Additional analyses of temporal trends and factors affecting PCB levels in baleen whales from the western North Pacific

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ABSTRACT

This short paper presents an additional analysis on PCB trend in common minke, Bryde's and sei whales from the western North Pacific in response to some recommendations from the JARPN II review workshop. The review Panel recommended that future studies on PCB must be carried out on a lipid weight basis. A total of fifteen whales in each species were additionally analyzed for fat contents and this was converted into concentrations in fat wt. basis. Results of the statistical analysis on PCB level trends in these baleen whale species were consistent with those originally presented by Yasunaga and Fujise (2009) (SC/J09/JR24).

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 PCB levels in baleen whales (common minke, Bryde's and sei whales) and environmental samples in the western North Pacific (SC/J09/JR24). Regarding whales yearly changes of PCB levels were not observed in these whale species in the period 2002-2007. Results from previous studies had suggested that PCB levels had been continually decreasing in this oceanic region (1980's-1990's). Results from the JARPN II analysis suggested that the level had stabilized since 2002 (Yasunaga and Fujise, 2009).

During the review workshop the IEP recommended that future studies must be carried out on a lipid weight basis (IWC, 2009). Thus, an additional analysis was performed on fat content (%) of some whale samples in order to convert wet wt. base levels into fat wt. base levels. This paper presents the results of the additional analyses.

MATERIALS AND METHODS

The sample size and body length of mature males of the common minke whales (Okhotsk Sea-West Pacific stock), Bryde's and sei whales used in this study are shown in Table 1. The samples were sent to the Japan Food Research Laboratories (Tokyo, Japan) for analysis of fat content (%) analyses. Analyses were performed according to the public analytical method of Japan (Science and Technology Agency, 2004). A detailed description of materials and methods of the PCB analysis is provided in Yasunaga and Fujise (2009) (SC/J09/JR24).

In this study only mature male whales were used. Males of minke, Bryde's and sei whales were defined as sexually mature by testis weight (larger side) of more than 290g, 560g and 1,090g, respectively (Bando *et al.*, unpublished data).

As in the previous study, the yearly trend of PCB levels in blubber of whales was examined by a multiple linear regression analyses (see Yasunaga and Fujise, 2009 for more details of the analytical procedure used).

RESULTS AND DISCUSSION

Table 1 shows the fat content, PCB levels (wet wt. basis and fat wt. basis) in blubbers of common minke, Bryde's and sei whales and Figure 1 shows the relationships between PCB levels (fat wt. basis) in these whale species and sampling year. For PCB levels (fat wt. basis) of common minke whales in sub-area 9, blubber thickness, sampling latitude, sampling year and body length were significantly selected (Table 2) with a rank order of effects of blubber thickness (B:+1.564) > latitude (-1.514) > year (-0.576) > body length (+0.468). For Bryde's whales from sub-areas 8 and 9 (Table 3), sei whales from sub-area 9 (Table 4) no factor was significantly selected in the regression equation.

Yearly trend of PCB levels in Bryde's and sei whales were not observed (Tables 3 and 4). The year would not be important factor for PCB levels in minke whales from sub-area 9, because the sampling year was selected as third factor (Table 2). The results of the present analysis are consistent with the results of PCB levels based on wet wt. basis presented by Yasunaga and Fujise (2009) (SC/J09/JR24, 2009).

REFERENCES

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Table 1. Body length, PCB concentrations (ppm wet basis and fat basis) in blubber of common minke , Bryde's and sei whales in the western North Pacific in 2002, 2004 and 2006.

species	Year	sub area		body length	PCB (ppm wet)	PCB (ppm fat)	Fat content (%)
common minke whal	2002	9	ave±sd	7.41 ± 0.04	0.67 ± 0.09	0.88 ± 0.10	75.7 ± 3.99
			ragne	(7.37 - 7.45)	(0.58 - 0.79)	(0.79 - 1.00)	(71.50 - 80.70)
			n	4	4	4	4
	2004	9	ave±sd	7.29 ± 0.08	0.30 ± 0.11	0.46 ± 0.21	65.7 ± 7.12
			ragne	(7.20 - 7.40)	(0.13 - 0.43)	(0.19 - 0.67)	(55.10 - 75.00)
			n	5	5	5	5
	2006	9	ave±sd	7.41 ± 0.20	0.58 ± 0.42	0.91 ± 0.74	66.4 ± 6.32
			ragne	(7.13 - 7.66)	(0.24 - 1.30)	(0.40 - 2.20)	(59.80 - 74.80)
			n	5	5	5	5
Bryde's whale	2002	8	ave±sd	12.67 ± 0.43	0.11 ± 0.06	0.19 ± 0.11	61.5 ± 6.93
			ragne	(12.07 - 13.11)	(0.05 - 0.21)	(0.07 - 0.36)	(54.50 - 72.00)
			n	5	5	5	5
	2004	8, 9	ave±sd	12.59 ± 0.36	0.13 ± 0.58	0.22 ± 0.14	60.1 ± 0.62
			ragne	(12.06 - 13.01)	(0.28 - 2.70)	(0.32 - 0.75)	(0.54 - 2.30)
			n	5	5	5	5
	2006	8	ave±sd	12.36 ± 0.47	0.07 ± 0.03	0.11 ± 0.04	62.8 ± 11.88
			ragne	(11.90 - 12.88)	(0.04 - 0.11)	(0.06 - 0.15)	(43.10 - 73.70)
			n	5	5	5	5
Sei whale	2002	9	ave±sd	13.60 ± 0.16	0.14 ± 0.18	0.27 ± 0.36	57.9 ± 4.92
			ragne	(13.42 - 13.86)	(0.03 - 0.47)	(0.05 - 0.91)	(51.60 - 64.80)
			n	5	5	5	5
	2004	9	ave±sd	13.61 ± 0.04	0.12 ± 0.07	0.21 ± 0.17	59.3 ± 8.57
			ragne	(13.55 - 13.66)	(0.04 - 0.22)	(0.07 - 0.49)	(44.60 - 65.00)
			n	5	5	5	5
	2006	9	ave±sd	13.84 ± 0.51	0.09 ± 0.06	0.14 ± 0.10	64.6 ± 6.97
			ragne	(13.23 - 14.48)	(0.04 - 0.19)	(0.06 - 0.30)	(53.80 - 72.40)
			n	5	5	5	5

Table 2. Results of multiple linear regression analyses with "PCB levels in blubbers of common minke whales from sub-areas 9" as the dependent variable.

a) Model of regression

Model	R	R2	R2'
1	0.936	0.876	0.769

b) Analysis of Variance Table

Model	Sum of Squares	DF	Mean Square	F value	P value
Regression	11.386	6	1.898	8.23	0.007
Residual	1.614	7	0.231		
Total	13.000	13			

c) Variables

Model	B	SE	B'	T	P value
Constant	3.27E-10	0.128		0.000	1.000
year	-0.576	0.189	-0.576	-3.054	0.018
date	-0.122	0.178	-0.122	-0.682	0.517
latitude	-1.514	0.352	-0.1514	-4.302	0.004
longitude	-0.144	0.334	-0.144	-0.432	0.679
body length	0.468	0.151	0.468	3.094	0.017
blubber thickness	1.546	0.273	1.546	5.668	0.001

Table 3. Results of multiple linear regression analyses with "PCB levels in blubbers of Bryde's whales from sub-areas 8 and 9" as the dependent variable.

a) Model of regression

Model	R	R2	R2'
1	0.722	0.522	0.163

b) Analysis of Variance Table

Model	Sum of Squares	DF	Mean Square	F value	P value
Regression	7.305	6	1.218	1.455	0.304
Residual	6.695	8	0.837		
Total	14.000	14			

c) Variables

Model	B	SE	B'	T	P value
Constant	-2.55E-10	0.236		0.000	1.000
year	-0.571	0.317	-0.571	-1.801	0.109
date	0.755	1.311	0.755	0.576	0.580
latitude	-1.047	0.977	-1.047	-1.072	0.315
longitude	1.062	1.192	1.062	0.891	0.399
body length	0.283	0.264	0.283	1.073	0.315
blubber thickness	-0.008	0.290	-0.084	-0.291	0.778

Table 4. Results of multiple linear regression analyses with "PCB levels in blubbers of sei whales from sub-areas 9" as the dependent variable.

a) Model of regression

Model	R	R2	R2'
1	0.659	0.434	0.010

b) Analysis of Variance Table

Model	Sum of Squares	DF	Mean Square	F value	P value
Regression	6.082	6	1.014	1.024	0.473
Residual	7.918	8	0.990		
Total	14.000	14			

c) Variables

Model	B	SE	B'	T	P value
Constant	-1.68E-10	0.257		0.000	1.000
year	-0.870	0.511	-0.870	-1.701	0.127
date	1.087	0.719	1.087	1.512	0.169
latitude	-1.273	0.898	-1.273	-1.419	0.194
longitude	0.113	0.389	0.113	0.291	0.779
body length	-0.150	0.378	-0.150	-0.398	0.701
blubber thickness	-2.22E-02	0.506	-0.022	-0.044	0.966

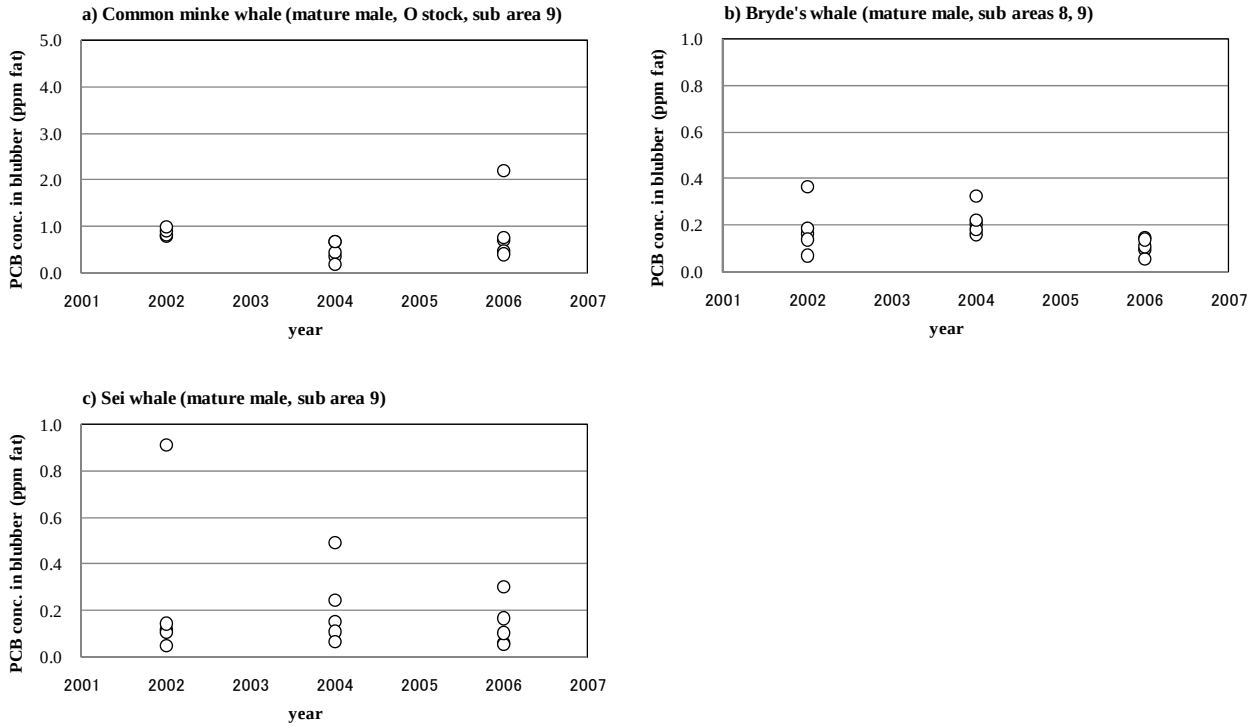

Figure 1. PCB levels (ppm fat wt.) in blubber of a) common minke, b) Bryde's and c) sei whales from sub-areas 8 and 9 in 2002, 2004 and 2006.