STRICTLY CONFIDENTIAL UNTIL THE OPENING PLENARY AT IWC/56

REVISED RESEARCH PLAN FOR CETACEAN STUDIES IN THE WESTERN NORTH PACIFIC UNDER SPECIAL PERMIT (JARPN II)

GOVERNMENT OF JAPAN

INTRODUCTION

The Research Plan for the Cetacean Studies in the Western North Pacific under Special Permit, JARPN II, was submitted to the 52nd IWC/SC (SC) meeting as a two-year feasibility study (Government of Japan, 2000). The feasibility study was conducted in 2000 and 2001 and results were presented to the 2002 SC meeting (Government of Japan, 2002a). Based on the results of the feasibility study, Japan presented the research plan for the full-scale JARPN II (Government of Japan, 2002b) to the 2002 SC meeting and begun the research in 2002 in compliance with Article VIII of the International Convention for the Regulation of Whaling.

The objectives of the full-scale JARPNII are: i) feeding ecology and ecosystem studies, involving prey consumption by cetaceans, prey preferences of cetaceans and ecosystem modelling, ii) monitoring environmental pollutants in cetaceans and the marine ecosystem, and iii) stock structure of whales (Government of Japan, 2002b).

The full JARPN II plan involved two survey components, the 'offshore' survey to be covered by the *Nisshin Maru* research unit and the 'coastal' survey to be covered by small type whaling catcher boats. The coastal component was necessary to cover the temporal and spatial gaps, which could not be covered by the *Nisshin Maru* unit (Government of Japan, 2002b).

The research area was set in sub-areas 7, 8 and 9 and the target species and sample sizes were set as follows: 150 common minke whales (100 to be sampled by the offshore survey and 50 by the coastal survey); 50 Bryde's whales (offshore survey); 50 sei whales (offshore survey) and 10 sperm whales (offshore survey) (Government of Japan, 2002b).

Scientific papers derived from JARPNII have been submitted to the annual SC meetings (Fujise *et al.*, 2001; 2002, 2003; Government of Japan, 2002a) and results have been reviewed by the SC (IWC, 2002; 2003; 2004a).

In the full JARPN II plan the coastal survey component was presented as a two-year feasibility study to be conducted in 2002 and 2003. The plan also noted that in the case of the sei whale, 'the required sample size will be recalculated after the first two years making use of the data accumulated' (Government of Japan, 2002b).

In accordance with these provisions, a revised JARPN II research plan is presented for the period starting from 2004, which takes into consideration i) the results of the coastal survey component (feasibility surveys in 2002 and 2003) regarding logistic and sample size of the common minke whale and ii) the results of new calculations of required sample size for the sei whale based on the data accumulated in those two years.

OBJECTIVES OF JARPN II

Same as in the original research plan (Government of Japan, 2002b):

1) Feeding ecology and ecosystem studies, involving prey consumption by cetaceans, prey preferences of cetaceans and ecosystem modeling.
2) Monitoring environmental pollutants in cetaceans and the marine ecosystem.
3) Stock structure of whales.

NUMBER, SEX, SAMPLING SIZE AND AREA

Sampling

A total of 220 common minke whales (100 by the offshore survey and 120 by the coastal survey), 50 Bryde's whales (offshore survey), 100 sei whales (offshore survey) and 10 sperm whales (offshore survey) will be sampled in sub-areas 7, 8, and 9. Regarding the coastal survey component, 60 common minke whales will be sampled in each of the early season and the late season.

The rationale for these modifications to the original JARPN II plan is explained below.

i) Coastal survey component (feasibility surveys in 2002 and 2003) regarding logistic and sample size of common minke whales

Detailed examination of the logistic aspects of the coastal surveys in 2002 and 2003 are given in Kato *et al.* (2004). From that examination it is concluded that no substantial logistic problem occurred during these surveys. Therefore, coastal survey will continue as a component of the JARPN II using the same type of vessels (small type whaling catcher boats) and methodology.

Results of the 2002 and 2003 coastal surveys revealed geographical and temporal changes of prey species of minke whales. Re-calculation of the required sample size was conducted by using these data for the purpose of securing statistically accurate data to be used for the construction of ecosystem models. Results suggest sample sizes of 80 and 60 individuals in the early and late seasons, respectively (Tamura *et al.*, 2004a). Taking account of these results, the coastal survey component will be conducted twice a year and 60 individuals will be sampled in early and late seasons, respectively beginning with the survey in the late season of 2004.

ii) Sample size of sei whales

Required sample size of sei whales was re-calculated using data from the 2002 and 2003 surveys (Tamura *et al.*, 2004b) for the purpose of securing statistically accurate data to be used for the construction of ecosystem models. It was revealed that sei whales feed on krill, copepods, Pacific saury and Japanese anchovy. These observations are different from what we knew in the past. New calculation of sample size for sei whales using data from these two surveys showed that at least 100 sei whales a year are required for estimating prey consumption with sufficient precision (C.V. =0.2). Therefore, the sample size for sei whales will be changed from 50 to 100 individuals beginning from the 2004 survey.

iii) Sampling of sperm whales

The full JARPN II research plan noted that it was desirable to keep the sperm whale as a target species (feasibility category) in order to study further their relationships with the surface ecosystem and also because of their large biomass (Government of Japan, 2002b). Target sample size of sperm whales was set tentatively at ten animals. During JARPNII surveys from 2000 to 2003, a total of 28 sperm whales were sampled mainly in the sub-area 7. The results show that neon flying squid, which is an important commercial species, occupied 5% of contents in the stomach of sperm whales (Tamura *et al.*, 2004c). This suggests that actual consumption of neon flying squid by sperm whales might be eight times larger than the commercial catch in the western North Pacific. Furthermore, because as a toothed whale, the sperm whale is one of the top predator species, it can be used for monitoring environmental pollutants (Yasunaga and Fujise, 2004). Therefore, it is concluded that sampling of sperm whale is useful for at least qualitative studies. Ten individuals will be maintained as the target for this species in the full-scale JARPNII survey.

Sampling design remains unchanged and no selection will be made for sex and size of the whales targeted except that sampling of sperm whales will be restricted to individuals below 11m in body length due to the limited capacity of the research base ship *Nisshin Maru.*

Research area

Research area also remains unchanged from the surveys in 2002 and 2003. Therefore, sub-areas 7, 8 and 9 will be covered by the offshore survey component and the coastal region (off the Pacific coast of northern Japan) in a part of sub-area 7 will be covered by the coastal survey component.

RESEARCH NEEDS AND APPLICABILITY OF NON-LETHAL METHODS

This issue has already been addressed in detail in the original plan (Government of Japan, 2002b) and discussed by the SC (IWC, 2003).

POSSIBLE EFFECT ON THE STOCK

The effect on common minke, Bryde's and sei whale stocks of future catches under JARPN II was already examined and presented in the original research plan (see Hakamada, 2002). Because new sample sizes were calculated for common minke whale (coastal survey) and sei whale (offshore survey), the possible effect on the stock in these two cases was re-assessed (see Appendix). The assessment is based on the standard HITTER method. It can be concluded that the effect on the stocks is negligible.

OPPORTUNITY FOR PARTICIPATION BY FOREIGN SCIENTISTS

This matter was already described in the original research plan (Government of Japan, 2002b). It should be noted that a total of three foreign scientists participated in the 2002 and 2003 JARPNII surveys (from Russia and the Republic of Korea). It is expected that this international collaboration will continue in the future.

OUTLINE OF RESEARCH FROM 2004

(1) Number of research vessels: No change from the original research plan (see Government of Japan, 2002b). In the offshore survey component three sighting and sampling vessels, one dedicated sighting vessel and one research base vessel will be used. In the coastal survey component: three or four sampling vessels (small-type whaling catcher boats) and one dedicated sighting vessel will be used. In addition prey survey vessels, which are equipped with trawling gear and echo-sounder will be used for both the offshore and coastal survey components.

(2) Research period: The offshore survey component will be conducted for approximately three months in the period between May and September. The coastal survey component will be conducted twice in each year, i.e. the early survey and the late survey.

(3) Research area: No change from the original research plan (sub-areas 7, 8 and 9) (see Government of Japan, 2002b).

(4) Sighting method: No change from the original research plan (see Government of Japan, 2002b). However, determination of sighting survey track lines will modified to take account of distribution of whales and geographic considerations

(5) Sampling method: No change from the original research plan (see Government of Japan, 2002b).

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Appendix

Examination of the effects on the whale stocks of future catches under JARPNII

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ABSTRACT

The effects on whale stocks of the proposed future catches of common minke whales (*Balaenoptera acutorostrata*) and sei whales (*Balaenoptera borealis*) under JARPN II for 30 years were examined by using HITTER methodology. HITTER calculations show that the minke whale stocks and the sei whale stock would increase over forthcoming decades in all cases examined, except the case of J stock minke whales with *MSYR*(1+) values as low as 1%.

INTRODUCTION

The effect on stock in the case of common minke, Bryde's and sei whales was examined in the original JARPN II plan. Because new sample sizes were calculated for common minke whale (coastal) and sei whale (offshore survey), here the effect on the stocks in these two cases is re-assessed.

MATERIALS AND METHODS

Western North Pacific minke whales

O stock

In this study, we examined a case that from 220 animals in total, 160 are caught from sub-areas 7 and 30 from sub-areas 8 and 9, respectively. Based on results from the JARPN surveys, two O stock scenarios were considered.

Scenario 1-1: Only O stock animals distribute in sub-areas 7, 8, 9, 11 and 12.

Scenario 1-2: Only O stock animals distribute in sub-areas 7, 8 and 11, the percentage of O animals in sub-area 9 is 70% and the percentage of those in sub-area 12 is 81.3%. In this case, 141 animals are caught from O stock.

For Scenario 1-2, the percentage of O animals in sub-areas 9 and 12 are based on Pastene *et al*. (2002). It is assumed that the percentage of O animals in sub-area 9 is 70% (i.e. the percentage of W animal is 30%) because the percentage of W animals in sub-area 9 is 50% and they occur each year with 60% probability. It was assumed that the percentage of O animals in sub-areas 12 is same as the average percentage of O animals for sub-areas 7, 8 and 9 in Pastene *et al*. (2002).

The past annual sex-disaggregated catches of western North Pacific minke whales are listed in Table 1 for scenario 1-1 and in Table 2 for O stock under scenario 1-2. Incidental catches, which are the same as option Jii) in IWC (2001), are taken into account. The number of incidental catches in sub-areas 2, 7 and 11 by sex used in this study is shown in Table 3. In these HITTER computations, the following parameter values, adopted by the Implementation Simulation Trials (IWC, 2001), are 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):

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

where a is age.

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

The best estimate of total (1+) abundance for O stock from sighting surveys is taken to be 25,591 (lower 5%-ile 16,894) in scenario 1-1, 20,872 (lower 5%-ile 13,907) in scenario 1-2, and these are applied to 1990. These estimates were based on specifications of the North Pacific minke whaling trials (IWC, 2001). The following years are chosen for the examination; 1988 (when commercial whaling ceased), 1994 (the start of JARPN surveys), 2004 (this year), 2014 (after ten years), 2024 and 2034. Results from JARPN and JARPN II feasibility surveys suggested that males are dominant in the research area therefore for catches from the offshore component of the survey, male sex ratio of 79.2% (the smallest value of those in 1996-2001 in sub-areas 7) and for catches from the coastal component a ratio of 74.9%, which were obtained from the samples collected during JARPN and JARPN II feasibility study, are also considered for both

scenarios. In the HITTER calculations, *MSYR*(1+), is used, as for the case of the Bering-Chukchi-Beaufort Seas stock of bowhead whales (IWC, 1998).

J stock
The effect of the catches on the J stock was also assessed. It was assumed that J stock animals were mainly distributed in sub-areas 5, 6 and 10 and that the percentage of J animals in sub-area 7 is 2.8% based on mtDNA analyses using commercial samples 1983-86 and JARPN samples 1996-99 (IWC, 2003).

The past annual sex-disaggregated catches of western North Pacific minke whales are listed in Table 4 for J stock. Incidental catches in Korea and Japan are taken into account. The number of incidental catches off Korea is shown in Table 5 and that from J stock animals off Japan is shown in Table 6. Proportions of male for the proposed future catches from J stock were assumed to be same as for commercial catches in sub-areas 6 (50.8% for male) and 10 (61.5% for male). For sub-area 7, average of the proportions among sub-areas 6 and 10 was applied because there is no information of sex ratio for incidental catches of J animals in sub-area 7. Mixing rate for research samples is assumed to be 2.8% for the offshore component and15.0% for the coastal component. In this scenario, 19 samples will be taken from J stock.

Biological parameters are the same as those used for the O stock. Minimum estimate of total (1+) abundance for J stock is 15,137 (Tanaka *et al*., 2003) and applied to 2003. The following years are chosen for the examination: 1988 (when commercial whaling ceased), 1994 (the start of JARPN surveys), 2004 (Beginning of JARPN II), 2014 (after ten years), 2024 and 2034.

Western North Pacific sei whales
It is assumed that 100 sei whales are caught every year. We consider the stock scenario of two stocks divided by 180° longitudinal line (IWC, 1971). Historical catch is taken from IWC (1996). Sex ratio of historical and future catch is assumed to be 1:1. This assumption is supported by the statistics in BIWS. Catches are allocated to west of 180^{o} and east of 180^{o} according to the ratio estimated from Ohsumi (Ohsumi *et al.*, 1971). Historical catch and future catch are shown in Table 10. It is assumed that biological parameters used in this calculation for sei whales are the same as that for Bryde's whales, which are described in the paragraph below. The following biological parameters are used, which were adopted during the Comprehensive Assessment of Western North Pacific Bryde's whales (1997):

Age of recruitment (coastal catches):	5.0
Age of recruitment (pelagic catches):	8.0
Age of maturity:	8.0
Natural mortality (independent of age and sex):	0.07
MSY level (*MSYL*)	60% (of *K*)

An abundance estimate for Western North Pacific (west of 180° and north of 30° N) of 67,642 (lower 5%-ile 34,971) (Hakamada *et al.*, 2004) which was estimated in 2003, is used in these calculations. For comparison, the estimate of 28,369 (lower 5%-ile 14,747) (Miyashita *et al.*, 2002), which was estimated in 1999, is also used. The following years are chosen for the examination; 1976 (when commercial whaling were ceased), 2004 (this year), 2014 (after 10 years), 2024 and 2034.

RESULTS AND DISCUSSIONS

Western North Pacific minke whales

O stock
Results for HITTER runs of two scenarios for both the best estimate and its 5% lower limit, are given in Table 7 and 8 for *MSYR* (1+) = 1%, 2%, 3%, 4% and 5%. These tables show depletion (the ratio of the population for the year compared to the pre-exploitation level) for the mature female component. The population of the mature female component increases for 30 years in all cases examined.

J stock
Result for HITTER run for J stock for the minimum estimate is given in Table 9 for *MSYR* (1+) = 1%, 2%, 3%, 4% and 5%. This table shows depletion for the mature female component. The population of the mature female component increases for 30 years in all cases examined except for *MSYR*(1+) = 1%. SC agreed that *MSYR*(mat) = 1% has a lower plausibility than *MSYR*(mat) = 4% for the North Pacific minke whale ISTs. The values of *MSYR*(mat) = 1% and 4% corresponded roughly to *MSYR*(1+) = 0.7% and 2.3% respectively (IWC, 2004). Therefore, the results for *MSYR* (1+) = 1% has lower plausibility than those for *MSYR* (1+) = 2 and 3%. From this, it is suggested that an increase in the population of the mature female component is more plausible than a decrease.

In this study, the minimum abundance estimate of 15,137 in Tanaka *et al*., (2003) was used. They estimated minimum population size by minimum number of births divided by maximum birth rate using LVPA. Therefore, the effect on the stock would not be worse than the results of HITTER run suggests.

The number of incidental catch (163 animals) is about 9 times as large as those due to the research (19 animals). Therefore, this calculation shows the effect of the incidental catches rather than of the research takes. Except for the less plausible case (i.e. *MSYR* (1+) = 1%), RY exceeds the sum of incidental catches and research takes. Therefore, it can be concluded that the population of the stock increases in plausible cases.

In summary, the effect on the J stock is negligible.

Western North Pacific sei whales

Results for HITTER runs in the case that 100 sei whales are taken, are given in Table 11 using the abundance estimate of 67,642 in 2003 and in Table 12 using the abundance estimate of 28,369 in 1999 for *MSYR* (1+) =1%, 2%, 3%, 4%, 5% and 6%. These tables show depletion for the mature female component. The population of the mature female component increases for 30 years in all cases examined.

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Table 1. Catch data of O stock, including incidental catch, used in this study under the Scenario 1-1. Historical catch from 1900 to 2003 and assumed future catch from the O stock of the minke whales in the North Pacific for two Scenarios examined using HITTER Fitter program.

Scenario 1-1
(Catch from subareas 7, 11, 8, 9 and 12)

year	male	female
1900-1929	31	4
1930	38	10
1931	38	10
1932	38	10
1933	39	10
1934	44	15
1935	44	15
1936	44	15
1937	64	28
1938	69	34
1939	69	34
1940	76	38
1941	64	28
1942	69	34
1943	90	46
1944	76	38
1945	69	34
1946	76	55
1947	86	64
1948	112	91
1949	103	66
1950	156	81
1951	144	124
1952	145	183
1953	146	123
1954	142	166
1955	197	212
1956	269	222
1957	193	199
1958	256	295
1959	154	162
1960	145	147
1961	176	192
1962	133	141
1963	127	128
1964	160	164
1965	158	189
1966	192	203
1967	142	163
1968	108	141

Scenario 1-1 (continued)

year	male	female
1969	105	143
1970	181	161
1971	173	125
1972	159	213
1973	294	259
1974	208	193
1975	205	158
1976	182	192
1977	192	89
1978	276	159
1979	293	134
1980	231	168
1981	247	146
1982	198	146
1983	169	145
1984	229	173
1985	223	131
1986	208	138
1987	213	126
1988	31	4
1989	31	4
1990	31	4
1991	31	4
1992	31	4
1993	31	4
1994	49	7
1995	122	13
1996	94	18
1997	118	17
1998	120	15
1999	102	33
2000	66	9
2001	124	11
2002	148	37
2003	145	40

Future catch
(including incidental catch)

2004+	200	55

Table 2. Catch data of O stock, including incidental catch, used in this study under the Scenario 1-2. Historical catch from 1900 to 2003 and assumed future catch from the O stock of the minke whales in the North Pacific for two Scenarios examined using HITTER Fitter program.

Scenario 1-2 (Catch from subareas 7, 8, 11, 70% of sub-area 9 and 81.3% of subarea12)		
year	male	female
1900-1929	31	4
1930	38	10
1931	38	10
1932	38	10
1933	39	10
1934	44	15
1935	44	15
1936	44	15
1937	64	28
1938	69	34
1939	69	34
1940	76	38
1941	64	28
1942	69	34
1943	90	46
1944	76	38
1945	69	34
1946	76	55
1947	86	64
1948	112	91
1949	102	66
1950	155	81
1951	144	123
1952	145	183
1953	145	122
1954	142	165
1955	196	212
1956	268	221
1957	193	199
1958	256	294
1959	154	162
1960	145	147
1961	176	192
1962	133	141
1963	127	128
1964	160	164
1965	158	189
1966	192	203
1967	142	163
1968	108	141

Scenario 1-2 (continued)		
year	male	female
1969	104	141
1970	179	161
1971	173	125
1972	159	213
1973	288	252
1974	203	186
1975	203	154
1976	182	192
1977	192	89
1978	276	159
1979	293	134
1980	231	168
1981	247	146
1982	198	146
1983	169	145
1984	229	173
1985	223	131
1986	208	138
1987	213	126
1988	31	4
1989	31	4
1990	31	4
1991	31	4
1992	31	4
1993	31	4
1994	44	6
1995	95	10
1996	94	18
1997	102	13
1998	120	15
1999	102	33
2000	61	9
2001	116	10
2002	139	36
2003	134	39

Future catch (including incidental catch)		
2004+	193	53

Table 3. Historical and future incidental catch for the O stock minke whales in the North Pacific from 1900 in sub-areas 2, 7 and 11 calculated following the Appendix 10 of the annex D of the report of 52 IWC/SC meeting.

year	male	female
1900+	31	4

Table 4. Catch data of J stock, including incidental catch, used in this study. Historical catch from 1900 to 2003 and assumed future catch from the J stock of the minke whales in the North Pacific examined using HITTER Fitter program.

J stock (Catch from subareas 5, 6, 10 and 2.8% of sub-area 7)		
year	male	female
1900-1936	38	36
1937	39	37
1938	39	37
1939	39	37
1940	92	79
1941	134	123
1942	165	151
1943	136	123
1944	128	116
1945	48	37
1946	39	37
1947	39	37
1948	95	75
1949	64	71
1950	68	46
1951	107	78
1952	191	81
1953	168	89
1954	104	68
1955	83	68
1956	107	83
1957	204	184
1958	177	199
1959	197	229
1960	175	233
1961	118	170
1962	140	193
1963	213	248
1964	270	295
1965	184	187
1966	208	270
1967	233	294
1968	231	287
1969	271	323
1970	436	477
1971	439	491
1972	449	499

J stock		
year	male	female
1973	515	558
1974	354	398
1975	377	404
1976	322	371
1977	582	631
1978	583	592
1979	527	596
1980	518	502
1981	441	415
1982	410	426
1983	288	279
1984	240	233
1985	109	100
1986	94	55
1987	42	38
1988	41	44
1989	44	53
1990	47	61
1991	50	69
1992	52	77
1993	55	86
1994	58	94
1995	71	132
1996	59	94
1997	47	72
1998	56	75
1999	59	93
2000	51	72
2001	84	80
2002	87	85
2003	88	83

Future catch (including incidental catch)		
2004+	93	89

Table 5. . Historical and future incidental catch for the minke whales off Korea

year	male	female
1900-1988	0	0
1989	3	8
1990	6	17
1991	9	25
1992	11	33
1993	14	41
1994	17	50
1995	20	58
1996	33	96
1997	20	58
1998	9	36
1999	17	39
2000	20	57
2001	12	36
2002+	45	44

Table 6. Historical and future incidental catch for J stock of the minke whales off Japan from 1900.

year	male	female
1900+	38	36

Table 7. The case where 220 minke whales (169 males and 51 females) are caught from 2004 to 2033 under the Scenario 1-1 (sub-areas 7, 8, 9, 11 and 12 for O-stock) taking the incidental catch into account. Depletion is given for the mature female component.

a) Hit 1990 total (1+) population of 25,591 (best estimate)

Statistic	MSYR (1+) (%)				
	1	2	3	4	5
K (1+)	34,465	31,128	29,174	28,011	27,295
Depletion - 1988	70.3%	75.3%	79.1%	81.9%	84.0%
Depletion - 1994	74.3%	81.5%	86.6%	90.1%	92.5%
Depletion - 2004	77.8%	87.5%	93.1%	96.1%	97.8%
Depletion - 2014	79.0%	89.6%	94.3%	96.3%	97.3%
Depletion - 2024	80.5%	91.6%	95.7%	97.3%	98.1%
Depletion - 2034	81.8%	93.0%	96.6%	98.0%	98.7%
RY - 2004	214	233	208	181	163
MSY (+1)	207	374	525	672	819

b) Hit 1990 total (1+) population of 16,894 (lower 5%-ile)

Statistic	MSYR (1+) (%)				
	1	2	3	4	5
K (1+)	26,353	23,107	21,038	19,721	18,878
Depletion - 1988	59.9%	64.9%	69.1%	72.6%	75.4%
Depletion - 1994	64.4%	72.4%	78.9%	83.9%	87.6%
Depletion - 2004	68.1%	80.1%	88.3%	93.2%	96.1%
Depletion - 2014	69.2%	83.4%	90.9%	94.3%	95.9%
Depletion - 2024	70.7%	86.5%	93.2%	95.9%	97.2%
Depletion - 2034	72.1%	88.9%	94.8%	97.0%	98.1%
RY - 2004	189	232	219	190	165
MSY (+1)	203	241	223	193	171

Table 8. The case where 211 minke whales (162 males and 49 females) are caught from O stock from 2004 to 2033 under the Scenario 1-2 (sub-areas 7, 8, 11, 70% of 9 and 81.3% of 12 only for O-stock) taking the incidental catch into account. Depletion is given for the mature female component.

a) Hit 1990 total (1+) population of 20,872 (best estimate)

Statistic	MSYR (1+) (%)				
	1	2	3	4	5
K (1+)	29,984	26,686	24,678	23,450	22,683
Depletion - 1988	65.5%	70.6%	74.7%	77.9%	80.3%
Depletion - 1994	69.7%	77.5%	83.3%	87.6%	90.5%
Depletion - 2004	73.5%	84.4%	91.2%	95.0%	97.1%
Depletion - 2014	74.9%	87.2%	93.0%	95.6%	96.7%
Depletion - 2024	76.4%	89.6%	94.8%	96.8%	97.8%
Depletion - 2034	77.9%	91.5%	95.9%	97.6%	98.5%
RY - 2004	204	230	207	178	158
MSY (+1)	180	320	444	563	680

b) Hit 1990 total (1+) population of 13,907 (lower 5%-ile)

Statistic	MSYR (1+) (%)				
	1	2	3	4	5
K (1+)	23,615	20,465	18,379	16,996	16,083
Depletion - 1988	54.7%	59.4%	63.5%	67.1%	70.2%
Depletion - 1994	59.4%	67.4%	74.2%	79.9%	84.3%
Depletion - 2004	63.1%	75.7%	85.1%	91.3%	94.9%
Depletion - 2014	64.1%	79.7%	88.7%	93.1%	95.1%
Depletion - 2024	65.5%	83.5%	91.8%	95.2%	96.8%
Depletion - 2034	66.8%	86.5%	93.8%	96.5%	97.9%
RY - 2004	190	237	225	195	169
MSY (+1)	142	246	331	408	482

Table 9. The case where 19 minke whales (10 males and 9 females) are caught from J stock from 2004 to 2033 (sub-areas 5, 6, 10 and 2.8% of 7 for J-stock) taking the incidental catches (83 males and 80 females) into account. Depletion is given for the mature female component.

Hit 2003 total (1+) population of 15,137 (minimum estimate)

Statistic	MSYR (1+) (%)				
	1	2	3	4	5
K (1+)	32,844	25,966	21,157	17,592	14,889
Depletion - 1988	41.2%	41.8%	41.8%	41.6%	41.8%
Depletion - 1994	42.0%	45.3%	48.1%	50.7%	53.9%
Depletion - 2004	41.7%	49.8%	58.2%	67.5%	78.2%
Depletion - 2014	41.3%	54.8%	69.6%	84.8%	97.9%
Depletion - 2024	40.9%	60.3%	80.4%	94.4%	93.5%
Depletion - 2034	40.5%	66.0%	87.9%	93.4%	91.8%
RY - 2004	150	262	352	412	426
MSY (+1)	197	312	381	422	447

Table 10. Catch data of sei whale used in this study. Historical catch from 1946 to 2003 and assumed future catch from the west of 180^{o} of sei whales in the North Pacific.

	Catches from the west of 180^{o}			
	coastal		pelagic	
year	male	female	male	female
1946	272	272	8	8
1947	191	191	42	42
1948	280	280	30	30
1949	409	410	39	39
1950	175	175	75	75
1951	235	235	84	84
1952	427	427	124	124
1953	335	336	35	35
1954	386	386	43	43
1955	308	308	14	14
1956	476	477	18	18
1957	293	293	57	57
1958	579	580	99	99
1959	735	736	36	36
1960	465	465	74	74
1961	417	417	16	16
1962	571	571	160	160
1963	435	436	415	415
1964	454	454	605	605
1965	233	233	595	595
1966	155	156	1,067	1,067
1967	276	277	1,554	1,554
1968	403	403	1,400	1,400
1969	233	233	1,331	1,331
1970	242	242	1,142	1,142
1971	138	138	773	773
1972	107	107	600	600
1973	21	22	515	515
1974	24	24	350	350
1975	15	15	136	136
2002	15	24	0	0
2003	23	27	0	0
Future catch				
2004+	50	50	0	0

Table 11. The effect on the stock of western North Pacific sei whales of taking 100 animals (50 males and 50 females) from 2004 to 2033 using the abundance estimate of 67,642 (CV=0.418). Depletion is given for the mature female component.

a) Hit 2003 total (1+) population of 67,642 (best estimate)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (1+)	89,396	77,212	71,317	68,974	68,148	67,859
Depletion - 1976	55.7%	53.2%	53.1%	54.6%	56.6%	58.5%
Depletion - 2004	72.0%	82.6%	90.8%	95.6%	97.9%	98.9%
Depletion - 2014	75.8%	87.8%	94.3%	96.9%	97.8%	98.1%
Depletion - 2024	79.2%	91.3%	95.9%	97.3%	97.7%	97.9%
Depletion - 2034	82.2%	93.6%	96.7%	97.4%	97.7%	97.9%
RY - 2004	370	432	305	166	84	44
MSY (+1)	536	927	1,284	1,655	2,044	2,443

b) Hit 2003 total (1+) population of 34,971 (lower 5%-ile)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (1+)	62,811	52,594	45,819	41,287	38,299	36,481
Depletion - 1976	36.0%	29.4%	23.9%	19.9%	17.6%	17.1%
Depletion - 2004	51.6%	58.5%	65.5%	72.7%	80.4%	87.9%
Depletion - 2014	55.4%	67.4%	77.7%	85.6%	91.0%	94.2%
Depletion - 2024	59.4%	75.5%	86.3%	92.0%	94.6%	95.6%
Depletion - 2034	63.4%	82.0%	91.1%	94.5%	95.6%	95.9%
RY - 2004	291	480	565	550	447	290
MSY (+1)	377	631	825	991	1,149	1,313

Table 12. The effect on the stock of western North Pacific sei whales of taking 100 animals (50 males and 50 females) from 2004 to 2033 using the abundance estimate of 28,369 (CV=0.414). Depletion is given for mature female component.

a) Hit 1999 total (1+) population of 28,369 (best estimate)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (1+)	58,932	50,113	43,967	39,612	36,227	33,562
Depletion - 1976	31.6%	25.6%	20.3%	16.0%	12.1%	9.5%
Depletion - 2004	46.3%	53.0%	59.3%	65.2%	71.2%	77.5%
Depletion - 2014	49.8%	62.0%	72.6%	80.8%	86.8%	90.9%
Depletion - 2024	53.6%	70.6%	82.8%	89.7%	93.1%	94.6%
Depletion - 2034	57.5%	78.0%	89.2%	93.5%	95.0%	95.5%
RY - 2004	264	462	581	623	588	490
MSY (+1)	354	601	791	951	1,087	1,208

b) Hit 1999 total (1+) population of 14,747 (lower 5%-ile)

Statistic	MSYR (1+) (%)					
	1	2	3	4	5	6
K (1+)	49,486	43,433	38,963	35,435	32,508	30,234
Depletion - 1976	17.9%	13.0%	8.7%	5.4%	2.8%	1.5%
Depletion - 2004	28.4%	31.2%	33.6%	35.7%	37.9%	39.9%
Depletion - 2014	30.1%	37.5%	45.2%	52.9%	60.3%	66.9%
Depletion - 2024	32.1%	45.1%	58.8%	71.0%	80.2%	86.2%
Depletion - 2034	34.3%	53.6%	71.9%	84.2%	90.3%	93.1%
RY - 2004	162	317	463	593	696	790
MSY (+1)	297	521	701	850	975	1,088