

COMMENTS ON PROPOSED RESEARCH PLAN FOR NEW SCIENTIFIC WHALE RESEARCH PROGRAM IN THE ANTARCTIC OCEAN (NEWREP-A) WITH REGARD TO FEEDING ECOLOGY OBJECTIVES

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ABSTRACT

The objectives of the Proposed Research Plan for New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A) with regard to feeding ecology include the estimation of prey consumption by Antarctic minke whales. In 2007 the Scientific Committee identified a number of issues that needed to be addressed before stomach contents analysis could be used to contribute to reduced uncertainty in consumption estimates. These issues included 1) length of the feeding season, 2) digestion rates, and 3) extent of feeding at night. The length of the feeding season and extent of feeding at night were not addressed within the JARPAII program. NEWREP-A does propose ambitious telemetry studies to try and address these issues. This will require a large commitment of ship time and development of techniques for tagging minke whales in the open sea. Until the success of these studies has been demonstrated, along with further work on digestion rates, it seems unlikely that the new program will be successful in reducing uncertainty in estimates of prey consumption. This is not a situation of comparing lethal versus non-lethal techniques but a case of non-lethal data being necessary for meaningful interpretation of the lethal samples.

INTRODUCTION

The program is described as having two main objectives:

Objective I. Improvements in the precision of biological and ecological information for the application of the RMP to the Antarctic minke whales.

Objective II. Investigation of the structure and dynamics of the Antarctic marine ecosystem through building ecosystem models.

Objective II has four sub-objectives:

- (i): Ecological Research (krill abundance estimation and oceanographic observation)
- (ii): Abundance estimate of some cetacean species as input data for ecosystem modelling
- (iii): Estimation of prey consumption by the Antarctic minke whale and its nutritional condition
- (iv): Ecosystem modelling (Spatial interaction among baleen whales and consideration of predators-prey system and allometric reasoning)

Lethal sampling is not relevant to the majority of the data required for Objective II. This paper focuses only on the aspects of this Objective where lethal sampling may have some relevance, namely II(iii) ('Estimation of prey consumption by the Antarctic minke whale and its nutritional condition'). Estimating prey consumption was a key component of the JARPAII program. Thus this aspect has already been subject to considerable discussion and review by the Scientific Committee.

In 2007, the Committee noted a number of issues with JARPA data that resulted in 'feeding rates derived from the very large JARPA data set falling in a wide range which covers what might be considered the plausible range of values from other sources, including allometric comparisons of energy requirements.' The Committee summarised three of these 'issues that would need to be resolved before progress can be made: (1) the length of feeding season; (2) to what extent consumption rate is sensitive to digestion rate (which is largely unknown); and (3) the extent of feeding at night'. The need to examine feeding at 'night' was identified because of observed diurnal patterns in stomach contents which were difficult to interpret since whales were not sampled between 21:00 and 03:00 (Tamura and Konishi, 2006).

The Committee agreed that ‘while these questions are being investigated it would be difficult to move beyond only broad estimates’ (IWC, 2008). Similar issues have arisen in the context of JARPNII. At the JARPNII workshop in January 2009, ‘the Panel did not believe that the presented estimates of cetacean consumption rates can be considered reliable until further analyses have been undertaken’. 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, 2010a).

The new proposal offers an attempt to address some of the issues identified by the Scientific Committee with the JARPAII data and methodology that resulted in that program not being able to contribute to reduced uncertainty in consumption estimates. Appendix 10 of NEWREP-A notes that ‘the main objective is, therefore, to increase the precision of estimates of consumption by the Antarctic minke whale by analysis of data from night-time sampling of stomach contents and by the tagging studies.’

Here we comment on the proposed data collection in NEWREP-A with respect to the three main issues identified by the Committee:

1. Length of feeding season

NEWREP-A states that ‘To consider the uncertainties in calculation of consumption, the tagging and satellite tracking that records the position of whales for a long period will be conducted for the Antarctic minke whale to examine the migration patterns and duration of stay in the Antarctic waters.’

Gales et al. (2013) concluded that telemetry studies using a number of different types of tag provided excellent opportunities for research on minke whales in and around a variety of sea ice habitats in the Antarctic. The tags provided information about the movements, habitat use, diving and acoustic behaviour of Antarctic minke whales. The tags were deployed from ice or small rigid inflatable boats close to the ice. Deploying tags on minke whales in the open sea would, however, require different techniques and is likely to prove a much greater challenge. 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.

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.

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 60°S 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.

DISCUSSION

There has been little progress on the three key issues identified by the Scientific Committee in 2007 that might have allowed stomach contents data to be used to estimate consumption rates with lower uncertainty than estimates based on allometry. No explanation is given for why it was not possible to incorporate some of these recommendations during the last seven seasons of JARPAII, but is now thought to be possible within the new proposal. NEWREP-A also fails to mention that addressing these issues is required in order for the stomach contents data to be interpreted. This is not a situation of comparing lethal versus non-lethal techniques but a case of non-lethal data being necessary for meaningful interpretation of the lethal samples. The comments and discussion by the Scientific Committee regarding JARPAII are equally applicable to the new proposal. 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.

The proposed telemetry studies needed to estimate the length of the feeding season are ambitious and may well require considerable experimentation. 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. It would make sense to commit the available ship time while not involved in abundance surveys for cetaceans or krill to the tagging components of the program, at least in the early field seasons. Once the success of tagging had been demonstrated then other aspects of the program could be considered. There also still remains considerable uncertainty over a number of other parameters, including digestion rates and diurnal feeding patterns, which are required in order to obtain quantitative estimates of consumption rates from stomach contents.

NEWREP-A does acknowledge that ‘It is already known that in the Antarctic, the Antarctic minke whales feed mainly on a single species, the Antarctic krill’ and that there is not much value in techniques that only investigate ‘species composition in the Antarctic minke whale diet’. Data that do not provide ‘quantitative information of food consumed’ are not considered of ‘much value’. Hence a key aspect that needs to be evaluated for the proponents themselves to consider that the research is valuable is whether the additional data will have a high chance of substantially reducing the uncertainty around quantitative estimates of consumption rates. Based on agreements by the Scientific Committee on the work required to address these issues it seems unlikely that this aspect of the program will be successful in its currently proposed form.

REFERENCES

- Gales, N., Bowers, M., Durban, J. W., Friedlaender, A. S., Nowacek, D. P., Pitman, R. L., Read, A. J., & Tyson, R. B. (2013). Advances in non-lethal research on Antarctic minke whales: biotelemetry, photo-identification and biopsy sampling. Paper SC/65a/IA12 presented to the IWC Scientific Committee, June 2013, Jeju Island, Republic of Korea (unpublished). 15pp
- IWC. 2008. Report of Scientific Committee. *J. Cetacean Res. Manage.* 10 (Suppl.) p.45
- IWC. 2010a. Report of Scientific Committee. *J. Cetacean Res. Manage.* 11 (Suppl.2) p.74
- IWC. 2010b. Report of Scientific Committee. *J. Cetacean Res. Manage.* 11 (Suppl.2) p.58

Jackson, S., Duffy, D.C. and Jenkins, J.F.G. 1987. Gastric digestion in marine vertebrate predators: in vitro standards. *Functional Ecology* 1: 287-291.

Kong, F and Singh, R.P. A Human Gastric Simulator (HGS) to Study Food Digestion in Human Stomach. *Journal of Food Science* 75(9): 627-635. doi: 10.1111/j.1750-3841.2010.01856.x

Leaper, R. 2007. A note on stomach contents analysis from JARPA. 4pp. Paper SC/59/IA8 presented to IWC Scientific Committee, Anchorage Alaska, USA.

Tamura, T. and K. Konishi. 2006. Food habit and prey consumption of Antarctic minke whale *Balaenoptera bonaerensis* in JARPA research area. Paper SC/D06/J18 presented to JARPA review, Tokyo, 2006.

Tamura, T., & Konishi, K. (2014). Prey composition and consumption rate by Antarctic minke whales based on JARPA and JARPA II data. Paper SC/F14/J15 presented to the JARPA II Special Permit Expert Panel Review Workshop, February 24-28 2014, Tokyo, Japan (unpublished). 20pp.