A response to Document SC/F15/SP01 'Comments on proposed research plan for new scientific whale research program in the Antarctic Ocean (NEWREP-A) with regard to feeding ecology objectives' by R. Leaper and B. A. Roel

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INTRODUCTION

This paper responds to each of the comments made by Leaper and Roel in Document SC/F15/SP01. Texts from SP01 are reproduced here in italics.

SP01 provided several comments on prey consumption rate estimates in NEWREP-A plan. At first, Leaper1 and Roel noted that "*The Panel was further concerned that 'insufficient work had been undertaken to address the full level of uncertainty with these estimates' and made a number of recommendations (IWC, 2010).*" However some of these uncertainties with Monte-Carlo simulation have already taken into account and presented in the JARPA II workshop in February 2014 and the Panel agreed that the approach proposed in Tamura *et al*. (2014) is both a positive development and a useful way forward. The Panel further recommended estimates be made within a sufficiently narrow range. The Panel recommends that work proposed in Tamura *et al*. (2014) be further developed and allocated high priority (IWC, 2014)'. In the study of consumption estimate in NEWREP-A, we fully considered the recommendations by the Review Panel in the JARPAII review meeting to make estimation of uncertainties with a narrower range.

Leaper and Roel admit that our plan to use tagging may provide useful information to improve the consumption estimate. Hence the points are only technical issues. Here we responded for three topics regarding to their concern.

RESPONSES

1. Length of feeding season in the Southern Ocean

In addition, expecting telemetry data to provide estimates of duration of stay in Antarctic waters is a very ambitious objective since long-term tags have rarely been deployed on Antarctic minke whales. Gales et al. (2013) did achieve four successful long-term (>100 day) deployments by a very experienced team under ideal conditions during a field project whose primary aim was tagging. NEWREP-A does not provide any estimates of the number of successful long-term deployments needed to address the issue of the duration of stay in Antarctic waters. In addition, tag deployments during the summer season will only identify when individuals leave Antarctic waters and not when they arrive. It seems very unlikely that a tag could remain functioning long enough to last through the winter. Having an estimate of the end of the feeding season in Antarctic waters but not the beginning will only contribute a limited amount to narrowing the overall uncertainty.

The comment from SC/F15/SP01 does not fit the recent development of tagging equipment. The recent tags have allowance of long-life battery and control emitting signals which can stretch the battery's running until the arrival of the minke whale at the feeding area. We recognize the difficulty of attaching tags for the Antarctic minke whale and keeping those mounted for a long period until the whales arrive at the feeding area. However we have recognized that development of the attachment technique and tags with a stable anchor in the trials are needed with a lot of trials. At first, we will try the attachment of several logger and transmitters for satellite tracking for the Antarctic minke whale in early and late seasons in this NEWREP-A. If the attachment of several loggers and transmitters for satellite tracking are successful, data on the length of the feeding season for Antarctic minke whales would be obtained during this NEWREP-A.

2. Digestion rate

In 2007, the Committee noted that digestion rate was largely unknown but could have a substantial influence on estimates of consumption based on stomach contents. Leaper (2007) showed that estimates of consumption were very sensitive to assumptions about digestion rates coupled with diurnal variation in feeding activity. Different

assumptions about digestion rates that were consistent with the data resulted in a range of estimates for mean daily consumption of around 1.5% – 7% of whale body mass. This covers a plausible range of values but was one of the issues that resulted in the Committee agreeing at the time that it was not possible to move beyond broad estimates. Tamura and Konishi (2014) describe a single experiment to estimate digestion rates in vitro. This was based on the methods of Jackson et al. (1987). However these methods seem more designed for investigating relative rates of digestion to examine potential biases in stomach content analysis. Absolute rates are more difficult to simulate under laboratory conditions. Digestion rates are complex and depend on the mechanical conditions in the stomach as well as the chemical composition. Kong and Singh (2010) report quite different results from a human gastric simulator to equivalent experiments using a shaking bath. There is a large body of literature on in vitro digestion experiments, and basing a whole study on one experiment is unlikely to give reliable results. At present it is not clear if any experimental methods can reliably determine digestion rates for whales.

We acknowledge that the authors of SC/F15/SP01 mentioned that the digestion rate is sensitive. However the range of consumption rate 1.5%-7% is not plausible for our purpose as an input parameter into ecosystem models and for detecting its trend. Tamura and Konishi (2014) made progress on this issue by calculating the digestion rate *in vitro* using digestive enzyme from the fundus of Antarctic minke whales sampled by JARPAII. It should be noted here that the method used (Jackson *et al*., 1987) has been used in the estimation of the digestion rate of small cetaceans (Sekiguchi, 1994). However further digestion experiments may possibly play an important role to clarify mechanical function of the whale stomach which has four compartments. We recognized that in general, digestion rates have some uncertainty, but we think that there is little uncertainty in the digestion rate of Antarctic minke whales. The combination of stomach contents change in relation to daily time and diving behaviour can possibly be used to estimate digestion rate.

3. Extent of feeding at night

Appendix 10 states that 'The proposed plan includes sampling whales during the night in the feeding area of the Antarctic minke whale'. No further details are given of how diurnal patterns in feeding will be evaluated or how night time sampling will be conducted, for example how whales might be located and sampled in darkness. At 60oS there is five hours between sunset and sunrise even on the longest day. It is not clear whether these night time studies are intended to allow interpretation of previously collected data (e.g. JARPAII) or just data collected at the time. Previous data from JARPA/JARPAII had shown diurnal patterns in stomach contents and it was suggested that the peak feeding period was at night (Tamura and Konishi, 2006). It is likely that if diurnal patterns of minke whale behaviour are influenced by light levels then these will change with latitude and date. However, the ability to locate and sample minke whales will also be affected by light conditions.

To clarify the existence of night feeding, we would use a data logger system in the NEWREP-A. Furthermore, we will attempt to obtain the Antarctic minke whales by lethal sampling from 21:00 to 02:00. The issue of extent of feeding at night is considered in NEWREP-A with a combination of tagging study (non-lethal method) and night time sampling (lethal method). We agree that night time sampling will be a difficult operation. Therefore sampling at night with the midnight sun at high latitude area is the most feasible. If daily change of stomach contents and diving behaviour are observed simultaneously in this experiment, precision of prey consumption will be improved.

CONCLUSION

We recognize that there were still some uncertainties in the estimates of prey consumption rates at this stage. Therefore, it is considered that this requires further investigation in NEWREP-A. The NEWREP-A considers the use of both satellite tracking (migration patterns) and data logger trials (daily feeding behaviour) to contribute to the study of feeding ecology and estimation of consumption in the Antarctic minke whale. The tagging study plan to understand migration pattern of the Antarctic minke whale is valid. And other plans for the estimation of consumption rate will contribute and respond to the recommendation by the Review Panel of 2014 JARPAII workshop.

Authors of SC/F15/SP01 pointed out that "*These studies could only really effectively be conducted in collaboration with the teams who have made most progress so far with tag deployment and attachment as a result*

of many years of intensive field work." in SC/F15/SP01. We recognized that it is difficult to attach the satellite tag for Antarctic minke whales at this stage. For example, during 2009-2013 a non-lethal intensive survey project, "SORP" dedicated their effort to attach tags for 4 years however, they could attach the tag to only 18 (2 multi-sensor tags, 13 satellite position only tags and 3 satellite positon with TDR tags) Antarctic minke whales on an opportunistic basis (Bell, 2013). In the 2006/2007 JARPAII survey, we successfully deployed one tag on a Antarctic minke whale from anterior sighting and sampling vessels that will be used for NEWREP-A (Nishiwaki *et al*., 2007). Unfortunately, technical problems were found with the transmission antenna. However, this *Yushin maru*-type vessel is suitable to shoot tags from a higher level with highly experienced professional crews and is more stable for waves than the zodiac type boat. These provide strong potential of successful long-term deployments on the Antarctic minke whale throughout open water to near ice-edge. For a longer deployment for detecting the migration patterns of the whales, long time period attachment parts for tags will be developed. We have opportunities to deploy satellite tags throughout the survey season and tagging success will have to be evaluated after a long time exercise and not from its planning. Given the difficulties of deployment of tags at this stage, it is difficult to make a population level inference of trend of prey consumption rate from data obtained from a small number of animals. In addition, knowledge of predators' population demography (e.g. sex, maturity and pregnancy rate) is required to estimate prey consumption rate as growth rate and cost of pregnancy must be accounted for (ICES, 2011). These data cannot be obtained only from tagging.

Authors of SC/F15/SP01 also noted that '*An additional weakness of the new proposal compared to JARPAII from the perspective of estimating consumption rates is that sample sizes were only determined with respect to Objective I and so do not take into account any requirements of Objective II.*'.

Even though the calculation of a sample size under the Main Objective II is not feasible at this stage, stomach contents and other tissue samples and data to be obtained from their analysis under the sample size calculated based on the Main Objective I will be fully utilized. Above all, we emphasize that the best approach to contribute to reducing uncertainty in consumption estimates of Antarctic minke whale is the combination of data obtained by lethal and non-lethal approaches. It might be possible in the near future to provide estimates with a narrow range.

In conclusion all of the planned research in the NEWREP-A regarding increasing the precision of prey consumption estimates are feasible and the results will contribute to increasing the precision of the estimates.

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