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## BRIEF REVIEW OF REPORT ON THE 2018 KING SHAG CENSUS

New Zealand King Salmon was given resource consent for two farms in Waitata Reach, Marlborough Sounds, in 2014. Part of the conditions of consent was the preparation of a King Shag Management Plan, which was completed in 2015. Biometrician Dr Darryl MacKenzie undertook population modelling using king shag survey data collected by Mr Rob Schuckard between 1992 and 2002 and estimated the population to be relatively stable. The modelling was used to develop a monitoring methodology which was incorporated into the management plan, setting out the requirements for a three yearly summer census of known king shag colonies.

The census has now been carried out in February 2015 and February 2018. The 2018 count shows a 24% decline in numbers of birds. This is substantially in excess of the management plan's 5% decline threshold, which triggers a set of management actions, including instigation of annual monitoring. In response to the latest census MacKenzie has undertaken further population modeling to examine the potential changes in fecundity and adult survival rates that might explain the observed results and Schuckard has completed a draft report discussing these results. This memo is a brief review of Schuckard's report. However, MacKenzie's report has also been examined to help interpret Schuckard's manuscript.

The 2015 and 2018 census reports examine the precision of observer counts. The analyses show that the census method is a relatively precise method for counting king shag individuals at colonies. It is likely to become more precise as technology improves further, and the method continues to be fine-tuned. The method is also accurate, in that it records colonies before any bird has left to begin foraging, and therefore photographs every bird in the population. It is rapid as all colonies are photographed within approximately one hour, and so eliminates any bias that might exist when colonies are surveyed over weeks or months (due to movements of birds between colonies).

However, it has limitations which are not described in the report. The first is that the census is dependent on all breeding colonies of king shag being known at the time of the census. The results from the censuses demonstrate abandonment and establishment of colonies between years (The Twins, Blumine and Ruakaka-Blackwood establishing between 2015 and 2018, and the concurrent abandonment of Sentinel Rock). Therefore, it is not possible to be certain that all breeding colonies have been located prior to the commencement of each census.

The second limitation is that the census method is not able to distinguish between juveniles/subadults and mature breeding birds. This could greatly influence census results. For example, 202 breeding pairs were detected during the 2015 winter breeding survey (MacKenzie 2018). If each of these pairs successfully fledged a chick which then survived through to the following February census, the census would record 202 juveniles, indistinguishable from the adults. In contrast, if breeding failed entirely, then the census would record 202 less birds than the previous scenario. The fluctuations in total numbers of birds counted during the census will be partly due to changes in the numbers of mature adults present, but are likely to be strongly affected by the success of nesting, fledging and juvenile/subadult survival in the intervening years.

This second limitation is particularly relevant when considering Schuckard's Section 6 where he states that the IUCN status of king shag needs to change "Due to the significant decline of the number of mature individuals of 24% in three years". In my opinion, it is extremely unlikely that the 24% decline is solely due to the loss of mature individuals. MacKenzie in fact models a scenario in which the decline can be explained by the decrease of the fecundity rate alone to 30% of the equilibrium value for three consecutive years<sup>a</sup>. However, the IUCN is conservative in its application of Red List criteria and may choose to upgrade the species without knowing for certain whether the decline includes mature individuals.

Schuckard notes that Duffers Reef has 218 mature individuals (Table 1 gives the mean count as 212). This cannot be determined from aerial photographs as it is not possible to distinguish subadults and juveniles from mature birds.

Schuckard uses 10 years as the period over which to assess the decline. BirdLife International estimates the generation time of king shag as 8.7 years<sup>b</sup>. Therefore, any decline needs to be assessed over 26 years (three times the generation time).

Schuckard's Figure 3 is a good way to represent the census data. However, it does not include pie charts for the new colonies at Blumine Island or Ruakaka-Blackwood. It would be helpful to add the number of birds to each of the charts to assist the reader to see the relative significance of the various increases and decreases. Another issue is that the map includes what appear to be a number of roost locations (the small cap letters). These are not explained in the Figure label or the text. Were they checked as part of the census? If not, they need to be removed as they are not relevant.

MacKenzie states in his discussion that a decrease in adult survivorship combined with a three-year decline in fecundity "may be, arguably, more conceivable than a change in only a single demographic parameter". Schuckard similarly notes that "A combined impact of fecundity and adult survival is the most likely scenario". Neither author explains their opinion. I am not so sure that a three-year significant decline in fecundity alone is not a reasonable scenario. Many long-lived bird species in New Zealand do not breed annually, and/or productivity is reduced in 'poor' years (for example, due to marine productivity, lower levels of fruiting and flowering, regular flooding of rivers within a season). Nevertheless, continued declines in the total numbers of birds could suggest ongoing impacts on fecundity, which would be cause for concern.

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<sup>a</sup> The term 'fecundity' refers to a combination of adult breeding frequency, the number of nesting attempts, clutch size, the percentage of eggs that hatch, and the percentage of hatched chicks that fledge.

<sup>b</sup> BirdLife International is the official IUCN Red List classification agency for birds of the world.

Furthermore, while significant decreases in fecundity in a long-lived species like king shag can be absorbed and offset by years of good productivity and recruitment, increases in adult mortality have immediate effects. Schuckard's recommendation that "an immediate species management response" is required is presumably based on an assumption of increased adult mortality (combined with reduced fecundity), rather than a one-off significant lowering of fecundity alone. This is an appropriate recommendation given the very small population and the general paucity of knowledge on the species breeding biology and the relative impacts of a long list of potential threats.

Schuckard discusses five main areas of research; distribution and abundance of prey species and how anthropogenic activities affect prey, king shag parasite associations, the use of alternative roosts to decrease exposure to extreme weather, examination of the Queen Charlotte population (which he considers stable) in relation to other parts of the species' distribution, and the effect of harmful algal blooms on king shag. These are his opinions and I do not necessarily agree with his priorities.

Of direct relevance to the winter and summer census, and not discussed by Schuckard, is the lack of detailed information about when king shag breed, the variability in the breeding cycle between years, and breeding success. Cameras situated within colonies and, ideally, regular boat surveys at several colonies at key times during the year, would provide a wealth of information in addition to the aspects noted above, and would assist in the interpretation of census results. Such work should be instigated as soon as possible, although camera deployment should be delayed until breeding at any particular colony has finished, in order to reduce the impact of disturbance at colonies.

Yours sincerely

A handwritten signature in black ink, appearing to read 'RMCC', with a long horizontal line extending to the right.

Rachel McClellan  
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