Additional analyses of temporal trends and factors affecting mercury levels in common minke, Bryde's and sei whales in the western North Pacific

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ABSTRACT

This short paper presents an additional analysis on total mercury (THg) trend in common minke whale from the western North Pacific in response to some recommendations from the JARPN II review workshop. Specifically a generalized additive model (GAM) analysis was recommended to examine temporal trend of THg levels in common minke whales from sub-area 9 in the period 1994-2007. Results of this analysis suggest two periods: the first extending until 1999 showing a decreasing trend and a second from 2000 showing a stable trend. These results based on GAM are the same as those obtained in the original paper based on multiple linear regression analyses (Yasunaga and Fujise, 2009) (SC/J09/JR23). In response to other recommendation, a schematic figure on total Hg (THg) flow in the western North Pacific food web is presented and described in this paper.

INTRODUCTION

The International Whaling Commission's Scientific Committee (IWC SC) carried out a Workshop to review the progress made in the research conducted under the Japanese Whale Research Programme under Special Permit in the North Pacific-Phase II (JARPN II) in its first six years (2002-2007). The review was carried out by an Independent Expert Panel (IEP) who examined primary papers related with the research objectives of JARPN II.

One of the objectives of the JARPN II is 'Monitoring environmental pollutants in cetaceans and the marine ecosystem' and regarding to this objective three primary papers were presented to the review workshop. Yasunaga and Fujise (2009) examined temporal trends and factors affecting mercury levels in common minke, Bryde's and sei whales and their prey species in the western North Pacific (SC/J09/JR23). Regarding whales, apart from common minke whales from sub-area 9, significant yearly changes of mercury levels were not observed. For minke whales in sub-area 9, levels decreased from 1994 to 1999 but increased from 2000 to 2007. Results of a multi linear regression analysis suggested that changes of mercury levels in sub-area 9 reflected changes in food habit rather than changes in accumulation levels in the environment.

During the review workshop the IEP recommended that 'a generalized additive model (GAM) fitted to these data would be a better method for determining the change points and examining non-linear trends in the Hg levels' (IWC, 2009). In response to such a recommendation an additional analysis based on (GAM) was conducted to determine the change points of Hg levels in muscle of common minke whales from sub-area 9 during the period 1994-2007. In addition the IEP recommended that a schematic figure on total Hg (THg) flow in the western North Pacific food web be added in any future paper (this figure was introduced in the Power Point presentation but not in the original paper). This figure is added and described in this paper.

MATERIALS AND METHODS

Muscle tissues from mature males of the common minke whales (Okhotsk Sea-West Pacific stock) from sub-area 9 were collected by JARPN II researchers in the surveys conducted in the period from 1994 to 2007. The GAM analyses were executed by R software (R Development Core Team, 2006). A more detailed description of the materials and methods used in the study is provided in the original paper by Yasunaga and Fujise (2009) (SC/J09/JR23).

RESULTS AND DISCUSSION

Figure 1 shows the relationships between THg levels in muscle of minke whales and sampling year. Figure 2 shows its smoothing curve using GAM. A changing point of THg levels were observed during 1999 and 2000 (Figure 2). Therefore, it is reasonable to distinguish between two periods for the THg levels in common minke whales from sub-area 9: the first extending until 1999 shows a decreasing trend and a second from 2000 shows a stable trend. These

results based on GAM are the same as those obtained in the original paper based on multiple linear regression analyses (Yasunaga and Fujise, 2009) (SC/J09/JR23).

A schematic figure of total Hg flow in the western North Pacific food web is shown in Figure 3. This figure indicates that differences in food habitat explain the pattern of Hg accumulation of baleen whales.

REFERENCES

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Yasunaga, G. and Fujise, Y. 2009. Temporal trends and factors affecting mercury levels in common minke, Bryde's and sei whales and their prey species in the western North Pacific. Paper SC/J09/JR23 presented to the JARPN II Review Workshop, Tokyo, January 2009 (unpublished). 14pp.

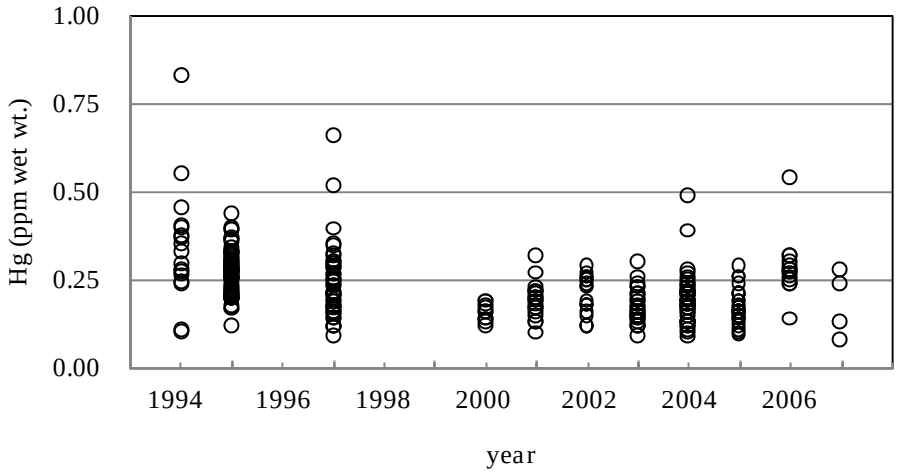

Figure 1. Total mercury (THg) levels in muscle of mature common minke whales in sub-area 9 during the period 1994-2007. This is a corrected figure of that presented in Yasunaga and Fujise (2009) (SC/J09/JR23) as Figure 6.

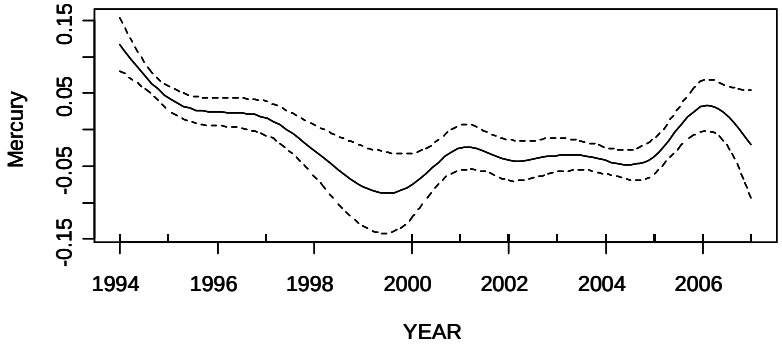

Figure 2. Smoothing plots of total mercury (THg) levels in muscle of mature common minke whales in sub-area 9 against research years for the period 1994-2007 using the generalized additive model (GAM).

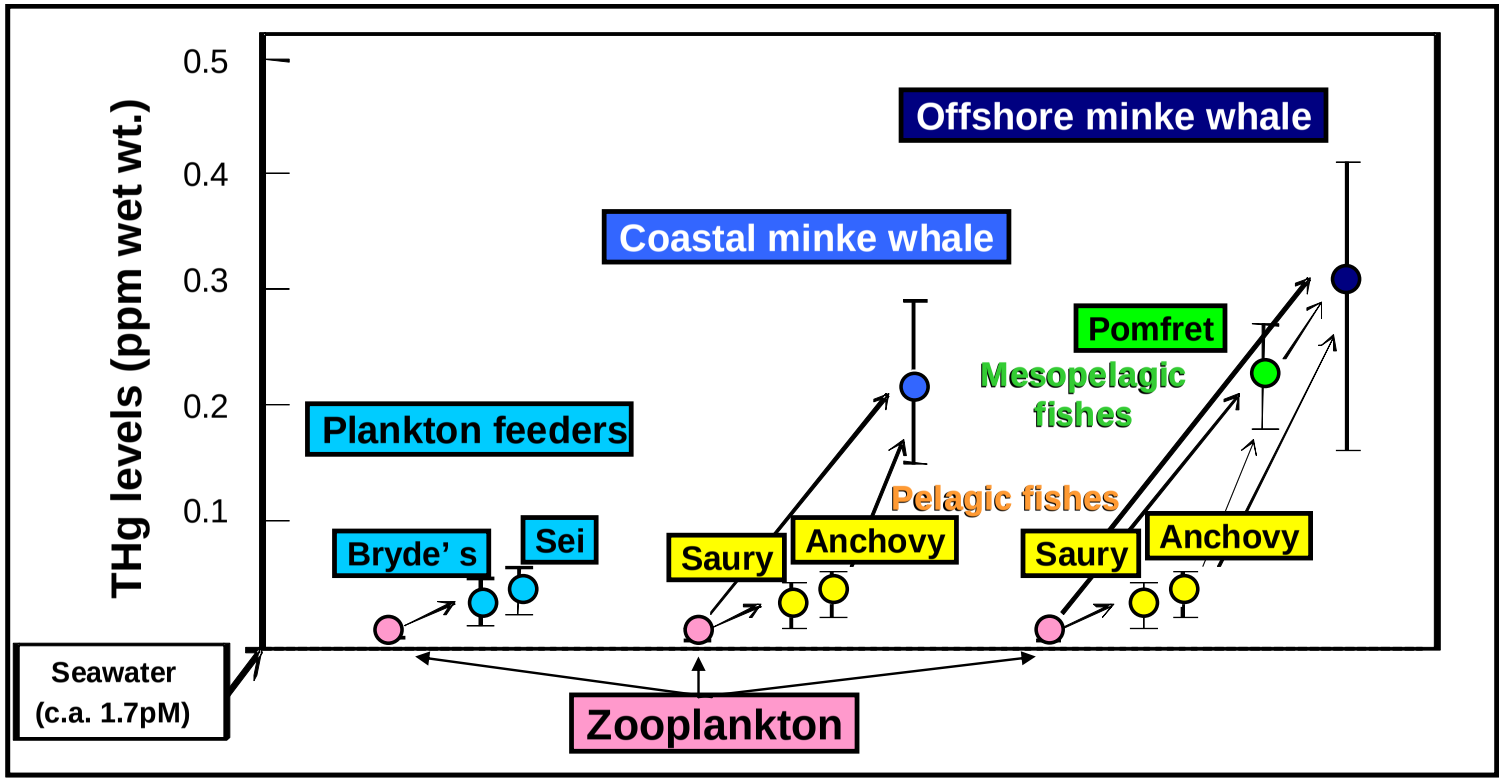

Figure 3. Schematic figure of total Hg flow in the western North Pacific food web.