Proposed Schedule amendment to permit the catching of minke whales from the Okhotsk Sea-West Pacific Stock by small-type coastal whaling vessels

Submitted by Japan

This proposal is to add the following sub-paragraph (f) to existing paragraph 10 of the Schedule.

(f) Notwithstanding the other provisions of paragraph 10, the taking of up to (***) minke whales from the Okhotsk Sea-West Pacific stock of the North Pacific in the coastal waters east of Japan north of 35˚N and west of 150˚E (excluding the Okhotsk Sea) shall be permitted for each of the years 2007, 2008, 2009, 2010 and 2011 and the meat and products are to be used exclusively for local consumption.

* Explanatory note: Adoption of this schedule amendment will require amendment to Table 1 of the Schedule.

Since the imposition of the moratorium on commercial whaling in Japanese coastal waters twenty years ago, the Government of Japan has repeatedly requested an interim relief allocation of minke whales in order to alleviate the hardships of small-type coastal whaling communities; Abashiri, Ayukawa, Wada and Taiji. These requests have been continually rejected by the International Whaling Commission even though the Commission has recognized the severe impacts of the moratorium on the four small-type whaling communities and agreed to work expeditiously to alleviate their distress (ref. resolutions IWC-45-51(1993), 1995-3, 1996-1, 2000-1, 2001-6, and 2004-2).

This proposal would only allow community-based whaling in order to reinstate traditional and local practices associated with catching, processing, distribution and consumption of whale meat, and revitalize traditional festivals and rituals of the regions.

Community Whaling

Whaling to be permitted with the adoption of this proposal is community-based local whaling. Vessels and people to be involved are based in the traditional local whaling communities. A limited entry Ministerial licensing system is in place so that new entrants to the community whaling are strictly restricted. The whaling operation consists primarily of one-day trips with a small boat. The size of the whaling vessel is also restricted. Landing, processing, distribution and consumption under the community whaling will also be local.

Scientific Basis

Whaling grounds will be restricted to areas 10 nautical miles or more off the Pacific coast of northern Japan (in so-called subarea 7), excluding the Okhotsk Sea. The whaling season will be a consecutive six month period within the period of March 1 to November

30. These measures will ensure that catches will have no negative impact on J stock (see Appendices I and VI).

Catches of minke whales under Special Permit in accordance with Article VIII of ICRW will be reduced by (***) animals so that the total take will not be increased by the adoption of this quota. In the western North Pacific, 220 minke whales per year are now being taken as part of the JARPN II program from the same stock that will be exploited by community-based whaling. Appendices II, III, IV, and V clearly shows that the take of O stock animals and the possible take of a small number of J stock animals will have negligible impact on the stocks.

Monitoring and Control

(a) National Inspector
One national inspector will be on board each whaling vessel during whaling operations. Another national inspector will be at each land station to oversee the landing and the processing of the harvested whales as well as data collection. The national inspector shall also perform duties as a biological researcher.

(b) International Observer
If an IWC member country wishes, it may send one international observer, who can communicate in Japanese, to be at each land station to observe the landing and the processing of the harvested whales as well as to collect required data. The stationing of such international observers shall be in accordance with a bilateral agreement on international observers concluded between the Government of Japan and the country which wishes to send the said observer.

(c) VMS
All whaling vessels shall be equipped with a VMS to monitor whaling operations from land bases so that national inspectors and international observers can check the operations.

(d) DNA Register System
All whales taken will be included in the domestic DNA registration system which is already in place and which includes information which allows individual identification of whales.

(e) Oversight Committee
An Oversight Committee will be established in order to review the results of implementing monitoring and control measures. The Committee will be formed by a team of technical experts at the end of each whaling season to review reports prepared by inspectors and observers and to determine if improvements or additional measures are required.

Appendix I

Genetic basis for limiting whaling operations on O stock common minke whales to waters 10 nautical miles or more from the Japanese Pacific coast

The mixing proportion of the J-stock common minke whale in sub-area 7 was investigated using mitochondrial DNA data obtained from samples of common minke whales from different sources: past coastal commercial whaling, coastal and offshore surveys of JARPN and JARPN II and by-catches. This analysis was made to restrict the area of operation of future whaling on the O stock and then minimize the catch of J-stock animals.

MATERIALS AND METHODS

Based on mitochondrial DNA (mtDNA) haplotype frequency data, the mixing proportion of the J stock in sub-area 7 was estimated for the samples from past coastal commercial whaling from 1983 to 1987 (n=141), coastal and offshore surveys of JARPN and JARPNII from 1996 to 2006 (n=664) and by-catches from 2001 to 2006 (n=135). In these estimations, the haplotype composition of samples from Japanese by-catches in sub-area 6 (Sea of Japan) (n=339) during 2001 to 2006 and that of samples from sub-areas 8 and 9 taken in JARPN and JARPNII surveys (n=607) between 1994 and 2005 were used as representative samples of J and O stocks, respectively. The mixing proportion was estimated using a Bayesian approach (Punt, 2003), which was previously employed during the *Implementation Simulation Trials* (IST) for North Pacific common minke whales and included estimation of the standard deviations.

RESULTS AND DISCUSSION

As shown in Table 1, the mixing proportion of the J stock for samples taken from past coastal commercial whaling during 1983 to 1987 was 2.4% (SD: 1.5%). Regarding the samples from the offshore component of JARPN and JARPNII, the estimations ranged from 4.5 to 6.7% for samples collected between 1996 and 1999. The estimations were higher (more than 10%) for samples collected between 2000 and 2006. Regarding the coastal component of JARPN II, the mixing proportions were similar to those in the offshore component. The proportions in samples taken during Sanriku surveys were slightly higher than those obtained during Kushiro surveys. The mixing proportion in the total samples from offshore and coastal components of JARPN and JARPNII during 1996-2006 was 12.0% (SD: 1.4%). These estimations are higher than that obtained for the samples taken two decades ago during past commercial operations. With regard to the by-catch samples, the mixing proportion during 2001 to 2006 was 53.0% (SD: 4.1%).

The distance from the coast where the samples were taken was as follow: JARPN-JARPN II: 2 n.m. from the coast to 150°E; past coastal commercial whaling: 3 to 70n.m. from the coast; by-catches: within 3n.m. from the coast. The mixing proportion of the J stock was high in whales caught incidentally in set nets within 3n.m. from the coast. In the next step the relationship between J stock mixing proportion and distance from the coast was investigated (Table 2). In these investigation, we used by-catch samples for estimation of 'within 3 n.m.' and samples taken by JARPN-JARPN II from 2002 to 2006 for estimation of relationship between mixing proportion of the J stock and distance from the Japanese Pacific coast in sub-area 7, since the coastal component has been started in 2002.

It was found that the mixing proportion decreased in waters 10 n.m. or more from the coast (11.8%), and that it remained at a similar level (5.5-7.9%) in waters 20 n.m. or more from the coast (Table 2). Based on these results it is assumed that the impact of community-based whaling on the J stock can be kept at the lower level by designating whaling operations to waters 10 n.m. or more from the coast, since the range of the J stock is thought to be limited to extreme coastal waters.

REFERENCE

Punt, A.E. 2003. A Bayesian Approach to Estimating 'J'-'O' Mixing Proportions. Annex F. Report of the Workshop on North Pacific Common Minke Whale (*Balaenoptera acutorostrat*a) *Implementation Simulation Trials* (SC/54/Rep1). *J. Cetacean Res. Manage.* (*Suppl.*) 5:482.

Table 1. The mixing proportion of the J stock in sub-area 7 based on mtDNA data and samples from past coastal commercial whaling, coastal and offshore surveys of JARPN and JARPNII and by-catches.

Sample source	Component	Period	Sample size	Mixing Proportion of J stock	Standard deviation
Commercial whaling		**1983-87**	**141**	**0.024**	**0.015**
JARPN	Offshore	1996	29	0.067	0.045
JARPN	Offshore	1998	55	0.045	0.033
JARPN	Offshore	1999	50	0.054	0.037
JARPNII	Offshore	2000	23	0.127	0.075
JARPNII	Offshore	2001	44	0.097	0.050
JARPNII	Offshore	2002	58	0.107	0.045
JARPNII	Offshore	2003	21	0.139	0.073
JARPNII	Offshore	2004	14	0.245	0.107
JARPNII	Offshore	2005	31	0.148	0.069
JARPNII	Coastal (Kushiro)	2002	47	0.145	0.050
JARPNII	Coastal (Kushiro)	2004	56	0.086	0.041
JARPNII	Coastal (Kushiro)	2005	52	0.185	0.054
JARPNII	Coastal (Kushiro)	2006	28	0.128	0.064
JARPNII	Coastal (Sanriku)	2003	45	0.116	0.049
JARPNII	Coastal (Sanriku)	2005	55	0.264	0.060
JARPNII	Coastal (Sanriku)	2006	54	0.236	0.057
JARPN+JARPNII	Offshore+Coastal	**1996-2006**	**664**	**0.120**	**0.014**
By-catches		**2001-2006**	**156**	**0.534**	**0.041**

Table 2. Relationship between mixing proportion of the J stock and distance from the Japanese Pacific coast in sub-area 7 based on samples taken by JARPN-JARPN II from 2002 to 2006 and by-catches (within 3 n.m.) from 2001 to 2006.

Distance from the coastal line	Sample size	Mixing Proportion of J stock	Standard deviation
Within 3 n.m.	156	0.534	0.041
3 n.m. or more	459	0.149	0.017
10 n.m. or more	365	0.118	0.018
20 n.m. or more	161	0.079	0.023
30 n.m. or more	90	0.055	0.027
40 n.m. or more	68	0.078	0.036
50 n.m. or more	56	0.076	0.040

Appendix II

Examination of the effects of future catches on 'O' stock common minke whales

ABSTRACT

HITTER methodology is used to examine the effects of future annual catches of 220 animals on the 'O' stock common minke whales (*Balaenoptera acutorostrata*) for a period of 30 years. Part of this quota will be taken by community-based whaling for local consumption and other part by scientific whaling under JARPN II. HITTER results showed that the minke whale stock would increase over the forthcoming decades in all cases examined.

MATERIALS AND METHODS

Stock scenario

Based on results of genetic and non-genetic studies based on JARPN and JARPN II surveys (Goto and Pastene, 2004), it was assumed that a single O stock distributes in sub-areas 7, 8, 9, 11 and 12. Appendix III presents the results of an updated mtDNA analysis in sub-areas 7, 8 and 9. These results support the single O stock scenario (Scenario B in IWC (2004a)), and are inconsistent with the multiple O stock scenarios (Scenarios A, C and D in IWC (2004a)). Appendix IV presents the results of an updated CPUE analysis using data from the past commercial whaling in coastal areas of Japan. Same as the genetic results, CPUE results are not consistent with multiple O stock scenarios, particularly with the occurrence of a coastal O stock. Based on the results of these updated analyses, it is concluded that the single O stock scenario (scenario B) has a higher plausibility. Therefore, this is the only scenario considered for the examination of the effect of future catches.

The numbers of historical and future catches from O stock

The numbers of commercial and research catches

The past commercial and research catches listed in IWC (2004a) were used in this examination. Future annual catch by JARPN II and community-based whaling are 220 in total.

The numbers of incidental catches

Incidental catches until 2000 were the same as in option (Jii) in IWC (2004a). From 2001 to 2006 the reported incidental catches listed in the Japan Progress Reports were used. It should be remembered that the new regulation for incidental catches were applied from the second half of 2001. It was assumed that the future annual incidental catches off Japan correspond to an average of those from 2001 to 2006.

Mixing rate of J stock

Mixing rate of J stock in the past and future incidental catches were assumed to be the average mixing rate by sub-area and sex in the catches after the change of regulation (2001-2005) using the modified assignment method by Goto *et al*. (2000).

Mixing rates of J stock in past JARPN and JARPNII surveys in sub-area 7 were estimated by year using a Bayesian approach (Punt, 2003) (see Appendix I). Mixing rate for animals in sub-area 7 taken by future community-based and research whaling was assumed using mixing rate of J stock in 10 n. miles or more distant from the coast (see Appendix I).

Sex ratio of males

For the past commercial catches, the ratio in IWC (2004a) was used. For past scientific whaling catches the ratio obtained from the JARPN and JARPNII cruise reports was used. For past incidental catches until 2000, the ratio of (Jii) option in IWC (2004a) was used and those from 2001 to 2006, the ratio presented in the Japan Progress Reports for 2001-2006 was used. For future research catches the average ratio from offshore component of JARPN II during 2002-2006 was assumed. For future community-based whaling catches the average ratio from costal component of JARPN II during 2002-2006 was assumed. For future incidental catches the average ratio for the incidental catches in the period 2001 to 2006 was assumed.

By using past catch statistics by sub-areas and estimates of mixing rate of J stock and sex ratio of males described above, the past and future annual sex-disaggregated incidental catches from ‘O’ stock are estimated (Table 1). The past and future annual sex-disaggregated catches of this stock are shown in Table 2.

Abundance estimate

Abundance estimates in sub-areas 7, 8 and 9 were derived from the data collected by the dedicated sighting survey vessel (KS2) during 2006 JARPNII survey (see Appendix V). As for sub-areas 11 and 12, the estimates in 1999 and 2000 (IWC, 2004b) were used. As the areas covered by the survey were 54%, 77% and 70% of sub-areas 7, 8 and 9, respectively and therefore, abundance estimates in sub-areas 7, 8 and 9 were extrapolated for covering unsurveyed areas. The sum of the unextrapolated and extrapolated estimates in sub-areas 7, 8 and 9, and abundances in sub-area 11 and 12 were 19,795 (CV=0.253) and 23,349 (CV=0.286), respectively (Table 3). Both unextrapolated and extrapolated abundances were used for HITTER calculations. As it was done in previous HITTER examinations, the cases of the lower 5%-ile of the estimates were also examined.

g(0)

The SC agreed that $g(0)=0.5$ had higher plausibility than $g(0)=1$ (IWC, 2004a). However, it was assumed that $g(0)=1$ for conservative assessment.

***MSYR*(1+)**

Butterworth and Punt (2003) argued that *MSYR*(1+) in most baleen whale cases lay in the 3-6% range. For the present examination calculation was made for *MSYR*(1+) = 1-6%.

Biological parameters

In these HITTER computations the parameter values adopted by the *Implementation Simulation Trials* (IWC, 2004a), were used:

Age at recruitment (same for both sexes): 4 (50%) and 7.53 (95%)

Age at maturity (same for both sexes): 7 (50%) and 10.53 (95%)

Natural mortality (age-dependent and independent of sex):

$$
\begin{array}{ll}
0.085 & \text{if } a \leqq 4 \\
0.0775 + 0.001875\,a & \text{if } 4 < a < 20 \\
0.115 & \text{if } a \geqq 20
\end{array}
$$

where a is age.

MSY level (*MSYL*): 60% (of K)

The following years were chosen for the examination; 1988 (when commercial whaling ceased), 1994 (the start of JARPN surveys), 2007 (current year), 2017 (after ten years), 2027 and 2037.

RESULTS AND DISCUSSIONS

Results for HITTER runs for abundance estimates without and with extrapolation and for both the best estimate and its lower 5%-ile, are given in Table 4 and 5, respectively for *MSYR* (1+) = 1%, 2%, 3%, 4%, 5% and 6%. Figs. 1 and 2 show projection of depletion for 1+ component assuming abundance estimates without and with extrapolation and for both the best estimate and its lower 5%-ile, respectively. These tables and figures show depletion (the ratio of the population for the year indicated to the pre-exploitation level) for mature female and 1+ component. The population of the mature female and 1+ component increases for 30 years in all cases examined. Therefore, it is suggested that there will be no adverse impact on O stock of catches under proposed community-based whaling and JARPNII survey.

REFERENCES

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Table 1. Historical and future incidental catch for the O stock minke whales in the North Pacific from 1900.

year	Male	Female
1900-2000	5	7
2001	8	7
2002	10	9
2003	9	12
2004	6	9
2005	8	11
2006	12	10
2007+	9	10

Table 2. Historical catch from 1900 to 2006 and assumed future catch from the O stock of the minke whales in the North Pacific used in this study, including incidental catch.

Catch from subareas 7, 11, 8, 9 and 12		
year	male	female
1900-1929	5	7
1930	12	13
1931	12	13
1932	12	13
1933	12	14
1934	19	17
1935	19	17
1936	19	17
1937	37	32
1938	43	37
1939	43	37
1940	50	41
1941	37	32
1942	43	37
1943	62	51
1944	50	41
1945	43	37
1946	51	57
1947	59	68
1948	86	94
1949	78	69
1950	130	84
1951	118	127
1952	119	186
1953	120	126
1954	116	169
1955	171	215
1956	243	225
1957	167	202
1958	230	298
1959	128	165
1960	118	150
1961	150	195
1962	107	144
1963	101	131
1964	134	167
1965	132	192
1966	166	206
1967	116	166
1968	82	144
1969	79	146

(continued)		
year	male	female
1970	155	164
1971	146	128
1972	133	216
1973	268	251
1974	182	196
1975	179	156
1976	156	195
1977	166	92
1978	250	162
1979	267	137
1980	205	171
1981	221	149
1982	172	149
1983	143	148
1984	203	176
1985	197	134
1986	182	141
1987	187	129
1988	5	7
1989	5	7
1990	5	7
1991	5	7
1992	5	7
1993	5	7
1994	23	10
1995	96	16
1996	52	13
1997	92	20
1998	92	17
1999	53	19
2000	38	11
2001	96	14
2002	117	38
2003	118	44
2004	135	30
2005	143	64
2006	142	51

Future catch
(including incidental catch)

2007+	158	63

Table 3 abundance estimates in each sub-area and total. Extrapolated abundance estimate in sub-areas 7, 8 and 9 are also shown. The bottom column shows the lower 5% -ile of the total abundance estimates.

straum	year	P	CV	covarage	P/covarage	CV
SA7	2006	2,755	1.000	54.0%	5,102	1.000
SA8	2006	478	0.727	77.1%	620	0.727
SA9(35-45N)	2006	1,692	0.420	70.0%	2,418	0.420
SA9(North of 45N	2006	789	0.648	70.0%	1,128	0.648
SA7- 9 sub total	2006	5,714	0.510		9,268	0.569
SA11	2000	1,456	0.565		1,456	0.565
SA12	2000	12,625	0.317		12,625	0.317
total	2003	19,795	0.253		23,349	0.286
LL of 90%CI		13,132			14,729	

Table 4. The case where 220 minke whales (due to community-based whaling and JARPN II surveys) are caught from 2007 to 2036 taking the incidental catch into account without the extrapolation of abundance estimate in sub-areas 7, 8 and 9. Depletion is given for mature female and 1+ component.

Mature female component

a) Hit 2003 total (1+) population of 19,795 (best estimate)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (mature female)	6,694	5,723	5,225	4,995	4,891	4,842
Depletion - 1988	60.6%	64.2%	68.4%	72.4%	75.7%	78.2%
Depletion - 1994	64.8%	71.4%	77.8%	83.1%	87.0%	89.7%
Depletion - 2007	69.0%	80.2%	88.2%	92.7%	95.1%	96.3%
Depletion - 2017	70.2%	83.3%	90.3%	93.4%	94.9%	95.6%
Depletion - 2027	71.5%	85.8%	92.1%	94.5%	95.7%	96.4%
Depletion - 2037	72.7%	87.8%	93.1%	95.2%	96.2%	96.9%

b) Hit 2003 total (1+) population of 13,132 (lower 5%-ile)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (mature female)	5,336	4,404	3,831	3,506	3,342	3,267
Depletion - 1988	48.9%	50.2%	52.5%	56.1%	60.6%	64.7%
Depletion - 1994	53.3%	58.1%	63.6%	69.9%	76.2%	81.3%
Depletion - 2007	56.9%	68.0%	78.1%	86.0%	91.0%	93.6%
Depletion - 2017	57.4%	72.2%	82.9%	89.0%	91.9%	93.3%
Depletion - 2027	58.1%	76.2%	86.7%	91.3%	93.4%	94.6%
Depletion - 2037	58.9%	79.6%	89.1%	92.7%	94.4%	95.4%

1+ component

a) Hit 2003 total (1+) population of 19,795 (best estimate)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (1+)	27,950	23,896	21,817	20,854	20,423	20,219
Depletion - 1988	64.6%	71.4%	77.9%	83.3%	87.2%	90.0%
Depletion - 1994	67.9%	77.3%	85.2%	90.8%	94.2%	96.2%
Depletion - 2007	71.1%	83.8%	91.4%	94.9%	96.6%	97.4%
Depletion - 2017	71.5%	85.6%	92.1%	94.8%	96.1%	96.8%
Depletion - 2027	72.4%	87.4%	93.0%	95.2%	96.3%	97.0%
Depletion - 2037	73.5%	88.8%	93.7%	95.5%	96.5%	97.2%

b) Hit 2003 total (1+) population of 13,132 (lower 5%-ile)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (1+)	22,280	18,387	15,996	14,637	13,956	13,639
Depletion - 1988	53.0%	57.9%	63.6%	70.2%	76.6%	81.8%
Depletion - 1994	56.3%	64.6%	73.2%	81.4%	88.0%	92.4%
Depletion - 2007	58.9%	72.8%	83.7%	90.5%	94.0%	95.7%
Depletion - 2017	58.4%	75.6%	86.3%	91.5%	93.9%	95.1%
Depletion - 2027	58.8%	78.7%	88.7%	92.6%	94.4%	95.5%
Depletion - 2037	59.4%	81.5%	90.2%	93.2%	94.8%	95.7%

Table 5. The case where 220 minke whales (due to community-based whaling and JARPN II surveys) are caught from 2007 to 2036 taking the incidental catch into account with the extrapolation of abundance estimate in sub-areas 7, 8 and 9. Depletion is given for mature female and 1+ component.

Mature female component

a) Hit 2003 total (1+) population of 23,349 (best estimate)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (mature female)	7,457	6,492	6,029	5,825	5,734	5,690
Depletion - 1988	65.1%	69.2%	73.4%	77.1%	79.8%	81.9%
Depletion - 1994	69.2%	75.9%	81.9%	86.4%	89.5%	91.7%
Depletion - 2007	73.3%	83.9%	90.6%	94.2%	96.0%	96.9%
Depletion - 2017	74.5%	86.4%	92.1%	94.6%	95.7%	96.3%
Depletion - 2027	75.8%	88.4%	93.4%	95.4%	96.4%	97.0%
Depletion - 2037	77.1%	90.0%	94.3%	95.9%	96.8%	97.4%

b) Hit 2003 total (1+) population of 14,729 (lower 5%-ile)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (mature female)	6,694	5,723	5,225	4,995	4,891	4,842
Depletion - 1988	52.2%	54.2%	57.3%	61.4%	65.7%	69.3%
Depletion - 1994	56.6%	62.0%	68.1%	74.5%	80.1%	84.4%
Depletion - 2007	60.4%	71.9%	81.6%	88.5%	92.5%	94.6%
Depletion - 2017	61.2%	75.8%	85.5%	90.6%	92.9%	94.0%
Depletion - 2027	62.1%	79.4%	88.6%	92.4%	94.2%	95.2%
Depletion - 2037	63.1%	82.4%	90.5%	93.5%	95.0%	95.9%

1+ component

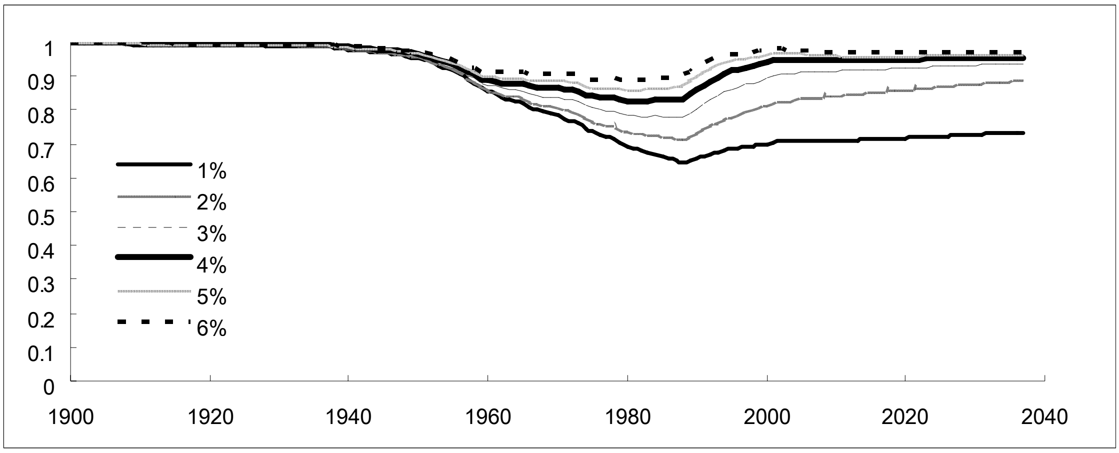
a) Hit 2003 total (1+) population of 23,349 (best estimate)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (1+)	31,136	27,105	25,175	24,321	23,940	23,757
Depletion - 1988	69.0%	75.9%	82.0%	86.6%	89.7%	91.9%
Depletion - 1994	72.2%	81.3%	88.3%	92.8%	95.5%	97.0%
Depletion - 2007	75.3%	87.0%	93.1%	95.9%	97.2%	97.8%
Depletion - 2017	75.8%	88.3%	93.6%	95.7%	96.7%	97.3%
Depletion - 2027	76.8%	89.7%	94.2%	96.0%	96.9%	97.5%
Depletion - 2037	77.9%	90.8%	94.7%	96.2%	97.1%	97.6%

b) Hit 2003 total (1+) population of 14,729 (lower 5%-ile)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (1+)	23,594	19,622	17,294	16,059	15,473	15,202
Depletion - 1988	56.3%	61.9%	68.2%	74.7%	80.5%	84.8%
Depletion - 1994	59.6%	68.5%	77.2%	84.9%	90.4%	93.9%
Depletion - 2007	62.5%	76.4%	86.4%	92.2%	95.0%	96.3%
Depletion - 2017	62.4%	78.9%	88.4%	92.7%	94.6%	95.7%
Depletion - 2027	63.0%	81.7%	90.2%	93.5%	95.0%	96.0%
Depletion - 2037	63.8%	84.0%	91.3%	94.0%	95.3%	96.2%

a) Hit 2003 total (1+) population of 19,795 (best estimate)



b) Hit 2003 total (1+) population of 13,132 (lower 5%-ile)

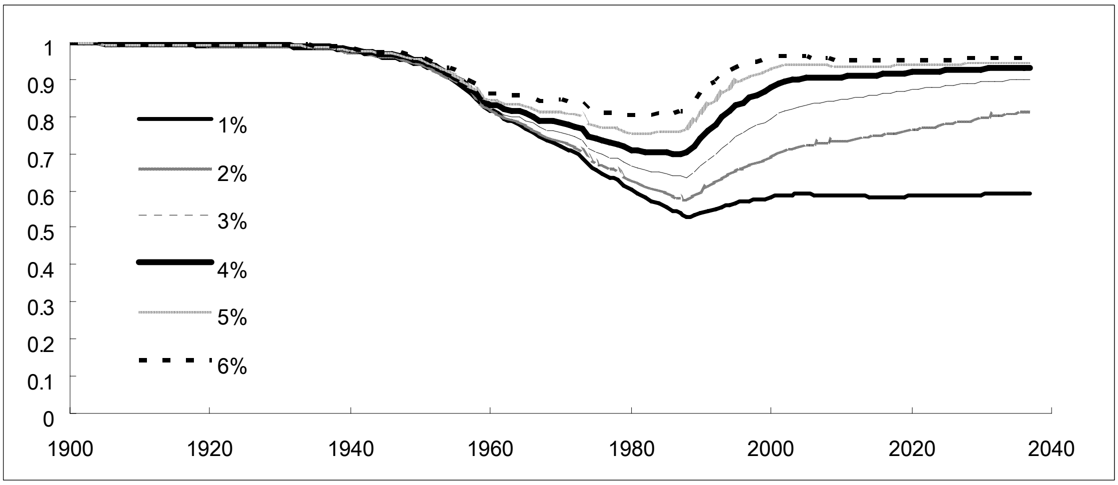
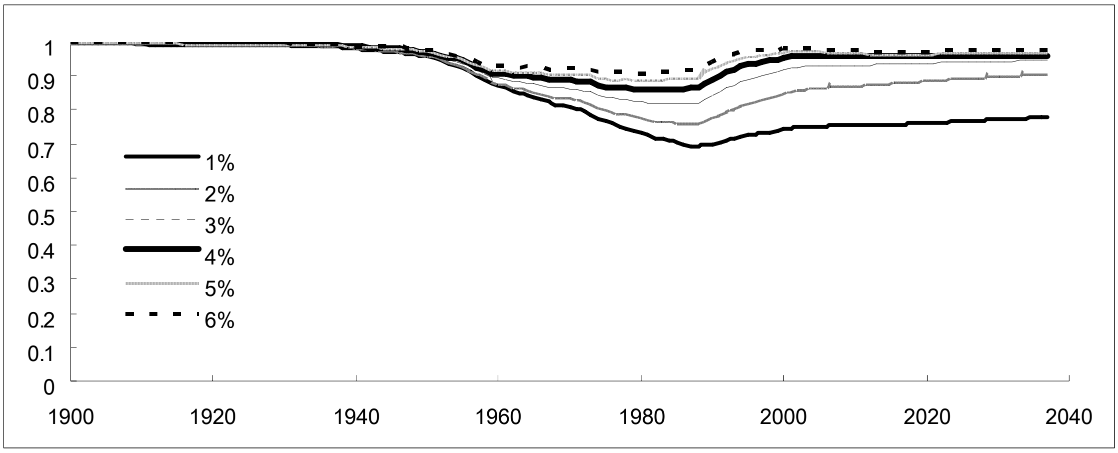


Fig. 1. Projection of depletion for 1+ component under HITTER calculation when unextrapolated abundance estimate is assumed.

a) Hit 2003 total (1+) population of 23,349 (best estimate)



b) Hit 2003 total (1+) population of 14,729 (lower 5%-ile)

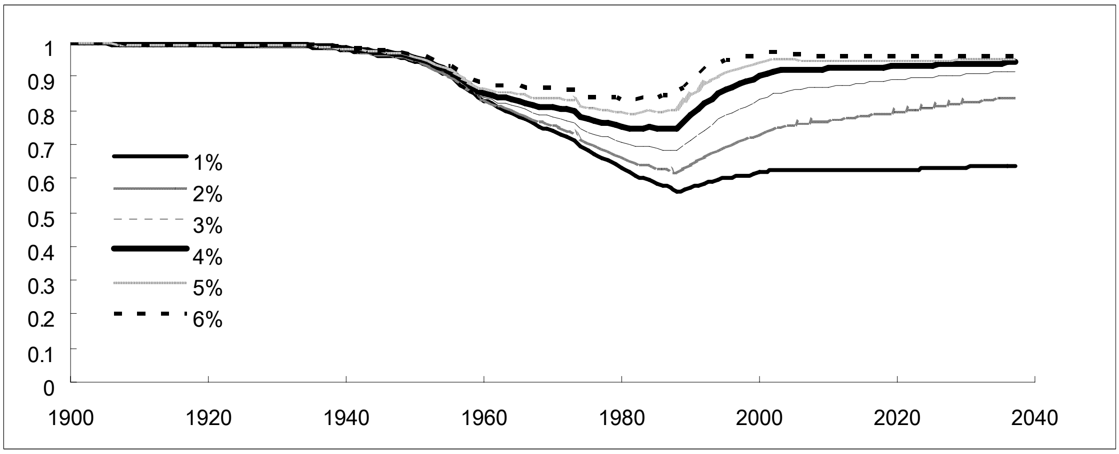


Fig. 2. Projection of depletion for 1+ component under HITTER calculation when extrapolated abundance estimate is assumed.

Appendix III

Mitochondrial DNA analysis of stock structure of western North Pacific common minke whales using samples from JARPN and JARPNII

INTRODUCTION

The IWC Scientific Committee (SC) completed the RMP *Implementation* for western North Pacific common minke whales during the 2003 Annual Meeting. At the final stage of the *ISTs* process the SC adopted the following stock scenarios and gave them the same ‘high’ plausibility (IWC, 2004).

(1) Baseline A: three-stock scenario (‘J’, ‘O’, ‘W’) with the ‘W’ stock found only in part of sub-area 9 and only sporadically.
(2) Baseline B: two stock scenario (‘J’ and ‘O’) with no W stock as a limiting case of Baseline A.
(3) Baseline C：four-stock scenario overall, with ‘O_W’, ‘O_E’ and ‘W’ to the east of Japan. Boundaries are fixed at 147°E and 157°E and there is no mixing between the stocks.
(4) Baseline D：three-stock scenario (‘J’, ‘O’, ‘W’), with ‘O’ and ‘W’ with O and W mixing over 147°E and 162°E, O being dominant to the west and W to the east.

In this study the plausibility of these four stock structure scenarios is examined through the genetic analysis of samples collected by JARPN and JARPNII from 1994 to 2006. Therefore this analysis include new samples collected between 2003 and 2006, which were not used during the previous *ISTs* process.

MATERIALS AND METHODS

During the *IST* Specification conducted in 2003, eighteen sub-areas were established for management purpose of the western North Pacific common minke whale (Fig.1). Sub-areas 7, 8 and 9 were divided into western and eastern strata by 147°E, 157°E and 162°E, respectively. Table 1 shows the number of samples used in the present mtDNA analysis by year, sub-area and the offshore and coastal components of JARPN II.

The randomized chi-square Test of Independence was used to investigate the temporal/spatial differentiation of mtDNA variation. In each test a total of 10,000 permutations of the original data was performed.

RESULTS AND DISCUSSION

Table 2 shows the results of the heterogeneity test for the comparison between samples taken in 7W by coastal and offshore components of JARPN II, by year. Since none of the comparison showed significant mtDNA differences, we combined coastal and offshore samples in 7W for subsequent analyses.

Table 3 shows the results of the heterogeneity test for yearly differentiation in each sub-area. Some year groups were omitted from this analysis because of small sample sizes (less than 10 individuals). No significant yearly differences were found within each sub-area.

Baseline A

Baseline A is three-stock scenario (‘J’, ‘O’, ‘W’) with the ‘W’ stock found only in part of sub-area 9 and only sporadically. In order to test the heterogeneity within sub-area 9, we compared the samples collectd in the western and eastern sides of sub-area 9, by year. No significant differences were found except for year 2003. There was no significant difference between western and eastern sides of sub-area 9 using total samples (Table 4).

Baseline C

Baseline C is four-stock scenario overall, with ‘O_W’, ‘O_E’ and ‘W’ to the east of Japan. Boundaries are fixed at 147°E and 157°E and there is no mixing between the stocks. Table 5 shows the results of heterogeneity test for samples divided according to this scenario (e.g. samples divided by the longitudinal boundaries at 147°E and 157°E). No significant differences were found.

Baseline D

Baseline D is three-stock scenario (‘J’, ‘O’, ‘W’), with ‘O’ and ‘W’ mixing over 147°E and 162°E, O being dominant to the west and W to the east. We examined the genetic differences among three groups divided by the longitudinal boundaries at 147°E and 162°E. Previously, heterogeneity test was conducted among samples from 7E, 8W, 8E and 9W, and there was no significant difference among these samples (P=0.0789). As shown in Table 6, overall significant differences were found, which was due to the comparison between 7W and 7E-9W samples.

In Appendix I it was shown that some J-stock animals migrate to the coastal region of Pacific side of Japan (sub-area 7W) and that the mixing proportion of J-stock animals in the coastal region was higher than that in the offshore region. As shown in Table 7, no significant difference was found among three groups when samples within 10 n. miles from coastal line in sub-area 7W were excluded. This result suggested that significant heterogeneity detected among three samples (Table 6) were caused by some J-stock animals occurring in the coastal region of sub-area 7W. Furthermore it is noted that there was no significant between samples from 7W and 9E which were representative samples for ‘O’ and ‘W’ stocks in Scenario D.

In conclusion the results of this updated analysis supported Scenario B, while Scenarios A, C and D are not supported.

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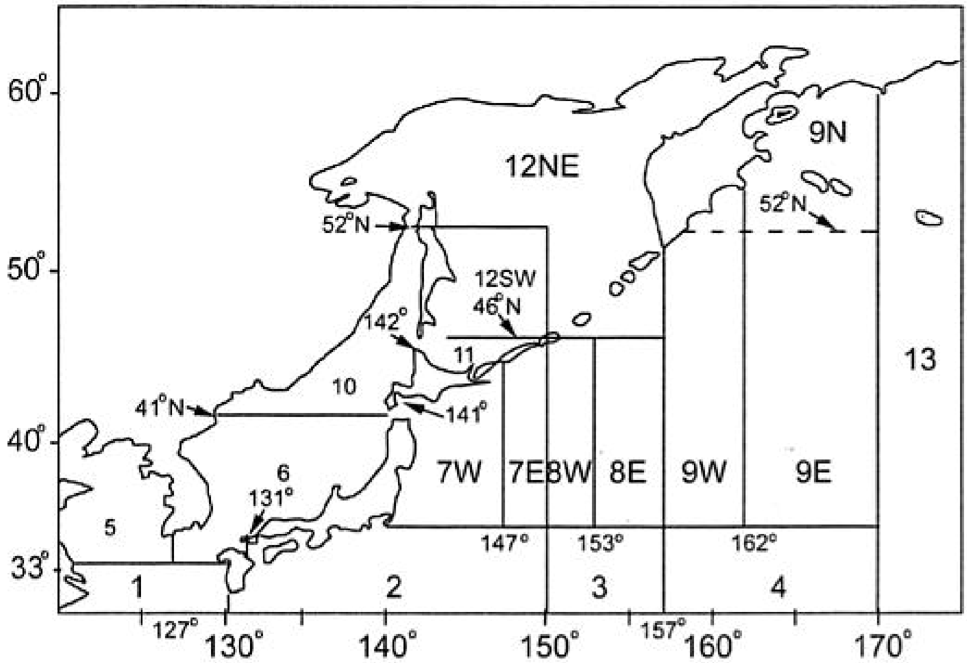

Fig. 1. The 18 sub-areas used for the *Implementation Simulation Trials* for North Pacific minke whales.

Table 1. Sample size used in this study by year, sub-area and offshore (A) and Coastal (B) components of JARPN II.

A) Offshore

Year	7W	7E	8W	8E	9W	9E	Total
1994					7	14	21
1995					78	22	100
1996	31		1	15			47
1997	2		1	30	19	48	100
1998	25	31	44				100
1999	50						50
2000	24				16		40
2001	43	7		21	29		100
2002	60			8	32		100
2003	17	7	21	17	24	14	100
2004	16				42	42	100
2005	32		6	7	19	30	94
Total	300	45	73	98	266	170	952

B) Coastal

Year	7W
2002	50
2003	50
2004	59
2005	119
2006	95
Total	373

Table 2. Statistical comparison between offshore and coastal samples in sub-area 7W, by year

	Sample size		
	Offshore	Coastal	P
2002	60	50	0.1726
2003	17	50	0.1369
2004	16	59	0.2813
2005	32	119	0.2326

Table 3.Yearly comparison within each sub-area

Sub-area	Year	Sample size	P
7W	1996	31	0.3603
	1998	25	
	1999	50	
	2000	24	
	2001	43	
	2002	110	
	2003	67	
	2004	75	
	2005	151	
	2006	95	
8W	1998	44	0.3544
	2003	21	
8E	1996	15	0.5855
	1997	30	
	2001	21	
	2003	17	
9W	1995	78	0.283
	1997	19	
	2000	16	
	2001	29	
	2002	32	
	2003	24	
	2004	42	
	2005	19	
9E	1994	14	0.4097
	1995	22	
	1997	48	
	2003	14	
	2004	42	
	2005	30	

Table 4. Statistical comparison between 9W and 9E, by year.

	Sample size		
	9W	9E	P
1994	7	14	0.5425
1995	78	22	0.1031
1997	19	48	0.8581
2003	24	14	0.0361
2004	42	42	0.3468
2005	19	30	0.4563
Total	266*	170	0.1411

*:including 2000, 2001 and 2002 samples, years in which samples were absent or in small numbers in 9E.

Table 5. Statistical comparison among samples from 7W, 7E-8E and 9W- 9E (Boundary at 147°E and 157°E).

Combination of simples	P
7E (n=45) * 8W (n=73) * 8E (n=98)	0.2757
9W (n=266)* 9E (n=170)	0.1411
7W (n=671)* 7E-8E (n=216)* 9W-9E (n=436)	0.1136

Table 6. Statistical comparison among samples from 7W, 7E-9W and 9E (Boundary at 147°E and 162°E).

Overall P value among samples: P=0.0459

	7E-9W (n=482)	9E (n= 170)
7W (n= 671)	0.0273	0.1576
7E-9W		0.5038

Table 7. Statistical comparison among 7W, 7E-9W and 9E.

Samples within 10 n. mails from coastal line in sub-area 7W were excluded.

Overall P value among samples: P=0.1102

	7E-9W (n=482)	9E (n=170)
7W (n=562)	0.0932	0.3116
7E-9W		0.5074

Appendix IV

An Assessment of Plausibility of Sub-Stock Scenarios on Western North Pacific Minke Whales Using the Historical CPUE series

ABSTRACT

The aim of this article is to investigate the plausibility of different stock structure scenarios on western North Pacific minke whales proposed in *Implementation Simulation Trials* (IST) of *Revised Management Procedure* (RMP). To provide an independent assessment of the plausibility, we used CPUE time series data, which were not used in IST. Using a simple Bayesian population dynamics model, we showed that the posterior confidence interval (CI) of the depletion rate contained that of initial depletion statistics of Stock Scenario A wholly. On the other hand, the confidence intervals of Stock Scenarios C and D were not included in the CI derived from the model. As a result, we conclude that the plausibility of Stock Scenarios C and D is much lower than that of Stock Scenario A on the assumption that CPUE is proportional to population abundance. The conclusion is supported even under square root nonlinearity of the relationship between CPUE and abundance.

1. INTRODUCTION

Implementation Simulation Trials (IST) of western North Pacific minke whales have four 'baseline' trials based on different stock structure scenarios, in which Baselines A and B have fewer stocks or simpler stock structure than Baselines C and D. Baseline A is the scenario with three stocks, J, O, and W, in which W-stock occurs sporadically in sub-area 9. Baseline A was derived from analysis of mt-DNA data by Japanese scientists. Baseline B is the same as Baseline A with no W-stock. Baseline C is the scenario with four stocks, J, Ow, Oe, and W, where the existence of Ow and Oe stocks was inferred by the boundary rank method. Baseline D is the scenario with three stocks, J, O, and W, where O and W-stocks are mixing among the whole sub-areas of western North Pacific. We hereafter refer to the stock structure scenario associated with each Baseline as 'Hypothesis'. See the details on pages 118-119 of JCRM 6 (Supplement) (IWC, 2004).

Hypotheses C and D predict the considerable decline of O or Ow stock in terms of initial depletion statistics of IST (IWC, 2004). For example, in the C1-J1 O trial, the 90% confidence interval of initial depletion is [0.25, 0.42] with the median value, 0.33. Kawahara (2003) pointed out that plausibility of Hypotheses C and D was lower than that of Hypotheses A and B using the historical catch per unit effort (CPUE) time series data, which were not used in IST and the result therefore was an assessment of plausibility of the different stock structure hypotheses independent from IST. In this article, we provide a more refined assessment of the CPUE time series data, especially in terms of statistical inference.

2. MATERIALS AND METHODS

2.1. The Data

Basic datasets are same as Kawahara (2003). Although Kawahara (2003) showed main results using the uncorrected CPUE time series data, we use the CPUE time series data with the effort data corrected for vessel tonnage effects. The corrected effort might overcompensate for the changes in efficiency (Kawahara, 2003). However, for our purpose, overcompensation is less problematic than undercompensation.

As in Kawahara (2003), we use the CPUE series from three periods 1955-1964 (Period 1), 1968-1977 (Period 2), and 1977-1987 (Period 3). Periods 1 and 2 series were corrected for the total vessel tonnage while Period 3 series was not corrected. Because there was no big change in the vessel tonnage between 1977 and 1987, this may be not so much problematic. We use three CPUE time series with Areas 3, 4, and 7 data derived from Anderson and Weaver (1991) as the independent time series data of Period 3. The plots of the CPUE time series data for each Period are shown in Fig. 1.

2.2. Model

A state-space model enables us to deal with natural variability underlying the annual population dynamics transitions (process error) and uncertainty in the observed abundance indices due to measurement and sampling error (observation error) distinguishably (Meyer and Millar, 1999). We use a state-space model to incorporate the intrinsic uncertainty as much as we can appropriately.

For the state equation, we use a population dynamics model with a simple exponential increasing rate:

$$N_{t+1} = N_t \exp(\lambda_t)$$

where $\lambda_t \sim N(\bar{\lambda}, \tau^2)$, in which $\bar{\lambda}$ is the mean increasing rate of population. It is possible to avoid making any extra assumptions using the simple model like this.

The observation equations are given by

$$I_{i,a,t} = q_i N_t \exp(\sigma_{i,a,t})$$

where q_i is the fishing efficiency of Period i, a denotes the corresponding area (a = 3,4,7 for Period 3. If Period is 1 or 2, a is omitted), and $\sigma_{i,a,t} \sim N(0, \nu_{i,a}^2)$.

We use a Bayesian approach to infer parameters because the Bayesian approach can easily handle nonlinearities of state and observation equations and realistic distributional assumption of each parameter (Meyer and Millar, 1999).

As prior distributions of each parameter, we use the following ones:

$\log(N_{1955}) \sim \mathrm{U}(8, 11)$ (This corresponds to $N_{1955} \in [3,000, 60,000]$),

$\bar{\lambda} \sim \mathrm{N}(0, 10^6)$,

$\log(q_i) \sim \mathrm{U}(-20, 20)$,

$1/\nu_{i,a}^2 \sim \text{Ga}(0.001, 0.001),$

$1/\tau^2 \sim \text{Ga}(0.001, 0.001),$

where we use approximately noninformative priors for the parameters except for $\log(N_{1955})$ and uniform distributions for the logarithms of scale parameters according to the custom of Bayesian population dynamics models (Punt and Hilborn, 1997; McAllister and Kirkwood, 1998). For $\log(N_{1955})$, we use a mildly informative prior distribution to stabilize estimation. The informative prior is set within 3,000 to 60,000 with reference to the existing information (IWC, 2004; Butterworth, 1996; Hakamada, 2004). Note nevertheless that as there is no scale information input to these analyses, because all the CPUE series are treated as relative indices and there are no catches or survey estimates of abundance used, the specific choice of the prior for $\log(N_{1955})$ will hardly affect results.

The inference is carried out using WinBUGS (Spiegelhalter et al., 2003), which produces the posterior samples using the Gibbs sampler (Gelfand and Smith, 1990). We use the 5 MCMC sequences with different initial parameter values to diagnose the convergence and the MCMC simulation for each sequence is repeated 35,000 times. We remove the first 5,000 iterations as the burn-in samples.

The posterior distribution of depletion $D_{2000} = N_{2000}/N_{1955}$ is compared with the initial depletion statistics of IST. We use N_{1955} as the initial population size, while IST used the catch statistics prior to 1955. However, the catches prior to 1955 would have made little impact on the population abundance, so the comparison whould not be much affected by the model not covering the pre-1955 period, as is evident from inspection of IST trajectories shown in IWC (2004). We use the results of O trials with $\text{MSYR}_{\text{mature}} = 1\%$ for comparison, since they are one of Basecase trials of North Pacific minke whales IST and have a big impact on the performance statistics for the O stock (IWC, 2004). In addition, we carry out two sensitivity tests, where one is done by removing the Period 1 CPUE dataset, which is considered the least reliable among three periods, and another is done by assuming the CPUE time series is proportional to the square root of population size to take into account the case that the changes in CPUE are proportionally smaller than changes in abundance. We call the former test the 'DR' trial, and the latter test the 'NP' trial (DR = Data Reduction, NP = Non-Proportionality).

3. Results

The trace plots of each parameters indicated the convergence and the $\hat{R}$ statistics of all the parameters was less than 1.1. When $\hat{R}$ is near 1, we can generally think that the analysis is acceptable in terms of convergence of MCMC simulations (Gelman et al., 2004). We repeated the analyses with different initial values several times so that we got almost identical results from every run. We therefore judged that we had the converged posterior samples.

The estimated population trend $\bar{\lambda}$ was 0.01 at the median value (90% posterior confidence interval [-0.016, 0.031]). The depletion D_{2000} was estimated to be 1.56 at the median value (90% CI [0.56, 3.31]). The observation errors $\nu_{i,a}$s were within 0.13 and 0.24 and the process error was 0.05 at the median. The summary of estimated main parameters was given in Table 1.

The plots of depletion D_{2000} were shown in Fig. 2 with trajectories of 5%-ile, 25%-ile, and 50%-ile. For comparison, we attached the confidence intervals of initial depletion statistics in the J1 O trials with $\mathrm{MSYR}_{\mathrm{mat}} = 1\%$ of Hypotheses A, C, and D (IWC, 2004). The 90% confidence intervals of J1 O trials with $\mathrm{MSYR}_{\mathrm{mat}} = 1\%$ were [0.70, 0.83], [0.25, 0.42], and [0.29, 0.47] for Hypotheses A, C and D, respectively (IWC, 2004). Because the result of Hypothesis B was omitted in IST in 2003, we do not mention the result of Hypothesis B. However, as Hypothesis B involves only one stock to the east of Japan, its results will be more optimistic than even those for Hypothesis A. The confidence interval of initial depletion of Hypothesis A was included in the 90% confidence interval of depletion D_{2000}, while those of Hypotheses C and D were not included in it. It is worth while mentioning that if the full range of C and D robustness trials is considered, only in a very few cases is there slight overlap with 90% confidence interval for depletion D_{2000}.

The summary statistics of sensitivity tests was given in Table 2. We can see that the lower limits of depletion of each sensitivity test declined to some extent. The plots from the sensitivity tests were shown in Figs. 3 ('DR' trial) and 4 ('NP' trial). The lower limits of trajectories in two plots were similar. The confidence interval of initial depletion of Hypothesis A was within the confidence intervals of depletion D_{2000}. On the other hand, the lower limits of confidence intervals of depletion D_{2000} slightly overlapped with the upper limits of initial depletion statistics of Hypotheses C and D, while most values of initial depletion statistics of Hypotheses C and D, which included the median values, were still outside the confidence intervals of depletion D_{2000}.

4. Discussion

Historically, there was a lot of discussion on the proportional relationship between CPUE and population size in fisheries circles including the International Whaling Commission (Cooke, 1985; IWC, 1989a). We also have to acknowledge our analysis to be of an initial nature. However, we believe that the CPUE series could give us valuable information on the status of stocks if we are sufficiently cautious about uncertainty of relationship between CPUE and stock size.

Cooke (1985) pointed out that proportionality between CPUE and population abundance did not hold giving a number of reasons, mainly on the theoretical basis. Some hold true for North Pacific minke whales but some do not. North Pacific minke whales are very difficult to detect and most of sightings are composed of a single animal. The former may cause variations in catchability and handling time so that CPUE is not proportional to stock size, while the latter removes some important impacts such as schooling effects. We incorporated observation and process errors into our model to deal with uncertainty as reasonably as we can. In addition, we carried out the sensitivity test in which CPUE is proportional to the square root of abundance. Although there is a degree of arbitrariness in choosing the square root dependence for the sensitivity test, it is worth noting that when CPUE data were included in the early RMP trials (IWC, 1989b), this was the alternative to linear proportionality chosen to be considered by the Scientific Committee, and further that Rose and Kulka (1999) showed that CPUE of northern cod, which might have been considerably hyperstable because of shoaling effects, was approximately proportional to the square root of local density.

We made efforts as many as we can at present to take account of uncertainty. For example, the use of corrected CPUE time series, incorporating observation and process errors, and carrying out a few sensitivity tests. Nevertheless, our analyses gave the impression that the stock decline of Hypotheses C and D is too extreme to be realistic. In addition, we used the exponential trend in our analysis to continue until 2000, whereas in reality catches were reduced substantially after 1987 because of the moratorium of commercial whaling, so that any negative trend the model caused from 1988 to 2000 may well have been overestimated by our approach which used the data up until 1987 only. So, our approach is likely to overestimate the extent of population decline. As a result, we conclude that the plausibility of Hypotheses C and D is much lower than that of Hypothesis A and hence it is unnecessary to consider stock scenarios C and D when accounting for the effect of catches on the O stock.

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Table 1. The 5%-ile, 25%-ile, and 50%-ile of posterior distribution of $\bar{\lambda}$ and D_{2000} under the basecase trial

	5%-ile	25%-ile	50%-ile
$\bar{\lambda}$	-0.016	0.001	0.010
D_{2000}	0.556	1.086	1.563

Table 2. The 5%-ile, 25%-ile, and 50%-ile of posterior distribution of $\bar{\lambda}$ and D_{2000} under the 'DR' trial

	5%-ile	25%-ile	50%-ile
$\bar{\lambda}$	-0.027	-0.004	0.010
D_{2000}	0.405	0.891	1.538

Table 3. The 5%-ile, 25%-ile, and 50%-ile of posterior distribution of $\bar{\lambda}$ and D_{2000} under the 'NP' trial

	5%-ile	25%-ile	50%-ile
$\bar{\lambda}$	-0.028	0.001	0.018
D_{2000}	0.411	1.165	2.320

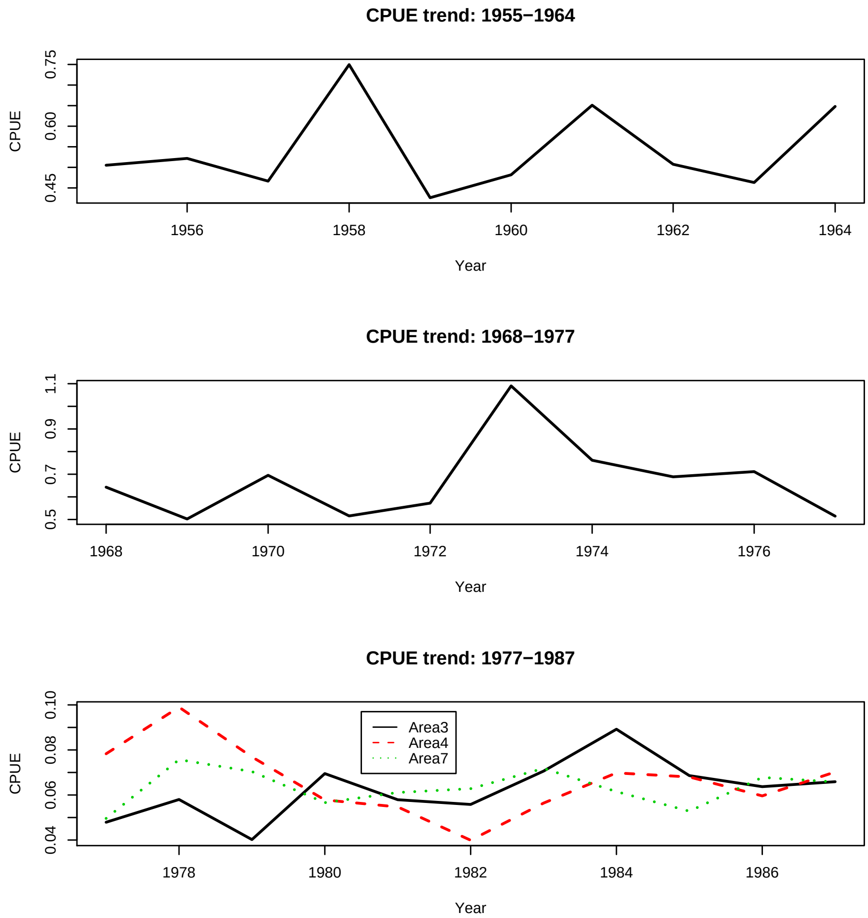

Figure 1. The CPUE time series data corrected for vessel tonnage effects used in the analysis.

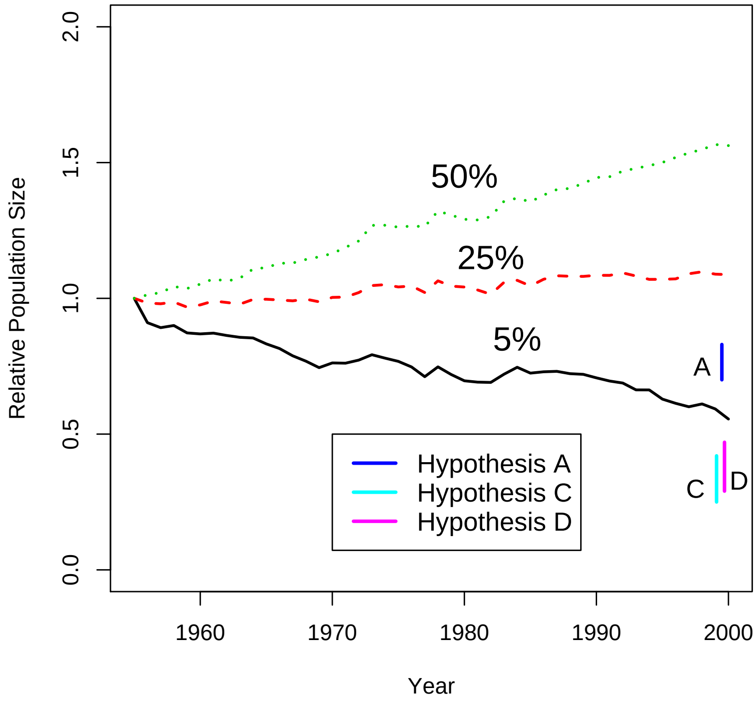

Figure 2. Comparison between 90% CIs of the depletion from the analysis in this article and initial depletion statistics under the Basecase trial for $\text{MSYR}_{\text{mat}} = 1\%$.

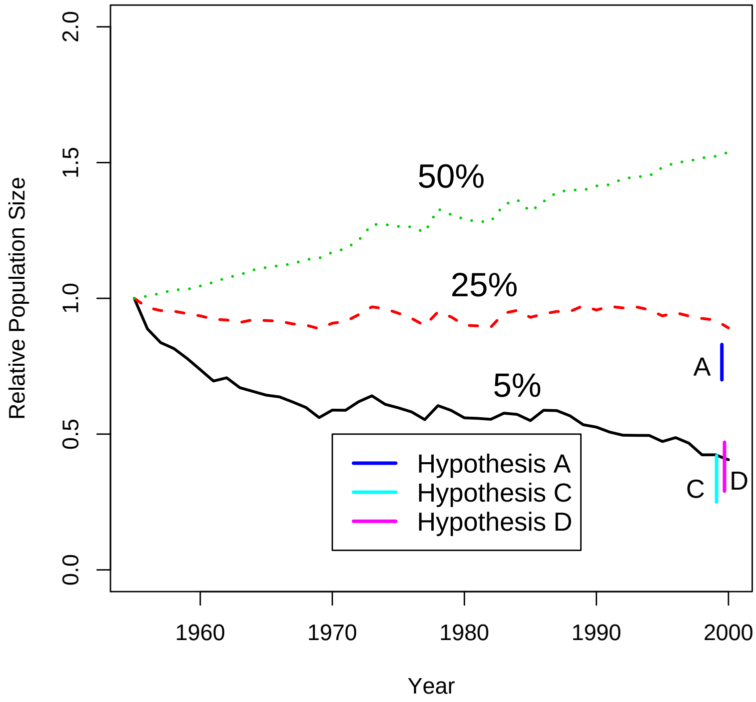

Figure 3. Comparison between 90% CIs of the depletion from the analysis in this article and initial depletion statistics under the ‘DR’ trial for $\mathrm{MSYR_{mat}} = 1\%$.

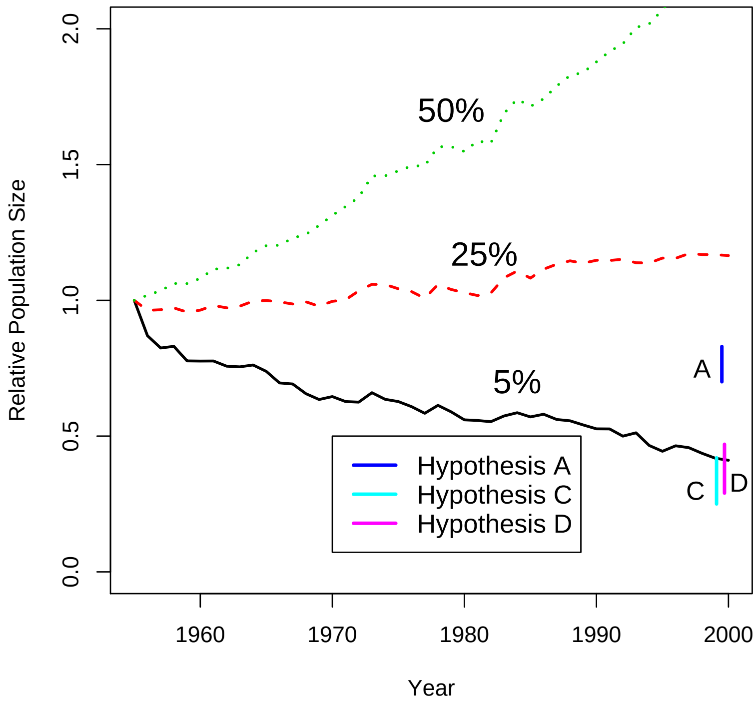

Figure 4. Comparison between 90% CIs of the depletion from the analysis in this article and initial depletion statistics under the 'NP' trial for $\mathrm{MSYR_{mat}} = 1\%$.

Appendix V

Abundance estimate for western North Pacific common minke whale in sub-areas 7, 8 and 9 based on JARPN II sighting data

ABSTRACT

Abundances of western North Pacific common minke whale in sub-areas 7, 8 and 9 were estimated using sighting data collected by the dedicated sighting vessel (KS2) during the 2006 JARPNII survey. In the estimations it was assumed that $g(0)=1$. The abundance estimates in sub-areas 7, 8 and 9 was 5,700 animals (CV=0.510) in total. Abundance estimates in sub-areas 7, 8 and 9 were extrapolated for covering unsurveyed areas (mainly Russian EEZ). The extrapolated abundance estimate was 9,300 (CV=0.569).

MATERIALS AND METHODS

Sighting survey

Sighting data collected by the dedicated sighting vessel (KS2) in 2006 JARPNII survey were used. The sighting survey was conducted in closing mode. The survey area is shown in Fig. 1. The cruise tracks and the primary sighting position of the common minke whales are shown in Fig. 2. As shown in this figure tracklines were allocated uniformly within each stratum. See Tamura *et al*. (2007) for details of the 2006 JARPN II survey,

Abundance estimation method

The ‘standard methodology’ adopted by the IWC (Branch and Butterworth, 2001) and implemented in the program DISTANCE (Buckland *et al*., 1993) was used in the present study.. The following formula was used:

$$P = \frac{AE(s)n}{2wL} \qquad (1)$$

where,

P = abundance in numbers

A = area of the stratum

$E(s)$ = estimated mean school size

n = numbers of schools (primary sightings)

w = effective search half-width for schools

L = searching distance (n. miles)

Then CV of P was calculated for each stratum using the following formula:

$$\mathrm{CV}(P)=\sqrt{\left\{\mathrm{CV}\left(\frac{n}{L}\right)\right\}^2+\{\mathrm{CV}(E(s))\}^2+\{\mathrm{CV}(w)\}^2} \qquad (2)$$

where variance of (n /L) was calculated by

$$Var\left(\frac{n}{L}\right)=\sum_{j}^{k_i}\frac{1}{(k-1)}\left(\frac{L_j}{L}\right)^2\left(\frac{n_j}{L_j}-\frac{n}{L}\right)^2 \qquad (3)$$

where k is the number of legs and j is an index of legs. Assuming abundance is log-normally distributed, 95% confidential interval of the abundance estimate was calculated as (P/C, CP);

$$C=\exp(Z_{0.025}\sqrt{\log_e[1+\{\mathrm{CV}(P)\}^2]}) \qquad (4)$$

where $Z_{0.025}$ represents 2.5-percentage point of standard normal distribution. See Buckland *et al*. (1993) and Branch and Butterworth (2001) for more details.

Distance and angle estimation experiment

To correct for biases in distance and angle estimations, a distance and angle estimation experiment was conducted. This was done for each sighting platform. Linear regression models with standard error proportional to true (radar) distance were conducted to detect significant bias of estimated distance at 5% level. In order to correct for significant bias, estimated distance was divided by the estimated slope through the origin. Linear regression models with constant variance were conducted to detect significant bias of estimated angle at 5% level. In order to correct significant bias, estimated angle was divided by the estimated slope through the origin.

Smearing and truncation

The radial distance and angle data for each sighting were smeared using the Method II of Buckland and Anganuzzi (1988). Smearing parameters used for angle and distance were 6.000 and 0.214, respectively. After smearing, the perpendicular distance was truncated at 1.5 n.miles. The smeared and truncated number of detections was substitute to formula (1).

Effective search half-width

Hazard rate model with no adjustment terms was used as a detection function. It was assumed that $g(0)=1$. Effective search half-width was estimated from data for all strata combined.

Mean school size

Only the sightings for which school sizes were confirmed were used for the estimation. We used the method of estimation described in Buckland *et al*. (1993). Regression of log of school size on $g(x)$ was conducted to estimate mean school size. If the regression coefficient was not significant at the 15% level, mean of observed school size for sightings within the truncation distance of 1.5 n.miles was substituted to formula (1). Mean school size was estimated from data for all strata combined.

Extrapolation of abundance estimate to unsurveyed area.

In the JARPNII Russian EEZ are not covered by the survey. We made extrapolation of abundance using density data to cover the unsurveyed area. The National Research Institute of Far Seas Fisheries (NRIFSF) conducted sighting surveys in Russian EEZ in 2005 and density/encounter rate were estimated for both Russian EEZ and high seas, respectively (Miyashita, 2006). Fig. 3 shows the trackline and sighting position (including secondary sightings) of the minke whales. The estimate is shown in Table 1. In this study, we adopted two assumptions. One is that the density in Russian EEZ is same as that in high seas as the most conservative case and the other is that the ratio of density in Russian EEZ to high seas is 2.3.

RESULTS AND DISCUSSIONS

Abundance estimates in sub-areas 7, 8 and 9 are shown in Table 2. Plot of detection function is shown in Fig. 4. The fit of the detection function seems to be good. The extrapolated abundance in sub-areas 7, 8, 9 and the total abundance estimate, are shown in Table 3. Estimates in sub-areas 11 and 12 are the same as in IWC (2004).

The abundance estimate in this analysis is considered conservative. This is because we assumed $g(0)$=1 and because the correction method in Haw (1991) was not applied because the surveys were conducted only in closing mode.

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Table 1. Ratio of density index (the number of primary sightings per 100 n. miles) in Russian EEZ to that in high seas based on cetacean sighting surveys in 2005 (Miyashita, 2006).

	EEZ	high seas	ratio
Density index (sch./100n. miles)	0.26	0.11	2.3

Table 2. Abundance estimate in sub-areas 7, 8 and 9 with their CV based on sighting data of KS2 during 2006 JARPNII survey.

straum	Area	n	L	n/L	CV	ESW	CV	E(s)	CV	D	P	CV
SA7	131,047	23.4	1135.90	0.021	0.946	0.580	0.319	1.19	0.051	0.021	2,755	1.000
SA8	162,214	3.0	1039.10	0.003	0.651	0.580	0.319	1.19	0.051	0.003	478	0.727
SA9(35-45N)	357,755	10.8	2328.60	0.005	0.269	0.580	0.319	1.19	0.051	0.005	1,692	0.420
SA9(North of 45N)	140,568	5.0	910.06	0.005	0.562	0.580	0.319	1.19	0.051	0.006	789	0.648
total	791,584	42.2	5413.66	0.008						0.007	5,714	0.510

Table 3. Extrapolated abundance estimate in sub-areas 7, 8 and 9 and total abundance in sub-areas 7, 8, 9, 11 and 12 in total. Abundance estimate in sub-area 11 and 12 are the same as in IWC (2004).

straum	year	P	CV	covarage	P/covarage	CV	ratio 2.3	CV
SA7	2006	2,755	1.000	54.0%	5,102	1.000	8,262	1.000
SA8	2006	478	0.727	77.1%	620	0.727	811	0.727
SA9(35-45N)	2006	1,692	0.420	70.0%	2,418	0.420	3,395	0.420
SA9(North of 45N	2006	789	0.648	70.0%	1,128	0.648	1,583	0.648
SA7-9 sub total	2006	5,714	0.510		9,268	0.569	14,052	0.603
SA11	2000	1,456	0.565		1,456	0.565	1,456	0.565
SA12	2000	12,625	0.317		12,625	0.317	12,625	0.317
total	2003	19,795	0.253		23,349	0.286	28,133	0.334
LL of 90%CI		13,132			14,729		16,473	

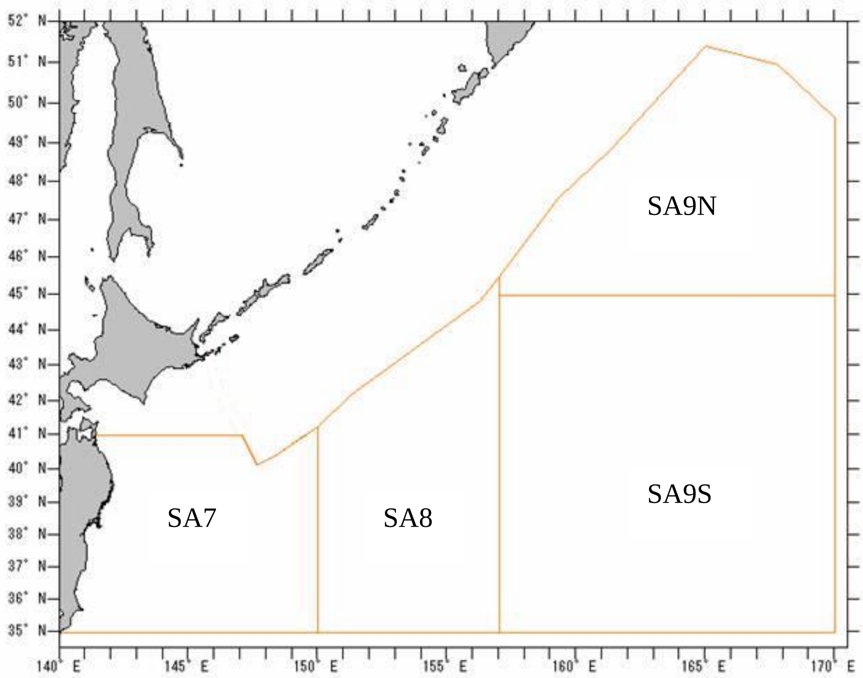

Fig. 1. Survey strata in the 2006 JARPNII offshore component survey. SA is abbreviation for sub-area.

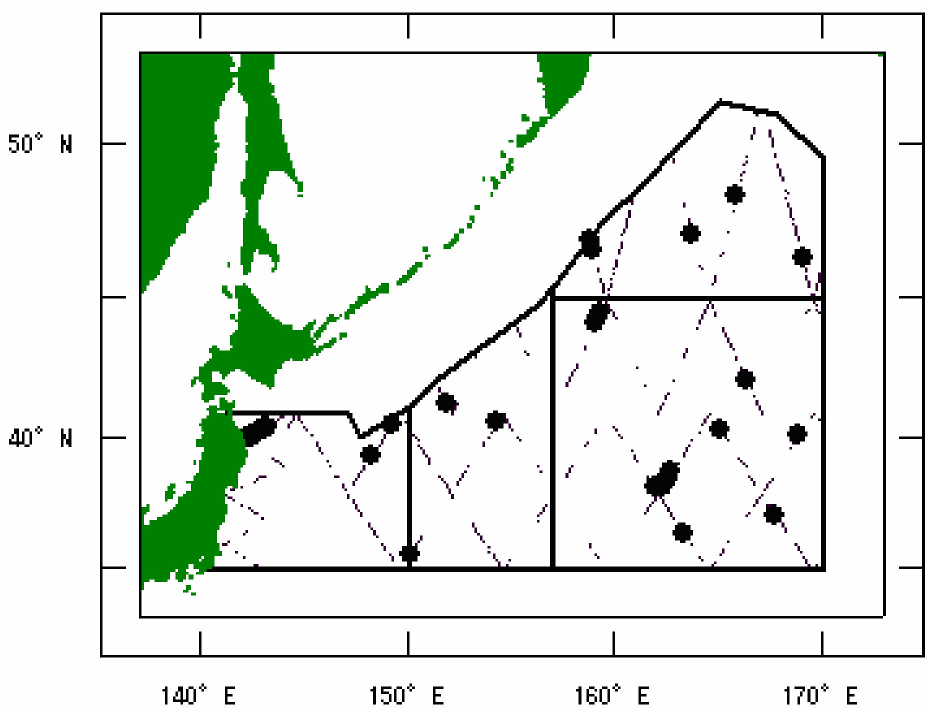

Fig. 2. Tracklines of the dedicated signting survey vessel (KS2) in the 2006 JARPN II survey showing the geographical distribution of searching effort and primary sightings for the common minke whales.

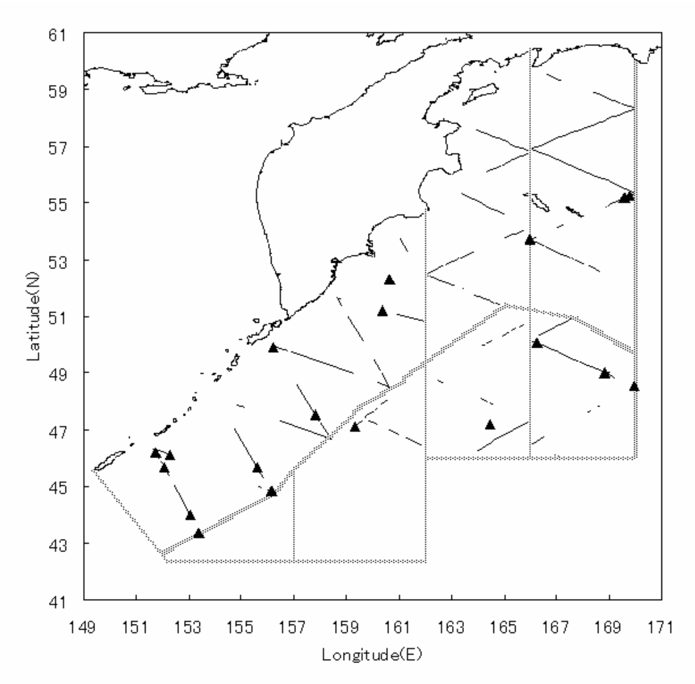

Fig 3. Sighting (including secondary sightings) positions of common minke whale (Miyashita, 2006).

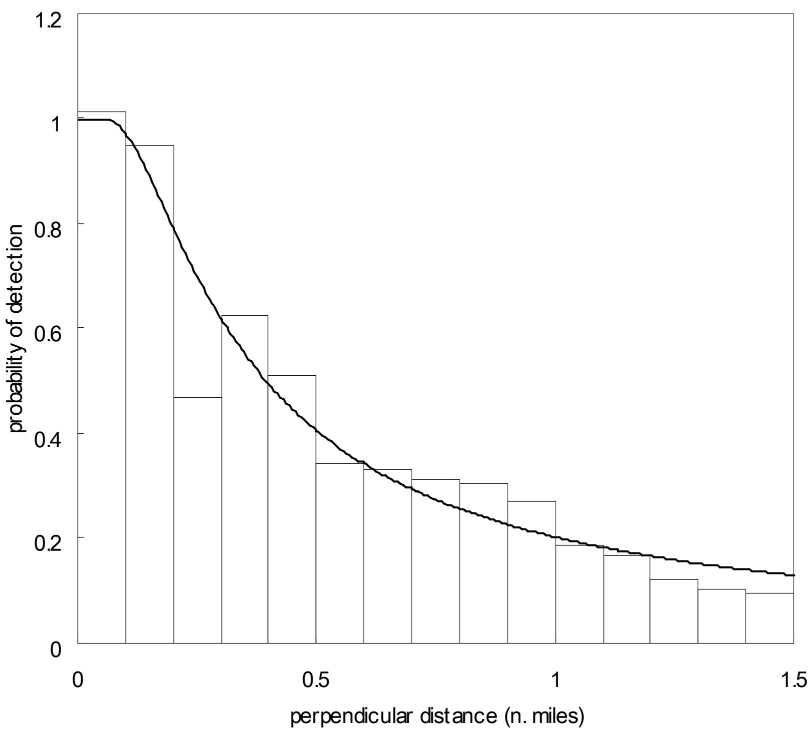

Fig. 4. Plot of detection function and distribution of perpendicular distance of the sightings.

Appendix VI

Examination of the effects of future catches on ‘J’ stock common minke whales

ABSTRACT

Japan proposes a community-based whaling targeting on O stock common minke whales in sub-area 7. A small number of J stock animals are expected to be caught unintentionally under this catch. An amount of animals are caught incidentally by the Japanese and Korean static gears. The fishing effort in Japan (the number of Japanese set nets), gradually decreased in recent decades, while the incidental catch in Japan and Korea have remained at similar levels in recent years. This suggests that incidental catches have not affected negatively the J stock. Unintentional catches of J-stock animals under community-based whaling are expected to be minimal by setting the operation in waters 10n.m or more from the coast. The effect on the stock of this whaling can be considered insignificant.

MATERIALS AND METHODS

Incidental catches and trend of fishing effort

Japan

The numbers of past incidental catches off Japan from J stock are shown in Table 1. A new regulation for incidental catches was enforced in 2001. From 2001 to 2006 the reported incidental catches listed in the Japan Progress Reports were used. Mixing rate of J stock in incidental catches was estimated based on the mtDNA analysis of samples from incidental catches in each sub-area from 2001 to 2005 using the modified assignment method by Goto *et al*. (2000).

Incidental catches off Japan is stable or increasing gradually. In Japanese coastal water, minke whales have been caught incidentally by set net fishery. There are three types of set nets, large-size, small-size and salmon set nets. The first two are run throughout the year, while the last one is run only in salmon fishing season. The numbers of three kinds of set nets are shown in Fig. 1 (MAFF 2003, 2004, 2005, 2006). Those have been gradually decreasing in recent decades.

Korea

The numbers of past incidental catches off Korea from J stock are shown in Table 2. The numbers of catches reported in IWC (2004) were used for incidental catches from 1995 to 2001 and those reported in the Korea Progress Report were used for incidental catches from 2002 to 2005. There was no information about fishing effort off Korea.

Catches during JARPN, JARPN II and Community-based whaling

The numbers of the past J-stock catches by JARPN and JARPN II are shown in Table 3. The past catches are listed in the cruise reports of JARPN and JARPN II (Fujise *et al*., 1995, 1996, 1997, 2000, 2001, 2002, 2003; Ishikawa *et al*., 1998; Tamura *et al*., 2004, 2005, 2006, 2007; Zenitani *et al*., 1999; Kishiro *et al*., 2003, 2005, 2006; Yoshida *et al*., 2004, 2006, 2007; Goto *et al*., 2007). Mixing rates of J stock in past JARPN and JARPNII surveys in sub-area 7 were estimated by year using a Bayesian approach (Punt, 2003) (see Appendix I). Future annual catch for J-stock in sub-area 7 taken by future community-based and research whaling was estimated to be 18 based on the mixing rate of J stock in 10 n. miles or more distant from the coast (see Appendix I).

Abundance estimate

Sighting surveys were conducted in the Japanese EEZ of sub-areas 6 and 10 in 2002 and 2003 and in Russian EEZ of sub-area 10 in 2006 by the National Research Institute of Far Seas Fisheries. Sighting surveys are conducted in Korean waters every year from 2002. Abundance based on the surveys in 2002 and 2003 were estimated (Miyashita, 2005). Abundance estimates based on the other surveys mentioned above have not been submitted yet.

DISCUSSIONS

The fishing effort in Japan gradually decreased in recent decades, while the incidental catch in Japan and Korea has remained at similar levels or has been increasing gradually in recent years. This suggests that incidental catches have not affected negatively the J stock. Incidental catches of J-stock animals under community-based whaling are expected to be minimal. The effect on the stock can be considered negligible.

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Table 1. Historical incidental catch of J stock off Japan.

year	catch
2001	93
2002	90
2003	102
2004	100
2005	108
2006	125

Table 2. Historical incidental catch of J stock in Korea from 1995 to 2005.

year	catch
1995	78
1996	129
1997	78
1998	45
1999	56
2000	77
2001	148
2002	89
2003	92
2004	69
2005	109

Table 3. Past catches of J stock by JARPN and JARPN II surveys.

year	catch
1994	0
1995	0
1996	24
1997	0
1998	3
1999	39
2000	3
2001	5
2002	14
2003	9
2004	9
2005	32
2006	24

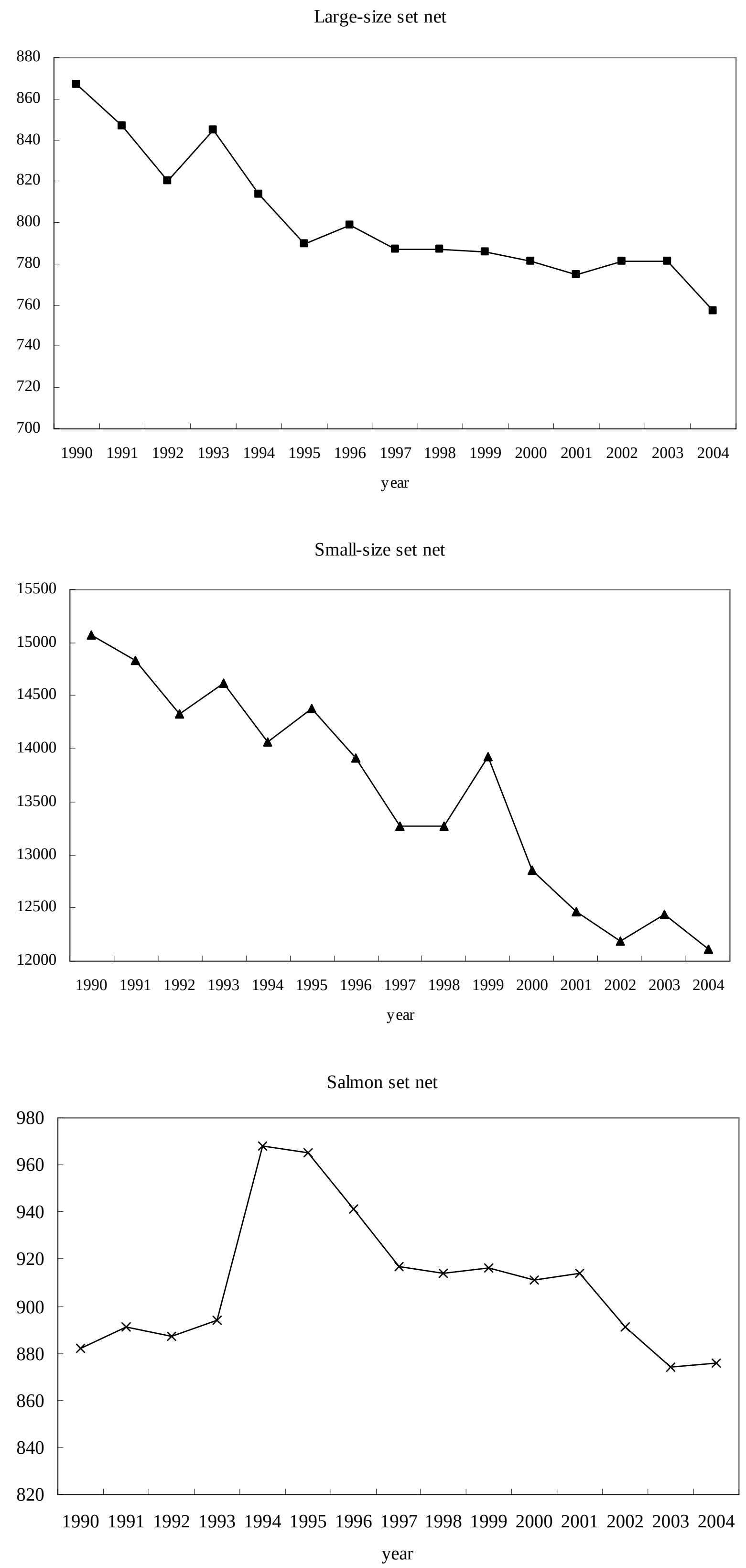

Fig. 1. The number of three types of set nets; Large-size, Small-size and Salmon set net, respectively.