Annex M

Report of the Sub-Committee on Whalewatching

Members: Kato (Chair), Amaral, Andreu, Bejder, Bjørge, Brito, Carlson, Choi, Cozzi, Deimer-Schutte, Dimis, Edwards, Engel, Fortuna, Freitas, Funahashi, Gallego, Galletti, Groch, Holm, Jaramillo-Legoretta, Luna, Lusseau, Mattila, Nicolau, Panigada, Parsons, Pagan, Ritter, Robbins, Rose, Scheidat, Sequeira, Silva, Simmonds, J., Simmonds, M., Sironi, Stachowitsch, Štrbenac, Urbán, Vely, Verborgh, Weinrich, Williams.

1. CONVENOR'S OPENING REMARKS AND TERMS OF REFERENCE

Kato welcomed the members of the sub-committee and noted the priority items identified by the Scientific Committee: (1) review whalewatching in Portugal (Azores, Madeira), Canary Islands and Strait of Gibraltar; (2) assess the impacts of whalewatching on cetaceans (methods and results of changes in behaviour and movement patterns; methods and results of physiological changes to individuals; and methods and results of demographic and distributional changes). In addition, the following items were identified: (1) Review reports from Intersessional Working Groups: large-scale whalewatching experiment (LaWE) (intersessional steering group), LaWE Advisory Group (intersessional advisory group), compile information on whale-watching programs and associated data, and further develop a questionnaire to assess the extent and potential impact of swim-with-whale operations; and to identify local researchers to distribute questionnaires to operators; (2) consider information from platforms of opportunity of potential value to the Scientific Committee; (3) review of whale-watching guidelines and regulations; and (4) review of risks to cetaceans from whale-watching vessel collisions.

2. ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEURS

Kato was elected Chair and Carlson was appointed rapporteur with assistance from Rose.

3. ADOPTION OF AGENDA

The adopted Agenda is given as Appendix 1.

4. REVIEW OF AVAILABLE DOCUMENTS

The documents available to the sub-committee were identified as: SC/61/WW1-12; SC/61/BC1; SC/61/SM20; SC/61/E16; SC/61/BRG27; Baldock *et al*. (in review), Stockin *et al*. (2001).

5. PROPOSAL FOR A LARGE-SCALE WHALEWATCHING EXPERIMENT (LAWE; INCLUDING REPORTS FROM THE INTERSESSIONAL STEERING GROUP AND THE ADVISORY GROUP)

Lusseau presented a report from the large-scale whalewatching experiment (LaWE) Intersessional Steering Group (see Appendix 2). The report elaborated on the hypotheses that the LaWE project initiative plans on testing and the research design needed to do so. It offered the next steps required to complete phase I of the initiative (see work plan TOR).

During discussions, members of the sub-committee clarified that the pursuit of the LaWE was not meant to discourage the conduct of short-term response studies, which are often the type of study most readily pursued in many locations. Until the LaWE is well underway and generating results, such studies remain a valuable tool in providing scientific advice to manage the development of whalewatching. It was then noted that the first objective of the LaWE is to determine whether the vital rate effects described in recent studies can be observed in other situations. If the primary hypothesis (that there are such vital rate effects) is found to be false, then it may ultimately mean that short-term response studies will be less important from a management perspective. However, it was noted that testing the vital rate hypothesis will take years, if not more than a decade. Therefore, waiting until that hypothesis is tested to engage in short-term response studies is neither preferable nor desirable.

After discussions, the sub-committee endorsed in principle the approach and hypotheses of the LaWE, understanding that there will be further intersessional work, as summarised in Appendix 2.

Bejder presented a summary of actions taken by the US government on Hawaiian spinner dolphins (*Stenella longirostris*). These animals have predictable daily movement patterns, foraging offshore at night and returning to inshore sheltered bays to rest during day time (Norris *et al.* 1994; Lammers 2004). They may be particularly vulnerable to disturbance because of their reliance on limited availability of sheltered waters to rest, socialize and avoid predators. Due to growing concerns of impacts of human activity on spinner dolphins, the U.S. National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) is in the process of developing management plans to reduce the exposure of spinner dolphins to human activity in Hawaiian waters.

As part of this process, Bejder conducted a review of the current human-spinner dolphin interaction situation in order to provide recommendations for management and future research priorities. Management recommendations included a short-to-medium term approach of time/area closures of resting bays. Recommendations for long-term management included the implementation of a regulatory framework for commercial dolphin-watching (and swim-with activities) through an enforceable permitting system comparable to that of Australia and New Zealand.

Research recommendations included the use of multiple types of research platforms; use of appropriate behavioural sampling techniques; monitoring of multiple response measures simultaneously; supplementation of opportunistic observations with controlled exposure experiments; taking advantage of historic photo-identification data; and taking advantage of innovative technologies such as bottom-mounted acoustic recorders. A five-year research plan was recommended, which would include: quantifying day time habitat use; determining residency and fidelity patterns during day-time in near-shore habitats; quantifying human presence in resting bays; producing quantitative measures of dolphin exposure to human activities within and outside of resting bays; and documenting short-term responses of dolphins in resting bays to human activity. Bejder also presented three general recommendations, as listed below (points 1-3).

Bejder reported that subsequent to the submission of his recommendations, NOAA Fisheries has indicated its intent to close off four spinner dolphin resting bays off the Big Island of Hawaii – and it had committed to fund research before and after the implementation of the time/area closures.

In discussion the sub-committee commended the government of the United States for supporting the establishment of control areas to facilitate long-term research and increase understanding of human-spinner dolphin interactions in Hawaii. They agreed that the three recommendations presented by Bejder could be applied generally to long-term impact assessment research, as follows:

(1) There should be a financial commitment to a longitudinal research program to detect cumulative effects over time and to determine the effectiveness of management intervention;

(2) a sufficient database must exist prior to the implementation of time/area closures. This information will serve as 'baseline data' for comparison after the implementation of closures; and

(3) there must be a commitment to an adaptive management framework to promote rapid and appropriate translation of research findings into management plans.

6. REVIEW WHALEWATCHING IN PORTUGAL (INCLUDING THE AZORES, MADEIRA), CANARY ISLANDS AND STRAIT OF GIBRALTAR

Sequeira and colleagues presented SC/61/WW11, a detailed overview of whalewatching in Portugal (including the Azores and Madeira), the Canary Islands and Strait of Gibraltar, providing for each area information on target species, communities where whalewatching occurs, platforms, research and existing guidelines or laws regulating the activities (Table 1).

During discussions, members of the sub-committee asked if the guidelines in Madeira would follow the regulations for the industry established in Portugal and the Azores, in particular, forbidding swim-with-dolphin excursions. The response noted that there is a Law Order under discussion in Madeira's Parliament to establish regulations for whalewatching, including a ban on swimming with dolphins. The sub-committee reiterated its recommendation of previous years, that in general, to be effective, codes of conduct should be supported by an appropriate legal framework so that they are enforceable and modified, if necessary as new biological information emerges. The sub-committee commended the Madeira Regional Government for taking these measures to date and encouraged the Madeira Parliament to approve and implement the proposed whalewatching regulations.

Some concern was expressed about the consistently high numbers of whale-watching trips off Tenerife, Canary Islands. When asked if there were problems with monitoring and enforcement in the region and if there was a levy or tax that could support enforcement, Silva replied that in the Azores, enforcement of the industry was problematic. Operators pay a licence fee and although it was proposed that a portion of the fee be used for monitoring and enforcement, there is no legal requirement that such funds be directed towards any specific purpose. This is similar to the situation in Madeira, mainland Portugal and many other sites. It was noted that in some locations independent, non-profit groups have been used to receive and administer such funds. After discussion, the sub-committee recommended that governments involved in issuing whalewatching permits or licences allocate a certain percentage of the taxes or fees received through the licensing process to monitoring efforts, research programmes, and/or enforcement activities

7. ASSESS THE IMPACTS OF WHALEWATCHING ON CETACEANS

SC/61/WW1 reviews recent advances in whalewatching research since SC60 and summarises five papers on short-term impacts. This includes Timmel *et al.* (2008), a study on Hawaiian spinner dolphins (*Stenella longirostris*) that rest in bays during the day, before heading offshore to feed at night. Dolphins were tracked for 178 hours by theodolite; results show that human swimmers or vessels were within 100m of the focal dolphin group 100% of the time, swimmers within 50m 85% of the time, and up to 34 vessels or swimmers at one time within 300m of the dolphin groups. The presence of swimmers and vessels increased the rate at which dolphins changed direction of travel and dolphins tended to swim faster when vessels were at a greater distance.

Courbis and Timmel (2009) report on the interaction of spinner dolphins with swimmers and vessels in three Hawaiian Bays. Researchers recorded aerial behaviours, group size, movement to and from the bays, and vessel and swimmer numbers. Results were compared to previous studies (Norris *et al.* 1994; Forest, 2001) to determine trends over time. Results indicated that in all three bays, mean occurrence of aerial behaviours was not significantly related to mean frequency of vessels and swimmers and that group size was not significantly different. In contrast to previous research, results show that midday (rest period) aerial behaviour increased while aerial behaviour during morning and afternoon decreased; this may be linked to increased vessel traffic.

Dans *et al.* (2008) investigated the effect of boat traffic (commercial whalewatching and research vessels) on dusky dolphins (*Lagenorhynchus obscurus*) in Golfo Nuevo, Argentina. Dolphin responses to vessel presence varied according to the initial behavioural state and type of vessel present: feeding and milling groups were most likely to change behavioural states (approximately 50% of the time) when approached by commercial vessels, whereas travelling dolphins did not respond to an approaching commercial vessel. By contrast, the approaching research vessel did not significantly alter any of the behavioural states observed. Results indicated that the dolphin's foraging and social budget decreased when commercial vessels were present.

Jensen *et al*. (2008) investigated noise impacts of smaller vessels, such as tour and research boats, in Koombana Bay, Western Australia (a shallow-water habitat) and Tenerife, Canary Islands, Spain (a deep-water habitat). Results showed that bottlenose dolphins (*Tursiops aduncus*) and pilot whales (*Globicephala macrorhynchus*) are likely to have their communication range significantly reduced by boat noise. However, if tour vessels adhere to current guidelines for whale and dolphin watching, i.e. keep at least 50 to 100m distance, vessel noise is unlikely to mask communication of these two cetacean species.

Sousa-Lima and Clark (2008) researched the effect of boat traffic (whale-watching and recreational vessels) on the acoustic behaviour of humpback whales in Abrolhos National Marine Park, Brazil, an area which is an important breeding ground for the southwest Atlantic population of humpback whales (*Megaptera novaeangliae*). The results of the study demonstrated that boat traffic had a significant negative response on singer activity. The authors suggest that an increase in acoustic events generated by marine vessels could displace the whales from the feeding grounds and/or males might cease to vocalize.

SC/61/WW2 presented a literature review of the effects of aircraft on cetaceans, as requested by the Committee last year. Aircraft produce noise at frequencies that are well within the frequency range of cetacean calls. Aircraft can also produce surface disturbance, as well as visual signals such as the aircraft's shadow. Aircraft noise, unlike boat and other underwater noise, is generated in air, transmitted through the water surface and then propagates underwater to the receiver. A detailed review of the physics of air-to-water transmission of aircraft noise can be found Richardson *et al*.

(1995). Aircraft noise also differs from boat noise in that it typically is present for shorter periods, and moves at a greater speed due to the higher travel speed of aircraft. Nevertheless, the sound pressure levels detected underwater from even small-sized aircraft may be extremely high.

Table 1

Whalewatching in Portugal and Spain and related information

[Prepared by Sequeira, Elejabeitia, Silva, Dinis, de Stephanis, Urquiola, Nicolau, Prieto, Oliveira, Cruz and Freitas]

WW country/ Communities/ Areas	**Platform**	**Species**	**Research?**	**Regulations / Codes of conduct**	**Other**
PORTUGAL					
Azores 1993	Boat	*Physeter macrocephalus, Delphinus delphis, Tursiops truncatus, Stenella frontalis, S. coeruleoalba, Grampus griseus, Globicephala spp., Balaenoptera physalus B. borealis, B. musculus, B. acutorostrata Hyperoodon ampullatus, Pseudorca crassidens, Mesoplodon bidens, Megaptera novaeangliae, Ziphius cavirostris, Orcinus orca, Kogia breviceps,*	Yes	Regulation published in 1999 and updated in 2003 and 2004.	Swim with dolphins still allowed but some operators have proposed to stop the activity within 5 years. Current regulations include a limit of boats in geographic areas where the activity is concentrated and where demand for licences is higher. Operators often collaborate in monitoring studies conducted by Department of Oceanography and Fisheries of the University of the Azores (DOP/UAc). Some operators contribute with sighting and photo-id information to DOP/UAc databases.
Madeira 1996	Boat	*Physeter macrocephalus, Delphinus delphis, Tursiops truncatus, Stenella frontalis, Globicephala macrorhynchus, Steno bredanensis, Balaenoptera edeni, B. physalus*	Yes	Voluntary code of conduct in place and accepted by the majority of the operators. Regulation waiting for approval from the regional parliament.	Operators often collaborate in monitoring studies conducted by the Whale Museum. Swim with dolphins is still allowed, but the legislative proposal awaiting approval considers a ban on this activity.
Mainland Portugal 2004	Boat	*Delphinus delphis, Tursiops truncatus* (including the resident population in the Sado estuary), *Stenella coeruleoalba, Orcinus orca, Balaenoptera acutorostrata, Phocoena phocoena* (occasionally)	No	Regulation published in 2006. Code of conduct as part of the regulation.	Swim with cetaceans is forbidden.
SPAIN					
Canary Islands late 1980's	Boat	<u>Resident populations:</u> *Globicephala macrorhynchus, Tursiops truncatus, Steno bredanensis, Physeter macrocephalus.* <u>Frequent:</u> *Stenella frontalis, Delphinus delphis, Stenella coeruleoalba, Balaenoptera edeni.* <u>Occasionally:</u> *B. physalus, Mesoplodon densirostris, Ziphius cavirostris.*	Yes	Regional regulation published in 1995 and updated in 2000. National Regulation published in 2008. Compulsory code of conduct.	Compulsory Environmental Impact Assessment to be provided by operators when applying for a whalewatching licence. Regulation includes a "mobile protection area," which extends 500m around a cetacean or group of cetaceans. "Blue boat" identification flag is mandatory for all licensed boats. Swim with cetaceans is forbidden. Mandatory presence of an officially entitled whale-watching guide during excursions. Operators collaborate with research projects.
Strait of Gibraltar 1986	Boat	*Globicephala melas, Tursiops truncatus, Physeter macrocephalus, Orcinus orca, Delphinus delphis, Stenella coeruleoalba*	Yes	National Regulation published in 2008. Compulsory code of conduct.	Operators often collaborate with researchers. Regulation includes a "mobile protection area," which extends 500m around a cetacean or group of cetaceans. Swim with cetaceans is forbidden. Due to the weather conditions in the Strait, any kind of recreational boat is forbidden in the whalewatching area.

Evidence of impacts of aircraft on cetaceans is largely anecdotal and mostly involves responses to aerial survey aircraft. A summary by Richardson *et al*. (1995) notes that some responses (e.g., changes in respiration frequency) are subtle and became apparent only after statistical analysis. Stronger responses have been observed in small groups or single individuals, in mothers with calves, in shallow waters and in situations where the initial observed behaviour was resting. In addition, a strong response has been observed when the aircraft flies at low altitudes. Würsig *et al.* (1998) noted that 'cryptic' species, such as beaked whales (*Ziphiidae*), and *Kogia* spp., showed a stronger response to the airplane than other species. Smaller delphinids also frequently changed their behaviour in response to aircraft. The authors noted that when the initial behaviours are 'milling' and 'resting,' animals appeared to be more sensitive to aircraft disturbance, although smaller delphinids were sensitive to disturbance while 'travelling'. Diving (especially in beaked whales and *Kogia* sp.) and horizontal displacement were common reactions.

Patenaude *et al*. (2002) assessed the short-term behavioural responses of migrating bowhead whales (*Balaena mysticetus*) and beluga whales (*Delphinapterus leucas*) to a Bell 212 helicopter and a Twin Otter fixed-wing airplane in the western Beaufort Sea). Fourteen percent of bowhead whales responded to the helicopter with abrupt dives, breaching, tail slapping, and changes in surfacing behaviour. In 38% of beluga whales, responses included immediate dives, changes in heading and behavioural state, or displacement. By contrast, only 2.2% of bowhead whales and 3.2% of beluga whales responded to the fixed wing airplane. These responses may correspond to higher levels, greater complexity, and/or greater variability of sounds from a passing helicopter as compared to a fixed-wing plane.

Richter *et al*. (2006) studied the reactions of male sperm whales off Kaikoura, New Zealand, to aerial whalewatching from fixed-wing planes and a Jet Ranger helicopter. Both resident and transient male sperm whales were present and the latter showed greater differences than resident animals in surfacing behaviour, surface time and time to first click (an indication of foraging behaviour) after a 'fluke-up' dive when exposed to aircraft.

Smultea *et al*. (2008) recorded reactions of sperm whales from small fixed-winged airplanes conducting surveys. A unique behavioural reaction by a group of 11 sperm whales was observed directly under the plane. The whales ceased their forward movement and positioned themselves closer to one another, forming a semi-circular 'fan' formation. The authors suggest this may be an anti-predator/distress response.

Throughout these studies little information was given of distances between aircraft and cetaceans, or sound levels in the water, making interpretation of impacts difficult. It was noted that reactions to aircraft noise may cause a bias in aerial survey data, which could lead to an underestimation of the population density (e.g. Würsig *et al.* 1998).

The sub-committee thanked Parsons for both comprehensive reviews and clarified that these reviews are not intended as critiques of methodologies or results but rather are to inform the sub-committee of new research results of interest. Some members of the sub-committee reiterated their concern about aerial whalewatching, particularly involving helicopters, and the potential disturbance to whales. Groch offered to review behavioural data from her research on southern right whales, collected from helicopters. The sub-committee welcomed this suggestion and agreed that she present her report at SC62. It was noted that other 'novel' platforms for whalewatching (i.e. jet skis, kayaks) exist and continue to be developed and little is known about potential impacts to the whales. The sub-committee recommended that a review of the nature and extent of aerial platforms be presented at SC62 and that such information could be stored in the on-line database for world-wide tracking of commercial whalewatching (item 8.1), once developed.

Paper SC/61/WW5 reports on the response of long-finned pilot whales (*Globicephala melas*) to whale-watching vessels in the Strait of Gibraltar. This response (approach, indifference or evasion) - be it initial or general - was statistically tested against different environmental variables using a cross-tabulation analysis. Results were statistically significant (p-value < 0.05) for presence/absence of calves, previous association with whale-watching vessels, group size and the coordination between whale-watching operators. The authors conclude that it is necessary to establish a carrying capacity for the number of whale-watching operators in the Strait of Gibraltar and to increase their collaboration to avoid disturbance. In addition, it is important that the code of conduct be enforced by a bilateral control body from Spain and Morocco, and that data collection is standardized among all the whale-watching companies in order to improve the compatibility between comparative studies.

In discussion of SC/61/WW5, some members of the sub-committee noted the problems with assigning orientation to the whale-watching platform without control data from an independent platform. Without such additional information there is no way to know what the pre-exposure behaviour was and it is difficult if not impossible to determine whether the behaviour during exposure was a response to the boat or a continuation of normal behaviour. Any conclusions of 'responses' drawn without proper controls must be treated with caution.

In this specific case, it also was noted that regardless of the caveats in determining response without control data, a very limited number of responses reported in the study were classified as 'evasive,' bringing into further question the potential biological consequences of the response. Some members noted the series of management recommendations with which the authors concluded their paper, and expressed concern that the data did not support the suggestions. Several others noted that nevertheless these recommendations remain relevant as a management tool under a precautionary approach until more rigorous studies are undertaken.

SC/61/WW6 describes the impact of unregulated whale-watching activities on a small endangered population of humpback whales breeding in New Caledonia. Between 2005 and 2007, land-based surveys were conducted to collect data on the behaviour of humpback whales in the presence and in the absence of boats using a theodolite. A multiple linear regression analysis was conducted on 184 tracking sessions and showed that whales significantly increase their dive time and decrease the linearity of their path when boats are present within 1000m of the animals. The effect on linearity increased with the number of boats. This short-term behavioural response could induce higher energetic costs and have longer term implications for this population. These results are likely to be linked to the high level of exposure of humpback whales to whale-watching activities in New Caledonia. Management measures implemented in 2008 are encouraging but further research will be required to know whether they have been effective in reducing any impacts. The conservation of the New Caledonian humpbacks on this breeding ground, now listed as world heritage site, remains a priority.

In discussion of SC/61/WW6, it was noted that although there were statistical differences in dive time and linearity of travel, effect sizes were relatively small (mean dive times increasing 24 seconds, or 15%, and linearity decreasing 5%), although it was also noted that this does not mean the effects are negligible for the animals. Further, if appropriate correction factors for multiple comparisons of the same datasets were applied (e.g., the Bonferroni correction factor) such comparisons may not remain statistically significant. The authors noted specific concern for mother-calf pairs; however, it appeared that only 20% of groups included a young calf. Despite these limited differences in the presence of whale-watching boats, impacts from underlying stress responses remain a concern. The sub-committee also encouraged researchers to report results in full, even when effects in such studies are found to be small or not statistically significant, in order to facilitate cross-study comparisons and meta-analyses.

Lusseau presented Baldock *et al.*(in review), which tested the mechanisms through which non-targeting vessel traffic - that is, vessels not seeking interactions with cetaceans - was influencing the foraging behaviour and habitat selection of bottlenose dolphins (*Tursiops truncatus*). Human activities can have non-lethal influences on wildlife not unlike predation. Animals will take into consideration perceived predation risk when selecting habitat to minimize mortality. Predators can also indirectly influence habitat selection by altering prey availability and catchability for their own prey items. Dolphins did spend less time foraging when boats were present; the more boats were present, the more likely dolphins were to be displaced at a short-time scale (minutes). However, boat presence did not influence dolphin occupancy at a longer time scale (hours). Under a 'disturbance-as-predation-risk' paradigm, changes were expected in effect size as individuals balanced the risk of predation with the benefits of occupying the foraging patch. The effect of boat presence did not change with variation in patch quality. These results were consistent with indirect influences of vessels on the behaviour of dolphin prey, with which dolphins appeared to be coping at this site. This study shows that it is important to consider alternative paradigms when studying the influence of disturbances on animal behaviour and that seemingly similar impacts can emerge from different processes.

SC/61/SM20 summarized information on the influence of whalewatching on a population of common dolphins (*Delphinus delphis*) in the Hauraki Gulf, New Zealand. This study showed that interactions with dolphin-watching vessels disrupted the foraging and resting behaviour of this population. These effects lead to a significantly altered behavioural budget and therefore raised concerns for potential long-term consequences.

SC61/E16 presented information on chronic stress in marine mammals. Anthropogenic disturbance, specifically underwater noise, has the potential to produce a prolonged stress response in marine mammals. Whalewatching actively targets marine mammals and this activity can in some areas be almost continuous. Cetaceans could begin to avoid certain areas if the disturbance reaches a certain threshold, but those that remain (perhaps the area is a vital habitat or an important feeding area) could be exposed to high levels of chronic stress, which could lead to increased energetic costs, a decline in health and an alteration of life history parameters (reduction in reproductive output). It should be emphasized that stress can affect the physiology of animals significantly without triggering obvious behavioural changes.

Due to the potential of stress critically altering life history parameters (e.g., disease susceptibility, reproductive rates, mortality rates), the authors of E16 suggest that the SC highlight the importance of the stress response and the impacts of chronic stress, in particular the problem of synergistic effects of multiple stressors (e.g., disturbance, pollution, prey depletion), on the demographics of cetacean populations. Although the importance of understanding stress responses in animals is recognized, the question of how to measure the impacts of chronic stress in cetaceans remains a challenge. This issue has also been discussed in the E Standing Working Group. The results of an outside workshop on chronic stress and cumulative impacts of multiple stressors will be presented next year and should be of interest to the sub-committee. The sub-committee noted the common interests and synergy between the E SWG and the WW sub-committee regarding the impacts of chronic noise.

SC/61/BRG27 details research on the distribution of gray whales within Laguna San Ignacio (LSI). The number of gray whales that utilize LSI, in the west coast of Baja California Peninsula during the winter breeding season has been monitored with standardised boat surveys since 1978 and represents the longest time series of winter breeding lagoon counts for this species. Counts from the most recent surveys (2007-2009) were compared with respect to the timing and duration of the occupation of the lagoon by gray whales. The distribution of gray whales within the lagoon during the winter was compared over three time periods: 1978-1982; 1996-2000; and 2006-2009. The percent of the total number of gray whales counted in the lagoon during the mid-February peak of the breeding season increased from 1978 to 2009 in the lower lagoon zone nearest the entrance and in the middle lagoon zones, while the percent of whales occupying the upper lagoon zone furthest from the entrance decreased during this period. This change in the distribution of the whales within the lagoon suggests that fewer whales are utilising the interior of the lagoon (closed to eco-tourism and whalewatching) and preferring the areas closer to the entrance to the open ocean (where whalewatching is permitted). Comparison of these trends with other breeding lagoons is needed to determine if these trends are representative of gray whales occupying the entire winter range or are unique to San Ignacio.

8. REVIEW REPORTS OF INTERSESSIONAL WORKING GROUPS

8.1 Compile information on whalewatching programs and associated data

SC/61/WW7 described the development of an on-line database for tracking whale-watching operations and associated data collection programs world-wide. The project is being implemented using a SQL database with a web interface for users. A suite of basic data will be requested on the details of the whale-watching operations, including: location and frequency of operations, species and frequency of encounter, number and type of vessels used. Basic information requested on associated data collection programs will include the span of research, the category of people responsible for data collection, species studied, types of data obtained and scientific products of the research. Individuals will have user accounts through which to enter data on their activities and to keep that information up-to-date. It is expected that data would be requested for research purposes through a formal data use agreement, and additional fields can be added to the database on demand to facilitate specific research. It is anticipated that this resource will facilitate studies of impact, as well as allow assessments of the scientific value of data collection programs.

The sub-committee thanked Robbins for her work and agreed that the on-line database would be extremely useful. In discussion, she clarified that initial development has focused on vessel-based whale-watching programs, but may expand to other types of operations. Similarly, the prototype web interface will be in English, but with programming to ultimately accommodate other languages. It is also conceivable that specific data may be shared directly at this site, in addition to user summaries of their effort and research.

Robbins commented that additional input would be helpful for ensuring that the database incorporates fields that will ultimately be useful for research. The sub-committee therefore recommended that an intersessional working group be established to assist in this task.

8.2 Further develop a questionnaire to assess the extent and potential impact of swim-with-whale operations

Rose stated that no new information was available for presentation to the sub-committee but that an update will be presented at SC/62.

9. OTHER ISSUES

9.1 Consider information from platforms of opportunity of potential value to the scientific committee

Weinrich presented SC/61/WW3. Data collected aboard whale-watching boats have been used in a variety of cetacean studies, including behavioural studies. While it has been hypothesized that behavioural data collected from a whale- watching vessel may be biased, this has not been tested. We used a dataset of 30-min focal samples on humpback whales on their feeding grounds in the southern Gulf of Maine collected from 1982 to 2007 to test whether data collected from a research vessel was comparable with that from a whale-watching boat. Standard residuals from X^2 tests were used to determine where differences existed within a data set of 2,608 focal samples collected from whale-watching boats and 657 samples from research vessels. Whale-watching boats were found to over-sample juveniles, solitary whales, and to have more samples of whales that engaged in aerial behaviours, deep feeding, and social behaviour/milling. Research vessel samples had proportionately more samples with adults, and logging/resting and travel-only behaviours. Combined, these results suggest that whale-watching boats were more likely to spend greater periods of time with younger whales that are more likely to be active. Some methods to compensate for this bias in behavioural studies, such as scan sampling of non-focal animals, were suggested. However, it was noted that some of these techniques may be looking at different hypotheses or questions. In general, this study points out some of the biases that may be inherent in data collected from whale-watching vessels, and emphasizes the need to compensate for such biases in study design and analysis. The sub-committee welcomed this study and noted its importance to many researchers who use whale-watching boats as platforms for their work.

Parsons presented Stockin *et al.* (2001), an analysis of North Atlantic minke whale surfacing data gathered from a whale-watching vessel as a platform of opportunity. The surfacing rates of North Atlantic minke whales are a major topic of discussion in RMP and Stockin *et al.* (2001) remains the most comprehensive peer-reviewed study on this issue. The study collected data over a three-year period in western Scotland in a habitat similar to that inhabited by minke whales off the coast of Iceland. Only dive sequences of greater than 30 minutes of single, identifiable whales, observed during ideal sighting conditions, were analysed, for a total of 1,367 dive sequences. Results showed significant daily and monthly changes in minke whale surfacing rates. Surfacing rates in this study were compared with other geographical locations and great variability was noted. As the data collected in this study was recorded by a predominantly immobile whale-watching vessel, there were no biases due to reactions to tag attachment or boat pursuit. The significant variability in minke whale surfacing behaviour noted in this study could affect the sightability of minke whales during sighting surveys. As minke whale surfacing rates vary significantly throughout the year, estimates based exclusively from surfacing data in only one season could substantially misrepresent actual minke whale population sizes.

Concern was expressed that there may be biases in the analyses if respiratory rates could only be obtained from solitary animals and not individual whales in an aggregation. In response, it was stated that measuring surfacing rates in a dense aggregation would be difficult as one could not guarantee the identity of surfacing individuals. However, in the study area, as in Iceland and other areas of interest to the work of the IWC, dense feeding aggregations that would cause such problems are rare.

Robbins commented on the applicability of SC/61/BC3 to the sub-committee. She stated that data relevant to assessing entanglement rates can and have been collected from whale-watching platforms. Oftentimes, it is these platforms that see and report entanglements, and in fact analyses of reporting reliability suggests that they are the most thorough and reliable sources of these reports.

9.2 Review of whale-watching guidelines and regulations

Carlson noted that the compendium of whale-watching guidelines and regulations around the world is in the process of being updated and will be available on the IWC's website in August.

SC/61/WW1 described two studies on whale-watching regulations and mitigation measures, including Duprey *et al.* (2008), that investigated the effectiveness of a voluntary 'rest period' introduced in 1999 to mitigate the impacts of whalewatching on a population of dusky dolphins in the waters off Kaikoura, New Zealand. There was a significant decrease in the number of vessels around the dolphins during the rest period (1.46 interactions/hour versus 2.63 interactions/hour), but this was due entirely to the compliance of one swim-with-dolphin company. When interactions from this company were excluded from analyses, there was no significant effect of the rest period on reducing dolphin/vessel interactions. The authors concluded that a lack of mandatory regulation and encouragement for compliance were responsible for this latter result. Tosi and Ferreira (2009) investigated the behaviour of the estuarine dolphin or costero, *Sotalia guianensis*, within a newly established marine reserve (Rio Grande do Norte, Brazil). Prior to their study, and before the establishment of a marine reserve in the area, Carrera (2004) reported that costeros significantly reduced their feeding behaviour in the presence of vessels. The new study found that from February to May breathing synchrony and social behaviour increased, and resting and feeding behaviour decreased in the presence of vessels. The level of change, however, was not statistically significant. The authors suggest that the differences documented in Carrera (2004) and the current study might be attributed to the creation of the marine reserve and restrictions on boat activity.

Bejder presented information from Higham and Bejder (2008) that reviewed a series of developments that evolved while stakeholders worked together to manage tourist interactions at Shark Bay, Western Australia. Bejder highlighted the positive outcomes that were achieved by designing a rigorous research methodology and publishing results, while working with managers and operators. Such an approach triggered the development of new management strategies that help promote sustainability of the local dolphin watching industry in Shark Bay.

Groch presented SC/61/WW9 on the development of whalewatching in Southern Brazil and conservation implications for southern right whales (*Eubalaena australis*). The southern Brazilian coast is an important wintering area for southern right whales. Most groups sighted in this region are mother-calf pairs with an increasing sighting frequency of social groups. In 1999, the regular presence of right whales along the southern coast of Santa Catarina State stimulated the development of a local whale-watching industry. The size and rapid growth of whalewatching world-wide as well as in Brazil have been motivating discussions regarding best practises in order to prevent impacts on cetacean populations.

Whalewatching in Brazil has been regulated since 1997 by Edict 117 that establishes several rules for boat approaches. In 2000, the right whales' main concentration area on the central-southern coast of Santa Catarina was protected by the establishment of the Right Whale Environmental Protection Area (EPA). Surface behavioural responses of right whales to boat approaches have been studied in the area and no clear evidence of immediate disturbance was detected in the preliminary analysis of data collected in 2002 and 2006. With the aim of determining general statistics for the whalewatching in the area, the EPA director has been requesting operators to provide a monthly summary on the area's cruises. The paper presented information gathered by the EPA from 2005 to 2008 as well as previous information collected by the Right Whale Project since 1999, with the aim of evaluating the development of the activity over the first 10 years of implementation, and the possible implications for the conservation of right whales.

At least 572 cruises were conducted in the Right Whale EPA, between July and November of 1999 to 2008 and this represents a 13-fold increase in the number of cruises over the period. Whale-watching observations were conducted in 18 bays along 50km of coast in the northern section of the EPA. Half of the total number of the encounters occurred in Ribanceira/Ibiraquera bay. By comparing the number of whales sighted during aerial surveys conducted at the peak of the breeding season, it was determined that the number of whale-watching cruises has been increasing in Ribanceira/Ibiraquera bay at the same proportion as the number of whales sighted in this bay during aerial surveys in all years but 2008, when the number of whale-watching cruises was five times higher.

The resighting of some females in the area indicates that at least some individuals return regularly to this nursing area, with a three year calving interval. Hence, it is likely that some individuals have been exposed to boat approaches repeatedly over the decade.

According to data presented in this paper, whalewatching in Santa Catarina has been targeting mother/calf pairs and most whale-watching cruises have been concentrated in one bay. Mother/calf pairs can spend up to 2 months in the region, and some individuals have been observed staying in the same bay for weeks. The time mother/calf pairs spend on the nursery ground is undoubtedly of great importance for calf growth and development. In this period, females probably do not feed and channel most of their energy into nursing and taking care of their calves.

In 2006, area closures in the Right Whale EPA were adopted and enforced, where no whale-watching cruises will occur. Two of the area closures are located in adjacent bays to Ribanceira/Ibiraquera, which may serve as a refuge for right whales targeted by whalewatching in that bay.

The information collected by the EPA director, in addition to long-term monitoring of this right whale population, is a valuable tool for the development of appropriate management of whalewatching in this area. It is hoped that the design and implementation of adequate management measures will ensure both the species' survival and the sustainability of the whale-watching industry.

The sub-committee welcomed Groch's report as well as the progress made in the development of management measures for protecting right whales in this important breeding area. They agreed that the information was of great value and recommended that right whale research in this area, including the monitoring of whalewatching and its potential impacts, be continued to ensure a lack of disruption in a valuable long-term database.

SC/61/WW10 described the process by which six new licences were given to whalewatching companies at Península Valdés, Argentina in 2009, and reports the progress made by the Provincial Government of Chubut and several local institutions and organizations that worked together to improve whale-watching regulations. The paper provides a summarized sequence of the main events related to the local whale-watching industry from its beginning in 1971 that led to the present granting of the new licences.

Whalewatching has become the main tourist attraction in coastal Patagonia, with a peak of 113,148 passengers in 2007. Six permits for the Nautical Transportation of Passengers for Whalewatching were granted on April 15 2009 by Provincial Decree 408/09 for the period 2009-2018. Each contract is specific for each company, according to the six proposals submitted. It is important to emphasize that the six companies are local: five of them were permittees from previous periods and one new company will begin operations in this period.

In 2006, the Provincial Secretary of Tourism organized monthly workshops that created a forum for open discussions where whale-watching company owners and captains, government officials, NGOs, wildlife managers, lawyers and whale scientists voiced their opinion and worked cooperatively on the text for a new whale-watching law. The new Provincial Law 5714 for the conservation of the southern right whale and the regulation of whalewatching was passed on December 21, 2007 and enacted on January 17 2008. Provincial Decree 167/08 was approved on February 29 2008. This Decree approves the 'Patagonian Technique for Whale Watching' and a 'Code of Conduct for Whale Watching'. These Annexes describe the manoeuvres that are forbidden, provide several time, speed, distance and age class restrictions when approaching the whales, determine the area boundaries for commercial whalewatching off Puerto Pirámide, and describe the rules that are aimed at making the experience safe, educational and pleasant to the visitor. The content of the Annexes built mostly on the experience from whale-watching company owners and captains and their daily experience with the whales with input from other stakeholders.

In discussion, questions about the new regulations were clarified. While the licensing program did not reduce the number of boats, the mandated maximum trip length (75 min) and minimum period between cruises (30 min) were designed to reduce exposure to the whales. While mother-calf pairs could not be approached until September, the presence of other classes of whales until that month makes the regulation realistic. This age class restriction was welcomed by the sub-committee. Finally, compliance and enforcement will come from funded officials, while independent researchers from a local NGO (Fundacion Patagonia Natural), working from cliffs, will continue to collect data on the movements of boats around whales and the animals' responses.

The sub-committee welcomed these new regulations, and commended the collaborative approach and joint work accomplished by the Provincial Government of Chubut in cooperation with all stakeholders to grant new whale-watching licences and improve regulations at Peninsula Valdés.

Galletti reported that in 2008, the Law for the Protection of Cetaceans (Law 20.293) was adopted in Chile. The law permanently bans any type of whaling operations on large and small cetaceans and includes several conservation measures for these marine mammals. One of these measures (Article 6) provides the framework to develop whale-watching regulations as well as rules for the observation of other marine species such as sea lions, marine otters, penguins and marine turtles. Any harassment that alters the behaviour of animals or forces physical contact with an animal causing stress and/or physical damage is forbidden. These regulations will be applied to all activities (commercial and recreational) and to all platforms (marine and aerial) that includes observation of cetaceans.

In 2009, the Under-Secretariat of Fisheries established an advisory committee of national authorities as well as non-governmental organisations, to discuss the development of whale-watching regulations. The process seeks to implement a general regulation for whalewatching by the end of 2009 and move towards the development of specific regulations for species already subject to whalewatching (humpback whale and bottlenose dolphin), critically endangered (southern right whale of Chile) and other species that are likely to be the subject of whalewatching in the near future. In addition, the Chilean Economic Development Agency (CORFO) provided funds to conduct two studies seeking to develop an agenda of actions that can be implemented to promote and consolidate high-quality whalewatching in two major areas of the country: Southern/Austral Chile (from Chiloe to Magallanes) and northern Chile (Arica and Punta de Choros-Chanharal). In addition, Centro de Conservacion Cetacea (CCC), a Chilean NGO, conducted an international seminar in 2009 on responsible whalewatching in a joint initiative of the CCC's blue whale project and CORFO. National authorities and international experts, the IWC Commissioner from Brazil, local tourist operators, artisanal fishermen and NGOs actively participated in the seminar. Main outcomes included an action plan, agreed by all participants, with general guidelines to implement the law for the protection of cetaceans as well as to move towards the development of high-quality, community-based whalewatching.

SC/61/WW12 was submitted but not presented. There was no discussion of this paper in the sub-committee.

9.3 Review of risk to cetaceans from collisions with whale-watching vessels

Ritter introduced SC/61/BC1, a summary of collisions of sailing vessels with cetaceans world-wide. Results of the survey indicate that such collisions appear to be increasing with sometimes detrimental outcomes, including severe injuries and mortalities to whales as well as risks to humans. None of the collisions involved whale-watching vessels; however, as a number of whale-watching operations use sailing vessels as platforms, it is important that the sub-committee be aware of this ongoing monitoring effort.

Mattila reported that there were a number of vessel collisions with whales off Hawaii this year, similar in number to previous reports from recent years, and that these were reported in SC/61/ProgRep USA. The types of vessels and classes of whales were also similar to past reports, with some of these collisions with whale-watching vessels, with varying degrees of severity.

The sub-committee was made aware of the on-going efforts in the working group on estimation of by-catch and other human-induced mortality to establish a world-wide database of vessel-whale collisions of all types. The information collected in that database should help discussions on this agenda item in future years, and help clarify the numbers and severity of the whale-watching strikes, especially in relation to other vessel classes.

10. WORK PLAN

The work plan prioritised major items as listed below.

(1) Review whalewatching off Africa.

(2) Assess the impacts of whalewatching on cetaceans (methods and results of changes in behaviour and movement patterns; methods and results of physiological changes to individuals; and methods and results of demographic and distributional changes).

In addition, the following items were recommended for the next meeting.

(3) Review reports from Intersessional Working Groups: (i) large-scale whalewatching experiment (LaWE) (intersessional steering group); (ii) LaWE Advisory Group (intersessional advisory group); (iii) on-line data base for world-wide tracking of commercial whalewatching and associated data collection; and (iv) further develop a questionnaire to assess the extent and potential impact of swim-with-whale operations; and to identify local researchers to distribute questionnaires to operators.

(4) Evaluate data from platforms of opportunity.

(5) Review of whale-watching guidelines and regulations.

(6) Review of risks to cetaceans from whale-watching vessel collisions.

The sub-committee discussed the work plan and set priorities for next year as listed. Terms of reference and members of the intersessional working groups as agreed by the sub-committee are listed in Table 2.

11. ADOPTION OF THE REPORT

The report was adopted at 17:38 on 7 June 2009. The sub-committee thanked Kato for his wise guidance during the discussions and thanked Carlson and Rose (and other sub-committee members) for their efficient rapporteuring.

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Table 2

Intersessional working groups and related information

Group	Terms of reference	Membership
Large-scale whalewatching experiment (Intersessional steering group)	Develop the mechanisms through which LaWE can be implemented, including rationale for the selection of procedures, Initiate data collation and perform meta-analysis to assess sample sizes required to detect a plausible range of effect sizes and discuss the possibility to use existing IWC procedures to archive and access data of relevance to LaWE.	Bejder (Convenor), Bjorge, Hammond, Lusseau, Underwood, Weinrich, Williams
LaWE Advisory Group (Intersessional advisory group)	Facilitate communication between the IWC SC WW Sub-Committee and the LaWE steering group and provide advice from regional and species experts.	Rose (convenor), Bolanos, Carlson, Fortuna, Galletti, Groch, Iniguez, Mattila, Parsons, Prieto, Robins, Schaffar, Sequeira, Silva, Simmonds, M., Sironi, Urban, Vely, Williams
On-line data base for world-wide tracking of commercial whalewatching and associated data collection	Advise on the design of a database of whalewatching activities and associated data.	Robbins (Convenor) Bejder, Carlson, Lusseau, Simmonds, J., Weinrich, Williams, R.
Swim-with operations (Working group)	Further develop a questionnaire to assess the extent and potential impact of swim-with-whale operations	Rose (Convenor) Parsons, Ritter, Sironi, Weinrich

Appendix 1

AGENDA

1. Opening Remarks
2. Election of Chair and Rapporteurs
3. Adoption of Agenda
4. Review of available documents and information
5. Discuss the proposal for a large-scale whalewatching experiment (LaWE; including reports from the Intersessional steering group and the advisory group)
6. Review whale watching in Portugal (including Azores and Madeira), Canary Islands and Strait of Gibraltar
7. Assess the impact of whalewatching on cetaceans
8. Review of intersessional working group
    8.1 Compendium of whalewatching site and associated information (Convenor, Robbins)
    8.2 Swim-with whale operation (Convenor, Rose)
9. Other issues
    9.1 Consider information from platforms of opportunity of potential value to the Scientific Committee
    9.2 Review of whalewatching guidelines and regulations
    9.3 Review risks to cetaceans from collisions with whalewatching vessels
10. Work plan.
11. Other matters
12. Adoption of the report

Appendix 2

ADDENDUM TO THE BUNBURY REPORT (SC/60/REP6)
INTERSESSIONAL LAWE STEERING GROUP AND LAWE ADVISORY GROUP

Preamble

The report from the Bunbury workshop entitled 'Report of the Intersessional Workshop to Plan a Large-Scale Whalewatching Experiment' (SC/60/Rep6) and recent literature (e.g., Beale and Monaghan 2004; Bejder *et al*., in press) highlight the technical challenges in interpreting the consequences of short term responses to disturbance, linking short-term responses to population level effects, and teasing apart ecological and human induced effects. For example, Gill *et al*. (2001, p.266) encapsulated the complexity of behaviour that studies of wildlife responses to human disturbance would need to explain: the decision of whether or not to move away from disturbed areas will be determined by factors such as the quality of the site currently being occupied, the distance to and quality of other suitable habitats, the relative risk of predation or density of competitors in different sites, and the investment that an individual has made in a site (for example, in establishing a territory, gaining dominance status or acquiring information).

Here, we aim to understand the effects of whalewatching on the demographic parameters of cetacean populations. The first aim is to demonstrate a causal relationship between whale watch exposure and the survival and vital rates of exposed individuals. The second aim is to understand the mechanisms involved in this causal effect, if they exist, in order to define a framework to manage it (PCAD approach, NRC 2005). There are two possible approaches to this project: to meet the aim sequentially or concurrently. Determining whether there is an influence of whalewatching on demographic parameters will be a lengthy process. Taking heed of the precautionary principle, a concurrent approach is preferable.

Objectives

To meet these aims the Bunbury report identified the following objectives for the LaWE project initiative.

1. Determine whether the vital rate effects described in recent studies can be observed in other situations.
2. Determine how exposure to whalewatching affects the ecology, behaviour and/or physiology of cetaceans
3. Conduct short-term studies to inform the likelihood of long-term population impacts.
4. Assess temporal variation of individual responses to disturbance (habituation and sensitisation).
5. Develop a modelling framework to explore potential population consequences of changes in life history parameters given observed effects and effect sizes and use additional dataset to test model predictions.
6. Determine the effectiveness of mitigation measures employed to reduce the effects of whalewatching.
7. Develop a management framework for whalewatching that accounts for uncertainties, and includes monitoring and feedback mechanisms.

Research design

At the Bunbury workshop, two different aims were identified that will require different study design approaches. For the first aim, i.e. demonstrate a causal relationship between whale-watching exposure and the survival and vital rates of exposed individuals, it is not feasible to account for all potential factors that can affect demographic processes. In order to disentangle the effects of whalewatching from other contributing factors we need to sample. We propose to use a block design to account for environmental and biological variability. This will be achieved by using a nested design, with control and whale-watching replicates within species, between ecological conditions, and between species with different life history strategies. A nested block design will allow accounting for inherent variability by using replicate control and impact sites.

It emerged that principally, four categories of cetaceans are targeted by whalewatching:

- Resident populations where breeding, nursing, and feeding occur in the same area
- Cetaceans on their breeding grounds
- Cetaceans on their feeding grounds
- Cetaceans on their migratory corridors

This design will meet the first aim of the study: to quantify the effect of whalewatching exposure to demographic processes in cetaceans given the contribution of other factors.

If a causal effect is detected, the second aim, i.e. to understand the mechanisms involved in this causal effect, will be achieved using short-term control exposure experiments. The interpretation of the results of these experiments will be context-specific, e.g. depending on habitat quality or physiological status. It is not feasible to measure all covariates that can influence these results. Therefore within- and between- species site replications and nested block design will also be essential.

To complete the research design, power analyses will be required to determine the number of replicates for each aim. Those will have to be informed by pilot studies based either on pre-existing data or newly collected data when the former does not exist. It is worth noting that much information is already available but inaccessible for such an exercise.

Variables

The suite of variables that will be collected will vary for each of the two aims: (1) the block design dedicated to determining whether there are demographic-level effects from whale-watching exposure; and (2) the component through which the mechanisms for such effects, if they exist, can be understood.

The first aim will rely on comparing levels of exposure to whalewatching, and measures of a variety of demographic parameters. Such data will include:

1. Vital rate and survival information, e.g. maturation, reproductive, and survival parameters, obtained through mark-recapture studies using photo-identification and other non-invasive techniques.
2. Range and spatial use information using photo-identification and passive acoustic techniques.
3. The quantity and rate of exposure to the number and type of whalewatching boats.

While not mandatory for such studies, appropriate data on a suite of other factors which could affect demographic processes are strongly encouraged as covariates. These could include data on prey availability, oceanographic parameters and ambient noise.

The second aim, the determination of the mechanism through which whale-watching responses take place involves collection of more immediate, short-term response data. These data would include:

1. Activity budgets, movement patterns, and habitat use by sampling the movement of individuals (theodolite and tags, including diving information).
2. Data on social patterns.
3. The physiological status of individuals using metabolic indices, body condition indices, and (where possible) stress hormone levels.
4. Characteristics of whale-watching interactions including characteristics of boat approaches (e.g. speed, approach distances and directions) and acoustic properties of the vessel presence (e.g. received sound levels).

Hypotheses and Work Plan

Objective 1. Determine whether the vital rate effects described in existing studies can be observed in other situations.

- *Hypothesis 1.1* There is a relationship between cumulative exposure to whale-watching interactions and the vital rates of individual cetaceans.
- *Hypothesis 1.2* For species that segregate their life history into different geographic locations, exposure in one of the locations can be sufficient to cause an effect in vital rates.

Objective 2. Determine how exposure to whalewatching affects the ecology, behaviour and/or physiology of cetaceans.

In order to determine the mechanism through which whale-watching interactions elicit a response from target animals, it is necessary to tease apart a number of potential pathways. While these hypotheses are not necessarily mutually exclusive, testing these will lead to an understanding of the way in which an animal perceives a whale-watching vessel to lead to short-term responses and, ultimately, vital-rate responses if they in fact exist.

- *Hypothesis 2.1* Interactions with whale-watching boats elicit behavioural responses that are analogous to responses to predation risk.
- *Hypothesis 2.2* Whale-watching boats impact cetaceans through trait-mediated indirect effects where the animals are forced to modify their behaviour because of environmental disturbance (e.g. by the boat influencing prey behaviour).
- *Hypothesis 2.3* Whale-watching boats affect cetaceans by obstructing their behaviour (e.g. the boat acting as a physical barrier or acoustic masking).
- *Hypothesis 2.4* The levels of stress hormones (e.g. corticosteroids) of individuals are related to their exposure to whalewatching interactions.

Objective 3. Conduct short-term studies to inform the likelihood of long-term population impacts.

This objective represents a work plan that follows on the hypotheses framed under objective 2. We anticipate that these studies will involve a series of controlled exposure experiments within and beyond the LaWE experimental sites using a pre-determined list of variables (see Variables section).

Objective 4. Assess temporal variation of individual responses to disturbance (habituation and sensitisation).

- *Hypothesis 4.1* The magnitude of an individual's response is temporally dependent on exposure to a controlled stimulus (Figure 1).
- *Hypothesis 4.2* If 4.1 is true, the rate of habituation or sensitisation will be dependent upon the exposure history in relation to the onset of the impact assessment.

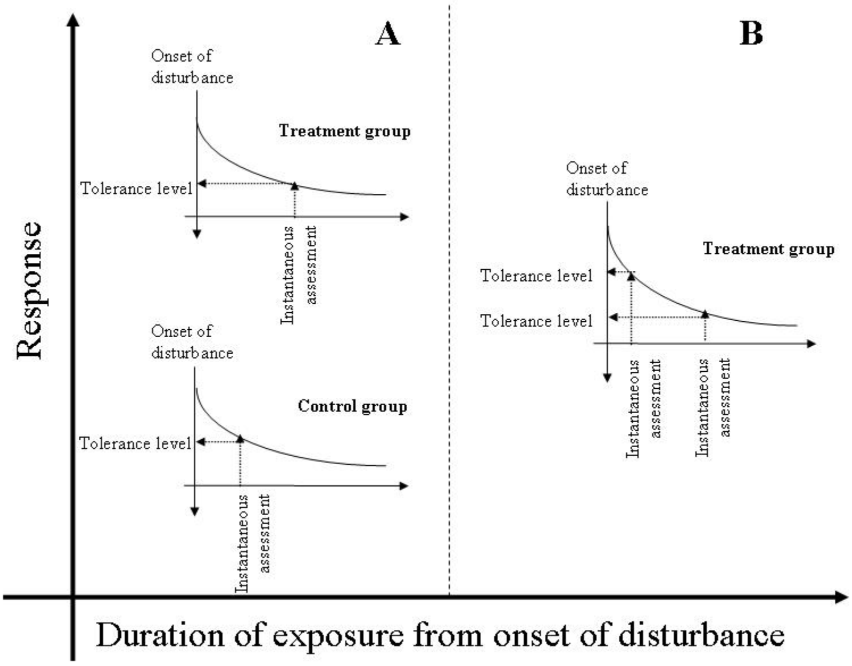

Figure 1. Examples depicting two study designs typically used for assessment of anthropogenic impact in a case where individuals are habituating. Time zero represents the time of onset of the disturbance factor and, hence, the x-axis denotes different exposure histories, and the y-axis represents corresponding levels of response to the stimulus. Figure 1A depicts an instantaneous comparison at one point in time of responses between 'treatment' and 'control' groups that have different durations of exposure. Figure 1B depicts a sequential comparison at two points in time of responses measured within one community at different exposure levels. Note direction of y-axis in small insert figures: tolerance levels increase as response levels decrease (large y-axis). Figure taken from Bejder *et al*. (in press).

Objective 5. Develop a modelling framework to explore potential population consequences of changes in life history parameters given observed effects and effect sizes and use additional datasets to test model predictions.

Individual-based models will be used to inform the mechanistic relationships between whale-watching exposure and individual vital rates and survival probability. Once these relationships have been established, it is straightforward to model the effect of altered demographic processes from exposure on population dynamics. There will be several aims to these simulations:

- Identify possible pathways that can lead exposed individuals to have significantly altered vital rates or survival probability.
- Inform study design by highlighting the minimum set of variables required to achieve project aim 2.
- Inform study design in two ways. First, by defining the sensitivity of demographic parameters to uncertainty in parameter estimates (i.e., identifying the most cost-effective variables to measure). Second, by estimating variance of parameters and hence informing sample size (i.e., the number of sites and replicates needed to detect a plausible effect size).
- These models will offer a mechanism through which we will then be able to run simulations to inform on the potential outcomes of different management actions (objective 7).

Objective 6. Determine the effectiveness of mitigation measures employed to reduce the effects of whalewatching.

While everything to this point has focussed on the perception of and response by the animal to whale-watching interactions, we view this objective as the first that addresses the behaviour of the vessel itself. The objective contains two distinct components: (a) understanding the precise stimulus (i.e. the component(s) of the whale-watching interaction) that elicit responses from the animal and (b) the effectiveness of mitigation measures that reduce exposure to those areas identified in (a).

Regarding mitigation measures, SC/60/Rep6, the Bunbury report, stated:

> 'The Workshop also recognised that advice may be welcome from IWC member states on measures to mitigate any impact of whale-watching activities whether or not there are population level effects. Management objectives may be precautionary and be aimed at individual effects. In this context, research to understand better the mechanisms that result in shorter term or individual effects is essential to inform the most appropriate management action (IWC 2009, p. 495).'

Therefore, the following hypotheses should be tested:

- *Hypothesis 6.1* The effect size of a response is the same regardless of the characteristics of the whale-watching interaction.
- *Hypothesis 6.2* If hypothesis 6.1 is refuted, the effect size of the response is dependent upon one or more specific properties of the interaction (e.g. acoustic exposure, proximity of the vessel, speed of approach).
- *Hypothesis 6.3* A reduction of the exposure to significant characteristics of the whale-watching interactions will significantly reduce effect size.

In considering a reduction of effect size, the concept of bio-equivalence offered a useful way forward to provide a framework in which to develop measures of recovery and test for changes that can show such recovery. Therefore, it was agreed that the research design should account for the possibility to test the efficacy of these mitigation measures. Such measures should rest on the precautionary principle.

Objective 7. Develop a management framework for whalewatching that accounts for uncertainties, and includes monitoring and feedback mechanisms.

Such framework would be based on an integrated and adaptive management model based largely upon the delineation and monitoring of limits of acceptable change (LAC) parameters (Higham *et al*. 2008). The proposed management model would highlight the importance of integrating multiple stakeholder perspectives in a way that is both research-informed and adaptive. The International Whaling Commission Scientific Committee has much experience in such frameworks through its work on the Revised Management Procedure. If needed, can we implement a RMP-like procedure for whalewatching?

- Once the models developed in objective 5 are informed by results from the empirical studies (including those from objective 3), we can use simulation to inform the potential outcome of different management actions in various situations.

Actions arising

1. LaWE steering group to develop procedural mechanisms for the LaWE project

> The LaWE steering group will meet intersessionally to develop a report presenting the mechanisms through which LaWE can be implemented, including rationale for the selection of procedures. This includes defining procedures to coordinate research efforts at all sites, ensure and control for data quality, communicate between the modelling and empirical components of the project, and archive and access data. Subsequently, the framework will be presented to SC62.

2. Initiate power analyses to further develop and refine methodology

> Obtain and perform meta-analysis on existing raw data to estimate the variance of the key variables and carry out assessments of sample sizes required to detect a plausible range of effect sizes. Present to SC62.

3. Receive advice from the LaWE advisory group on appropriate sites and species.

> The LaWE advisory group will work intersessionally to provide a preliminary list of potential species and sites for inclusion in the LaWE, including background summaries on pre-existing information about the specific populations under consideration and characteristics of the whalewatching industry at each site, and present to SC62.
>
> The advisory group should identify species/populations/sites for the four categories highlighted above, including a restricted number of species for whichever sites are available across a variety of ecological conditions, including both odontocetes and mysticetes. Other sites should also be selected to represent a variety of life history strategies. There should be no restrictions at selected sites to collect variables highlighted above. For pre-existing sites, QA/QC procedures should be in place to ensure quality of pre-existing data. For short-term studies (objectives 2, 3 and 6), the advisory group should identify species and sites where controlled exposure to boat interactions will be possible. Sites will need the possibility to include control replicates (locations where whalewatching does not exist or can be excluded) can be designated.

4. Develop an IWC-centralised data collection and QA/QC procedure for pre-existing and new data to inform Objective 3 and power analyses.

> Discuss the possibility to use existing IWC procedures to archive and access data of relevance to LaWE (variables for aim 2). Discuss anticipated needs to meet this demand (including estimate for equipment and staff time). Present to SC62.

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