Report of the Workshop on the Western Gray Whale: Research and Monitoring Needs

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The meeting was held at the Lotte Hotel, Ulsan, Korea, from 22-25 October 2002. A list of participants is given in Annex A.

1. CONVENORS' OPENING REMARKS

Kim and Brownell welcomed the participants to the meeting. Brownell noted that the last review of gray whales by the IWC occurred in 1990, but at that time little attention was given to the western population (IWC, 1993). At that time only a few papers were presented on western gray whales (WGW). In 1998, the Scientific Committee (SC) started to examine the status of the WGW as more details became available (IWC, 1999, p.36). At its 2002 meeting, the SC strongly recommended that the Commission facilitate a workshop comprising interested scientists, including those from range states (Korea, Japan, Russia and China). The workshop was to: (1) assess the current status of the population; (2) develop the foundation for range-wide research; and (3) update the 10-year research and monitoring programme presented to the SC in 1999 (Brownell, 1999). A Steering Group was established comprising Brownell (Chair), Borodin, Kim and Ohsumi. The Commission agreed with the SC that such a meeting was needed; however, it did not provide any funding to support the meeting. The Government of Korea offered to host the meeting, and the US government provided seed money to help to organise the workshop. Brownell obtained additional funding from Exxon, Greenpeace, and the International Fund for Animal Welfare, Sakhalin Energy Investment Corporation and the World Wildlife Fund. The Korean government provided additional support to host the workshop in Ulsan city.

2-4. ARRANGEMENTS, ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEURS

Bannister was elected Chair. Clapham served as rapporteur, with assistance from Bradford and Nowacek.

5-6. ADOPTION OF AGENDA AND WORKSHOP RULES

The Agenda as adopted is given in Annex B. Bannister reminded participants that the proceedings of the Workshop were not to be made public until they had been formally submitted to the Commission. Substantive discussion in the Workshop was preceded by a series of presentations by participants on the biology and status of the western gray whale, together with information on relevant threats and conservation issues.

[1] Presented to the meeting as SC/55/Rep4.

7. REVIEW OF DOCUMENTATION AND DATA

A list of available documents is given in Annex C.

8. STOCK IDENTITY

Brownell noted that western and eastern gray whales appeared to be geographically separated, and then summarised recent comparative genetic analysis; this summary represented an update of LeDuc *et al.* (2002). To date, 45 biopsy samples from western gray whales have been analysed and compared to a sample of 120 biopsies from eastern gray whales. A total of 39 mitochondrial DNA (mtDNA) haplotypes have been recorded between the two populations, of which 13 were found in the western population and 33 in the eastern stock. Although nine haplotypes were shared between the two populations, there is a significant difference in haplotype frequencies. This, together with the very different recovery histories of the two populations, indicates that western and eastern gray whales should be considered as distinct management units. Although 13 haplotypes were found in western gray whales, only six are known in females and four are represented by a single known female; since mtDNA is maternally inherited, much of the existing diversity in this population may be lost in the near future.

9. MIGRATION AND DISTRIBUTION

SC/O2/WGW3 summarised results from aerial surveys for gray whales off northeastern Sakhalin Island from 19 July to 19 November 2001. These surveys were designed to assess the abundance and distribution of gray whales off Sakhalin, notably in conjunction with seismic surveys being conducted in the area. A total of 1,696 sightings was made over the entire period, with concentrations found in two areas. In the first area, off Piltun Lagoon, the number of whales observed each day during July and August was unchanged until mid-September, after which a decline occurred through November. A second, offshore, feeding area to the southeast of Piltun was documented on a 10 September 2002 survey, in an area characterised by depths of 35-50m. In this area, there was a total of 410 sightings. The largest number of whales recorded on-transect in the offshore area was 43 (53 gray whales were observed on and off transect combined), while in the Piltun Bay area the largest number of animals recorded on and off transect on a single survey was 39. All sightings included observations of mud plumes.

Some movements of whales in the study area were correlated with periods of seismic survey activity. The proportion of gray whales that were feeding was unchanged over the pre-seismic, seismic and early post-seismic periods.

SC/O2/WGW13 summarised historical records of western gray whales in Chinese coastal waters from 1933 to 2002. Assessment of the status of gray whales in China is complicated by the great length (18,000km) of coastline. Seven strandings of gray whales were documented between 1933 and 2002; two of these animals were females with full-term foetuses. There have been two sightings of mother/calf pairs in the Hainan area. Eleven sightings of gray whales have been documented between 1953 and 1979, and six animals were caught between 1949 and 1958. Together, the records suggest that the calving ground for western gray whales occurs somewhere in the South China Sea.

SC/O2/WGW14 provided information on gray whales in Korean waters. Records indicate that western gray whales migrating southward from late November to early January were hunted between Cape Homi and Ulsan until the late 1960s. Since then, there have been no records of sightings, strandings or entanglements in Korean waters, and it is unclear whether gray whales still migrate off the Korean coast as they once did. The influence, if any, of a documented increase in coastal water temperatures since 1965 is unknown. A programme of systematic monitoring and research is required and will be initiated in the near future.

SC/O2/WGW15 reviewed historical records of gray whales in Japanese waters; this review was based upon newly discovered sighting and catch statistics from the Sea of Japan. Catch records from various places in the late 19th century indicate that gray whales were common along the Sea of Japan coast of Hokkaido at that time. A decline in the number of whales in this area may have resulted from Japanese commercial catches off the coasts of Korea and Russia. Japanese whalers believed that gray whales ate herring eggs; however, it is unlikely that the decline in gray whales in Japanese waters was related to a decline in local stocks of herring. The authors of SC/O2/WGW15 concluded that a migration route of the western gray whale existed along the west coast of Honshu, Japan, but that the route was of relatively minor importance to the population.

SC/O2/WGW22 noted further evidence for the existence of a gray whale migration route off the west coast of Japan. The existence of such a route has been disputed in light of the absence of gray whale catches over 258 years at Ine, on the eastern side of the Sea of Japan. However, gray whale occurrence in this area is apparent in various historical accounts from the late 19th and early 20th centuries; the western Japanese route was in addition to documented migratory paths off the Korean Peninsula and the east (Pacific) coast of Japan. The historical records suggest that gray whales migrated north from the west coast of Honshu, arriving off the southwestern coast of Hokkaido in early March and moved slowly (perhaps feeding as they went) to northeastern Hokkaido through Soya Strait (La Perouse Strait). It is very likely that the whales migrating along the western coast of Japan were bound to or from feeding areas in the Okhotsk Sea.

In discussion, Kasuya agreed that gray whales had occurred off the western coast of Japan, but suggested that the details of their migration through this region was not known. Participants agreed that current data did not permit conclusions regarding how many migratory routes exist for the remaining population. Brownell noted that if three migratory routes still exist, and if the few remaining animals in the population use all of them, this had logistical implications for any monitoring programme that is to be developed. Specifically, with so few whales using any one route, the resulting low density would make detection of migrating animals very difficult. The contention in SC/O2/WGW22 that gray whales migrate along the western side of Sakhalin and through Tatarski Strait around the north coast of that island is not supported by observations; a more likely path would be through Soya (La Perouse) Strait at the southern end of Sakhalin and from there up the island's east coast. Borodin noted that aerial surveys of Tatarski Strait had never observed gray whales.

Kim noted that the current belief about an inshore migration route was based upon historical catches, which occurred exclusively inshore. He believed that it was possible that whales proceeding directly from breeding areas off southern China to feeding grounds in the Okhotsk Sea might in some cases utilise an offshore migration route.

Burdin noted that gray whales had been recorded historically from both the Commander Islands and the northeastern coast of Kamchatka, and that some sightings had been made in these areas in recent years. The population identity of these whales is unknown, although it is likely that they are part of the eastern population.

10. CATCH HISTORY

10.1 Aboriginal catches

What is known of aboriginal whaling for western gray whales has been summarised previously (Krupnik, 1984; Omura, 1984), and there was no new information on this topic available to the Workshop.

10.2 Commercial/direct catch

Kato and Kasuya (2002) estimated that between 1891-1966 the minimum total commercial catch was 1,750 gray whales, including 44 caught in net whaling in the 1890s. They believed a better estimate would be between 1,800 and 2,000 individuals. Brownell agreed with this higher number and noted that his minimum catch estimate for the same period was 1,873 (SC/O2/WGW1). The population was reduced to a moderately low level in the early 1900s, and a continued low level of catches through the 20th century, until the 1960s, may have inhibited or slowed any recovery.

No gray whale catch statistics are available for North Korea after the end of World War II.

10.3 Incidental catches and strandings

SC/O2/WGW8 discussed recent gray whale strandings around Japan. There have been six records of strandings and another four sightings of live whales since the 1950s. All but two of these 10 records were from the Pacific coast of Japan, with the majority (6) off southern Honshu. The other two records (both strandings) were from the Sea of Japan coast. One whale was found floating off the coast of Hokkaido; the body had been butchered, and the animal had been struck by multiple harpoon heads (which some participants thought were similar to those used in dolphin fisheries in Japan). The relatively fresh condition of this animal suggests that it had died close to where it was found, but the exact nature of its death is unclear. In total, at least two of the six stranded whales showed evidence of human impact (the second had apparently been entangled), but the other four carcasses were not examined.

In addition, Vladimirov reported that a young gray whale had been found stranded on the western coast of Aniva Bay (southern Sakhalin) in June 2001. Brownell noted that several of the Japanese stranded animals would be classified, based upon their length, as yearlings, which may indicate vulnerability of this age class during migration. About half

of the animals previously observed as calves off Sakhalin have not been observed to return in subsequent years; thus any information on their possible fate is valuable (Weller *et al.*, 2002b). Borodin commented that just because these whales were not observed at Sakhalin did not mean that they were not alive somewhere else. The Workshop agreed that it would be very useful to match materials from strandings (photographs or tissue samples) to similar data collected by the joint Russia-US long-term research programme off Sakhalin.

Kim noted that there are no recent records of stranded gray whales in Korean waters.

A list of known strandings of western gray whales is given in Table 1.

11. POPULATION ESTIMATES

11.1 Aerial surveys on the feeding grounds

The aerial survey off Sakhalin reported by Blokhin (SC/O2/WGW3) was designed to estimate abundance using NMFS/IWC approved line-transect methodology, but no estimate is currently available. Blokhin noted that an analysis of survey data from 1984 through 2001 could potentially provide an estimate of abundance if a suitable value for $g(0)$ could be obtained, but that this had not yet been done; however, preliminary analysis of this time series suggested no apparent trend (positive or negative) in abundance off Piltun. It was important to note that any estimate of abundance calculated from these data did not necessarily apply to the entire population of the western gray whale, since it remained unclear whether additional (i.e. currently undocumented) whales existed in other habitats.

Most whales photographed outside the Piltun feeding area have been individuals known from Piltun (Weller *et al.*, 2002a). The photo-identification programme off Sakhalin suggests that approximately 100 whales utilise this area (Weller *et al.*, 1999; 2002b); this number is broadly consistent with the number of animals observed off Piltun by the aerial surveys in this area (SC/O2/WGW3). However, the Workshop agreed that minor differences in abundance estimates did not alter the critically endangered status of this population, and that precisely establishing absolute abundance was not as important as determining survival and population trend (positive or negative). This approach is consistent with that established by the IWC during status reviews for other highly endangered whale populations (e.g. North Atlantic right whales: IWC, 2001b).

11.2 Vessel surveys on the feeding grounds

Borodin noted that VNIRO has conducted a sighting survey off Sakhalin that corresponded to the post-seismic period; this survey sighted 41 gray whales. Yazvenko reported results of a Russian vessel survey off northeastern Sakhalin on 16 and 17 September 2001 (SC/O2/WGW7). On 16 September the vessel, with two observers, ran two lines at 5km spacing through the offshore area, then proceeded to run a line through the area off Piltun Lagoon. Sightings of 52 whales were made in the offshore area and another 31 off Piltun. On 17 September, the vessel ran three lines at 5km spacing through the offshore area and made sightings of 83 whales, of which 98% were within 1,500m of the ship. In discussion, it was stated that the reported numbers of whales in these surveys may have been overestimated.

The Workshop noted that the information on the 12 September 2001 survey referred to by Borodin was provided at SC/54 (Doroshenko and Ivannikov, 2003), and **recommended** that this information be made available in full to the Scientific Committee at its next meeting, to include all relevant details of the survey effort, conditions and results. Similarly, the Workshop recommended a similar submission to the SC regarding the surveys on 16 and 17 September.

11.3 Photographic identification

Bradford, Ivashchenko and Tsidulko demonstrated the methods used for photo-identification of gray whales in the joint Russia-US programme off Sakhalin. Identifications are made using patterns of pigmentation and scarring, primarily on the flank in the region below the dorsal hump. Work on eastern gray whales has indicated that these markings remain stable for at least 20 years (Darling *et al.*, 1998). Cataloguing is based upon right-side photographs, although images of flukes and of both right and left sides are available for almost all of the 118 individuals identified to date.

Work to photographically identify gray whales in the Sakhalin offshore area, and to compare those identifications with the existing Russia-US catalogue from the Piltun Lagoon area, was summarised by Burdin (SC/O2/WGW4). A dedicated vessel survey of the offshore area was conducted on 24-28 August 2002. Seventeen whales were

Table 1

20th century stranding records of western gray whales.

Location	Date	Length (m)	Sex	Remarks	Reference
Wailuo Harbor (*ca*. 18 N) PRC*	1949	12.5	M		Wang (1984)
Daya Harbor (*ca*. 19 N) PRC*	1954 spring?	-	F	With full term foetus (4.8m)	Wang (1984)
Zhejiang (*ca*. 28 N) PRC*	1933	11.48	F	With full term foetus (NHMZ)	Wang (1991)
Changhai Co. Southern Bohai (*ca*. 35 N) PRC*	30 Apr. 1960	12.39	M	Weight 18,353kg	Wang (1978)
Jin Co. (*ca*. 37 N) PRC*	15 Sept 1949	12.5	M		Wang (1978)
Zhuanghe, Bohai (*ca*. 39 N) PRC*	7 Dec. 1996	11.5	F	Found alive (DMNH)	Zhu (1997)
Miyazaki Pref. Japan (*ca*. 34 N)	19 Mar. 2000	*	-	Skull+ MPMNH	Yamada *et al*. (2002)
Shingu Pref. Japan (*ca*. 34 N)	2 Feb. 1968	9	F	Skeleton TWM taken by small whaler	Nishiwaki and Kasuya (1970)
Odawara Pref. Japan (*ca.* 35 N)	25 Jan. 1990	8	M	Skeleton (KPMNH)	Kasamatsu and Ishikawa (1990)
Kashiwazaki Pref. Japan (*ca.* 36N)	2 Mar. 1997	-	-	Skull (NSM)	Kato & Tokuhiro (1997)
Toyokoro Japan (*ca.* 43 N)	7 Apr. 1995	9.5	F	Skeleton (AMP)	Kato & Tokuhiro (1997)
Suttu, Japan (*ca*. 43 N)	16 May 1996	11-13	?	Skull+ (SM)	Kato & Tokuhiro (1997); Brownell and Kasuya (1999)
Piltun Lagoon, Sakhalin, Russia (*ca*. 53 N)	26 Aug. 2000	?	?	Partial skull, Piltun Lighthouse Station	Burdin and Weller, pers. comm., Sept. 2000

*People's Republic of China

observed in the offshore area. Ten of these whales were photo-identified, and these were compared to 118 animals photographed off Piltun between 1994 and 2002 (SC/O2/WGW9). Two of the 10 whales observed in the offshore area were skinny (see below). Nine of the 10 offshore animals had previously been observed off Piltun, and a possible match of the tenth animal awaits confirmation. Four of the 10 were resighted in 2002 in the nearshore area. These findings confirm similar results from earlier work in 2000, as summarised in Weller *et al.* (2002a). It is clear that whales move regularly between the inshore and offshore habitats.

No estimate of abundance has been calculated from mark-recapture data, but a minimum estimate would be something lower than the 118 animals currently in the catalogue, since allowance must be made for dead animals.

Weller provided new information on 'skinny' gray whales observed off Sakhalin (SC/O2/WGW5). In 1999, a panel of 10 experts reviewed photographs of skinny whales and all agreed that the whales concerned were abnormally thin, that they had a greatly diminished muscle mass, and that all could be considered to be in poor condition. Preliminary analysis indicates that the minimum numbers of skinny individuals observed in the four years between 1999 and 2002 were 10, 27, 19 and 15, respectively. Between 1999 and 2001, 48 individuals were observed to exhibit this condition, some in multiple years; this represented almost half of the catalogued population up to 2001. Mature females, including those known to be pregnant or lactating, were among the skinny whales. It is unclear what causes this phenomenon, but nutritional stress resulting from inadequate quantity or quality of prey, or disruption of feeding activities are possibilities (Weller *et al.*, 2002b). In this regard, total cumulative feeding time is likely to be a key factor in recovery of skinny animals. Whatever the cause, the skinny whale issue represents a major concern for this critically endangered population.

Brownell noted that the skinny whale phenomenon had been observed in both western and eastern gray whale populations in the same year (1999), and had also been reported in other whale species. Consequently, this may reflect an ocean-basin-wide or even global change that has influenced the availability of, or access to, the whales' primary prey (Tregenza *et al.*, 2002).

12. REVIEW OF BIOLOGICAL PARAMETERS

12.1 Review of values

SC/O2/WGW9 gave new information on vital rates for the animals observed off Sakhalin. There are at least 17 known reproductive females in the population; crude birth rate has varied from 4.3% in 1997 to 14.8% in 1998. Data on calving intervals are now available from a small number of known females (Brownell and Weller, 2002); the inter-birth interval varies between two and three years. In recent years, this interval appears to have lengthened to at least three years (Brownell and Weller, 2002). Limited data on age at attainment of sexual maturity will become available in future years as known-age whales mature.

To date, 118 individuals have been identified. Relatively few new (i.e. previously unknown animals), non-calf whales are observed each year. The resighting rate in 2002 of previously known whales was 92.5%. A total of 93 individuals have been biopsied; the ability of the field team to identify individuals on sight means that very few whales are biopsied more than once. The sex ratio in the population, both overall and in biopsied calves, is biased towards males.

Calf survival appears to be very low; this is based upon low resighting rates of known calves in the year following their birth, and mark-recapture survival estimation using the Russia-US programme's photographic record (Bradford *et al.*, 2002). In 2002, four animals which had not been sighted as yearlings were recorded off Sakhalin; while this certainly indicates that calf or juvenile survival is not as low as previously thought, Bradford stated that she believed the survival rate was below 0.7, which is of grave concern.

No biological data are available from any dead specimens except size and sex.

12.2 Compare and contrast with eastern gray whales

Known parameter values for the eastern gray whale population are summarised in Table 2 (from IWC, 1993, p.247). The pregnancy rate of eastern gray whales is close to 0.50, but in recent years some identified individuals have shown increased calving intervals (IWC, 2003, pp.28-31).

Table 2

Known parameter values for eastern gray whales (from IWC, 1993 p.247).

Mean conception date:[1]	5 December (range late Nov. - early Jan.) (Rice, 1990)
Gestation period:[1]	418 days (Rice, 1990) Somewhat greater than 12 months (Reilly, 1984)
Median birth date:	27 Jan. (range 26 Dec. - 1 Mar.) (Rice, 1990)
Mean birth length:	4.6m (both sexes) (Rice, 1990)
Calves weaned:[1]	Mostly by July (Rice, 1990) *ca* 7m (Rice, 1990) *ca* 8m (Tomilin, 1957)
Body length at 1 year:[1]	*ca* 8m (Rice, 1990)

Von Bertalanffy growth curve parameters:

	Males		Females	
L_∞:	12.43	±0.12	12.95	±0.11
K:	0.141	±0.121	0.246	±0.035
t_o:	-8.346	±1.721	-2.842	±0.772

Physical maturity:	*ca* 40 years and lengths of 13m (males), 14.1m (females)
Sexual maturity:[1,5]	9 years median, 6-12 years range (Rice, 1990) 6 years median, 5-9 years range (Rice, 1990)
Ovulation rate:	*ca* 0.50 per year (Rice, 1990)
Pregnancy rate:	0.46 per year (Rice, 1990) 0.48 (95% CI 0.463-0.498) (SC/A90/G18)
Foetal sex ratio:	50.0% males (Rice, 1990)
Neonatal sex ratio:	56.4% male but not statistically different from 50% (Swartz and Jones, 1983)[2]
Mortality rate:[4]	M = 0.055 female (Reilly, 1984) M = 0.046 male (Reilly, 1984) M = 0.112 juvenile[3] (Reilly, 1984)

[1]Committee recommends reanalysis. [2]Primarily from stranded animals. [3]From a balance equation. [4]Reanalysis should consider new increase rate from SC/A90/G9 and recent age-frequency data from Soviet fishery. [5]Assuming 1 growth layer per year over the life of the animal, rather than 2 layers in the first year of life, as previously assumed in Rice and Wolman, 1971 (see Rice, 1990).

12.3 Compare and contrast with other mysticetes

During the 1990 IWC assessment of gray whales, it was stated 'that it was not useful to apply directly the values of biological parameters from one species to another' (IWC,

1993). The Workshop agreed with this statement, but noted that a key variable, that of pregnancy rate, does provide a useful measure for comparison. For example, in western North Atlantic right whales, there is some evidence that pregnancy rates are related to nutritional status; this may also be the case in both western and eastern gray whale populations. Comparative (inter-specific) studies of this type of issue can provide insights for application to western gray whales. However, it was noted that specific comparisons should be treated with caution.

13. REVIEW OF HABITAT-RELATED PROBLEMS

13.1 Oil and gas development and production

Brownell summarised the history of oil and gas development activities in or near gray whale feeding grounds offshore Piltun Lagoon, Sakhalin Island. Activities include seismic surveys, installation of drilling and production platforms, and major increases in aerial and shipping traffic. In addition, construction of pipelines are scheduled for 2004. Seismic survey activity occurred in the Piltun area in 1997 and 2001. Oil and gas related activities are expected to expand significantly in the next five years. Brownell noted that cumulative impacts on whales from repeated and long-term exposure to oil and gas activities are of concern, notably with regard to displacement from preferred habitat, with consequences for foraging time and quality; this was of particular concern with regard to skinny whales.

Johnson summarised a review of the effects of seismic surveys on baleen whales in areas other than Sakhalin. Seismic surveys use arrays of airguns which fire strong low-frequency pulses at intervals of 10-20 seconds, with most energy concentrated between 10 and 150 Hz. Propagation of sound from airguns attenuates more rapidly in shallow water. Effects are presumed to diminish with distance, and may include (from short to long range) physical damage, temporary hearing loss, strong disturbance effects, and (at greater distances) slight or no changes in behaviour. Species in which airgun disturbance to migrating or feeding whales have been studied include eastern and western gray whales, humpback whales and bowhead whales. Physical hearing damage has not yet been documented, but appropriate studies are difficult to conduct.

Studies of migrating eastern gray whales off California (Malme *et al.*, 1983; Malme *et al.*, 1988) indicated that whales avoided the sound source, with 50% of whales moving to stay outside the zone characterised by received levels of 170 dB re 1 Pa. In another experiment on a small sample of feeding gray whales in the Bering Sea area, reaction thresholds to airgun sounds were similar to those observed in migrating whales. Some behavioural reactions were observed at levels of 149 dB and above, and 10% of animals avoided a sound source of 163 dB. Most whales returned to the area and resumed feeding within an hour after testing was conducted.

Studies of humpback whales' reactions to airgun arrays off western Australia (McCauley *et al.*, 1998; 2000) included initial avoidance at distances of 5-8km (equivalent to a received sound level of 146 dB). Bowhead whales showed marked reactions to seismic activity within 7.5km by strongly avoiding sources and consistently changing respiration and dive characteristics. In experiments conducted on bowheads between 1996 and 1998 (Richardson, pers. comm., per Johnson), whales consistently stayed about 20km away from small to moderate airgun arrays, and well outside the 180 dB received level (equating to a distance of about 1km). Some responses were observed at 30km. Whales recolonised the test areas 12-24 hours after the end of airgun operations. Bowheads appear to be more sensitive to airgun disturbance during their autumn migration than when they are in their summer feeding areas.

13.1.2 2001 Odoptu seismic surveys

Weller reported on a study of the influence of seismic surveys on gray whales off Sakhalin during July-September 2001 (Weller *et al.*, 2002c). To test the hypothesis that the distribution of gray whales would shift away from nearby seismic surveying, the study examined the number of whales and pods sighted during 55 shore-based systematic scans in relation to pre-seismic, seismic and post-seismic periods. Results showed that the number of whales and pods observed during pre- and post-seismic periods was significantly lower than during the seismic period. This suggests that whales shifted their distribution to the south during periods of seismic surveys. Weller stated that boat-based surveys conducted at the same time confirmed a shift away from the northern area where seismic activity was occurring. Whales and pod numbers in the scan area decreased afterwards, suggesting that animals returned to the northern area when seismic activity ceased. Given the potential for displacement by seismic activity of whales from potentially preferred feeding habitat, this issue represents a major concern for this critically endangered population, notably in light of the existence of so many animals in apparently poor body condition. Melton suggested that the lighthouse station sighting data from 1997-2000 should be evaluated relative to that from 2001, taking into account industrial activity during those years. This analysis should be submitted to IWC SC.

Borodin noted that a survey conducted on 12 September 2001 found no movement of whales out of an area and no unusual behaviour. However, Brownell noted that this would be expected given that this survey occurred several days after seismic survey activity had been concluded.

SC/O2/WGW19 summarised four reports relating to marine mammal mitigation and monitoring for the 2001 Odoptu 3-D seismic surveys off Sakhalin. Mitigation of impacts on gray whales was the key issue in the environmental impact assessment prepared for the seismic survey. The Odoptu seismic survey block is located adjacent to the waters off Piltun Lagoon. Johnson noted that conducting seismic surveys during winter when gray whales were absent was impossible because of the lack of shore-fast ice; surveys in spring could not be conducted due to insufficient planning time and unforeseen logistical problems, and surveys in late autumn were considered too dangerous because of poor weather conditions at this time.

Seismic surveys were conducted between 17 August and 9 September 2001. Buffer zones for the seismic surveys were established based upon exclusion of the 20m isobath, inside which the majority of gray whales off Piltun feed. These were defined as areas in which received sound levels (below 163 dB re 1 Pa) were considered to result in minimal impact on gray whales, based upon previous work. Acoustic monitoring of sound levels was conducted at the margin of the buffer zone, but not inside where gray whales were potentially feeding. Mitigation strategies included elimination or reduction of seismic surveys from some areas, and a ramp-up ('soft start') of the airgun arrays. In addition, real-time aerial and behavioural surveys were conducted, as well as vessel-based marine mammal surveys with the authority to shut down the seismic work if gray whales were observed inside the buffer zone. Five shutdowns occurred

during the surveys, and the marine mammal observers reported no unusual or avoidance behaviour by gray whales during the surveys. The vessel surveys provided new information on the use of the offshore feeding area by gray whales.

Before, during and after the seismic surveys, more than one hundred aerial surveys were conducted and the results were analysed for evidence of statistically significant impact of the seismic activity on gray whale distribution or behaviour. The authors of SC/O2/WGW19 noted a southward shift in distribution associated with the period of seismic operations and concluded that the shift was within the range of normal movement patterns in the Piltun area. However, interpretation of whale movements requires data on the distribution and abundance of gray whale prey. Overall, the authors concluded that the mitigation measures which have been adopted were effective in limiting impact on gray whales.

Melton requested that the following statement be inserted into the report:

> In the report of the 2002 SC meeting (IWC, 2003, p.47), the following statement is made:
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> Last year, the Committee had strongly recommended that no seismic work be conducted while whales are on the feeding ground (IWC 2002d, p. 47). As a result of this and Resolution 2001-3 (IWC 2002c), the Russian government was able to get the seismic work stopped last summer and the Committee commends this action.
>
> Exxon Neftegas Limited (ENL), the operator of the Sakhalin I Consortium, concluded the seismic survey on the Odoptu field offshore Sakhalin Island on September 9, 2001. In conducting the survey, ENL implemented the most stringent mitigation measures ever undertaken by the industry in a major seismic survey to be protective of the western gray whales off Sakhalin Island. ENL concluded the survey as it had obtained the information required to enable the Sakhalin I consortium to continue development of the Odoptu field. The data will be used to allow wells to be drilled from a shore location, reducing future offshore operations in the area. A Russian government representative was on board the seismic survey vessel at all times during the survey. At no time was ENL ordered to shut down by the Russian federal government.

Nowacek, Moore and Weller commended Exxon-Neftegas for their extensive monitoring and mitigation efforts during the 2001 Odoptu seismic surveys. They also recognised that Exxon-Neftegas included aspects in their monitoring and mitigation programme that were not required by law or permits (i.e. behavioural monitoring, extra ship-based monitoring, extra aerial overflights and additional acoustic calibration) in an effort to minimise the effects of their activities on western gray whales. During the 3D seismic surveys conducted in the Odoptu license area off the northeast Sakhalin Island during August and September 2001, Exxon-Neftegas supported a monitoring and mitigation programme that included vessel and aerial surveys and behavioural and acoustic studies.

However, they stated that the general conclusions in SC/O2/WGW19 are drawn without reporting the data on which they are based. Not having the data for evaluation compromises interpretation and extrapolation of the results. Without details of how whale observations and surveys were conducted from vessel and aircraft (i.e. equipment specifications, transect design, methods used to determine sighting distance, weather conditions as related to sightability and numerous other issues regarding data analysis techniques) it is impossible to determine if the monitoring effort produced repeatable results and thereby puts the interpretation of such results into question. Four technical reports containing the details of the programme components (aerial and vessel surveys and acoustic and behavioural studies), analyses and results are anticipated, but are not available for review at this time.

The Workshop **recommended** that the detailed results of this programme go forward to the IWC Scientific Committee, in as timely a manner as possible, and be submitted to peer-reviewed scientific journals. Examples include a population estimate for the Piltun region from the 2001 aerial survey data (for comparison to photo mark-recapture estimates), quantitative accounts of seismic energy exposure levels and whale responses, as possible, and assessment of environmental and anthropogenic factors that influence habitat selection in the Piltun feeding area.

Melton and Johnson responded that release of the four reports will be requested but the timing of their availability is uncertain and could involve a delay of a year or more.

13.1.3 Post-2002 seismic surveys

Seismic surveys were conducted in 2002 in the Sakhalin V area, approximately 100km north of the entrance to Piltun Lagoon. Johnson summarised future plans for seismic activities in the Sakhalin II area. For the Piltun-Astokhskoye (PA) field, there are no plans for the next five years. For the Lunskoye field, 3-D seismic surveying covering 327km^2 is planned for four weeks in July-August 2003 (the exact timing depends on vessel availability and weather). The seismic work will take place 12km offshore of Lunskoye Bay, at water depths of 25-60m. Johnson indicated that an EIA for this work is being carried out, and an Environmental Management Plan with specific mitigation measures and controls will be in place.

Johnson also reviewed future plans for offshore construction activities in the Sakhalin II area. The following schedule has been submitted to the Russian Partner: (1) construction of offshore pipelines at the PA and Lunskoye fields to begin approximately during the third quarter of 2004; and (2) construction of offshore platforms at the PA-B and Lunskoye-A fields to begin approximately during the third quarter of 2005. Again, Johnson pointed out that an EIA for this work is being carried out, and an Environmental Management Plan with specific mitigation measures and controls will be in place.

Melton provided additional details on plans for work in the Sakhalin I area, which includes the Odoptu area as well as others to the south. Some of the oil extraction in the Odoptu field will be undertaken by extended drilling from land, with offshore (platform-based) extraction of remaining resources. It is likely that a vertical seismic profile (lasting one to two days and using a small airgun array) will be conducted in the Chayvo field about 40km south of Piltun. Whale-related research is planned, including aerial and vessel surveys, acoustic, behavioural and prey/benthic studies, and photo-identification work.

13.2 Other habitat-related problems

A major concern with regard to oil and gas production in the Sakhalin area relates to pollution in the form of oil seepage, an oil spill, or chemical mitigation of the latter. Melton stated that it was difficult to imagine a scenario by which oil from a spill would sink and contaminate the benthos and thus the prey field. Clapham responded that this was not the only concern with a spill, which could potentially exclude whales from the feeding grounds even if the oil remained at the surface. The type of oil (in terms of weight, notably relative to that in previous major spills worldwide) being extracted at Sakhalin was not known. Brownell noted a concern relative to use of dispersants in the feeding area in the event of an oil spill because of possible effects on the benthic community.

Nowacek noted a concern regarding long-term cumulative effects of increasing industrial activities in the Sakhalin area (e.g. temporary threshold shift as a result of shipping noise, construction etc), and that impacts from seismic surveys were not the only concern with regard to this population.

No data are available for levels of contaminants in western gray whales (such as chlorinated hydrocarbons or heavy metals) because of the lack of available specimens.

There is also no information on the question of possible impacts of vessel noise and vessel traffic on western gray whales, but this issue may be of considerable importance in the calving area which is generally believed to be off southern China.

No specific data on habitat alteration or degradation were presented at the Workshop. However, the Workshop noted that this issue should be examined throughout the range of this population because of the coastal nature of these whales. This need is particularly urgent in the population's calving grounds.

14. ASSESSMENT OF POPULATION

14.1 Status

Overall, the workshop agreed with the conclusions of previous reviews on western gray whales. Specifically, that the population is very small, and suffers from a low number of reproductive females, low calf survival, male-biased sex ratio, dependence upon a restricted feeding area, and apparent nutritional stress (as reflected in a large number of skinny whales). Other major potential concerns include behavioural reactions to noise (notably in light of increasing industrial activity in the area), and the threat of an oil spill off Sakhalin which could cover all or part of the Piltun area and thus potentially exclude animals from this feeding ground.

The Workshop noted that assessments of the potential impact of any single threat to the survival and reproduction of western gray whales were insufficient, and **strongly recommended** that risk assessments consider *cumulative* impact of multiple threats (from both natural and anthropogenic sources). For example, past environmental assessments relating to oil and gas production activities off Sakhalin have assessed the impacts of each project in isolation; this ignores the possible cumulative impact on individual whales of all ongoing industrial projects, which may be further compounded by natural factors such as ecosystem variability leading to inadequate availability of prey.

The Workshop recognised that Sakhalin remains the only known feeding ground for this population, and that neither the migration route nor the location of the breeding/calving grounds is clear.

15. RESEARCH AND MONITORING OF THE POPULATION

15.1 Current programme

The status of work on the western gray whale population in 2002 was summarised in SC/O2/WGW9. The area off the northeastern coast of Sakhalin Island remains the only known feeding ground for western gray whales. The long-term Russia-US collaborative study off Sakhalin began in 1995 (Brownell *et al.*, 1997), and in the seven years of the study a total of 242 days had been spent on the water, comprising 452 hours of direct observation (Weller *et al.*, 1999; 2002b; Würsig *et al.*, 1999; 2000; SC/O2/WGW9). Mother/calf pairs are found closer to shore and in shallower water than other groups. Additional information on biological parameters is given in Item 12.

Borodin stated that the research by the joint Russia-US programme has been conducted in Russian territorial waters, although most of the collected data have been analysed in the USA. He stated that the Russian side often has not been able to obtain original data on this research (e.g. detailed data on skinny whales), and that the absence of such information does not allow Russia to adequately monitor and manage the population. Borodin also noted some potential logistical difficulties with the Russia-US programme. Specifically, he stated that, being an international programme, it has to go through a lengthy process of obtaining permits and licenses according to the laws of the Russian Federation.

Brownell noted that the joint Russia-US programme is conducted as part of the Marine Mammal Project under Area V: Protection of Nature and the Organization of Reserves within the framework of the US-Russia Agreement on Cooperation in the Field of Environmental Protection, since 1995.

Borodin stated that the scope of western gray whale studies should be broadened to cover the entire geographical range including migration routes and calving/breeding grounds. He suggested that such studies would be more efficient when conducted as national programmes. Kim concurred with this statement, and suggested that range states be encouraged to develop such programmes.

The Workshop **agreed** that, in addition to international cooperative studies, range states (including Russia, China, Korea and Japan) should organise studies of western gray whales within their respective territories and conduct these as national programmes; a special IWC Scientific Committee working group could coordinate this effort.

15.2 Long-term programme

SC/O2/WGW18 summarised details of the Russia-US research programme on western gray whales for the period 2003-2007. The programme will determine population status and trends by investigation of abundance, reproduction, survival, population composition, effective population size and genetic diversity. The primary research methodology used is photo-identification and biopsy sampling of individual whales. Data collected in 2003-2007 will be combined with those recorded in previous years, resulting in a comprehensive 12-year dataset.

Burdin added that the Kamchatka Branch of the Pacific Institute of Geography planned to establish a Centre for Studies for Endangered Whales.

Vladimirov summarised plans for a Russian national research programme to be implemented in 2003 and to continue until 2007. He indicated that the research programme would include the following components: (1) aerial surveys; (2) vessel surveys; (3) photo-identification; (4) satellite telemetry; (5) benthic sampling; and (6) behavioural and acoustic monitoring relative to industrial activity.

Vladimirov also provided details of a proposed satellite tagging programme for western gray whales. The tags will be produced by the Russian space agency and will be first tested on eastern gray whales off Chukotka; if this test is successful, it is anticipated that they would be available for deployment on western gray whales by the autumn of 2004. Clapham noted the history of failure with newly developed satellite tags, and commended Vladimirov for his offer to bring in experts with experience in this field, and to first test the tag on eastern gray whales. He noted recent concerns of

the Scientific Committee and others with regard to the impact of tagging on small populations (notably North Atlantic right whales; Kraus *et al.*, 2000; IWC, 2001a), and the recommendation that this work be conducted with extreme caution. Given the critically endangered state of the western gray whale, the workshop **agreed** with this **recommendation**. Recalling that at its 2000 meeting (IWC, 2001a, p.33) the Scientific Committee stated:

> In view of the ready access of scientists to subsistence harvested bowheads at Barrow, Alaska, the Committee **recommends** that implantable tags proposed for use on the North Atlantic right whale be tested on harvested bowhead whales. Appropriate tests could include assessing depth and nature of the wound, extent to which epidermal material is carried into the wound, and the holding strength of attachment devices.

the Workshop urged that objective criteria be established for determining success during the test tagging of eastern gray whales. These criteria should involve both the duration/information yield of the tag and impact on tagged animals. For example, criteria could include operation of the tag during the entire migration to Baja California, and examination of tagged whales in Mexican waters to assess the condition of the animal and of the tag.

OBJECTIVES FOR FUTURE RESEARCH

The Workshop agreed that the principal objectives for future research on western gray whales should be as follows:

(1) Determine population status and trend, through investigation of: (a) abundance; (b) reproduction; (c) survival, and rates and causes of mortality; (d) population composition; (e) effective population size; and (f) genetic diversity.
(2) Characterise summer feeding habitat in terms of prey distribution and abundance, bottom topography, and physical and biological oceanography.
(3) Identify calving grounds in southern Chinese waters.
(4) Determine patterns of habitat use and temporal/spatial distribution on the feeding grounds and other portions of the range.
(5) Investigate the influence of human activities on distribution, occurrence, foraging success, reproduction and survival, with emphasis on oil and gas production on the feeding grounds.
(6) Assess the influence of variability in environmental factors such as climatic changes or ecosystem shifts, on distribution, occurrence, foraging success, reproduction and survival.
(7) Assess locations of historical feeding and calving grounds, and migratory pathways, by reviewing historical records (catches and sightings) of western gray whales throughout their range.

As directed in the Terms of Reference, the Workshop then proceeded to update the 10-year research and monitoring programme developed at the 1999 La Jolla workshop (Brownell, 1999) in the context of the above objectives, and agreed to the tabulation given in Annex D.

It was evident from discussion that substantial differences in viewpoint existed among scientists from the Russian programme, scientists from the Russia-US programme, and industry representatives; these differences related to how the required research should be conducted and how much data should be shared in order for management goals to be met.

The Workshop was unable to resolve these issues, but considerable concern was expressed regarding potentially unnecessary duplication of research as well as the impact of such redundant effort on the animals.

16. GENERAL RECOMMENDATIONS

The Workshop reviewed recommendations made by the Scientific Committee at its 2002 meeting (IWC, 2003, pp.47-48). These updates, and additional recommendations made by the Workshop, are given in Table 3.

17. PUBLICATIONS

The Workshop reviewed the list of meeting documents and a list of papers to be considered for publication was created for submission to the Journal Editor. The Workshop **recommends** that consideration be given to their being published collectively as a special issue of JCRM, or incorporated into a single issue of the journal.

18. ADOPTION OF REPORT

The report was adopted at 10:32am on 25 October 2002.

The Workshop commended Bannister and Clapham for their hard work during the meeting. On behalf of all participants, Bannister expressed appreciation to Kim and his staff for their hard work with regard to meeting arrangements, and he thanked Brownell for all his preparatory work including the arrangement of funding. Bannister also expressed considerable appreciation to Kim, K-J Ahn (President of the National Fisheries Research and Development Institute), and the mayor and city of Ulsan for their generous hospitality.

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Annex A
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M. Vorontsova

Annex B
Agenda

1. Convener's opening remarks
2. Arrangements for meeting
3. Election of Chair for Workshop
4. Selection of rapporteur(s)
5. Adoption of Agenda
6. Rules for IWC/SC meetings
7. Review of documentation and data
8. Stock identification
9. Migration and distribution
10. Catch history
    - 10.1 Aboriginal catch
    - 10.2 Commercial/direct catch
    - 10.3 Incidental catch and strandings
11. Population estimates
    - 11.1 Aerial surveys on summer feeding grounds
    - 11.2 Vessel surveys on summer feeding grounds
    - 11.3 Photographic identification
12. Review of biological parameters
    - 12.1 Review of values
    - 12.2 Compare and contrast with eastern gray whales
    - 12.3 Compare and contrast with other mysticetes
13. Review of habitat related problems
    - 13.1 Oil and gas development and production
    - 13.2 Other habitat related problems (e.g. Contaminants and pollution, vessel traffic, habitat alteration, etc.)
14. Assessment of population
    - 14.1 Status
15. Research and monitoring of the population
    - 15.1 Current programme
    - 15.2 Longer-term programme
16. General recommendations
17. Publications
18. Adoption of Report

Annex C
List of Documents

SC/O2/WGW

1. BROWNELL, R. L., Jr. Modern commercial whaling for western gray whales.
2. [NO PAPER].
3. BLOKHIN, S.A., VLADIMIROV, V.L., LAGEREV, S.I. and YAZVENKO, S.B. Abundance, distribution, and behavior of the gray whale (*Eschrichtius robustus*), based on aerial surveys off northeast coast of Sakhalin from July to November 2001.
4. BURDIN, A.M., TSIDULKO, G.A., IVASHCHENKO, Y.V., BRADFORD, A.L. and WELLER, D.W. Photo-identification of western gray whales in coastal and offshore Sakhalin shelf waters.
5. WELLER, D.W., BURDIN, A.M., BRADFORD, A.L. and BROWNELL, R.L., Jr. Observations of skinny whales on the Piltun feeding ground 1999-2002.
6. [NO PAPER].
7. MAMINOV, M.K. and YAKOVLEV, Y.M. New data on the abundance and distribution of the gray whale on the northeastern Sakhalin shelf.
8. YAMADA, T.K., UNI, Y. and ISHIKAWA, H. Recent gray whale strandings and sightings around Japan.
9. WELLER, D.W., BURDIN, A.M. and BROWNELL, R.L., Jr. Status of the western gray whale population in 2002.
10. [NO PAPER].
11. CLAPHAM, P., BROWN, M., ROBBINS, J., FRASIER, T., KRAUS, S. and BAKER, C.S. The importance of biopsy sampling to conservation and management of endangered whale populations.
12. BROWNELL, R.L., Jr., LANG, A.R., BURDIN, A.M. and WELLER, D.W. Future long-term genetic research on the western gray whale.
13. ZHU, Q. Historical records of Western Pacific stock of gray whale *Eschrichtius robustus* in Chinese coastal waters from 1933 to 2002.
14. KIM, Z.G., SOHN, H. and HAHN, S.D. Overview of gray whale, *Eschrichtius robustus* in Korean waters.
15. UNI, Y. and KASUYA, T. Review of historical records of gray whales in Japanese waters.
16. [NO PAPER].
17. BROWNELL, R.L., Jr. Western gray whale specimens in scientific institutions outside of the range states.
18. BURDIN, A.M., WELLER, D.W. and BROWNELL, R.L., Jr. Russian-American research program on western gray whales: 2003-2007.

19. JOHNSON, S.R. Marine mammal mitigation and monitoring program for the 2001 Odoptu 3-D seismic survey, Sakhalin Island, Russia.
20. WELLER, D.W., IVASHCHENKO, Y.V., TSIDULKO, G.A., BURDIN, A.M. and BROWNELL, R.L., Jr. Influence of the Odoptu seismic surveys on western gray whales while on their feeding ground in 2001.
21. [NO PAPER].
22. PARK, K.B. Migration route of gray whales on the west coast of Japan.
23. WURSIG, B. Anthropogenic noises and whale reactions: Habitat degredation and loss.
24. VLADIMIROV, V.A. Contemporary status of the Okhotsk-Korean gray whale population, actual tasks of its study and conservation.
25. PERLOV, A.S. Some behavioral traits of the Korean-Okhotsk population of gray whales.

Annex D
Summary and Status/Update of a 10-Year Plan for Research and Monitoring of Western Gray Whales[1]

1. Monitor the status of gray whales on their summer feeding grounds off the northeastern coast of Sakhalin Island.
   - 1.1 Conduct annual population surveys, including calf counts, using photo-identification and other methods.
     - 1.1.1 Status: JRUS – Weller *et al.* (1999); Weller *et al.* (2002a); SC/O2/WGW9
     - 1.1.2 Future research plan:
       - 1.1.2.1 Schedule: ongoing
       - 1.1.2.2 Responsible party: JRUS, ISS, RUS
       - 1.1.2.3 Methodologies: photo-id, biopsy
   - 1.2 Examine photographs for evidence of disease and for scars from killer whales, ship strikes, net entanglement, and other human activities.
     - 1.2.1 Status: SC/O2/WGW9; SC/O2/WGW5; Southern *et al.* (2001)
     - 1.2.2 Future research plan:
       - 1.2.2.1 Schedule: ongoing
       - 1.2.2.2 Responsible party: Japanese cetacean stranding networks
       - 1.2.2.3 Methodologies: matching with photo and genetic catalogues
2. Investigate habitat characteristics of gray whale summer feeding grounds off the northeastern coast of Sakhalin Island.
   - 2.1 Conduct research on the benthic invertebrate community found in the summer feeding grounds and in nearby areas where whales are not known to feed.
     - 2.1.1 Status: Samples taken by ISS, JRUS, and RUS
     - 2.1.2 Future research plan:
       - 2.1.2.1 Schedule: ongoing
       - 2.1.2.2 Responsible party: ISS, JRUS, RUS
       - 2.1.2.3 Methodologies: grid samples with Van Veen grabs, video sleds, cores
   - 2.2 Characterise free fatty acid and stable isotope profiles for gray whales and their known prey species.
     - 2.2.1 Status: no work to date
     - 2.2.2 Future research plan:
       - 2.2.2.1 Schedule:
       - 2.2.2.2 Responsible party:
       - 2.2.2.3 Methodologies:
   - 2.3 Collect faecal samples from feeding gray whales to identify prey.
     - 2.3.1 Status: analyses pending
     - 2.3.2 Future research plan:
       - 2.3.2.1 Schedule: ongoing
       - 2.3.2.2 Responsible party: JRUS, RUS
       - 2.2.2.3 Methodologies:
   - 2.4 Measure organic carbon levels on the Piltun feeding grounds.
     - 2.4.1 Status: no work to date
     - 2.4.2 Future research plan:
       - 2.4.2.1 Schedule:
       - 2.4.2.2 Responsible party:
       - 2.4.2.3 Methodologies:
   - 2.5 Monitor human-related contaminants in feeding ground sediments.
     - 2.5.1 Status: ?
     - 2.5.2 Future research plan:
       - 2.5.2.1 Schedule:
       - 2.5.2.2 Responsible party:
       - 2.5.2.3 Methodologies:
3. Determine movements and behaviour of gray whales by radio and satellite telemetry.
   - 3.1 Determine residence times of gray whales in the Piltun feeding area.
     - 3.1.1 Status: Weller *et al.* (1999)
     - 3.1.2 Future research plan:
       - 3.1.2.1 Schedule: ongoing
       - 3.1.2.2 Responsible party: JRUS, ISS, RUS
       - 3.1.2.3 Methodologies: photo-id, radio tag

[1] Updated from Brownell (1999).

- 3.2 Study behavioural patterns of gray whales, with particular emphasis on quantifying proportion of time spent feeding.
  - 3.2.1 Status: Weller *et al.* (2002a)
  - 3.2.2. Future research plan:
    - 3.2.2.1 Schedule: ongoing
    - 3.2.2.2 Responsible party: JRUS, ISS, RUS
    - 3.2.2.3 Methodologies: focal individual follow, radio tag
- 3.3 Determine movements and behaviours of gray whales in response to repeated exposures to industry-related noise in the Piltun feeding area.
  - 3.3.1 Status: Würsig *et al.* (1999) and subsequent reports; Weller *et al.* (2002b); SC/O2/WGW20
  - 3.3.2 Future research plan:
    - 3.3.2.1 Schedule: June-Oct., 2003-2007
    - 3.3.2.2 Responsible party: JRUS, ISS, RUS
    - 3.3.2.3 Methodologies: aerial survey, focal individual follow, scan samples, remote hydrophones, theodolite
- 3.4 Investigate the timing of southward migration and migratory pathway(s) with satellite tags.
  - 3.4.1 Status: planning stage
  - 3.4.2 Future research plan:
    - 3.4.2.1 Schedule: autumn-spring, 2004 and beyond
    - 3.4.2.2 Responsible party: RUS
    - 3.4.2.3 Methodologies: vessel, land based surveys and satellite tags

4. Monitor airborne and underwater noise related to industrial development off the northeastern coast of Sakhalin Island.
   - 4.1 Conduct acoustic monitoring to determine ambient and industrial sound levels and to identify sources.
     - 4.1.1 Status: Würsig *et al.* (1999) industry report; SC/O2/WGW19 and subsequent reports
     - 4.1.2 Future research plan:
       - 4.1.2.1 Schedule: summer ongoing
       - 4.1.2.2 Responsible party: ISS, RUS
       - 4.1.2.3 Methodologies: remote, autonomous acoustic sampling
   - 4.2 Investigate short- and long-term effects of noise on gray whale behaviour.
     - 4.2.1 Status: Wursig *et al.* (1999); SC/O2/WGW19 and subsequent reports; SC/54/BRG14; SC/O2/WGW20
     - 4.2.2 Future research plan:
       - 4.2.2.1 Schedule: summer ongoing
       - 4.2.2.2 Responsible party: JRUS, RUS, ISS
       - 4.2.2.3 Methodologies: vessel based and aerial surveys, theodolite tracking, focal individual follows

5. Identify possible breeding/calving habitat in southern China to determine the winter range of this population.
   - 5.1 Conduct interviews with local fishermen, and survey archival materials in regional temples and museums.
     - 5.1.1 Status: promising areas identified
     - 5.1.2 Future research plan:
       - 5.1.2.1 Schedule: 2003-04
       - 5.1.2.2 Responsible party: Chinese team
       - 5.1.2.3 Methodologies: review historical documents, interviews
   - 5.2 Based on the results from items 5.1, and any additional new information, initiate shore-based surveys in areas of probable gray whale occurrence.
     - 5.2.1 Status: areas identified
     - 5.2.2 Future research plan:
       - 5.2.2.1 Schedule: 2003-04
       - 5.2.2.2 Responsible party: Chinese team
       - 5.2.2.3 Methodologies: shore based and aerial surveys
   - 5.3 Initiate photo-identification and genetic sampling studies in areas determined by items 5.1 and 5.2 to be inhabited by gray whales.
     - 5.3.1 Status: planned
     - 5.3.2 Future research plan:
       - 5.3.2.1 Schedule: 2003-04
       - 5.3.2.2 Responsible party: Chinese team
       - 5.3.2.3 Methodologies: photo-id, biopsy

6. In spring 2004 establish a shore-based monitoring station in the Republic of Korea to determine the feasibility of assessing southbound and northbound migratory timing.
   - 6.1 Status: planned
   - 6.2 Future research plan:
     - 6.2.1 Schedule: 2004 and beyond
     - 6.2.2 Responsible party: Korean team
     - 6.2.3 Methodologies: vessel and shore based surveys

7. Conduct intra- and inter-population genetic and biochemical analyses.
   - 7.1 Investigate genetic differences between western and eastern gray whale populations using analyses of mtDNA and appropriate nuclear markers.
     - 7.1.1 Status: LeDuc *et al.* (2002); SC/O2/WGW12; SC/O2/WGW11
     - 7.1.2 Future research plan:
       - 7.1.2.1 Schedule: 2003-05
       - 7.1.2.2 Responsible party: Japanese team
       - 7.1.2.3 Methodologies: biopsy and other tissue samples
   - 7.2 Use molecular techniques to determine the sex of all sampled individuals.
     - 7.2.1 Status: Weller *et al.* (2002a)
     - 7.2.2 Future research plan: ongoing JRUS
       - 7.2.2.1 Schedule:
       - 7.2.2.2 Responsible party:
       - 7.2.2.3 Methodologies: biopsy
   - 7.3 Conduct microsatellite analyses to investigate: (a) genetic variation; (b) relatedness, including maternity/paternity; (c) effective population size; (d) individual identity; and (e) inter-area movement and abundance.
     - 7.3.1 Status: SC/O2/WGW12
     - 7.3.2 Future research plan:
       - 7.3.2.1 Schedule: ongoing

7.3.2.2 Responsible party: Japanese team
7.3.2.3 Methodologies: population identity studies

7.4 Develop and continue an archival tissue bank for materials collected.
7.4.1 Status: SC/O2/WGW17
7.4.2 Future research plan: Japanese team
7.4.2.1 Schedule: ongoing
7.4.2.2 Responsible party: JRUS
7.4.2.3 Methodologies:

7.5 Examine tissue-based biomarkers to assess geographic movements, habitat use patterns and contaminant exposure.
7.5.1 Status: SC/O2/WGW12
7.5.2 Future research plan:
7.5.2.1 Schedule: to be planned
7.5.2.2 Responsible party: JRUS
7.5.2.3 Methodologies: to be developed

8. Determine the individual identity and number of gray whales off the southern Kamchatka Peninsula, [and other areas of the WGW range] and their genetic relationship to either western or eastern gray whales.
8.1 Conduct photo-identification surveys.
8.1.1 Status: SC/54/BRG13
8.1.2 Future research plan:
8.1.2.1 Schedule: 2003-04
8.1.2.2 Responsible party:
8.1.2.3 Methodologies: photo-id, biopsy

8.2 Collect biopsy samples.
8.2.1 Status: LeDuc *et al.* (2002)
8.2.2 Future research plan: ongoing
8.2.2.1 Schedule:
8.2.2.2 Responsible party: JRUS
8.2.2.3 Methodologies: biopsy

9. Review historical records of western gray whales throughout their range to obtain better insight into the locations of historic feeding and calving grounds, and migratory pathways.
9.1 Status: promising areas identified
9.2 Future research plan:
9.2.1 Schedule: 2003 and beyond
9.2.2 Responsible party: Korean, Japanese and Chinese teams
9.2.3 Methodologies: literature searches

10. Review results of the above items through the Scientific Committee (SC) of the International Whaling Commission (IWC).
10.1 Present results from any of the above studies to the SC/IWC.
10.2 Request that sighting, stranding, and human-related mortality records be annually reported by IWC member countries.
10.3 Make recommendations regarding the monitoring and conservation of western gray whales.

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