



# Population assessment during the non-breeding season of King Shag in the Marlborough Sounds; January 2019.



## Population assessment during the non-breeding season of King Shag in the Marlborough Sounds; January 2019.

Mike Bell<sup>1</sup>, Peter Frost<sup>2</sup>, Graeme Taylor<sup>3</sup> and David Melville<sup>4</sup>.

<sup>1</sup>Wildlife Management International Ltd  
PO Box 607  
Blenheim 7240  
New Zealand  
[www.wmil.co.nz](http://www.wmil.co.nz)

<sup>2</sup>Science Support Service  
87 Ikitara Road,  
Whanganui 4500

<sup>3</sup>Department of Conservation  
PO Box 10 420  
Wellington

<sup>4</sup>1261 Dovedale Road  
RD2  
Wakefield  
Nelson 7096

June 2019

### **Citation:**

This report should be cited as:

Bell, M.D.; Frost, P.G.; Taylor, G.A.; Melville, D.M. 2019. Population assessment during the non-breeding season of King Shag in the Marlborough Sounds; January 2019. Unpublished Technical Report to New Zealand King Salmon.

Cover image: Aerial imagery from Duffers Reef roost site, 26 January 2019.

All photographs in this Report are copyright © WMIL unless otherwise credited, in which case the person or organization credited is the copyright holder.

## 1. INTRODUCTION

In April 2014, New Zealand King Salmon were granted resource consent to establish new salmon farms in Waitata Reach and Richmond Bay. One resource consent condition requires New Zealand King Salmon to develop and implement a King Shag Management Plan. The objective of the King Shag Management Plan “shall be to ensure that the establishment and operation of the new salmon farms do not result in a reduction in the population of King Shag in the Marlborough Sounds. This with particular regard to the Duffers Reef roost site” (Schuckard 2015).

A resource condition, adopted by the King Shag Management Plan (Schuckard 2015) requires the population to be censused at least once every three years by aerial survey. If the overall population, or the Duffers Reef roost site is 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). In February 2018 the aerial survey was repeated, with 634 King Shag recorded 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 their consent condition. This report presents the results of an aerial survey in January 2019 to assess King Shag numbers.

## 2. METHODS

This aerial survey is undertaken during the non-breeding season to census the entire King Shag population. During the non-breeding season, King Shag roost at both breeding colonies, and other sites within the Marlborough Sounds. For consistency in this report, we refer to all sites as King Shag roost sites.

Methods followed those of the 2015 and 2018 surveys, incorporating modifications to aerial survey height and turning distance recommended after the 2018 survey. For 2019 a new operator, Canterbury Aviation, flew the 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, a protocol was developed prior to the aerial survey being undertaken. This protocol identified 14 known King Shag breeding and/or roost sites for which aerial photographs were required. The imagery needed to be collected between 06:30h and 08:30h, 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 each site, the aircraft had to turn to line up the next run no closer to the roost site than 0.4 NM (740m) to prevent disturbance.

The aerial survey was carried out in a Cessna 180. High-definition geo-referenced aerial photographs were taken with a Canon 5DS r camera and an 85mm lens located on a stabilised mount on the underbody of the aircraft. Each photo had embedded Exif data showing the GPS position and time the photo was taken. This provided aerial imagery of similar resolution to the 2015 and 2018 surveys.

To determine the number of birds leaving the roost sites prior to the aerial survey, boats were stationed off three roost sites (White Rocks, Duffers Reef and Tawhitinui) from 06:00h until 09:00h on the day of the survey to record departing birds.

Four 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 26 January 2019. The first images were captured at Ruakaka at 06:31h and the last images at Tawhitinui at 08:18h, a survey period of 107 minutes (Table 1). The weather was calm with patchy cloud, with most images captured in full sunlight.

Unfortunately due to a communication breakdown with the pilot, no GPS track of the flight was recorded, nor was the height at which each set of photos were taken. The pilot believes that he followed the agreed protocol with each pass over the roost site being at 700 feet, with a ground speed of less than 90 knots, although this cannot be verified.

*Table 1. Time of aerial photography at each King Shag roost site captured during the King Shag survey 26 January 2019.*

Roost site	Area	Time
Ruakaka	Queen Charlotte	06:31
Oruawairua/Blumine	Queen Charlotte	06:37
The Twins	Queen Charlotte	06:47
White Rocks	Queen Charlotte	06:53
Hunia	Port Gore	07:04
Sentinel Rock	Pelorus	07:12
Moturaka/The Haystack	Pelorus	07:17
Duffers Reef	Pelorus	07:30
Tekuru Kuru/Stewart Island	Admiralty Bay	07:41
Kuru Pongi/ South Trios	Admiralty Bay	07:45
Kuru Pongi/North Trios	Admiralty Bay	07:49
Squadron Rocks	Tasman Bay	07:59
Rahuinui	Tasman Bay	08:09
Tawhitinui	Pelorus	08:18

Although the quality of most images was good, that at three roost sites was of lower quality. Images at Hunia were greatly overexposed, while at both the Moturaka/The Haystack and Rahuinui roost sites, which are situated on steep slopes, the high contrast between areas in full sunlight and those in shadow made counting difficult. Despite this, the quality of imagery from these three roost sites was still suitable enough for counts to be made at each site, albeit with greater uncertainty.

#### Population count

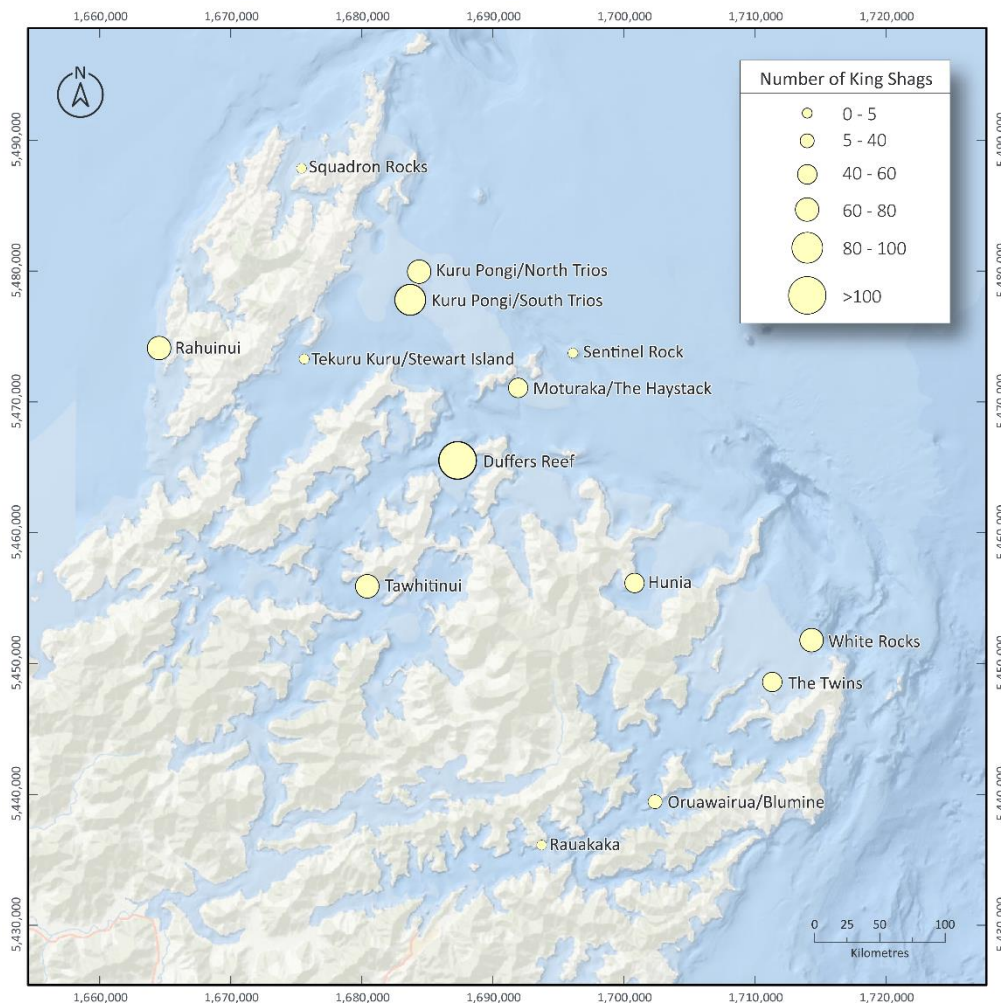
An overall population of 789 King Shag was recorded at 11 sites throughout the Marlborough Sounds from the mean total number of birds counted by the four independent assessors (Table 2, Figure 1). The 95% confidence interval for this estimate is 1.9, meaning that there is a 95% probability that the actual population count lies between 787 and 791 birds. The coefficient of variation of counts within each roost site, a measure of the variability in individual assessments, was low: 1.1–6.0%. The greatest

variability occurred at those roost sites with the poorest image quality (Moturaka/The Hay Stack, Hunia and Rahuinui).

Table 2. Aerial survey counts at all roost sites, 26 January 2019, made by four independent assessors.

Roost site	Area	A1	A2	A3	A4	Mean	SD	CV
Tekuru Kuru/ Stewart Island	Admiralty Bay	0	0	0	0	0	0.00	
Kuru Pongi/ North Trios	Admiralty Bay	76	76	76	77	76	0.50	0.7
Kuru Pongi/ South Trios	Admiralty Bay	96	96	98	95	96	1.26	1.3
Duffers Reef	Pelorus	215	214	214	214	214	0.50	0.2
Moturaka/ The Haystack	Pelorus	48	47	50	44	47	2.50	5.3
Sentinel Rock	Pelorus	0	0	0	0	0	0.00	
Tawhitinui	Pelorus	79	78	78	80	79	0.96	1.2
Hunia	Port Gore	44	47	41	46	45	2.65	6.0
Oruawairua/ Blumine	Queen Charlotte	37	37	37	36	37	0.50	1.4
Rauakaka	Queen Charlotte	0	0	0	0	0	0.00	
The Twins	Queen Charlotte	53	53	54	54	54	0.58	1.1
White Rocks	Queen Charlotte	68	68	69	71	69	1.41	2.1
Rahuinui	Tasman Bay	71	73	68	68	70	2.45	3.5
Squadron Rocks	Tasman Bay	2	2	2	2	2	0.00	0.0
<b>Total</b>		<b>789</b>	<b>791</b>	<b>787</b>	<b>787</b>	<b>789</b>	<b>1.91</b>	<b>0.2</b>

Figure 1. Location and size of King Shag roosts recorded during an aerial survey on 26 January 2019.



## Birds departing from roost sites to aerial survey

Boats were stationed 100-200m offshore from three roost sites from 06:00h to determine if any shags departed the roost site prior to the aerial survey. At Tawhitinui 1 bird departed at 06:50h before the plane passed over; at White Rocks 1 bird departed at 06:20h prior to the overflight; and at Duffers Reef 2 birds departed 06:17h and a further bird left at 06:41h before the plane had completed its passes. This represents an average of 1.4% of birds departing prior to the survey (Table 3).

*Table 3. Number of birds departing roost sites prior to aerial survey.*

Roost site	Count	Departed prior	%
Tawhitinui	79	1	1.3
White Rocks	69	1	1.4
Duffers Reef	214	3	1.4

## Population numbers

The number of King Shags recorded is 25% higher than that recorded in 2018, but is still 6% lower than that recorded in 2015 (Table 4), indicating substantial annual fluctuation, for whatever reason.

Sentinel Rock remains abandoned by birds and, for the first time, no birds were recorded at Stewart Island. The Kuru Pongi/Trio Islands population is now split between the North and South Islands. A new roost site has formed at Moturaka/The Haystack.

*Table 4. King Shag roost site counts 2015-2019.*

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

There is variation in the degree of apparent population change in each area. The two areas with the highest King Shag numbers (Pelorus Sound and Admiralty Bay) appearing to be in decline, whereas numbers in Queen Charlotte Sound are increasing. Both Tasman Bay and Port Gore remain relatively stable (Table 5). Furthermore, roost sites within the Inner Sounds (Tawhitinui and Oruawairua/Blumine Island) appear to be increasing (Table 4).

*Table 5. Numbers of King Shag recorded in each area of the Marlborough Sounds.*

Area	2015	2018	2019
Admiralty Bay	199	145	172
Pelorus	404	277	340
Port Gore	53	31	45
Queen Charlotte	103	129	160
Tasman Bay	75	51	72
Total	834	633	789

#### 4. DISCUSSION

Aerial survey remains a cost-effective way of censusing the King Shag population. Despite the poorer quality of some images, all could be counted with low variation between assessors. This is similar to the results from previous censuses of King Shag and highlights the appropriateness of aerial survey for monitoring this species.

Image quality was the main cause of variation between assessors, with higher variation among poorer quality images. Over-exposure in an image is particularly hard to correct. In contrast, under-exposed images can be brightened. In future flights the aperture settings or EV settings should be reduced to ensure better exposure of areas with bright backgrounds. Other areas may be underexposed but the assessors can brighten these as they analyse them.

The aerial survey methodology needs further investigation, including flying at a slightly lower altitude, and using different camera equipment to see if better quality (higher resolution) images can be obtained. Traditionally flights have been done on fine clear days, but possibly overcast days may provide better images with less stark contrast. Better quality images are needed, not only to make them easier to count, but also to see if first-year birds can be distinguished from adults because year-to-year variation in breeding success, and therefore in the number of young birds present, may be a major source of variation in population counts in the following season.

Observers at three roost sites found few birds departed the roost sites prior to the aerial survey being undertaken. This finding supports the methodology proposed in the King Shag Management Plan, which recommends aerial survey being carried out before 08.30h when most birds start departing.

The 2019 survey recorded 24% more King Shag than recorded in 2018, but still 6% below that recorded in 2015. These fluctuations in numbers are hard to interpret and could be due to several factors, including annual variations in breeding success or the missing of some roost sites during surveys. A count in January 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).

The number of roost sites flown in each survey has been different, with each survey targeting all sites known at the time. However, there has been no ground truthing to check if historical roost site or roost sites have become re-occupied before each survey. This increases the risk that a survey is missing birds at such a site. Future surveys should cover all known, and past King Shag roost site and roost sites to ensure each survey is complete.

From the perspective of determining the long-term dynamics of the King Shag population it is important to know how many adults of breeding age there are and what the long-term trend in their numbers is; hence the need to try distinguishing 'adults' and first-year birds in the images. The current aerial survey methodology is not providing images in which it is possible to make such a distinction.

To account for this inter-annual variation, annual surveys are needed to determine year-to-year changes in King Shag numbers from which the long-term population trend can be more clearly discerned. We recommend that annual surveys be carried out for at least the next five years to improve our understanding of how variable King Shag numbers are between years 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 carry out annual aerial surveys in mid-late January to determine the population trend and better account for the effects of inter-annual variation.
- That the aerial survey protocol be further revised to improve image quality (especially reducing over-exposure of brightly lit sites with strongly contrasting backgrounds) and data recording (including GPS records of the flight path) to ensure more accuracy assessment of King Shag numbers in future surveys. This revision should include investigating the influence of aircraft height and speed together with camera equipment on image quality.
- Future aerial surveys should include all known, and historical King Shag colonies and roost sites to ensure complete coverage.

## **5. ACKNOWLEDGMENTS**

Thanks to the Department of Conservation, Sanford's and New Zealand King Salmon for stationing boats and observers at three roost sites to record birds departing before aerial surveys. This contract was managed by Mark Gillard and we thank him for his patience and effective management of this contract.

## **6. References**

Schuckard, R. 2015. New Zealand King Salmon – King Shag Management Plan. Client report prepared for New Zealand King Salmon.

Schuckard, R. 2018. Report on King Shag census February 2018 and population trend. Client report prepared for New Zealand King Salmon.