Annex E

Report of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP)

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1. INTRODUCTORY ITEMS

1.1 Convenor's opening remarks
Donovan welcomed the participants, noting that the Standing Working Group (SWG) had a very heavy Agenda this year, with a focus on the *Implementation Review* for gray whales as well as its usual work on Greenlandic hunts and providing management advice.

1.2 Election of Chair
Donovan was elected Chair.

1.3 Appointment of rapporteurs
Brandon, Givens and Punt were appointed as rapporteurs with assistance from the Chair.

1.4 Adoption of Agenda
The adopted Agenda is shown in Appendix 1. In addition to the normal business of the SWG, there were two issues to be considered in view of the proposed consensus decision of the Chair and Vice-Chair of the Commission (IWC/62/7rev).

(1) The conservation implications, if any, of increasing the catch limits by five animals per year to account for 'stinky whales'.
(2) The footnote to the gray whale section in Table 4. In the Table, the number 145 appears in each of the seasons 2010/11 to 2019/29. The footnote reads: 'This is the maximum number of animals that may be struck in any one year. The total number of animals that may be landed over the 10 seasons from 2011–20 is 1,290 (i.e. an average catch of 129 over the 10-year period)'.

These issues are addressed under Item 2.8.2.

1.5 Documents available
The documents considered by the SWG were SC/62/AWMP1-2, BRG 1, 5, 8, 11, 13, 21, 32, 35, Laake *et al.* (2009), IWC/62/9 and SC/62/Rep3.

2. *IMPLEMENTATION REVIEW* OF EASTERN GRAY WHALES

Implementation Reviews are subject to the Data Availability Agreement (IWC, 2004) incorporating a timetable of events. Although many datasets and analyses were completed within the appropriate timelines, unfortunately, just before adoption of the report, the SWG realised that the photo-identification and genetics data central to its discussions of stock structure and movements under Item 2.2 had not formally been submitted to the IWC under the DAA (although the papers themselves had met the appropriate deadlines). The same is also true for the telemetry data that, while not central to the conclusions reached, were also discussed under that Agenda Item; in this case the paper did not meet the appropriate deadline.

The SWG recognised that discussions of these data cannot be considered as part of the *Implementation Review.* Thus although the *Implementation Review* is considered complete with respect to the discussions involving the data properly made available under the DAA, the SWG **recommends** that a new *Implementation Review* takes place at the next Annual Meeting. This is to enable the SWG to take properly into account the important new information received this year that had not met the DAA timeline. This issue is referred to where appropriate in other parts of this report.

The Chair of the SWG has **agreed** to take responsibility to ensure that all likely contributors to the new *Review* are made aware of the DAA and timelines as well as the guidelines for genetic analyses and data, to make sure that this unfortunate event does not happen again.

2.1 What is an *Implementation Review*?
In 2004 (IWC, 2005), the Committee presented the Commission with its recommended Gray Whale *Strike Limit Algorithm* (the *Gray Whale SLA*) and this was endorsed by the Commission. The scheduled 2009 *Implementation Review* had been postponed because a number of key analyses would not be ready in time.

The purpose of an *Implementation Review* is to update information on catch history and abundance and to determine whether any other new information that has become available in the intervening (normally) 5-year period indicates that the present situation is outside the region of parameter space tested during *SLA* development. If this is the case, additional trials will need to be developed to test the performance of the *SLA* in this new region. If performance is found to be unacceptable under these new trials, revisions to the *SLA* will be required.

A few key aspects of the trials include:

(a) a single stock;
(b) a need envelope based on strikes from 150 in 2003 to a maximum of 530, 100 years later;
(c) survey frequency 10 years; and
(d) MSYR 1.5%–5.5%.

Full details of the parameter space investigated in the development of the *Gray Whale SLA* can be found in IWC (2005). In practical terms, the most important issues relevant to the present *Implementation Review* relate to the issues of stock structure and updated information on abundance/trends.

2.2 Stock structure and movements

In the development process for the *Gray Whale SLA*, there had been a discussion of stock structure at several meetings. While the possibility of a summer feeding aggregation along the Pacific coast between California and southeast Alaska was noted (e.g. IWC, 2001), the Committee had agreed that a single stock scenario was the most appropriate (IWC, 2001).

Considerable new information has been collected since that time on the animals feeding along the Pacific coast and the SWG received three papers of relevance to stock structure at this meeting (unfortunately, as noted above, these did not meet all of the DAA requirements). Although different names have been used in the past by different authors (e.g. the southern feeding group, the Pacific Coast Feeding aggregation), the SWG **agreed** to refer to the animals that spend the spring, summer and autumn feeding in coastal waters of the Pacific coast of North America from California to southeast Alaska as the Pacific Coast Feeding Group or PCFG.

SC/62/AWMP1 presented data on the genetic differentiation between the southern feeding group (the PCFG in SWG parlance) of eastern North Pacific gray whales and the larger population. The impetus for this work was based on photo-identification (photo-id) studies reporting a high re-sighting rate of identified individuals over time, suggesting that whales show fidelity to this southern feeding area. The hypothesis was that this sighting pattern was based on maternally-directed site fidelity, where, as with many other baleen whale populations, feeding area usage is passed on from mother to offspring. The study compared mitochondrial DNA sequences from 40 individuals sampled off western Vancouver Island to sequences obtained from 83 individuals sampled in the winter breeding/calving areas off Baja California that had previously been published by Goerlitz *et al.* (2003). The rationale was that these latter samples should be representative of the larger population. Significant differences in the frequencies of mitochondrial haplotypes were found between the two sample sets (F_{ST} = 0.01975, P = 0.00391), rejecting the hypothesis of panmixia. Moreover, estimates of Θ ($N_e\mu$ for mitochondrial data) were significantly different (P = 0.000135), and relative migration rates were estimated at << 1%. The authors concluded that in combination, these results suggest that the matrilines of the southern feeding group are demographically independent from those of the rest of the population, and therefore require separate management consideration.

SC/62/BRG32 reported the results of an 11-year (1998–2008) collaborative study examining the abundance and the population structure of eastern gray whales that spend the spring, summer and fall feeding in coastal waters of the Pacific Northwest conducted over a number of regions from northern California to British Columbia using photographic identification. With respect to stock structure, SC/62/BRG32 concluded the population structure of gray whales using the Pacific Northwest in summer and fall is complicated and involves two elements. There is one group of whales that return frequently and account for the majority of the sightings in the Pacific Northwest during summer and autumn (i.e. the PCFG). This group is certainly not homogeneous and even within this group, there is some degree of preference for certain subareas. Despite widespread movement and interchange among areas, some of these gray whales are more likely to be seen returning to the same areas they were seen before. A second group of whales, apparent stragglers, were encountered in this region after the migration. These animals are seen in only one year, tend to be seen for shorter periods than a year, and in more limited areas.

SC/62/BRG21 presented information on satellite telemetry work on eastern gray whales. One of the authors (Mate) was asked to summarise the results of this paper and previous telemetry studies, focussing on stock structure issues. His summary of this work follows. A total of 18 eastern gray whales considered to be part of the PCFG were marked off Oregon and northern California from September to December 2009. Biopsy samples were collected from 14 tagged whales (5 females and 9 males) and twelve tags were fully deployed. Follow-up observations and photographs of tagged whales were taken from September 2009 to April 2010 and will continue.

On the summer/autumn foraging grounds, tagged whales showed a high degree of variability in their movements and the number of areas used, as noted in past photo-ID studies (Calambokidis *et al.*, 2002; Darling, 1984; Darling *et al.*, 1998). However, the majority of the field work in those studies took place before mid-November, whereas the data from the satellite tags provide insights into movements over a longer time period. Of the first 6 whales tagged during 3 consecutive days along the central Oregon coast, 4 whales moved south during the first 2 weeks, and the 2 other whales stayed in the immediate tagging area, indicating whales in the same area and time do not necessarily subsequently do the same thing. Within 2 weeks, one tagged whale moved south to Cape Blanco and then north to the west coast of Vancouver Island, BC, covering all of its previous known range from 15 years of photo-id studies. Travel speeds during transits were similar in speed to migrations, suggesting the whales moved directly from one spot to the next without much *en route* ‘sampling’.

Eight whales began their migration from near Point St. George, CA, from 4 December to 13 February and 6 whales arrived at Laguna Ojo de Liebre near Guerrero Negro, BCS Mexico. The apparent site fidelity to Ojo de Liebre Lagoon of these PCFG whales may be a general feature of PCFG whales. However, with large numbers of whales breeding in this lagoon, the mechanism to maintain a genetic subset of the overall population is most likely to be along maternal lines. An earlier 2005 tagging study tracked six gray whales tagged in Ojo de Liebre to the Chukchi Sea, showing they were part of the much larger subpopulation which summers in the Arctic (Mate and Urbán-Ramirez, 2006). If the PCFG comprises around 200 animals, they would be a small percentage of whales using that lagoon, so it is not surprising that only ‘Arctic’ animals were tagged even if PCFG whales were present.

Northbound migration was documented for three whales in this study, with two of them reaching PCFG feeding destinations. Whale 23041 exhibited a great deal of mobility, moving back and forth repeatedly between the OR and WA coasts. Whale 5938, on the other hand, travelled initially to Vancouver Island where it remained for one month, prior to moving to Icy Bay, AK, where it has stayed for five weeks (as of April 28). Although their sample size was small, Calambokidis *et al.* (2002) documented an inter-annual resighting of one animal between southeast Alaska and Washington, and suggested that either the range of the PCFG extends farther north than the efforts of their study, or that there are other feeding aggregations along the west coast with some interchange among them. It seems reasonable the PCFG may contain animals with differing sized home ranges and that annual environmental changes may result in animals using different portions of their home ranges to find adequate food.

The SWG thanked Mate for the update on this work and noted that the tagging data may provide the best estimator of residency times for PCFG gray whales in order to evaluate their relative vulnerability with respect to the spatial and temporal characteristics being considered for the Makah hunt. Analogous data from non-PCFG whales may also help determine if there are differences between PCFG and non-PCFG whales with regard to their migrations (distances from shore, water depths or timing) or other behaviours. Therefore, the SWG **recommended** that the satellite tagging work should continue and that these data be analysed with the goal of providing input (e.g. as required in mixing matrices, etc.) as necessary for any future trials of the *Gray Whale SLA*.

The SWG thanked the authors for these comprehensive papers. There was considerable discussion of them and their implications for stock structure. A number of interesting issues were raised, including: the choice of the genetic reference set used in SC/62/AWMP1 (a re-analysis with a larger reference set is provided in Appendix 2, and this did not alter the conclusions); the patterns observed from photo-id data collected in other areas; the conclusions that could be drawn from satellite tagged animals (see also Item 2.7). Despite some differences in interpretation and recognising that further analyses could be carried out, the SWG **agreed** that the hypothesis of demographically distinct southern feeding group is plausible and warranted further investigation. The implications of this for the *Implementation Review* are discussed later in the report.

2.3 Catch data

Allison informed the SWG that the catch series had been updated to incorporate new information. The complete series can be found in Tables 1a and 1b.

Table 1a

Aboriginal removals from the eastern north Pacific stock of gray whales 1600–1845 (see Appendix 3).

Years	Annual kill
1600–1675	182
1676–1750	183
1751–1840	198
1841–1845	194
Total kill 1600-1845	**46,300**

Table 1b

Catches from the eastern North Pacific stock of gray whales 1846–2009.

Year	Male	Female	Total	Year	Male	Female	Total
1846	105	123	228	1859	311	683	994
1847	127	196	323	1860	369	834	1,203
1848	123	182	305	1861	293	690	983
1849	99	98	197	1862	176	294	470
1850	103	102	205	1863	182	304	486
1851	102	102	204	1864	228	413	641
1852	120	156	276	1865	228	427	655
1853	162	297	459	1866	198	322	520
1854	162	293	455	1867	224	390	614
1855	144	237	381	1868	178	245	423
1856	162	284	446	1869	148	172	320
1857	175	318	493	1870	157	182	339
1858	304	649	953	1871	157	188	345

Cont.

Table 1b (cont.)

Year	Male	Female	Total	Year	Male	Female	Total
1872	139	140	279	1941	38	39	77
1873	136	141	277	1942	60	61	121
1874	125	125	250	1943	59	60	119
1875	112	113	225	1944	3	3	6
1876	105	105	210	1945	25	33	58
1877	114	115	229	1946	14	16	30
1878	110	110	220	1947	11	20	31
1879	126	127	253	1948	7	12	19
1880	114	114	228	1949	10	16	26
1881	110	111	221	1950	4	7	11
1882	111	111	222	1951	6	8	14
1883	109	108	217	1952	17	27	44
1884	110	111	221	1953	21	27	48
1885	94	93	187	1954	14	25	39
1886	71	71	142	1955	22	37	59
1887	72	72	144	1956	45	77	122
1888	69	69	138	1957	36	60	96
1889	70	70	140	1958	55	93	148
1890	66	66	132	1959	74	122	196
1891	43	43	86	1960	58	98	156
1892	42	43	85	1961	77	131	208
1893	42	43	85	1962	59	92	151
1894	39	39	78	1963	68	112	180
1895	39	39	78	1964	90	129	219
1896	35	34	69	1965	71	110	181
1897	35	34	69	1966	95	125	220
1898	35	34	69	1967	161	213	374
1899	32	32	64	1968	89	112	201
1900	31	31	62	1969	89	125	214
1901	30	31	61	1970	71	80	151
1902	30	31	61	1971	57	96	153
1903	30	31	61	1972	61	121	182
1904	30	31	61	1973	97	81	178
1905	28	29	57	1974	94	90	184
1906	28	29	57	1975	58	113	171
1907	28	29	57	1976	69	96	165
1908	28	29	57	1977	87	100	187
1909	28	29	57	1978	94	90	184
1910	28	30	58	1979	58	125	183
1911	29	29	58	1980	53	129	182
1912	28	29	57	1981	36	100	136
1913	28	30	58	1982	57	111	168
1914	37	39	76	1983	46	125	171
1915	28	29	57	1984	59	110	169
1916	26	26	52	1985	54	116	170
1917	26	26	52	1986	46	125	171
1918	26	26	52	1987	48	111	159
1919	26	26	52	1988	43	108	151
1920	27	27	54	1989	61	119	180
1921	46	44	90	1990	67	95	162
1922	32	29	61	1991	67	102	169
1923	26	26	52	1992	0	0	0
1924	27	26	53	1993	0	0	0
1925	99	87	186	1994	21	23	44
1926	51	43	94	1995	48	44	92
1927	36	48	84	1996	18	25	43
1928	30	34	64	1997	48	31	79
1929	23	27	50	1998	64	61	125
1930	23	24	47	1999	69	55	124
1931	5	5	10	2000	63	52	115
1932	10	10	20	2001	62	50	112
1933	38	37	75	2002	80	51	131
1934	66	60	126	2003	71	57	128
1935	71	83	154	2004	43	68	111
1936	93	105	198	2005	49	75	124
1937	12	12	24	2006	57	77	134
1938	32	32	64	2007	50	82	132
1939	19	20	39	2008	64	66	130
1940	56	69	125	2009	59	57	116

2.4 Abundance and trends

SC/62/BRG1 presented calf counts from shore-based surveys of northbound eastern North Pacific gray whales. These surveys have been conducted each spring between 1994 and 2009 at the Piedras Blancas Light Station in central California. Results from the 1994 to 2000 portion of the study have previously been published (Perryman *et al.*, 2002) and paper SC/62/BRG1 presented an update of information from these counts for 2001–2009. Estimates for the total number of northbound calves in 2001 to 2009 were 256, 842, 774, 1528, 945, 1020, 404, 553 and 312, respectively. These calf estimates were highly variable between years, with no sign of a positive or negative trend. Calf production indices, as calculated by dividing the estimates of northbound calves by estimates of abundance for the population (Laake *et al.*, 2009), ranged between 1.6–8.8% with an overall average of 4.2%. No significant trend in the median migration date was observed, although a trend toward a later median date beginning in 2002 was apparent. The annual indices of calf production reported reflect, at least to a large degree, calf loss due to postnatal mortality, but may ultimately overestimate recruitment into the population because they do not account for the possibly significant level of predation on gray whale calves by killer whales occurring north of survey site. The relatively low reproductive output in this population is consistent with the reports of little or no growth in this population over the same time period – see Laake *et al.* (2009) and SC/62/AWMP2. Based on comparisons of Arctic sea ice distributions taken from satellite images and estimates of northbound calves, Perryman *et al.* (2002) suggested that there is a link between the timing of the melt of seasonal ice and calf production in this population the following winter. These authors hypothesize that a late retreat of seasonal ice may delay access to the feeding areas for pregnant females and reduce the probability that existing pregnancies will be carried to term.

The SWG noted that the calf production indices were particularly low (<3%) during two periods (1999–2001 and 2007–09). During the first period, calf counts were low and high numbers of strandings also occurred. However, although the calf counts were low during 2007–09, there is no evidence for higher numbers of strandings during these years (see also discussion of SC/62/BRG35). Moreover, unlike 1999–2000, there are no observations that that the proportion of 'skinny' whales in the Mexican lagoons were higher during 2007–09 than during the years immediately prior to 2007. The SWG noted that the calf production indices in SC/62/BRG1 are being used to quantify the extent and temporal auto-correlation in reproductive rates (see Item 2 of SC/62/Rep2; Item 2 of Annex D). Although the time-series of calf counts is now 16 years long, this is only just long enough to allow estimation of these parameters. The SWG therefore **recommended** that these data continue to be collected, and reviewed during future *Implementation Reviews*.

In discussion, the SWG noted that the calf count data had been used during the initial development and *Implementation* for eastern gray whales. It **agreed** that the information provided in SC/62/BRG1 did not indicate any need to modify the trials structure.

SC/62/BRG36 reported on changes in the abundance of gray whales inferred from boat surveys at Laguna Ojo de Liebre (1980–83, 1985, 1987–89, and 1996–2010) and Laguna San Ignacio (1978–82, 1996–2000, and 2006–10). In Laguna Ojo de Liebre, the most whales during the peak of the season occurred during 2004 (889 cow-calf pairs and 233 single whales), while this peak occurred in 1984 in Laguna San Ignacio (137 cow-calf pairs and 270 single whales). There was a decrease in the numbers of cow-calf pairs in both lagoons during 2007 to 2009, similar to the results from shore-based surveys at Piedras Blancas during the northbound migration. The counts of cow-calf pairs in both lagoons in 2010 were the lowest over the last 15 years.

The SWG welcomed the information in SC/62/BRG36, and noted that the series of cow-calf counts in lagoons, which provide a relative index not absolute estimates, are consistent with the calf counts in SC/62/BRG1. The lagoon data were not used when conditioning the operating models used to evaluate candidate *SLA*s for the ENP gray whales. The correlation between these data and the calf counts in SC/62/BRG36 suggest that their inclusion when conditioning would not have impacted the evaluation of how well the *Gray Whale SLA* performed.

SC/62/BRG8 reported a 'new' counting approach that has recently been adopted for the counts of southbound migrating whales at Granite Canyon, California, which form the basis of abundance estimation for the ENP gray whales. In 23 years, between 1967 and 2007, counts of the number of observed pods have been rescaled by a series of correction factors to provide abundance estimates. The 'traditional' counting approach involved a single observer independently searching for whales and hand-recording entries onto a data form. The 'new' counting approach involves a team of paired-observers working together, using a computer to log data and map whale sightings. SC/62/BRG8 compares the performance of the traditional and new counting approaches during simultaneous and independent trials conducted during the 2006/07 and 2007/08 southbound migrations. In general, the number of pods counted showed a high degree of similarity between stations. However, there was a tendency for the new paired-observer teams to count fewer pods but estimate relatively higher numbers of whales. This probably represents a tendency for the paired-observers to lump rather than split whales into recorded pods because the tracking software facilitated the repeated relocation of whales in close proximity to each other. However, there may also have been a differential pod size estimation bias. The authors note the need for new calibration data to evaluate the different pod size estimation biases of new counting methods and new observers before count data can be reliably rescaled to estimate abundance.

The SWG welcomed this report. It noted the importance of ensuring comparability among years in any long-term monitoring effort. It **recommended** that data be collected to re-evaluate pod size bias given the change in survey protocol and that variance estimates for future survey estimates of abundance account for the uncertainty associated with calibration of abundance estimates computed using different survey protocols.

Laake *et al.* (2009) re-evaluated the data from all 23 seasons of shore-based counts for the Eastern North Pacific stock of gray whales conducted throughout all or most of the southbound migration near Carmel, California using a common estimation procedure and an improved method for treatment of error in pod size and detection probability estimation. Population estimates have been derived from these surveys using a variety of techniques that were adapted as the data collection protocol evolved. The resulting time series of estimates was used to evaluate trend and population status, resulting in the conclusion that the population was no longer endangered and had achieved its optimum sustainable population level under the US MMPA. The newly derived abundance estimates between 1967 and 1987 were generally larger (–2.5% to 21%) than previous abundance estimates. However, the opposite was the case for survey years 1992 to 2006, with estimates declining by –4.9% to –29%. This pattern is largely explained by the differences in the correction for pod size bias which occurred because the pod sizes in the calibration data overrepresented pods of two or more whales and underrepresented single whales relative to the estimated true pod size distribution.

The SWG thanked the authors for this comprehensive and careful review of this extremely valuable time-series of absolute abundance estimates. It **recommends** that the estimates of abundance given in Table 2 be **adopted** for use in the *Implementation Review* and for use when applying the *Gray Whale SLA*.

Table 2

Time-series of agreed abundance estimates of eastern gray whales for use in the *Gray Whale SLA* (taken from Laake *et al.* 2009).

Year	Estimate	CV	Year	Estimate	CV
1967/68	13,426	0.094	1979/80	19,763	0.083
1968/69	14,548	0.080	1984/85	23,499	0.089
1969/70	14,553	0.083	1985/86	22,921	0.081
1970/71	12,771	0.081	1987/88	26,916	0.058
1971/72	11,079	0.092	1992/93	15,762	0.067
1972/73	17,365	0.079	1993/94	20,103	0.055
1973/74	17,375	0.082	1995/96	20,944	0.061
1974/75	15,290	0.084	1997/98	21,135	0.068
1975/76	17,564	0.086	2000/01	16,369	0.061
1976/77	18,377	0.080	2001/02	16,033	0.069
1977/78	19,538	0.088	2006/07	19,126	0.071
1978/79	15,384	0.080			

As noted under Item 2.2, SC/62/BRG32 reported the results of an 11-year (1998–2008) collaborative study examining the abundance and the population structure of the ENP gray whales that spend the spring, summer and fall feeding in coastal waters of the Pacific Northwest conducted over a number of regions from Northern California to British Columbia using photographic identification. Some 12,679 identifications representing 872 unique gray whales were obtained. Gray whales seen after 1 June (after the northward migration) were more likely to be seen repeatedly and in multiple regions and years and 1 June was used as the seasonal start date for the data included in the abundance estimates. Gray whales using the Pacific Northwest during summer and fall include two groups: (1) whales that return frequently and account for the majority of the sightings; and (2) apparent stragglers from the migration seen in only one year, generally for shorter periods and in more limited areas. SC/62/BRG32 concluded the population structure of gray whales using the Pacific Northwest in summer and fall is complicated and involves two elements; the PCFG animals and the 'stragglers'. Abundance estimates for whales present in summer and autumn were estimated using both open and closed population models. Methods were proposed in SC/62/BRG32 for removing the 'stragglers' from both types of analyses to estimate abundance only of regularly returning whales. Three methods and four geographic scales revealed the abundance of animals that regularly return to the Pacific Northwest to be at most a few hundred individuals. Abundance estimates were lower for more limited ranges, but these more limited areas do not reflect closed populations. The proportion of calves documented was generally low, but varied dramatically among years and may have been biased downward by weaning of calves prior to much of the seasonal effort. Observations of calves returning to the Pacific Northwest in subsequent years, provides one possible mechanism for recruitment to the area.

The SWG **agreed** that these data would be extremely useful during the proposed 2011 *Implementation Review*, along with telemetry data, to determine the probability that animals from the putative feeding aggregation in the Pacific northwest are at risk of being caught during hunts in that area (see Item 2.6). The estimates in SC/62/BRG32 will also be useful to condition any trials developed to examine the performance of *SLA* variants for this feeding aggregation.

2.5 Other

2.5.1 Assessment

SC/62/AWMP2 fitted an age- and sex-structured population dynamics model to data on the catches and abundance estimates for the ENP stock of gray whales using Bayesian methods. The prior distributions used for these analyses incorporated the revised the estimates of abundance in Laake *et al.* (2009) and SC/62/BRG1, and accounted explicitly for the drop in abundance caused by the 1999–2000 mortality event. A series of analyses were conducted to evaluate the sensitivity of the results to different assumptions. The baseline analysis estimated the ENP gray whale population to be above the maximum sustainable yield level (MSYL), because the posterior mean for the ratio of 2009 abundance to MYSL is 1.29 (with a posterior median of 1.37 and a 90% probability interval of 0.68–1.51). The baseline analysis estimated a probability of 0.884 that the population is above MSYL. These results are consistent across all the model runs. The baseline model also estimated the 2009 ENP gray whale population size (posterior mean of 21,911) to be at 85% of its carrying capacity (posterior mean of 25,808), and this was also consistent across all the model runs.

The analyses of SC/62/AWMP2 only estimated an extra mortality parameter for 1999–2000. In discussion, it was noted that this choice was supported by the calf count data, the strandings records and the results of an analysis in which annual parameters were estimated for reproduction and survival (Brandon and Punt, 2009). It was noted that a large drop in abundance is estimated to have occurred between 1987–88 and 1992–93 (Table 2). There are no calf count data for this period but the strandings records provide no evidence for a mortality event of the scale of that which occurred in the late 1990s.

The SWG thanked the authors of SC/62/AWMP2 for the updated assessment. It **agreed** that the results of the assessment were within the bounds considered during the *Implementation*. Specifically, although the base operating model used to estimate the *Gray Whale SLA* did not explicitly include the 1999–2000 event, robustness tests involving catastrophic mortality events were conducted and the *Gray Whale SLA* performed as expected for these tests.

2.5.2 Strandings data

SC/62/BRG25 provided a summary of all gray whale strandings in California, Oregon and Washington between 1 January 2010 and 31 May 2010. The SWG welcomed this information, **agreed** that it showed that stranding levels were now similar to 'normal' years, and **recommended** that these data continue to be collected and presented to the SWG.

2.6 Consideration of need for new trials (and, if applicable, results of those)

The SWG refers to its earlier comments on the situation with respect to the DAA and the need for an *Implementation Review*.

Although some of the papers/data available to the SWG could not be considered in terms of the 2010 *Implementation Review*, the SWG agreed that the information provided on the PCFG was such that its existence represents a plausible hypothesis, not considered in the original *Implementation,* such that it was sufficient to trigger a new *Implementation Review* in 2011. The reason that this hypothesis is important from an AWMP perspective relates to the potential harvesting in this region by the Makah Tribe and thus the need for the SWG to provide advice/develop an *SLA* to fulfil both the 'conservation' and 'user' objectives given by the Commission. It noted that the situation for PCFG is not the same as for the Greenlandic feeding aggregation of humpback whales, in that the latter case involves a feeding aggregation that does not occur (even in the short-term during migration) with animals from other feeding aggregations in the waters where the hunt takes place. In the case of the proposed area for the Makah hunt, both PCFG and migrating whales from the other feeding areas co-occur at least some of the time.

The SWG **agreed** therefore that the information on stock structure and hunting warranted the development of trials to evaluate the performance of *SLA*s for hunting in the Pacific Northwest at the 2011 *Implementation Review*. The question of a timetable for this work is discussed later in the report.

The SWG also noted that the assessment work discussed above showed that the population as a whole is in a healthy state. It **agreed** that for the purposes of the 2011 *Implementation Review*, the primary focus should be the PCFG.

That being said, it agreed that over the next few years, further work should be undertaken to investigate the possibility of structure on the northern feeding grounds, especially in the region of the Chukotkan hunts. It **recommends** that additional information be collected from the Chukotkan region, in particular, where possible, including genetic samples and photographs from the hunt. In addition, the collation of information on the geographical and temporal distribution of the hunt will be valuable.

To provide some general guidance for the 2011 *Implementation Review*, the SWG **agreed** that any acceptable future *SLA* for the hunt in the Pacific Northwest must include a feedback mechanism. It was unable and not appropriate for it to fully specify a set of trials during the present meeting. However, it had preliminary discussions on those aspects that could form part of a final set of trials for the 2011 *Implementation Review.* A summary of the key factors is given below.

(1) **Current abundance**. The best estimate of current (1+) abundance for the PCFG would be 200 based on the estimates in SC/62/BRG32. A 'low' value of 150 would also be considered in trials. This latter value is lower than would be expected from the confidence intervals in SC/62/BRG32, but would be informative about the performance of a *SLA* and reflects uncertainties that may not have been captured in SC/62/BRG32. In addition, this value is close to the average of the number of individuals identified in recent years (SC/62/BRG32).
(2) **Relative availability of PCFG and non-PCFG whales to the hunters**. The SWG is currently unable to specify ranges for this parameter. It **recommended** that best estimates and lower and upper values could be obtained by analysing data from a variety of sources including the estimates of abundance in SC/62/BRG32 and information from satellite-tagged animals. The hunt is likely to be restricted to certain periods of the year and if this is the case, the measures of availability will need to pertain to those periods. The impact of inter-annual variability in availability will need to be accounted for in the trials. It is desirable for attempts to be made to estimate this variation.
(3) **Need**. The level of need (in the form of a need envelope) will need to be provided to the SWG by the US. The SWG **recommended** that the Chair of the SWG discuss its requirements for need envelopes with the hunters and members of the US delegation. The SWG will also need to be provided with any domestic regulations (such as time-area restrictions) that will be imposed on the hunt so that these can be accounted for in the trials to evaluate *SLA*s.
(4) **MSYR**. The SWG will explore a similar range of MSYR values to those considered for the development of the *Gray Whale SLA*.

2.7 Conclusions and recommendations

In light of the DAA difficulties discussed earlier, the SWG **agreed** that it had completed the *Implementation Review* on the basis of the data that had been made available to it in accord with the DAA. However, given the new information available that did not meet the DAA conditions, it **agreed** that a new *Implementation Review* should occur in 2011 to take into account information provided on the PCFG presented outside the DAA. The Chair of the SWG **agreed** to ensure that all likely contributors to the review are made aware of the DAA requirements as well as the guidelines for genetic analyses and data.

The SWG **agreed** that the following would assist in the trial development process:

(1) collection/analysis of genetic data that would allow more robust comparison of such data from animals in the northern and southern feeding areas;
(2) collection/analysis of genetic data from Kodiak Island to California to further examine the probable range of the PCFG;
(3) collection/analysis of genetic data to compare further animals seen in only one year with animals that are frequently seen within the hunting area;
(4) collection/analysis of additional information (including telemetry data) on the relative temporal 'availability' of PCFG animals within the hunting area (e.g. by month); and
(5) an updated analysis of any additional data to obtain the most recent abundance estimate for the PCFG at the time of the 2011 *Implementation Review.*

2.8 Management advice

2.8.1 Summary of previous season's catch data

A total of 115 gray whales (58 males, 57 females) was harvested in Chukotkan waters in 2009 and 1 was lost. A total of 6 of the 115 individuals were considered as unfit for consumption in 2009 (samples were taken from all 6). Biological sampling was conducted on 61 gray whales.

2.8.2 Management advice

As noted under Item 2, the SWG **agreed** that it has completed the *Implementation Review* but that a new *Implementation Review* should take place next year. In this context, the SWG **agreed** that its position with respect to the provision of management advice was unchanged from last year, i.e. the *Gray Whale SLA* remains the appropriate tool to provide management advice for eastern North Pacific gray whales. This remains the case, at least until the 2011 *Implementation Review* is completed.

In line with the values in table 4 of the proposed consensus decision (IWC/62/7rev), the Secretariat ran the *SLA* using the updated information on catches and abundance agreed at this meeting. This confirmed that an annual strike limit of 145 animals will not harm the stock (note that 145 is the maximum catch that can be taken in any one year; the annual average catch is 129 whales). In providing this advice, the SWG **draws attention** to the need for a new *Implementation Review* next year. It was noted that although table 4 included strike limits for 10 years, the proposed consensus decision envisages the usual periodic reviews of strike limits for indigenous whaling.

Borodin commented that the annual strike limit should include the actual number of struck-and-lost whales and 'stinky' whales (e.g. in 2009 the numbers were 1 and 6, respectively). If hunting is on large whales then the number of struck-and-lost whales will be higher. Within that context, he noted that the annual strike limit should not exceed 150 whales (the number included in the *Gray Whale SLA* trials for the early period of catches during the development process).

3. COMMON MINKE WHALES OFF WEST GREENLAND

3.1 Further discussion of the sex ratio method

3.1.1 Summary of discussions at the intersessional Workshop

The SWG reviewed its progress toward developing a sex-ratio method for assessing the West Greenland stock of common minke whales including, most recently, the Report of the Third AWMP Workshop on Greenlandic Hunts, held intersessionally, December 14–17, 2009, in Roskilde, Denmark (SC/62/Rep3). That meeting had focused on highly technical aspects of the estimation method, of which the topic with broadest implications was the specification of a new method for the calculation of one-sided confidence intervals for carrying capacity, *K*, and hence for other management related parameters including stock abundance.

The sex-ratio approach has been described in previous SWG reports (e.g. IWC, 2009b). The one-sided confidence limit approach proposed in Roskilde is described in Annex B of SC/62/Rep3. Put simply, for a given *K* the method is a parametric bootstrap of the left branch of the deviance function, defined to be the ordinary deviance if the bootstrap pseudo-estimate of *K* does not exceed the actual value, and zero otherwise (Fig. 1). One such bootstrap at each of a sequence of possible *K* values enables estimation of the 95% deviance contour which, when compared to the deviance function from the observed data, provides the desired confidence interval.

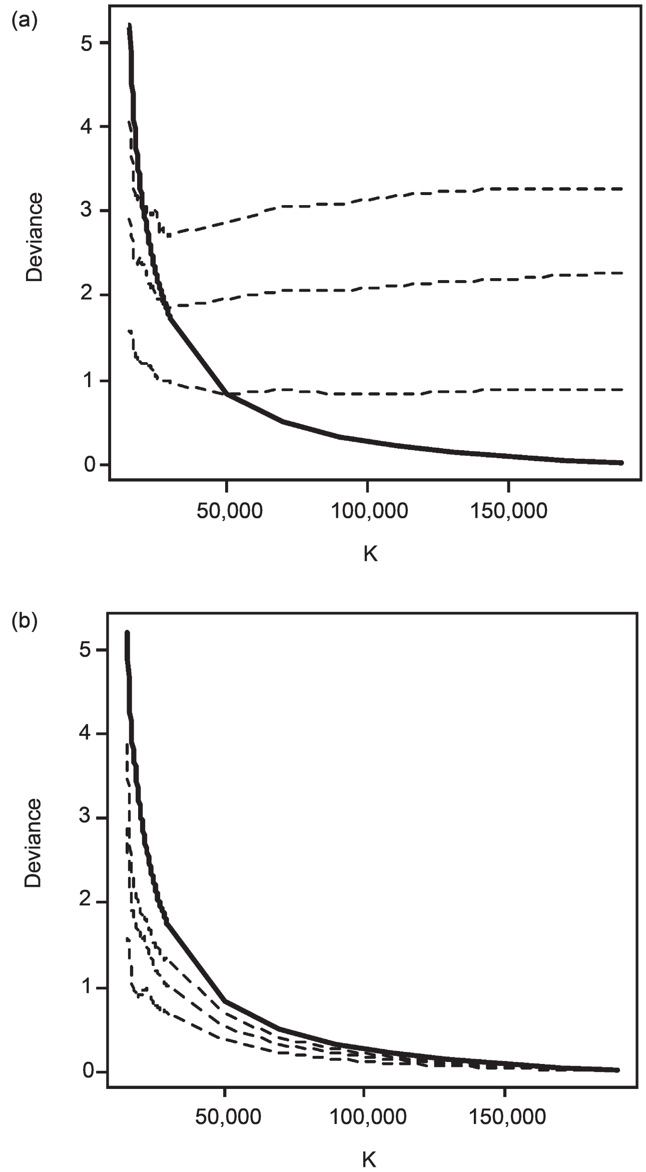

Fig. 1. Examples of the left branch of the deviance function and some expected quantiles of left deviance (a) and the left branch of the deviance function and some examples of quantiles of left deviance obtained using the algorithm agreed during the Third AWMP Workshop (b).

3.1.2 Results of intersessional work

Allison and Punt had implemented the 'Annex B' method after the Workshop. The numerical results they found raised concerns about whether the specification of the method was correct and appropriate. In particular, the quantiles of the left deviance function did not intersect the deviance based on the actual data. A variety of revisions and alternative approaches were explored by the Workshop participants before the SWG meeting, but there were no wholly satisfying results.

3.1.3 Review by the SWG

Givens was requested by the SWG to review the intersessional work and the various options surrounding the 'Annex B' approach. He stated that the original Annex B represented the correct approach. Appendix 4 details his recommended algorithm to implement this approach. The SWG **emphasised** the need to further refine this approach and to carefully ensure that the computer program is correctly implemented.

However, Givens had also identified a potential problem with the implementation of the parametric bootstrap, originating from the estimation procedure's truncation of parameter space at $K = 200{,}000$. The truncation had been introduced as a convenience to limit numerical search, since for many potential sex-ratio datasets the likelihood increases monotonically with K and hence the maximum likelihood estimate for K diverges to infinity. Adopting the notation in Appendix 4, the shape of the likelihood will often lead to $\hat{K}_{ig}$ values that exceed the truncation point of 200,000. In these cases, $LD_{ig}(\hat{K}_{ig}, K_g) > LD_{ig}(\hat{K}_{ig}, 200{,}000)$ when $K > 200{,}000$ and $LD_{ig}(200{,}000, K_g) < LD_{ig}(\hat{K}_{ig}, K_g)$. If such a simulation were to be discarded, or if $\hat{K}_{ig}$ were to be replaced with the value 200,000 so that $LD_{ig}(\hat{K}_{ig}, K_g)$ was replaced with $LD_{ig}(200{,}000, K_g)$, then the bootstrap simulation would not produce a sufficiently heavy right tail for the deviance distribution. Allison reported that the latter option was currently used. Either approach results in a downward bias when estimating $LD_g(.95)$, which in turn leads to a upward bias in the left confidence limit for K. This is the direction of bias that is least desirable in the sense that it could lead to over-exploitation of the stock.

In statistical terms, the truncation point perhaps creates an instance of right-censored data. Thus, the 95% left-deviance quantile at K_g should be estimated using a method that accounts for censored data, not with the direct empirical percentile method. Although seemingly a small problem, the censored instances occur quite frequently, and in a general sense the problem is indicative of the continued difficulties the SWG has faced with the likelihood function that underlies the sex-ratio approach.

Several remedies were considered by the SWG. The most promising of these was to re-parameterise the analysis by replacing K with $1/K$ or another suitable transformation. The SWG considered this to be a high-risk/high-reward option: it could provide a fundamentally more stable basis for estimation thereby eliminating many of the intricacies that continue to plague the current framework, but it may introduce new difficulties. The SWG **recommended** that this approach receive the highest priority during the next intersessional period. If a transformed analysis could be completed and agreed at the 2011 Scientific Committee meeting, the SWG would be prepared to use the sex-ratio method as a basis for abundance estimation and submit this to appropriate simulation trials to testing of performance and robustness. If these trials are passed, the approach could then be used for providing management advice.

The SWG also considered other options which would not require such a drastic change but which it considered had less chance of being successful. For example, the application of a censored data method for quantile estimation was also worth investigating. In addition, the likelihood function from recent aerial survey data could be incorporated into the approach, and this might change the deviance sufficiently to reduce some of the difficulties; however, application of this is not straightforward because, *inter alia*, the stock portion to which the estimate applies is uncertain. The SWG recognised that considering a new Bayesian approach (the original paper motivating the use of sex ratio data had followed a Bayesian approach) would probably not resolve the SWG's difficulties and would introduce a new set of challenges for the specification of priors. As a final option, the SWG considered raising the current truncation point. Work to examine whether this will be successful is underway and may be available by the Plenary sessions.

3.1.4 Conclusion on the use of the sex ratio method

The SWG **agreed** that the continued difficulties in successfully implementing a sex-ratio approach required a re-evaluation of the SWG's work plan. The original motivation for this work had been the Committee's inabililty to provide management advice for this hunt. Thus, reflecting the priorities of the Scientific Committee and the Commission, work on a sex-ratio estimation of abundance for West Greenland common minke whales has been the dominant focus of SWG effort for a number of Scientific Committee meetings and three intersessional workshops. The participants have devoted considerable research effort to this task, the work has been scientifically challenging and methodologically innovative and the potential gain in terms of providing adequate management advice extremely high. However, despite enormous effort, no satisfactory conclusion has been achieved to date.

Therefore, the SWG **agreed** that it would no longer prioritise development of the sex-ratio approach unless a comprehensive final analysis could be endorsed at the 2011 Scientific Committee meeting. The SWG believed that the transformation strategy may provide a promising basis for estimation in the short time remaining. Although it would be regrettable to abandon the sex-ratio effort without obtaining an agreed abundance estimate, there are many other urgent issues to which the SWG must turn its focus.

3.2 Management advice

3.2.1 Summary of previous season's catch

In the 2009 season, 153 minke whales were landed in West Greenland and 11 were struck and lost. Of the landed whales, there were 105 females, 47 males, and one whale of unreported sex.

3.2.2 Management advice

In 2007, the Commission agreed that the number of common minke whales struck from this stock shall not exceed 200 in each of the years 2008–12, except that up to 15 strikes can be carried forward. Last year, as it has said on several occasions in the past, the Committee has never been able to provide satisfactory management advice for this stock, although in recent years, the situation has been improving. Last year, the Committee was for the first time ever able to provide management advice for this stock, and adopted a new abundance estimate last year, although it is negatively biased, and has also agreed a method for providing interim management advice and this was confirmed by the Commission. Such advice can be used for up to two five-year blocks whilst *SLAs* are being developed (IWC, 2009a, p.16). Based on the application of the agreed approach, and the lower 5th percentile for the 2007 estimate of abundance (i.e. 8,918), the Committee **repeats its advice** of last year that an annual strike limit of 178 will not harm the stock.

3.3 Progress with *SLA* development

3.3.1 Summary of discussions at the intersessional workshop

In Greenland, a multispecies hunt occurs. The expressed 'need' is for 670 tonnes of edible products from large whales for West Greenland (IWC/62/9); at present this involves catches of common minke whales, fin whales and bowhead whales. Greenland has also requested a catch of humpback whales from the Commission (IWC/62/9). The flexibility among species is important to the hunters.

The issue of what is the 'correct' level of need itself is outside the scope of the Scientific Committee. In generic terms, the relevant Governments submit a 'need statement' to the Commission and it is then a Commission decision as to whether to accept that need request. Once that is agreed then the task of the Scientific Committee is to evaluate whether that need request can be achieved within the agreed conservation objectives of the Commission.

Where need is expressed as a number of animals of a particular species/stock this can be a relatively straightforward exercise. However, in developing long-term *SLA*s in the context of a 100-year simulation period, the Committee (and the Commission) has agreed that it is important to bound the likely levels of future need for testing purposes in order to avoid having re-evaluate the *SLA* itself every time an increased need request is accepted (should that occur). This bound is termed the 'need envelope' and has initially been developed by the Chair of the AWMP in conjunction with the hunters. It is important to note that this is a hypothetical upper bound in terms of the robustness of the *SLA* and neither commits the Commission to accepting increased need requests should these be presented nor indeed prevents the submission of need requests greater than the bound at some time in the future. In the latter case, the *SLA* would have to be re-evaluated as the circumstances would be outside the tested parameter space (this could be undertaken in the context of an *Implementation Review* in the same way that other new information might be obtained that led to the conclusion that further *Robustness Trials* were needed).

The Workshop noted that satisfying 'subsistence need' to the extent possible was a critical component of an *SLA*, yet the situation in Greenland, where there is a multispecies fishery with need expressed in tonnes of food and there is a request for flexibility amongst species, is complex. The Workshop considered some of the challenges presented by this issue (SC/62/Rep5), noting that the development of a combined approach to calculate strike limits for more than one species is beyond what the SWG and Scientific Committee have previously attempted. Consultation with both the hunters and the Commission will be required.

3.3.2 Further discussion and recommendations for further work

The SWG noted that the approach developed to provide safe interim advice was agreed for a limited time span of two consecutive 5-year blocks. It was not intended to replace or delay development of an appropriate *SLA* for this fishery but rather to allow time for this to be accomplished prior to the end of the second 5-year block. The SWG **reaffirmed** the importance of developing such an *SLA*. It had previously been awaiting the outcome of the evaluation of a sex ratio method approach; the decision potentially to cease work on a sex-ratio abundance estimate does not affect the need to begin work on an *SLA* as soon as possible such that a suitable *SLA* can be developed and tested before the current short-term advice expires. Section 11 describes the future work plan.

4. FIN WHALES OFF WEST GREENLAND

4.1 Management advice

4.1.1 Summary of previous season's catch data

A total of 8 (1 male; 7 females) fin whales were landed, and 2 struck and lost, in West Greenland during 2009 (SC/62/ProgRep Denmark). Genetic samples were collected for 5 of the 8 fin whales harvested during 2009.

4.1.2 Management advice

In 2007, the Commission agreed to a quota (for the years 2008–12) of 19 fin whales struck off West Greenland. The Committee agreed an approach for providing interim management advice in 2008 and this was confirmed by the Commission. It had agreed that such advice could be used for up to two five-year blocks whilst *SLA*s were being developed (IWC, 2009a). Based on the application of the agreed approach in 2008 (IWC, 2009a), the SWG **agreed** that an annual strike limit of 19 whales will not harm the stock.

4.2 Progress with SLA development

The general consideration of *SLA*s for Greenlandic fisheries was discussed at the intersessional workshop (SC/62/Rep3) and summarised under Item 3.3.1 above.

Simulation evaluation of *SLA*s requires the development and parameterisation of a set of operating models. Unlike the situation for West Greenland minke whales, the SWG has an assessment for West Greenland fin whales which means that it is in a better position to develop an *SLA* for fin whales. The SWG **agreed** last year that the set of RMP trials developed to evaluate variants of the *CLA* for North Atlantic fin whales are an appropriate starting point for developing trials for this case, and this year the SWG was presented with a summary of the stock structure hypotheses underlying those trials. The trials for the North Atlantic fin whales were focused on the areas likely to be subject to whaling off Iceland. These trials will need to be modified to focus more on the uncertainties pertinent to West Greenland if they are to form the basis for evaluation of *SLA*s for fin whales. The SWG did not have time to consider a working paper outlining the RMP trials at this meeting. It **re-emphasises** the importance of developing *SLA*s for Greenlandic fisheries as soon as possible. This is discussed further under the work plan.

5. COMMON MINKE WHALES OFF EAST GREENLAND

5.1 New information

Revised estimates of abundance for minke whales in parts of the central Atlantic were presented based on data collected during the 2007 T-NASS survey (SC/62/RMP5). Standard stratified line transect methods were used and estimation of $g(0)$ was not attempted. The resulting accepted abundance estimates for the CG and CIP *Small Areas* were 1,048 (CV 0.60) and 1,350 (CV 0.38) (see Item 3.3.2 of Annex D).

5.2 Management advice

5.2.1 Summary of previous season's catch data

Three males and one female common minke whale were struck (and landed) off East Greenland in 2009 (no animals were struck and lost) (SC/62/ProgRep Denmark). Genetic samples were obtained from two of these whales. The SWG noted that catches of minke whales off East Greenland are believed to come from the much larger Central stock of minke whales.

5.2.2 Management advice

In 2007, the Commission agreed to an annual quota of 12 minke whales from the stock off East Greenland for 2008–12, which the Committee stated was acceptable in 2007. The present strike limit represents a very small proportion of the Central Stock (see Table 3). The SWG **agreed** that the present strike limit would not harm the stock.

Table 3

Most recent abundance estimates for minke whales in the central North Atlantic.

Small Area(s)	Year(s)	Abundance and CV
CM	2005	26,739 (CV=0.39)
CIC	2007	10,680 (CV=0.29)
CG	2007	1,048 (CV=0.60)
CIP	2007	1,350 (CV=0.38)

6. MANAGEMENT ADVICE FOR HUMPBACK WHALES OFF WEST GREENLAND

In 2007, the Committee agreed an approach for providing interim management advice and this was confirmed by the Commission. It had agreed that such advice could be used for up to two five-year blocks whilst *SLA*s were being developed (IWC, 2009a, p.16). Using this approach, as last year, the SWG **agreed** that an annual strike limit of 10 whales will not harm the stock.

7. MANAGEMENT ADVICE FOR HUMPBACK WHALES OFF ST. VINCENT AND THE GRENADINES

7.1 Summary of previous season's catch data

The SWG was advised that three females (lengths 34', 34'3" and 43'2") were taken during 2010. Neither genetic samples nor photographs were available for these animals. The SWG has encouraged St. Vincent and The Grenadines to submit as much information as possible about any catches to the Committee via an annual progress report. The SWG **strongly recommended** collection of genetic samples for any harvested animals as well as fluke photographs, and submission of these to appropriate catalogues and collections. In respect of genetic samples, the SWG again **agreed** that the North Atlantic Whale Archive maintained by Per Palsbøll was an appropriate facility.

7.2 Management advice

In recent years, the Committee has agreed that the animals found off St. Vincent and The Grenadines are part of the large West Indies breeding population. The Commission adopted a total block catch limit of 20 for the period 2008–12. The SWG **agreed** that this block catch limit will not harm the stock.

8. SCIENTIFIC ASPECTS OF AN ABORIGINAL SUBSISTENCE WHALING SCHEME

8.1 Lessons learned from the bowhead *Implementation Review*

Donovan reported that there were two main issues arising from the bowhead *Implementation Review*: (1) stock structure and in particular genetic samples; and (2) data availability.

In relation to the first of these two issues, the SWG noted that there are now guidelines for DNA data quality which arose from, for example, the difficulties encountered during the bowhead *Implementation Review* (IWC, 2008, p.70).

In relation to data availability in general, members noted that some data sources (e.g. genetics samples) can be obtained fairly quickly (in contrast to, for example, survey results which frequently require several years of planning). The possibly multi-year *Implementation* and *Implementation Review* process adds some uncertainty with respect to the application of appropriate deadlines. In addition, there is a lack of guidance regarding which data sources need to be submitted (some data sources such as genetics and survey data must clearly be available, but this is less clear for other data sources such as age data which, for bowheads, are used to determine a prior distribution for survival rate which is used when conditioning trials). The SWG noted that one reason for this was the lack of explicit guidelines for conducting *Implementations* and *Implementation Reviews* and that the processes used when applying the RMP, particularly the structure of a *pre-Implementation assessment*, has provided more structure and hence clarity regarding data availability and timelines. The SWG recognised that having something similar for the *SLA* development and review process was desirable. It **requested** Donovan to provide a draft of such a document for consideration at next year's meeting.

8.2 Other

In 2002, the Scientific Committee **strongly recommended** that the Commission adopt the Aboriginal Subsistence Whaling Scheme (IWC, 2003, pp.22–23). This covers a number of practical issues such as survey intervals, carryover and guidelines for surveys. The Committee has stated the AWS provisions constitute an important and necessary component of safe management under AWMP *SLA*s and the SWG continues to **concur** with this view. It noted that discussions within the Commission of some aspects such as the 'grace period' are not yet complete.

9. OTHER MATTERS

9.1 Conversion factors for edible products for Greenland fisheries

Donovan introduced the background to IWC/62/9, an extensive 52 page report of the Small Working Group on conversion factors for the Greenlandic large whale hunt, and overviewed the contents of the report that has been available for several months. He noted that this report had arisen out of a request from the Chair of the Commission that a small group be formed to provide advice on conversion factors for the Greenlandic hunt. The full Terms of Reference for that group can be found in IWC/62/9. He stressed that the group (Donovan, Palka, George, Hammond, Levermann and Witting) had not been tasked to examine the Greenlandic need statement itself, which is expressed in terms of tonnes of edible products. The report of the group was presented to the Intersessional Commission meeting to consider Greenlandic strike limits. No decisions on catch limits could be taken at that intersessional meeting since there were insufficient members present to constitute a quorum. In discussion of the report at that meeting, it was agreed that there was no need for the report to be reviewed in detail by the Scientific Committee but that individual scientists should send comments to the authors so that the report could be revised, if necessary, by the Commission meeting in Agadir. That request was circulated to the Scientific Committee with a request for comments by 6 June. However, it had been agreed that this issue could be added to the SWG agenda.

As noted the report itself is a lengthy document. The work of the group included a number of phases: a field visit; a review of available data and publications on length-weight relationships; a review of available data from the Greenlandic hunts themselves; an analysis of conversion factors based on what was agreed to be the best available datasets for each species; and recommendations on possible conversion factors and future work.

A major part of the work involved determining if the available Greenlandic datasets (provided by hunters) could be used. Extensive analyses of these data, including comparison of these with available datasets from elsewhere was undertaken (different ways of measuring whales in Greenland when compared to elsewhere meant that allowance for this had to be made). The authors concluded that truncated datasets (the truncation approach taken is described in the report) for common minke whales and fin whales were sufficiently reliable for analysis, noting that for reasons given in the report the large dataset for common minke whales was more reliable than the considerably smaller dataset for fin whales. Data from elsewhere had to be used for bowhead and humpback whales.

The authors developed conversion factors for each of the species. For reasons documented in the report it was clear that the efficiency of flensing under local conditions was greater for common minke whales than for larger species. The factor for common minke whales was considered the most reliable and was in accord with similar data collected by scientists for North Pacific common minke whales. The factors derived for the other species were recommended to be used as interim conversion factors for a five-year block. The report provided advice on conversion factors based on a per animal basis as well as factors taking struck-and-lost animals into account and taking into account whether strike limits are met (the last of these allows estimation of the amount of edible products reaching Greenlanders). The authors made a number of recommendations for future accurate data collection that required collaboration amongst scientists, hunters and wildlife officers and offered to assist in the design of this work.

In discussion, Clapham provided a number of comments on the report; these comments focused on the underlying approach to calculating conversion factors, as well as to the quality of the data used by the authors. He recognized that the authors had done a very good job with some very difficult data. However, with regard to the underlying approach, he questioned whether conversion factors should be based only upon what product yield has been achieved in the past, or should in addition consider what could be achieved with significant improvements in processing efficiency. He noted that the primary approach taken by the authors of the report followed that of Witting last year, i.e. to base future factors on past data, without considering alternatives. He noted the problems with the length data, and also the considerable range in the weights at lengths of the various edible products. Clapham suggested that these problems partly reflected the likely inaccuracy and unreliability of the information on which the report was based. He cautioned that, in light of this uncertainty, he believed the proposed conversion factors may be substantially in error. He recognized the authors' attempt to adjust for these problems, but suggested that there is no way to know the extent to which the existing product yield data are in error. His reading of the authors' description of how such estimates are derived and reported suggested that: (a) there is great variation in the likely accuracy of the reports; and (b) there is very little independent verification of the data's reliability. In light of this, he suggested that Greenland be asked to come back next year with data of verifiable quality on length and product yield, and/or that the Scientific Committee be given details of the new data collection methods, together with information on the process by which the reliability of the product yield data is verified.

In response, the authors noted that they had spent considerable time and effort in investigating the original data, recognising that it had not been collected by scientists for the purposes of estimating conversion factors. In particular they had compared the datasets with those available from elsewhere as well as testing them for internal consistency. The large sample size and the consistency with edible product information collected by scientists in the North Pacific, revealed that the data for common minke whales were sufficient to calculate a robust conversion factor (as well as showing the flensing process to be efficient). The limitations of the conversion factors provided for the other species were recognised in the report and considered interim pending the collection of additional data on length correction and edible products. They also noted that it would take some time to obtain sufficient sample sizes for some species. They noted that matters of efficiency were appropriate for discussion by the Commission.

The SWG endorsed the **recommendations** of the report. In particular, it supported the recommendations for further work that data on both 'curved' and 'standard' measurements are obtained during the coming season for common minke whales, fin whales and bowhead whales and that new data on edible products be collected using properly-designed protocols, analysed appropriately and reviewed. It also supported the recommendation that the work be undertaken by scientists, hunters and wildlife officers since this would improve the ability of hunters, particularly those in remote areas, to obtain more accurate length and weight measurements. Witting noted that Greenland has already begun to implement some of the recommendations of the Small Working Group and they will be implementing all of them in the next season. There is now increased collaboration between hunters, scientists and managers and improved estimates of the three types of edible product should be possible by having each product stored in separate bins and weighed. It was also noted that collaboration between hunters from Alaska and Greenland was underway with the respect to flensing techniques for bowhead whales. Finally, the SWG **requested** Greenland to provide information on its sampling scheme and data validation protocols to next year's meeting.

10. WORK PLAN

The SWG agreed that its work plan for the 2011 Annual Meeting would be as follows:

(1) Working Group (Allison, Punt, Schweder, Witting) to further explore the correctness of the sex-ratio method.
(2) Butterworth to consider whether a suitable transformation can be identified for the sex-ratio method. Givens, Schweder, and Witting will review progress.
(3) Conduct a 5-day intersessional Workshop, with Terms of Reference:
    (a) Make progress on developing *SLA*s for West Greenland fin and common minke whales [with fin whales the highest priority].
    (b) Evaluate progress on the development of the sex-ratio method.

(c) Prepare for the *Implementation Review* for the ENP gray whales.

(4) Donovan to develop a short working paper on appropriate operating models for West Greenland minke whales to complement that developed for fin whales.

(5) Further consider possible stock structure hypotheses for the fin whales off West Greenland in preparation for developing a *SLA* for these whales.

(6) Donovan to develop an outline of document which lists the factors which need to be considered when conducting *Implementations* and *Implementation Reviews* for aboriginal hunts.

(7) Review any new scientific information related to conversion factors for edible products for Greenland fisheries.

11. ADOPTION OF REPORT

The report was adopted at 19:20 on 7 June 2010. The sub-committee thanked the Chair for guiding them though a long and difficult agenda. The Chair thanked the rapporteurs.

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Appendix 1

AGENDA

1. Introductory items
    - 1.1 Convenor's opening remarks
    - 1.2 Election of Chair
    - 1.3 Appointment of rapporteurs
    - 1.4 Adoption of Agenda
    - 1.5 Documentation available

2. *Implementation Review* of eastern gray whales
    - 2.1 What is an *Implementation Review*?
    - 2.2 Stock structure and movements
    - 2.3 Catch data
    - 2.4 Abundance and trends
    - 2.5 Other
        - 2.5.1 Assessment
    - 2.6 Consideration of need for new trials (and, if applicable, results of those)
    - 2.7 Conclusions and recommendations
    - 2.8 Management advice
        - 2.8.1 Summary of previous season's catch data
        - 2.8.2 Management advice

3. Common minke whales off west Greenland
    - 3.1 Further discussion of sex ratio method
        - 3.1.1 Summary of discussions at the intersessional workshop
        - 3.1.2 Results of intersessional work
        - 3.1.3 Review by the SWG
    - 3.2 Management advice
        - 3.2.1 Summary of previous season's catch data
        - 3.2.2 Management advice
    - 3.3 Progress with *CLA* development
        - 3.3.1 Summary of discussions at the intersessional workshop
        - 3.3.2 Further discussion and recommendations for further work

4. Fin whales off west Greenland
   4.1 Management advice
      4.1.1 Summary of previous season's catch data
      4.1.2 Management advice
   4.2 Progress with *CLA* development

5. Common minke whales off east Greenland
   5.1 Management advice
      5.1.1 Summary of previous season's catch data
      5.1.2 Management advice

6. Management advice for humpback whales off west Greenland
   6.1 Management advice
      6.1.1 Summary of previous season's catch data
      6.1.2 Management advice

7. Management advice for humpback whales off St. Vincent and The Grenadines
   7.1 Management advice
      7.1.1 Summary of previous season's catch data
      7.1.2 Management advice

8. Scientific aspects of an aboriginal subsistence whaling scheme
   8.1 Lessons learned from the bowhead Implementation Review
   8.2 Other

9. Other matters
   9.1 Conversion factors for edible products for Greenland fisheries (IWC/62/9)

10. Work plan

11. Adoption of Report

Appendix 2

COMPARISON OF DATA FROM SC/62/AWMP1 WITH THOSE FROM DR. AIMEE LANG (WHICH INCLUDES DATA FROM LEDUC *et al*., 2002)

Timothy R. Frasier and James D. Darling

Several members of the AWMP group expressed concerns regarding the reference dataset that SC/62/AWMP1 used as a proxy for the 'northern feeding group', specifically the dataset of Goertliz *et al*. (2003). Instead, several suggested that the dataset of Leduc *et al*. (2002) would be more appropriate. Dr. Aimee Lang noted that she had a more up-to-date data set that also contained all of the data from Leduc *et al*. (2002), and she was willing to share those data for the purposes of these analyses. Her data contained sequences from 136 individuals from the eastern population.

The comparison of our data to that dataset is below. The overall picture is the same as in the original analyses.

Results

Arlequin Analysis (Using ver. 3.5)

$F_{ST} = 0.0605$, $P < 0.0001$

$\Phi_{ST} = 0.02362$, $P = 0.0332$

MIGRATE Analysis

Reject hypothesis that $\Theta_{southern} = \Theta_{northern}$, $P = 0.00257$.

Iteration

	$\Theta_{northern}$	$\Theta_{southern}$	$M_{southern\text{-}northern}$	$M_{northern\text{-}southern}$
1	0.0347 (0.0140–0.0570)	0.0147 (0.00550–0.0245)	875 (640–1,000)	870 (645–1,000)
2	0.0325 (0.0150–0.0534)	0.0149 (0.00580–0.0258)	886 (674–1,000)	846 (596–1,000)
3	0.0319 (0.0146–0.0520)	0.0159 (0.00580–0.0278)	869 (638–1,000)	849 (590–1,000)
Average	0.0330 (0.0145–0.0541)	0.0152 (0.00570–0.0260)	877 (651–1,000)	855 (610–1,000)

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Appendix 3

EASTERN NORTH PACIFIC GRAY WHALE CATCH NUMBERS

C. Allison, R. Reeves, T. Smith and M. Hughes

1. Pre 1846 catches

Table 1 lists the nominal estimated aboriginal catches (adjusted to account for hunting loss) from the eastern North Pacific stock of gray whales 1600–1845 as estimated by Mitchell and Reeves (1990 revised).

Table 1

Aboriginal removals from the eastern north Pacific stock of gray whales 1600–1845. The numbers are taken from Mitchell and Reeves (1990, revised), rounded up to the nearest integer. The sex ratio is assumed to be 1:1 (IWC 1993:243).

Years	Annual kill
1600–1675	182
1676–1750	183
1751–1840	198
1841–1845	194
Total kill 1600–1845	**46,300**

2. Catches 1846–1909

Commercial whaling on the eastern North Pacific stock of gray whales commenced in 1846. Table 2 lists the estimated catches (aboriginal and commercial) from 1846–1909. Herein, the term 'removals' is used to indicate secured catches (whales landed and processed) plus an adjustment (or correction) for whales killed or mortally injured but not secured (struck/lost). The estimates of removals are subject to various forms of uncertainty due to vagaries of reporting and due to statistical sampling errors. This is especially true for the 19th century removals (Reeves and Smith, 2010; Reeves *et al.*, 2010). Although the uncertainty values are not reported here, the median annual coefficients of variation were 21% for California shore whaling (Reeves and Smith, 2010) and 17% for ship-based whaling in Mexico (Reeves *et al.*, 2010).

Table 2 includes:

- aboriginal catches (Column A), taken from Mitchell and Reeves (1990 revised);
- estimated removals by shore whaling in California and Baja California 1854–1899 (Column B), taken from Reeves and Smith (2010, table 3) after applying their suggested loss rate factor of 1.2;
- estimated removals by ship-based whaling in Baja California and along the Mexican mainland 1846–1874 (Column C). These data are taken from Reeves *et al.* (2010, table 4) using the authors' 'medium-case' number of vessel-seasons and after applying a loss rate factor of 1.24. The loss rate is midway between their minimum value of 1.06 (animals which sank or escaped spouting blood) and 1.42 (total animals struck); and
- estimated ship-based removals outside of Baja California 1846–74 (Column D), taken from Henderson (1984, table 1) who estimated that 75, 232 and 232 gray whales were taken in the periods 1845/6–53/4, 1854/5–64/5 and 1865/6–73/4 respectively. The estimates include a loss rate factor of 1.34. The totals for the three time periods were allocated to years based on the number of vessel-seasons/year in the North Pacific fishery in Bockstoce and Botkin (1983).

Sex ratio of the catches

In the past (e.g. Butterworth *et al.*, 2002; IWC, 1993, pp.243 and 57; Lankester and Beddington, 1986, p.354) the sex ratio of all commercial catches from 1846–1909 was assumed to be 1:2 male:female. However, there is no basis for assuming a sex ratio different from 1:1 for the catches by shore whaling (Reeves and Smith, 2010) or for the catches in northern waters. Therefore, here we assume a 1:1 sex ratio for the California shore (Column B) and ship-based northern (Column D) catches.

The ship-based whaling in Mexico (Column C) includes whales taken both inside and outside the lagoons. Reeves *et al.* (2010, p.33) state that lagoon catches were 'strongly biased toward adult females and calves of the year', following Henderson's (1972, pp.149 and 54) comments that:

> 'The majority of the whales killed inside, or just outside, Scammon's and other lagoons were cows because their capture was easy in the shallow, crowded lagoon channels where cows were concentrated and encumbered by calves, and because outside the mouths of the lagoons whales retarded by the care of calves were easier marks than other whales'

and

> 'As at Scammon's Lagoon, whalers at Magdalena Bay had concentrated almost entirely upon capturing cows until the female population became so reduced that bulls had to be taken also.'

There is no basis for assuming other than a 1:1 sex ratio for whales taken outside the lagoons. We estimate that 66% of the catch in the Mexico ship-based fishery (1846–1874) was made inside the lagoons, based on the ratio of Henderson's (1984) estimated kill of 3,290 in 'Baja California lagoons and bays' and his estimate of the total kill by the ship-based Mexico fishery (4,968). Following Reilly (1981), we assume that Henderson's comments meant at least 80% and, as an upper bound, at most 100% of the whales killed inside the lagoons and bays were females. This gives a range of the proportion of females in the Mexico ship-based fishery from 0.70 to 0.83[1], corresponding to a 1:2.3 to 1:4.9 sex ratio. For the Column C point estimates in Table 2, we assume an intermediate sex ratio of 1:3.6 (or 76.4% female). Although this accounts for the over-representation of females in the lagoon portion of the fishery, it does not address the high calf mortality associated with selective hunting of 'cows' in the lagoons (see Reeves *et al.*, 2010).

Table 2

Estimated catches from the eastern North Pacific stock of gray whales 1846–1909. See text for details of the data sources.

Year	A. Aboriginal	B. California shore	C. Mexico ship	D. Ship north	Total	Total males	Total females
1846	193.5	0.0	34.7	0.0	228	105	123
1847	192.5	0.0	130.2	0.0	323	127	196
1848	192.5	0.0	112.8	0.0	305	123	182
1849	192.5	0.0	0.0	4.7	197	99	98
1850	192.5	0.0	0.0	12.8	205	103	102
1851	187	0.0	0.0	16.5	204	102	102
1852	187	0.0	68.2	21.0	276	120	156
1853	187	0.0	256.7	15.8	459	162	297
1854	187	15.6	248.0	4.2	455	162	293
1855	187	15.6	174.8	3.1	381	144	237
1856	187	24.0	230.6	4.0	446	162	284
1857	187	31.2	269.1	5.3	493	175	318
1858	187	69.6	653.5	42.9	953	304	649
1859	187	64.8	704.3	38.1	994	311	683
1860	187	111.6	882.9	21.7	1,203	369	834
1861	111	100.8	751.4	19.9	983	293	690
1862	111	126.0	224.4	8.9	470	176	294
1863	111	128.4	230.6	15.5	486	182	304
1864	111	144.0	350.9	35.4	641	228	413
1865	111	130.8	375.7	37.2	655	228	427
1866	111	133.2	234.4	41.5	520	198	322
1867	111	147.6	312.5	42.5	614	224	390
1868	111	153.6	127.7	30.7	423	178	245
1869	111	142.8	44.6	21.5	320	148	172
1870	111	153.6	45.9	28.2	339	157	182
1871	111	152.4	59.5	22.0	345	157	188
1872	111	150.0	0.0	17.9	279	139	140
1873	111	138.0	9.9	17.9	277	136	141
1874	111	129.6	0.0	9.7	250	125	125
1875	111	114.0	0.0	0.0	225	112	113
1876	110	99.6	0.0	0.0	210	105	105
1877	110	118.8	0.0	0.0	229	114	115
1878	110	110.4	0.0	0.0	220	110	110
1879	110	142.8	0.0	0.0	253	126	127
1880	110	117.6	0.0	0.0	228	114	114
1881	108	112.8	0.0	0.0	221	110	111
1882	108	114.0	0.0	0.0	222	111	111
1883	108	109.2	0.0	0.0	217	109	108
1884	108	112.8	0.0	0.0	221	110	111
1885	108	79.2	0.0	0.0	187	94	93
1886	108	33.6	0.0	0.0	142	71	71
1887	108	36.0	0.0	0.0	144	72	72
1888	108	30.0	0.0	0.0	138	69	69
1889	108	32.4	0.0	0.0	140	70	70
1890	108	24.0	0.0	0.0	132	66	66
1891	62	24.0	0.0	0.0	86	43	43
1892	62	22.8	0.0	0.0	85	42	43
1893	62	22.8	0.0	0.0	85	42	43
1894	62	15.6	0.0	0.0	78	39	39
1895	62	15.6	0.0	0.0	78	39	39
1896	62	7.2	0.0	0.0	69	35	34
1897	62	7.2	0.0	0.0	69	35	34
1898	62	7.2	0.0	0.0	69	35	34
1899	62	2.4	0.0	0.0	64	32	32
1900	62	0.0	0.0	0.0	62	31	31
1901	61	0.0	0.0	0.0	61	30	31
1902	61	0.0	0.0	0.0	61	30	31
1903	61	0.0	0.0	0.0	61	30	31
1904	61	0.0	0.0	0.0	61	30	31
1905	57	0.0	0.0	0.0	57	28	29
1906	57	0.0	0.0	0.0	57	28	29
1907	57	0.0	0.0	0.0	57	28	29
1908	57	0.0	0.0	0.0	57	28	29
1909	57	0.0	0.0	0.0	57	28	29
Totals	**7,278**	**3,775**	**6,534**	**539**	**18,127**	**7,333**	**10,794**

[1]0.70 (= 0.66*.80 + 0.34*.50) to 0.83 (= 0.66*1.0 + 0.34*.50)

3. Catches 1910–2009

The catches since 1910 are listed in Table 3 by area and operation type.

Table 3

Estimated catches from the eastern North Pacific stock of gray whales 1910–2009. See text for key.

Year	1. Baja California (ship)	2. California (LSt)	3. California (ship)	4. Washington (LSt + AbS)	5. Br. Colum. (LSt)	6. Alaska (LSt+Ship)	7. Alaska (Ab.S)	8. Bering/ Chukchi (Fl.F)	9. Chukotka (Ab.S)	Total
1910	0	0	0	1	0	0	0	0	57	58
1911	0	0	0	0	1	0	0	0	57	58
1912	0	0	0	0	0	0	0	0	57	57
1913	0	0	0	0	0	1	0	0	57	58
1914	19	0	0	0	0	0	0	0	57	76
1915	0	0	0	0	0	0	0	0	57	57
1916	0	0	0	0	0	0	0	0	52	52
1917	0	0	0	0	0	0	0	0	52	52
1918	0	0	0	0	0	0	0	0	52	52
1919	0	0	0	0	0	0	0	0	52	52
1920	0	2	0	0	0	0	0	0	52	54
1921	0	1	36	0	0	1	0	0	52	90
1922	0	5	4	0	0	0	0	0	52	61
1923	0	0	0	0	0	0	0	0	52	52
1924	0	0	0	1	0	0	0	0	52	53
1925	100	0	0	0	0	0	1	33	52	186
1926	41	1	0	0	0	0	0	0	52	94
1927	29	0	3	0	0	0	0	0	52	84
1928	9	0	1	0	0	2	0	0	52	64
1929	2	0	1	0	0	0	0	0	47	50
1930	0	0	0	0	0	0	0	0	47	47
1931	0	0	0	0	0	0	0	0	10	10
1932	0	0	10	0	0	0	0	0	10	20
1933	0	0	60	0	0	2	1	2	10	75
1934	0	0	60	0	0	0	2	54	10	126
1935	0	0	110	0	0	0	0	34	10	154
1936	0	0	86	0	0	0	0	102	10	198
1937	0	0	0	0	0	0	0	14	10	24
1938	0	0	0	0	0	0	0	54	10	64
1939	0	0	0	0	0	0	0	29	10	39
1940	0	0	0	0	0	0	0	105	20	125
1941	0	0	0	0	0	0	0	57	20	77
1942	0	0	0	0	0	0	0	101	20	121
1943	0	0	0	0	0	0	0	99	20	119
1944	0	0	0	0	0	0	0	0	6	6
1945	0	0	0	0	0	0	0	30	28	58
1946	0	0	0	0	0	0	0	22	8	30
1947	0	0	0	0	0	0	0	1	30	31
1948	0	0	0	0	0	0	0	0	19	19
1949	0	0	0	0	0	0	0	0	26	26
1950	0	0	0	0	0	0	1	0	10	11
1951	0	0	0	0	1	0	1	0	12	14
1952	0	0	0	0	0	0	2	0	42	44
1953	0	0	0	0	10	0	1	0	37	48
1954	0	0	0	0	0	0	3	0	36	39
1955	0	0	0	0	0	0	0	0	59	59
1956	0	0	0	0	0	0	1	0	121	122
1957	0	0	0	0	0	0	1	0	95	96
1958	0	0	0	0	0	0	3	0	145	148
1959	0	2	0	0	0	0	7	0	187	196
1960	0	0	0	0	0	0	0	0	156	156
1961	0	0	0	0	0	0	1	0	207	208
1962	0	4	0	0	0	0	0	0	147	151
1963	0	0	0	0	0	0	1	0	179	180
1964	0	20	0	0	0	0	2	9	188	219
1965	0	0	0	0	0	0	1	5	175	181
1966	0	26	0	0	0	0	0	0	194	220
1967	0	125	0	0	0	0	0	124	125	374
1968	0	66	0	0	0	0	0	0	135	201
1969	0	74	0	0	0	0	1	0	139	214
1970	0	0	0	0	0	0	5	0	146	151
1971	0	0	0	0	0	0	3	0	150	153
1972	0	0	0	0	0	0	1	0	181	182
1973	0	0	0	0	0	0	0	0	178	178
1974	0	0	0	0	0	0	3	0	181	184
1975	0	0	0	0	0	0	0	0	171	171
1976	0	0	0	0	0	0	0	0	165	165
1977	0	0	0	0	0	0	1	0	186	187

Cont.

Table 3 (cont.)

Year	1. Baja California (ship)	2. California (LSt)	3. California (ship)	4. Washington (LSt + AbS)	5. Br. Colum. (LSt)	6. Alaska (LSt+Ship)	7. Alaska (Ab.S)	8. Bering/ Chukchi (Fl.F)	9. Chukotka (Ab.S)	Total
1978	0	0	0	0	0	0	2	0	182	184
1979	0	0	0	0	0	0	5	0	178	183
1980	0	0	0	0	0	0	3	0	179	182
1981	0	0	0	0	0	0	0	0	136	136
1982	0	0	0	0	0	0	3	0	165	168
1983	0	0	0	0	0	0	2	0	169	171
1984	0	0	0	0	0	0	0	0	169	169
1985	0	0	0	0	0	0	1	0	169	170
1986	0	0	0	0	0	0	2	0	169	171
1987	0	0	0	0	0	0	1	0	158	159
1988	0	0	0	0	0	0	1	0	150	151
1989	0	0	0	0	0	0	1	0	179	180
1990	0	0	0	0	0	0	0	0	162	162
1991	0	0	0	0	0	0	0	0	169	169
1992	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	44	44
1995	0	0	0	0	0	0	2	0	90	92
1996	0	0	0	0	0	0	0	0	43	43
1997	0	0	0	0	0	0	0	0	79	79
1998	0	0	0	0	0	0	0	0	125	125
1999	0	0	0	1	0	0	0	0	123	124
2000	0	0	0	0	0	0	0	0	115	115
2001	0	0	0	0	0	0	0	0	112	112
2002	0	0	0	0	0	0	0	0	131	131
2003	0	0	0	0	0	0	0	0	128	128
2004	0	0	0	0	0	0	0	0	111	111
2005	0	0	0	0	0	0	0	0	124	124
2006	0	0	0	0	0	0	0	0	134	134
2007	0	0	0	1	0	0	0	0	131	132
2008	0	0	0	0	0	0	0	0	130	130
2009	0	0	0	0	0	0	0	0	116	116
Total	**200**	**326**	**371**	**4**	**12**	**6**	**66**	**875**	**9,216**	**11,076**

Key to Table is as follows:

1. Baja California, Mexico: Norwegian factory ships *Capella I*, *Kommandoren I*, *Ragnhild Bryde*, *Mexico* and *Esperanza.*
2. California: Moss Landing and Trinidad Land Stations and the Scientific permit catch off San Francisco 1959–69.
3. California: American ships Carolyn Frances, Herman, Lancing and California.
4. Washington: Bay City land station and Makah tribe, Neah Bay.
5. British Columbia: Sechart and Coal Harbour land stations.
6. Alaska: Port Armstrong and Port Hobron land stations.
7. Alaskan aboriginal subsistence catch (various villages) + 1 by *Carolyn Frances*.
8. Bering/Chukchi: factory ships *Kommandoren* (Norway), *Aleut* and another (USSR) and *Tonan Maru* (Japan).
9. Chukotka: Soviet/Russian aboriginal subsistence catch.

Data sources

1. Baja California, Mexico: Norwegian factory ships *Capella I*, *Kommandoren I*, *Ragnhild Bryde*, *Mexico* and *Esperanza.*

The data are taken from Allison (2010), Anon. (1915), Anon. (1925), Reeves (1984, p.191) and Rice and Wolman (1971). There are discrepancies in the data sources concerning the catches in 1925 and 1926:

Year	Blue	Fin	Sperm	Humpback	Sei/Bryde's	**Gray**	Total	Source
1925	156	4	1	403	26	**100**	690	Allison (2010) and Reeves (1984, p.191), including 82 gray by *Kommandoren I* (A/S Vega) and 18 gray by *Mexico* (A/S Mexico)
	220	1	4	493	45	**140**	903	Kellogg (1931) and Radcliffe (1933)
1926	239	0	3	499	34	**41**	816	Allison (2010), Reeves (1984, p.191) and Rice and Wolman (1971)
	239			498		**42**		Kellogg (1931) and Radcliffe (1933). The difference is due to a humpback in the individual data that is included as a gray whale in Anon. (1926a).

2. California Land Stations

Catches from Moss Landing and Trinidad land stations are taken from Starks (1922), Clapham *et al.* (1997) and Rice and Wolman (1971).

The scientific permit catches off San Francisco 1959–69 are taken from Allison (2010):

Date	Catch	Sexes	
Mar. 1964	20 gray whales	(15M, 5F)	
Mar. 1966	26 gray whales	(15M, 11F)	
Dec. 1966	26 gray whales	(4M, 22F)	
Jan.–Mar. 1967	99 gray whales	(48M, 51F)	Gives 1966/67 total of 125 whales (52M, 73F)
Jan.–Mar. 1968	66 gray whales	(41M, 25F)	
Dec. 1968	21 gray whales	(6M, 15F)	
Jan.–Mar. 1969	53 gray whales	(33M, 20F)	Gives 1968/69 total of 74 whales (39M+35F) including one lost and washed up later. Some sources, e.g. Wolman and Rice (1979), omit the lost whale.

3. California Ships

The catch by the Carolyn Frances in 1921 is taken from Tønnessen (1967, p.163) and by the Herman in 1922 from Henderson (1984, p.176). Catches by the Lancing in 1927 and 1928 are taken from Radcliffe (1933), Reeves (1984, p.195) and Rice and Wolman (1971). The 1929 catch is taken from Donahue and Brownell (2001), who cite Martin ([no date], unpublished manuscript, not seen).

Catches by the *California* 1932–37 are modified from those estimated in Brownell and Swartz (2006). The revised estimates, which are upper bounds, are summarised below together with details of the rationale.

Year	Total catch	Brownell and Swartz estimate	Revised estimate	Species division and notes	References
1932	50	20 gray	10 gray	~ 30 fin up to 1 December.	Radcliffe (1933); Anon. (1933a and b)
1933	200	180 gray	60 gray	Good runs of humpbacks in the first half of the year. In July a run of sulphur bottoms.	IWS[2] V:9 and IX:7; Anon. (1933c)
1934	205	185 gray	60 gray	Took nearly 60 fin and humpback whales in the first 4 months of the year. Operated virtually the entire year.	Anon. (1934); IWS VI:9 and IX:7
1935	189	186 gray	110 gray	Gaze (1936): 2 sperm, 1 humpback, the rest gray.	IWS VII:19 and IX:7
1936	96	86 gray	86 gray	Gaze (1936): 50+ taken by end of January are virtually all gray whales. Operation closed 29 June.	IWS IX: 7 and 13
1937	37	0 gray	0 gray	8 blue, 14 fin, 3 humpback and 12 sei. Gray whales protected.	Allison (2010)

Gray whales formed an important part of the catch by the *California* from 1932–37, as reported in Anon. (1938, p.458): 'the recent international treaty prohibiting the killing of gray whales, one of the principal species available to the California concern, apparently made profitable operation difficult, if not impossible'. The owners of the *California* went into liquidation after the 1937 season (Anon., 1938).

1932. Anon. (1933a) reports the *California* 'operating off St. Nicholas Island, the westernmost of the Santa Barbara group of southern California, had caught about 30 finback whales up to the first of December' and the captain expected the total 1932 catch to be ~50 whales. The final 1932 catch by the California was 50 whales (1933b). Brownell and Swartz (2006) assume the 20 unspecified whales were gray whales. We assume that no more than half of these (10) are likely to be gray whales as no mention was made of changing area and the total catch was as predicted.

1933. Brownell and Swartz (2006) note that the fictional book Keyes (1939) reports 27 (13%) of the total catch of 205 whales processed in the 1934 season were taken in the summer around Santa Barbara Island, California (and hence were not gray whales). From this they suggest a similar pattern of catching in 1933 such that 10% of the 1933 catch were non-gray whales taken in the summer and 90% (180) were gray whales taken in the winter.

Anon. (1933c, published in August 1933) reports the *California* resumed whaling on 5 July 1933 off San Diego where a run of sulphur-bottoms [blue whales] was reported. Prior to 5 July 1933 'The *California* has been off Monterey for several months with good runs of humpbacks'. 'The company thus far has delivered 4,000bbls of oil'. The total catch in 1933 was 200 whales and 6160bbls oil (IWS V:9). Since the *California* took ~65% of the total oil produced in 1933 mainly from humpbacks before July and further that Anon. (1934) states the *California's* 'most active season starts about July 1,' it is unlikely that gray whales made up more than 30% of the total 1933 catch of 200 whales.

1934. Anon. (1936a) reports 'In California waters the California Whaling Co. continued to operate its floating plant *California* keeping it active at one point or another along the coast through virtually the entire year.' The total catch is given as 205 whales (110 by catcher *Port Saunders* and 95 by *Hawk)*. Anon. (1934, dated May 1934) reports the *California* 'took nearly 60 fin and humpback whales in the first four months of the year' and further states that the fleet's 'most active season starts about July 1'.

From this we estimate that, at most, 30% of the total catch might have been gray whales.

1935. Gaze (1936, dated January 1936) reports 'A whaling fleet this week is well into its second season of operation off Point Dume, 15n.miles westerly from Santa Monica.... Its two killer boats captured 199 whales here last season and more than 50 this season thus far... With few exceptions, California gray whales (baylenes) are the only species caught in the vicinity of Point Dume. Sperm whales and humpbacks are the exceptions, two of the former and one of the latter having been taken.... The grays first appear in this area early in December and the majority have returned northward by the latter part of March or early in April.'

The figure of 199 in Gaze (1936) is taken to be a typo for 189, as is assumed in Brownell and Swartz (2006) who use these numbers (i.e. 186 gray and 3 other).

[2]IWS = International Whaling Statistics published annually by the Committee for Whaling Statistics, Sandefjord 1930–84.

Anon. (1936b) reports the *California* 'worked three months of the year off San Francisco and nine months off Los Angeles and San Diego' taking a total catch of 189 whales. We assume the nine month period included the Point Dume operation. However, gray whales are only off California for about four months of the year so even if the Point Dume operation was the most productive, other species must have been taken in the remaining months. If three times more whales/month were taken in the gray whale period than in the rest of the year, this gives an estimated maximum of ~110 gray whales.

1936. Gaze (1936) reports 50+ whales were taken off Point Dume as of the end of January. Anon. (1937) reports in 1936 the *California* operated only during the first half of the year and operations were suspended on 29 June and had not resumed to the end of the year. A total of 96 whales were taken.

4. Washington

Mitchell and Reeves (1980, p.712) show photographs of gray whales taken by the Makah tribe at Neah Bay in (a) 1910 and (b) 1922. However photograph (a) is similar to one given in Scheffer and Slipp (1948, fig. 3) whose caption says the whale was taken at Neah Bay in 'about 1910–1912' and photograph (b) is identical to one given in Scheffer and Slipp (1948, fig. 2) whose caption again says the whale was taken at Neah Bay in 'about 1910–1912'. We assume that at least one whale was taken in 1910–12 (included in Table 3 under year 1910), but do not include one in 1922.

The gray whale taken at Bay City land station in 1924 comes from Kellogg (1931) and Scheffer and Slipp (1948).

5. British Columbia

The catches from Sechart in 1911 and from Coal Harbour in 1951 ('taken in error') and 1953 (taken under scientific permit) are from Allison (2010).

6. Alaska, Port Armstrong and Port Hobron land stations and *Carolyn Frances*

There is a discrepancy between sources concerning the 1913 catch from Sechart land station as shown below. The 1928 and 1933 catches are from Allison (2010), Reeves *et al*. (1985) and Rice and Wolman (1971).

Year	Blue	Fin	Sperm	Humpback	Sei/Bryde's	**Gray**	Bottlenose	Total	Source
1913	58	29	73	21	3	**1**	1	186	Tønnessen (1967, p.554); Radcliffe (1933)
	58	40	52	28	8	**0**		186	IWS and Risting (1922, p.578)

The one gray whale caught by the *Carolyn Frances* in 1921 is from Tønnessen (1967, p.163).

7. Alaskan aboriginal subsistence catch (various villages).

Catches prior to 1981 are from Marquette and Braham (1982) as H. Braham (after consultation with Rice and Breiwick) advised this to be the best source; catches since 1980 are from the infractions reports submitted to the IWC by the USA. There are discrepancies between the data sources in some years as noted below.

Year	Gray whale	References	Notes
1959	7	Marquette and Braham (1980)	6 taken at Barrow + 1 at Cape Thompson
	6	Marquette and Braham (1982); Rice *et al.* (1984); Maher (1960)	All 6 taken at Barrow
1973	0	Marquette and Braham (1982); Rice *et al.* (1984)	
	1	Wolman and Rice (1979)	
1974	3	Marquette and Braham (1982); Rice *et al.* (1984)	
	1	Wolman and Rice (1979)	
1975	0	Marquette and Braham (1982); Rice *et al.* (1984)	
	7	Wolman and Rice (1979)	
1976	0	Marquette and Braham (1982); Rice *et al.* (1984)	
	2	Wolman and Rice (1979)	
1979	5	Infractions report (USA)	Taken at Gambell (2), Savoonga, St. Michael and Little Diomede Is.
	4	Marquette and Braham (1982)	Taken at Gambell (2), Savoonga, St. Michael
1980	3	Marquette and Braham (1982)	Taken at Savoonga, Sheshalik and Toksook Bay
	2	Infractions report (USA)	Taken at Savoonga and Sheshalik
1982	3	Infractions report (USA)	
	4	Rice *et al.* (1984)	
1987	1	Infractions report (USA)	1 unconfirmed taken at Hooper Bay

8. Bering/Chukchi: factory ships *Kommandoren* (Norway), *Aleut* and another (USSR) and *Tonan Maru* (Japan).

1925 *Kommandoren* (A/S Vega). Two versions of the individual data (from IWS) detail 5 blue, 153 fin, 73 humpback, 5 sei, **31 gray**, 18 sperm and 1 bottlenose (= 286 whales). Anon. (1926a, p.79) reports 5 blue, 152 fin, 72 humpback, 6 sei, 18 sperm and **33 gray** (= 286 whales) but Anon. (1926b) lists the lengths of **31 gray** whales.

Catches by the *Aleut* from 1933–47 are taken from Zenkovich (1937), Zenkovich (1955), Sleptsov (1955), Reeves (1984, p.197) and Yablokov and Bogoslovskaya (1984). Sleptsov (1955) and Rice and Wolman (1971) list the 1943 catch as **77 gray whales**; Reeves (1984, p.197) reports this figure was corrected to **99** by A.Yablokov (in letter of April 7 1982).

The 1940 catch by the *Tonan Maru* is from Reeves (1984, p.197–98) and data for the Soviet factory ships in 1964–7 are from Doroshenko (2000).

9. Chukotka: Soviet/Russian aboriginal subsistence catches.

1910–30. The catch numbers are from Mitchell and Reeves (1990 revised).

1931–43. Catches are from IWC (1993, p.243).

1944–47 The numbers are from Krupnik (1987, p.26–27) after assuming a loss rate of 50%. Krupnik reports the numbers landed as 3, 14, 4 and 15 in 1944, 5, 6 and 7 respectively and notes that the 1944–46 numbers are incomplete. He also notes that ‘the rate of unproductive losses in the 1940s and 50s was rather high; some estimates suggest that up to 30% of the whales killed sank, with the same percentage being struck and lost (Ivashin and Mineev, 1981; Zimushko and Ivashin, 1980)’.

1948–81. Catches are from Yablokov and Bogoslovskaya (1984), Ivashin (1990) and Rice *et al*. (1984). There are discrepancies between the data sources in some years as noted below.

1982–2009. Catches are from information submitted directly to the IWC.

Year	Gray numbers	References
1955	59	Yablokov and Bogoslovskaya (1984); Zimushko and Ivashin (1980); Rice *et al.* (1984) and Ivashin (1990).
	69	Anon. (1980).
1957	95	Anon. (1980); Zimushko and Ivashin (1980); Rice *et al.* (1984) and Ivashin (1990).
	56	Yablokov and Bogoslovskaya (1984).
1969	139	Anon. (1980); Zimushko and Ivashin (1980); Wolman and Rice (1979) and Ivashin (1990); confirmed in Ivashin’s letter of 6 Dec 1989.
	199	Yablokov and Bogoslovskaya (1984).
1973	178	IWC (1974, p.71); Ivashin (1990) and confirmed in Ivashin’s letters of 28 Nov and 6 Dec 1989.
	173	Anon. (1980); Yablokov and Bogoslovskaya (1984); Zimushko and Ivashin (1980); Wolman and Rice (1979) and Rice *et al.* (1984).
1976	165	Wolman and Rice (1979); Ivashin (1990) and confirmed in Ivashin’s letters of 28 Nov and 6 Dec 1989.
	163	Anon. (1980); Zimushko and Ivashin (1980) and Yablokov and Bogoslovskaya (1984).
1978	182 (93 male, 89 female)	Anon. (1980, p.167).
	182 (179 landed + 3 lost)	Ivashin’s letter of 28 Nov 1989.
1979	178 (55 male, 123 female)	Ivashin (1981, p.221).
	178 (176 landed + 2 lost)	Infractions report and IWC circular of 10/10/80.
1996	38	Donahue and Brownell (2001) and Blokhin (1997). The Infractions Sub-committee was informed the number was 43 and not 38 (see IWC/49/7).
	43	Punt and Butterworth (1997).

Table 4 lists the catches known by sex. The catches of unknown sex are allocated to sex as given in Table 5. All catches of unknown sex are allocated in the ratio 1:1 except for the Aboriginal Subsistence catches off Chukotka which are allocated as follows:

1910–44 are allocated in the ratio 1:1 as specified in IWC (1993, p.243) (in the absence of specific data).

1945–91 are allocated in the ratio of the known catches off Chukotka (1965–91) = 1,330m : 2,239f. The changed sex ratio is attributed to the change in whaling technique. Ivashin and Mineev (1981) report that in the late 1940s and early 1950s the hunters began to change from canoes to whaling boats following the introduction of collective farms and agricultural co-operatives which ‘contributed to improvements in whaling methods’;

1994–96 are allocated in the ratio of known catches from 1994–99 = 235m : 209f. The 1994–99 period is used because different whaling methods were being used when catching resumed in 1994.

1997 on are allocated using the ratio of animals of known sex in that year (the only whales of unknown sex from 1997 on are lost whales).

Table 4

Summary of catches known by sex 1910–2009.

	California/Mexico				Washington/BC				Alaska				Bering and Chukchi Comm.				Chukotka Aboriginal			
Year	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total
1910			0	0			1	1			0	0			0	0			57	57
1911			0	0			1	1			0	0			0	0			57	57
1912			0	0			0	0			0	0			0	0			57	57
1913			0	0			0	0			1	1			0	0			57	57
1914			19	19			0	0			0	0			0	0			57	57
1915			0	0			0	0			0	0			0	0			57	57
1916			0	0			0	0			0	0			0	0			52	52
1917			0	0			0	0			0	0			0	0			52	52
1918			0	0			0	0			0	0			0	0			52	52
1919			0	0			0	0			0	0			0	0			52	52
1920			2	2			0	0			0	0			0	0			52	52
1921	1	0	36	37			0	0			1	1			0	0			52	52
1922	4	1	4	9			0	0			0	0			0	0			52	52
1923			0	0			0	0			0	0			0	0			52	52
1924			0	0	1		0	1			0	0			0	0			52	52
1925	46	36	18	100			0	0			1	1	17	14	2	33			52	52
1926	25	17	0	42			0	0			0	0			0	0			52	52
1927	2	14	16	32			0	0			0	0			0	0			52	52
1928	3	6	1	10			0	0	1	1	0	2			0	0			52	52
1929		2	1	3			0	0			0	0			0	0			47	47
1930			0	0			0	0			0	0			0	0			47	47
1931			0	0			0	0			0	0			0	0			10	10
1932			10	10			0	0			0	0			0	0			10	10
1933			60	60			0	0	0	2	1	3	2		0	2			10	10

Cont.

Table 4 (cont.)

	California/Mexico				Washington/BC				Alaska				Bering and Chukchi Comm.				Chukotka Aboriginal			
Year	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total	M	F	Unk	Total
1934			60	60			0	0			2	2	30	24	0	54			10	10
1935			110	110			0	0			0	0	11	23	0	34			10	10
1936			86	86			0	0			0	0	45	57	0	102			10	10
1937			0	0			0	0			0	0			14	14			10	10
1938			0	0			0	0			0	0			54	54			10	10
1939			0	0			0	0			0	0			29	29			10	10
1940			0	0			0	0			0	0	23	35	47	105			20	20
1941			0	0			0	0			0	0			57	57			20	20
1942			0	0			0	0			0	0			101	101			20	20
1943			0	0			0	0			0	0			99	99			20	20
1944			0	0			0	0			0	0			0	0			6	6
1945			0	0			0	0			0	0			30	30			28	28
1946			0	0			0	0			0	0			22	22			8	8
1947			0	0			0	0			0	0			1	1			30	30
1948			0	0			0	0			0	0			0	0			19	19
1949			0	0			0	0			0	0			0	0			26	26
1950			0	0			0	0			1	1			0	0			10	10
1951			0	0	1	0	0	1			1	1			0	0			12	12
1952			0	0			0	0			2	2			0	0			42	42
1953			0	0	6	4	0	10			1	1			0	0			37	37
1954			0	0			0	0			3	3			0	0			36	36
1955			0	0			0	0			0	0			0	0			59	59
1956			0	0			0	0			1	1			0	0			121	121
1957			0	0			0	0			1	1			0	0			95	95
1958			0	0			0	0			3	3			0	0			145	145
1959	1	1	0	2			0	0	0	2	5	7			0	0			187	187
1960			0	0			0	0			0	0			0	0			156	156
1961			0	0			0	0			1	1			0	0			207	207
1962	4		0	4			0	0			0	0			0	0			147	147
1963			0	0			0	0			1	1			0	0			179	179
1964	15	5	0	20			0	0			2	2			9	9			188	188
1965			0	0			0	0			1	1			5	5	56	88	31	175
1966	15	11	0	26			0	0			0	0			0	0	23	18	153	194
1967	52	73	0	125			0	0			0	0			124	124	24	40	61	125
1968	41	25	0	66			0	0			0	0			0	0	16	32	87	135
1969	39	35	0	74			0	0			1	1			0	0	5	13	121	139
1970			0	0			0	0			5	5			0	0	66	75	5	146
1971			0	0			0	0			3	3			0	0	2	2	146	150
1972			0	0			0	0			1	1			0	0	3	22	156	181
1973			0	0			0	0			0	0			0	0	95	77	6	178
1974			0	0			0	0			3	3			0	0	91	88	2	181
1975			0	0			0	0			0	0			0	0	58	113	0	171
1976			0	0			0	0			0	0			0	0	68	95	2	165
1977			0	0			0	0			1	1			0	0	86	100	0	186
1978			0	0			0	0			2	2			0	0	93	89	0	182
1979			0	0			0	0	1	0	4	5			0	0	55	123	0	178
1980			0	0			0	0			3	3			0	0	52	126	1	179
1981			0	0			0	0			0	0			0	0	36	99	1	136
1982			0	0			0	0	0	1	2	3			0	0	54	106	5	165
1983			0	0			0	0			2	2			0	0	45	123	1	169
1984			0	0			0	0			0	0			0	0	59	109	1	169
1985			0	0			0	0			1	1			0	0	54	114	1	169
1986			0	0			0	0			2	2			0	0	45	123	1	169
1987			0	0			0	0			1	1			0	0	46	108	4	158
1988			0	0			0	0			1	1			0	0	43	107	0	150
1989			0	0			0	0			1	1			0	0	60	118	1	179
1990			0	0			0	0			0	0			0	0	66	94	2	162
1991			0	0			0	0			0	0			0	0	29	37	103	169
1992			0	0			0	0			0	0			0	0	0	0	0	0
1993			0	0			0	0			0	0			0	0	0	0	0	0
1994			0	0			0	0			0	0			0	0	4	8	32	44
1995			0	0			0	0			2	2			0	0	44	40	6	90
1996			0	0			0	0			0	0			0	0	9	17	17	43
1997			0	0			0	0			0	0			0	0	48	31	0	79
1998			0	0			0	0			0	0			0	0	62	60	3	125
1999			0	0		1	0	1			0	0			0	0	68	53	2	123
2000			0	0			0	0			0	0			0	0	62	51	2	115
2001			0	0			0	0			0	0			0	0	62	50	0	112
2002			0	0			0	0			0	0			0	0	80	51	0	131
2003			0	0			0	0			0	0			0	0	70	56	2	128
2004			0	0			0	0			0	0			0	0	43	67	1	111
2005			0	0			0	0			0	0			0	0	45	70	9	124
2006			0	0			0	0			0	0			0	0	55	74	5	134
2007			0	0			1	1			0	0			0	0	48	78	5	131
2008			0	0			0	0			0	0			0	0	63	64	3	130
2009			0	0			0	0			0	0			0	0	58	57	1	116
Total	**248**	**226**	**423**	**897**	**8**	**5**	**3**	**16**	**2**	**6**	**64**	**72**	**128**	**153**	**594**	**875**	**2,151**	**3,066**	**3,999**	**9,216**

Table 5

Summary of catches allocated to sex 1910–2009. See text for method of allocation of animals.

	Calif./Mexico		WA/BC		Alaska		Bering/Chukchi		Chukotka AS		Totals		
Year	M	F	M	F	M	F	M	F	M	F	M	F	Total
1910	0	0	0	1	0	0	0	0	28	29	28	30	58
1911	0	0	1	0	0	0	0	0	28	29	29	29	58
1912	0	0	0	0	0	0	0	0	28	29	28	29	57
1913	0	0	0	0	0	1	0	0	28	29	28	30	58
1914	9	10	0	0	0	0	0	0	28	29	37	39	76
1915	0	0	0	0	0	0	0	0	28	29	28	29	57
1916	0	0	0	0	0	0	0	0	26	26	26	26	52
1917	0	0	0	0	0	0	0	0	26	26	26	26	52
1918	0	0	0	0	0	0	0	0	26	26	26	26	52
1919	0	0	0	0	0	0	0	0	26	26	26	26	52
1920	1	1	0	0	0	0	0	0	26	26	27	27	54
1921	19	18	0	0	1	0	0	0	26	26	46	44	90
1922	6	3	0	0	0	0	0	0	26	26	32	29	61
1923	0	0	0	0	0	0	0	0	26	26	26	26	52
1924	0	0	1	0	0	0	0	0	26	26	27	26	53
1925	55	45	0	0	0	1	18	15	26	26	99	87	186
1926	25	17	0	0	0	0	0	0	26	26	51	43	94
1927	10	22	0	0	0	0	0	0	26	26	36	48	84
1928	3	7	0	0	1	1	0	0	26	26	30	34	64
1929	0	3	0	0	0	0	0	0	23	24	23	27	50
1930	0	0	0	0	0	0	0	0	23	24	23	24	47
1931	0	0	0	0	0	0	0	0	5	5	5	5	10
1932	5	5	0	0	0	0	0	0	5	5	10	10	20
1933	30	30	0	0	1	2	2	0	5	5	38	37	75
1934	30	30	0	0	1	1	30	24	5	5	66	60	126
1935	55	55	0	0	0	0	11	23	5	5	71	83	154
1936	43	43	0	0	0	0	45	57	5	5	93	105	198
1937	0	0	0	0	0	0	7	7	5	5	12	12	24
1938	0	0	0	0	0	0	27	27	5	5	32	32	64
1939	0	0	0	0	0	0	14	15	5	5	19	20	39
1940	0	0	0	0	0	0	46	59	10	10	56	69	125
1941	0	0	0	0	0	0	28	29	10	10	38	39	77
1942	0	0	0	0	0	0	50	51	10	10	60	61	121
1943	0	0	0	0	0	0	49	50	10	10	59	60	119
1944	0	0	0	0	0	0	0	0	3	3	3	3	6
1945	0	0	0	0	0	0	15	15	10	18	25	33	58
1946	0	0	0	0	0	0	11	11	3	5	14	16	30
1947	0	0	0	0	0	0	0	1	11	19	11	20	31
1948	0	0	0	0	0	0	0	0	7	12	7	12	19
1949	0	0	0	0	0	0	0	0	10	16	10	16	26
1950	0	0	0	0	0	1	0	0	4	6	4	7	11
1951	0	0	1	0	1	0	0	0	4	8	6	8	14
1952	0	0	0	0	1	1	0	0	16	26	17	27	44
1953	0	0	6	4	1	0	0	0	14	23	21	27	48
1954	0	0	0	0	1	2	0	0	13	23	14	25	39
1955	0	0	0	0	0	0	0	0	22	37	22	37	59
1956	0	0	0	0	0	1	0	0	45	76	45	77	122
1957	0	0	0	0	1	0	0	0	35	60	36	60	96
1958	0	0	0	0	1	2	0	0	54	91	55	93	148
1959	1	1	0	0	3	4	0	0	70	117	74	122	196
1960	0	0	0	0	0	0	0	0	58	98	58	98	156
1961	0	0	0	0	0	1	0	0	77	130	77	131	208
1962	4	0	0	0	0	0	0	0	55	92	59	92	151
1963	0	0	0	0	1	0	0	0	67	112	68	112	180
1964	15	5	0	0	1	1	4	5	70	118	90	129	219
1965	0	0	0	0	1	0	2	3	68	107	71	110	181
1966	15	11	0	0	0	0	0	0	80	114	95	125	220
1967	52	73	0	0	0	0	62	62	47	78	161	213	374
1968	41	25	0	0	0	0	0	0	48	87	89	112	201
1969	39	35	0	0	0	1	0	0	50	89	89	125	214
1970	0	0	0	0	3	2	0	0	68	78	71	80	151
1971	0	0	0	0	1	2	0	0	56	94	57	96	153
1972	0	0	0	0	0	1	0	0	61	120	61	121	182
1973	0	0	0	0	0	0	0	0	97	81	97	81	178
1974	0	0	0	0	2	1	0	0	92	89	94	90	184
1975	0	0	0	0	0	0	0	0	58	113	58	113	171
1976	0	0	0	0	0	0	0	0	69	96	69	96	165
1977	0	0	0	0	1	0	0	0	86	100	87	100	187
1978	0	0	0	0	1	1	0	0	93	89	94	90	184
1979	0	0	0	0	3	2	0	0	55	123	58	125	183
1980	0	0	0	0	1	2	0	0	52	127	53	129	182

Cont.

Table 5 (cont.)

	Calif./Mexico		WA/BC		Alaska		Bering/Chukchi		Chukotka AS		Totals		
Year	M	F	M	F	M	F	M	F	M	F	M	F	Total
1981	0	0	0	0	0	0	0	0	36	100	36	100	136
1982	0	0	0	0	1	2	0	0	56	109	57	111	168
1983	0	0	0	0	1	1	0	0	45	124	46	125	171
1984	0	0	0	0	0	0	0	0	59	110	59	110	169
1985	0	0	0	0	0	1	0	0	54	115	54	116	170
1986	0	0	0	0	1	1	0	0	45	124	46	125	171
1987	0	0	0	0	1	0	0	0	47	111	48	111	159
1988	0	0	0	0	0	1	0	0	43	107	43	108	151
1989	0	0	0	0	1	0	0	0	60	119	61	119	180
1990	0	0	0	0	0	0	0	0	67	95	67	95	162
1991	0	0	0	0	0	0	0	0	67	102	67	102	169
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	21	23	21	23	44
1995	0	0	0	0	1	1	0	0	47	43	48	44	92
1996	0	0	0	0	0	0	0	0	18	25	18	25	43
1997	0	0	0	0	0	0	0	0	48	31	48	31	79
1998	0	0	0	0	0	0	0	0	64	61	64	61	125
1999	0	0	0	1	0	0	0	0	69	54	69	55	124
2000	0	0	0	0	0	0	0	0	63	52	63	52	115
2001	0	0	0	0	0	0	0	0	62	50	62	50	112
2002	0	0	0	0	0	0	0	0	80	51	80	51	131
2003	0	0	0	0	0	0	0	0	71	57	71	57	128
2004	0	0	0	0	0	0	0	0	43	68	43	68	111
2005	0	0	0	0	0	0	0	0	49	75	49	75	124
2006	0	0	0	0	0	0	0	0	57	77	57	77	134
2007	0	0	0	1	0	0	0	0	50	81	50	82	132
2008	0	0	0	0	0	0	0	0	64	66	64	66	130
2009	0	0	0	0	0	0	0	0	59	57	59	57	116
Total	**458**	**439**	**9**	**7**	**34**	**38**	**421**	**454**	**3,809**	**5,407**	**4,731**	**6,345**	**11,076**

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Appendix 4

COMMENTS ON THE PARAMETRIC BOOTSTRAP OF THE DEVIANCE STATISTIC FOR ONE-SIDED CONFIDENCE LIMITS

Geof Givens

For several years the AWMP SWG has struggled to apply a parametric bootstrapping approach to estimate confidence limits in the analysis of the sex ratio data for West Greenland minke whales. Currently one topic is receiving a lot of attention: how to implement a one-sided confidence limit calculation. In our meeting, I asserted that the method implied by figure 2 in Annex B of the Report of the 3rd AWMP Workshop should be strictly adhered to as it stands (according to my interpretation of it), without any omissions of certain draws or setting certain quantities equal to zero as seems to be popular at the moment. However, this figure is difficult to translate to the WG minke case due to some of the notation used in text discussing this figure and the axis itself. The SWG asked me to write an explicit recipe for carrying out the calculation which is provided below together with a figure illustrating of some of the key conceptual aspects of the problem, although this is not intended as an illustration of the recipe.

Use the real data X to estimate $\hat{K}$

Let g index a grid of values for carrying capacity, $K_1,\ldots,K_G$.

For g = 1,…,G:

For i = 1,…,1000:

- Generate data X_{ig} from the model, treating K_g as the truth
- Calculate $\hat{K}_{ig}$ from X_{ig} using the sex ratio estimation approach
- Calculate $LD_{ig}(\hat{K}_{ig},K) = 2\log\{L(\hat{K}_{ig} \mid X_{ig})/L(K/X_{ig})\}\, I(K < \hat{K}_{ig})$. Note that LD_{ig} is a function of K that has the shape illustrated in figure 1 of Annex B.

End i loop

Histogram the 1,000 values for LD_{ig} for i = 1,…,g.

Calculate $LD_g(.95)$, specifically the 95th percentile of the histogram

End g loop

Connect the dots of $LD_g(.95)$ for g = 1,…,G.

Identify the K^* where $LD(\hat{K}, K^*)$ crosses the curve created in the previous step.

The other problem concerning the large number of simulations for which K is estimated to be > the truncation point (of 200,000) is different. When K_g is large, some $\hat{K}_{ig}$ may exceed the truncation point of 200,000 adopted for numerical stability. In these cases, $LD_{ig}(\hat{K}_{ig},K) > LD_{ig}(\hat{K}_{ig},200000)$ when $K > 200{,}000$, yet the actual value is uncalculated. These problematic cases are instances of right-censored data. The deviance quantiles at K_g should therefore be estimated using a method for censored data, not the percentile method. Such approaches include, I believe, methods relying on density estimation and/or the Kaplan-Meier approach.