers recorded during these non-breeding season aerial surveys, and further to support research by the Marine Farming Association-led King Shag Working Group, New Zealand King Salmon adopted annual aerial surveys as a routine in their revised King Shag Management Plan (Bell 2019a). This report presents the results of the latest aerial survey of the non-breeding season population of King Shag conducted in February 2020.

## 2. METHODS

This aerial survey aimed to census the entire King Shag population during the non-breeding season, a time when King Shag roost both at breeding colonies and at other sites within the Marlborough Sounds. For consistency throughout this report we refer to all these sites as King Shag roosts.

The methods followed those of previous surveys, but with modifications to aerial survey height and turning distance, as recommended after the 2018 survey, and with the survey being done on an overcast day, as recommended following the 2019 survey (Bell et al 2019). The same operator used for the 2019 survey, Canterbury Aviation, flew the 2020 survey. Canterbury Aviation has extensive aerial survey experience, having previously been involved in breeding season censuses of King Shag, and so is familiar with the area and requirements for surveying King Shags.

In consultation with New Zealand King Salmon, the King Shag Working Group and Canterbury Aviation developed a protocol prior to undertaking the aerial survey. This identified 16 known King Shag roost sites for which aerial photographs were required, an increase in the number of known roost sites following the establishment of a new roost site at Bottle Rock Point, found during a boat survey carried out in June 2019 (Bell 2019b). Photographs had to be taken between 0630 and 0830 hours, on an overcast morning, with an aircraft height of 700 feet (213m) above sea-level and speed less than 90 knots (166km/h). Because up to three passes of each roost site might be needed to fully cover the site, the aircraft had to turn to line up the next run no closer than 0.4 NM (740m) from the roost to prevent disturbance.

The aerial survey was flown in a Cessna 180. High-definition geo-referenced aerial photographs were taken with a Canon 5DS r camera and a Tamron SP 85mm F/1.8 Di VC USD F016 lens located on a stabilised mount on the underbody of the aircraft. The embedded Exif data showed the time the image

was taken which was linked to a GPS track of the flight. This provided aerial imagery of similar resolution to previous surveys.

Three independent assessors counted the number of shags present at each roost site from the set of images taken of each site. The mean, standard deviation and coefficient of variation of these counts for each roost site was calculated and the sum of these means across all roost sites used to estimate the total population of King Shag in the Marlborough Sounds.

### 3. RESULTS

#### Aerial survey

The aerial survey of all known active, or recently active King Shag breeding or roost sites was carried out on 21 February 2020. The first images were captured at Rahuinui at 0752 h and the last images at White Rocks at 0924 h, a survey period of 93 minutes (Table 1). The weather was calm and overcast cloud, with most images captured in cloud.

*Table 1. Time of aerial photography at each King Shag roost site photographed during the King Shag survey 21 February 2020.*

Roost site	Area	Time
Rahuinui	Tasman Bay	0752
Squadron Rocks	Tasman Bay	0800
Kuru Pongi/North Trios	Admiralty Bay	0807
Kuru Pongi/ South Trios	Admiralty Bay	0810
Tekuru Kuru/Stewart Island	Admiralty Bay	0815
Tawhitinui	Pelorus	0824
Duffers Reef	Pelorus	0832
Te Kaiangapipi	Pelorus	0835
Moturaka/The Haystack	Pelorus	0842
Sentinel Rock	Pelorus	0845
Hunia	Port Gore	0853
Oruawairua/Blumine	Queen Charlotte	0901
Bottle Rock Point	Queen Charlotte	0906
The Twins	Queen Charlotte	0910
Ruakaka	Queen Charlotte	0914
White Rocks	Queen Charlotte	0924

Image quality was generally high, helped by photographing in overcast conditions, which minimised the risk of overexposure.

## Population count

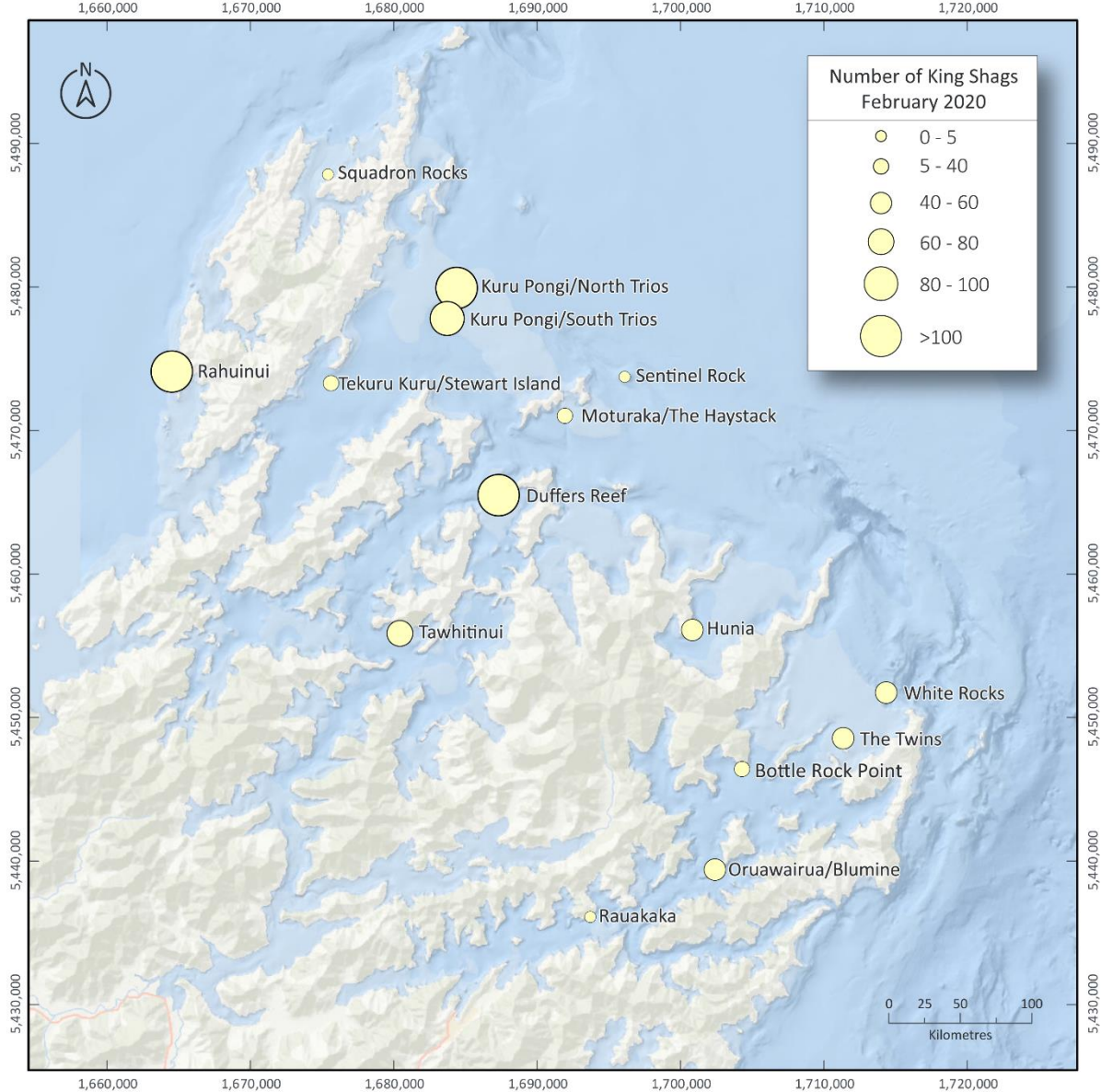
Overall, 815 King Shag were recorded at 13 sites throughout the Marlborough Sounds. This is the sum of the mean count for each roost as determined by the three independent assessors (Table 2, Figure 1). At two sites, Kuru Pongi/South Trios and Rahuinui, King Shag were roosting in two separate groups at. These have been lumped together at each site to make the numbers comparable with previous surveys. The 95% confidence interval for this estimate is 1.96, meaning that there is a 95% probability that the actual population count lies between 812 and 816 birds. The coefficient of variation (CV) of counts within each roost site, a measure of the variability in individual assessments, was low: 0.7 – 13.3%. The greatest variability occurred at Tekuru Kuru/Stewart Island where a low number of birds at the site and a difference in interpretation of two peripheral objects by one of the assessors produced a higher CV at this site.

*Table 2. Aerial survey counts at all roost sites, 21 February 2020, made by three independent assessors.*

Roost	Area	A1	A2	A3	Mean	SD	CV
Tekuru Kuru/Stewart Island	Admiralty Bay	8	10	8	9	1.15	13.3
Kuru Pongi/North Trios	Admiralty Bay	119	119	119	119	0.00	0.0
Kuru Pongi/South Trios	Admiralty Bay	85	86	85	85	0.58	0.7
Duffers Reef	Pelorus	207	207	207	207	0.00	0.0
Moturaka/The Haystack	Pelorus	16	16	16	16	0.00	0.0
Sentinel Rock	Pelorus	0	0	0	0	0.00	
Tawhitinui	Pelorus	78	77	78	78	0.58	0.7
Hunia	Port Gore	44	44	44	44	0.00	0.0
Oruawairua/Blumine	Queen Charlotte	55	55	55	55	0.00	0.0
Rauakaka	Queen Charlotte	2	2	2	2	0.00	0.0
The Twins	Queen Charlotte	42	42	44	43	1.15	2.7
White Rocks	Queen Charlotte	46	45	46	46	0.58	1.3
Bottle Rock Point	Queen Charlotte	8	8	8	8	0.00	0.0
Rahuinui	Tasman Bay	105	104	100	103	2.65	2.6
Squadron Rocks	Tasman Bay	0	0	0	0	0.00	
<b>Total</b>		<b>815</b>	<b>815</b>	<b>812</b>	<b>815</b>	<b>1.73</b>	<b>0.2</b>



Figure 1. Location and size of King Shag roosts recorded during an aerial survey on 21 February 2020.



## Population numbers

The number of King Shags recorded is higher than that counted in 2019 but still lower than that observed in 2015 (Table 3), continuing to highlight the marked annual fluctuations in this species.

Table 3. King Shag roost site counts 2015-2020.

Roost site	Area	2015	2018	2019	2020
Tekuru Kuru/Stewart Island	Admiralty Bay	26	16	0	9
Kuru Pongi/North Trios	Admiralty Bay	173	129	76	119
Kuru Pongi/South Trios	Admiralty Bay	NF	NF	96	85
Duffers Reef	Pelorus	297	212	214	207
Moturaka/The Haystack	Pelorus	NF	NF	47	16
Sentinel Rock	Pelorus	64	0	0	0
Tawhitinui	Pelorus	43	65	79	78
Hunia	Port Gore	53	31	45	44
Oruawairua/Blumine	Queen Charlotte	NF	4	37	55
Rauakaka	Queen Charlotte	NF	5	0	2
The Twins	Queen Charlotte	0	51	54	43
White Rocks	Queen Charlotte	103	69	69	46
Bottle Rock Point	Queen Charlotte	NF	NF	NF	8
Rahuinui	Tasman Bay	75	51	70	103
Squadron Rocks	Tasman Bay	0	0	2	0
<b>Total</b>		<b>834</b>	<b>633</b>	<b>789</b>	<b>815</b>

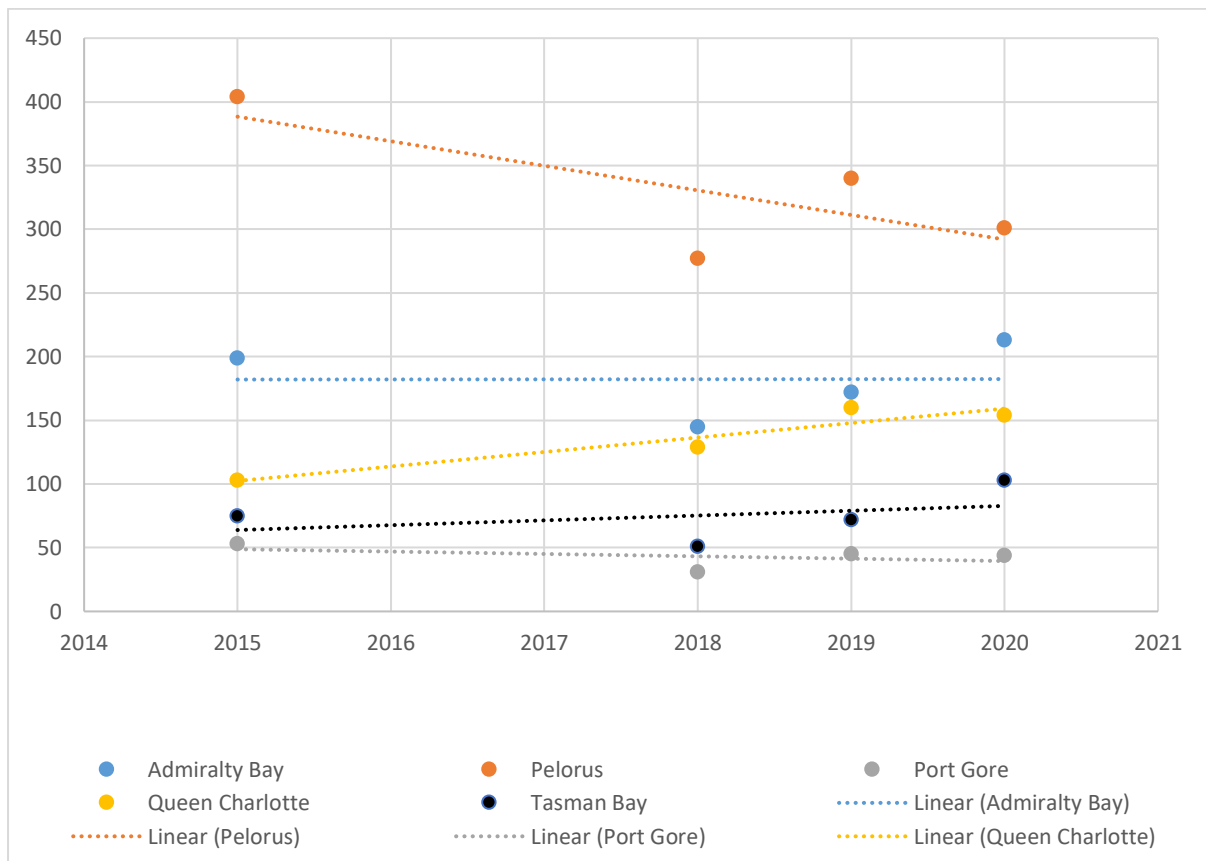
Note: NF = roost site not flown during that year's survey; 0 = roost site was flown in aerial survey and no birds were recorded at the site. Count data from 2015 and 2018 from Schuckard (2018), including corrections to data reported in Schuckard (2015). We exclude the 9 birds reported in Schuckard (2018) reported in June four months after the aerial survey.

The King Shag populations in each area also vary through time (Table 4 and Figure 2). Numbers in Pelorus Sound appear to be declining, primarily because the Sentinel Rock site has been abandoned and only 16 birds were recorded on Moturaka/The Haystack this year, compared with 47 in 2019 (Table 3). The populations in Admiralty Bay, Tasman Bay and Port Gore appear to be relatively stable, whereas in Queen Charlotte Sound the population appears to be increasing slightly.

Table 4. Numbers of King Shag recorded in each area of the Marlborough Sounds.

Area	2015	2018	2019	2020
Admiralty Bay	199	145	172	213
Pelorus	404	277	340	301
Port Gore	53	31	45	44
Queen Charlotte	103	129	160	154
Tasman Bay	75	51	72	103
<b>Total</b>	<b>834</b>	<b>633</b>	<b>789</b>	<b>815</b>

Figure 2. Numbers of King Shag recorded in each area of the Marlborough Sounds





## 4. DISCUSSION

These results highlight again the appropriateness of aerial survey as a tool for monitoring the King Shag population, and it remains a cost-effective way of censusing this species. Undertaking the survey in overcast conditions improved image quality and reduced variation in interpretation among the assessors. It is recommended for all future aerial surveys.

The 2020 survey recorded the highest number of King Shag since the 2015 baseline survey, with numbers only 2% lower. As stated in last year's report (Bell et al. 2019), these fluctuations in numbers are hard to interpret at present. They could be due to several factors, including annual variations in breeding success or missing some roost sites during surveys (this was a particular feature of the first two surveys). A count in January/February will include adults of breeding age, young birds that fledged the previous year in August–November, and sexually immature birds which are too young to have started to breed (1-2 year old birds).

Changes in King Shag numbers between different areas of the Marlborough Sounds suggest there is movement between areas and emphasises the importance of surveying all colonies in a single morning.

In spite of this inter-annual variation, annual surveys are essential to track year-to-year changes in King Shag numbers and determine the long-term population trend. Although King Salmon is not obliged to we recommend continuing these annual surveys for at least the next five years, not only to identify long-term trends, if possible, but also to improve our understanding of the inter-annual variability in King Shag numbers and what factors might correlate with these. This will allow further investigation into what might be driving any population changes.

### Recommendations

- That New Zealand King Salmon continue to support annual aerial surveys in mid-January to mid-February to determine the population trend and better account for the effects of inter-annual variation.
- That the current aerial survey protocol be continued for future aerial surveys of King Shag.
- Future aerial surveys should continue to include all known and historical King Shag colonies and roost sites to ensure complete coverage.

## 5. ACKNOWLEDGMENTS

This contract was managed by Mark Gillard and we thank him for his patience and effective management of this contract.

## 6. References

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