

SC/67b/RP15

CMP - A qualitative assessment of threats to Arabian Sea humpback whales using existing photographic and UAV data



INTERNATIONAL
WHALING COMMISSION



PROJECT PROPOSAL REQUEST

1. PROPOSAL TITLE

Please provide the title of the project or the name of the workshop/meeting.

A quantitative assessment of threats to Arabian Sea Humpback Whales using existing photographic and UAV data

2. BRIEF OVERVIEW OF THE PROPOSAL AND ITS EXPECTED OUTCOME

Give a very brief overview (max 150 words) on your proposal and its expected outcomes. Use bullet point to list outcomes. Be succinct and clear as this may be used to summarise your project for the report.

The project will assess the prevalence of anthropogenic and natural threats in Arabian Sea humpback whales through a robust and quantitative assessment of available photographic data. These data include the entire Oman photo-ID catalogue, imagery recently acquired using UAVs (drones) and images provided by third parties. The latter include several images from elsewhere in the populations range. The project will provide an assessment of the relative prevalence of a suite of indices typically associated with major threats (fisheries entanglements, ship-strikes, other scars) as well as scars associated with natural sources (barnacles, cyamids, Penella sp., killer whales). Project outcomes will include assessment of the risks posed by each threat, as well as the development of a set of metrics with which further changes can be monitored. Project results will be reported to the IWC SC in 2019 and will contribute to the development of a draft Conservation Management Plan for this population.

3. RELEVANT IWC SCIENTIFIC COMMITTEE GROUPS OR SUB-GROUPS

List all the IWC Scientific Committee groups or sub-groups that the outcomes of this work would be relevant to and provide a brief (1-2 lines) explanation of how it would contribute more widely to their ongoing programmes of work. Where possible, do not simply list only the sub-committee within which or for which the project proposal was generated.

CMP

HIM

E

Bycatch working group

4. TYPE OF PROJECT (PLEASE TICK)

Research project	✓
------------------	---

Modelling	
Workshop/meeting	
Database creation/maintenance	
Compilation work/editing (e.g. on whalewatching regulations, SOCER, etc.)	
Other (please specify below)	

5. BRIEF DESCRIPTION OF THE PROPOSAL AND ITS CONNECTION WITH SCIENTIFIC COMMITTEE RECOMMENDATIONS (DO NOT EXCEED 1500 WORDS)

(A) BACKGROUND, RATIONALE, AND RELEVANCE TO THE PRIORITIES IDENTIFIED BY THE IWC SCIENTIFIC COMMITTEE:

Provide a clear explanation of the background and rationale for the proposal and its relevance to Scientific Committee identified priorities. Clearly identify the most relevant and recent Scientific Committee recommendations.

The Endangered Arabian Sea humpback whale (ASHW) subpopulation occurs in the Arabian Sea throughout the year. The population is small (Minton et al. 2011) and reproductively isolated (Pomilla *et al.*, 2014). The population has been the subject of a standing agenda item and numerous recommendations for research and conservation actions in the IWC's Scientific Committee since 2010. These recommendations include the formation of a Conservation Management Plan for the population (e.g. IWC, 2016).

Thirteen of 14 satellite tagged individuals in Oman remained off the coast of the Arabian Peninsula for the duration of their tag-lives, suggesting that they are typically local in their distributions. However, recent data suggest a capacity for broader movement and highlight the vulnerability of these whales to a suite of anthropogenic activities across the range (Willson et al. 2018 SC/67B/CMP13 Rev1). Known and suspected threats include expanding fisheries, habitat degradation, vessel traffic and offshore oil and gas activities (Baldwin, Willson and Collins, 2015). The impact of a tattoo-like skin disease remain uncertain but a study of photos collected off Oman through 2011 found that prevalence reached 21.7% in the 60 whales examined (Van Bresseem *et al.*, 2014). In other species tattoo skin disease (TSD) has been associated with environmental stressors, and may an indicator of overall population health for cetaceans (Van Bresseem *et al.*, 2009).

It has been suggested that the ASHW restricted northern Indian Ocean range and adherence to a northern hemisphere breeding cycle may render the population particularly vulnerable to climate change although the potential effects remain uncertain (Thomas, Reeves and Brownell, 2015).

An earlier assessment of ASHW photographic data collected off the coast of Oman up to 2004 found that 30-40% of examined individuals bore scars consistent with fisheries interactions (Minton et al. 2011). Information presented in recent years suggests that environmental and anthropogenic pressures on the Arabian Sea humpback whale population have increased over time ([Baldwin, Willson and Collins, 2015](#)). A large volume of photographic data for ASHW has been collected between 2010 and 2017, providing an opportunity to update previous studies documenting evidence of pathology and anthropogenic scarring as well as to conduct other analyses that would provide key indicators of population health indices and exposure to known and suspected threats.

(B) SPECIFIC OBJECTIVES OR TOR AND DELIVERABLES/OUTCOMES:

Provide the specific objectives and the expected deliverables. In the case of workshops and meetings, include the Terms of Reference (ToR) and expected outcomes.

Specific Objectives of this project include the re-assessment of all available photographic and video data from the Arabian Sea humpback whale population for the following:

- Evidence of interactions with fishing gear
- Evidence of vessel/ship strikes
- Other scars that may have an anthropogenic origin
- Scarring linked to natural predation (killer whales, sharks, cookie-cutter sharks etc)
- Prevalence and epidemiology of tattoo-like skin disease
- Other ectoparasites (e.g. barnacles, whale lice, Pennella sp.)

Indices of anthropogenic threats

Analysis using previously established methods to quantify rates of scarring indicative of fisheries interactions, ship strikes or other anthropogenic interactions will be completed. These will allow for a revised and updated estimate of the prevalence and severity of these threats among Arabian Sea humpback whales, as well as a means to detect any changes in rates of prevalence since previous studies were conducted.

Tattoo-like skin disease

Diseases are important factors in the decline of endangered species (Smith, Acevedo-Whitehouse, & Pedersen, 2009) and TSD-like may be a potential indicator of ASHW population health, including the potential for reduced immune response (Van Bressemer et al., 2009; 2014). For this project we will update and expand on a 2014 study of the characteristics and epidemiology of a TSD-like condition in ASHW using images recorded between 2000 and 2018 in Omani waters (see Van Bressemer et al. 2014).

A recommendation was made by the E subcommittee in reference to the recent UAV work in Oman to conduct a cross validation exercise that uses both vessel based photos and those obtained by UAV in order to allow monitoring of possible changes in prevalence of TSD-like disease over time.

Indices of external parasites and scars of natural origin

Previous studies have found low incidence of cookie-cutter shark and killer whale scarring in ASHW in comparison to other populations (Mikhalev, 1997; Mikhalev, 2000; Mehta *et al.*, 2007), and unpublished observations indicate that barnacle scarring is also lower in ASHW than other Indian Ocean populations (G. Minton pers obs.), but this has never been quantified.

The proposed health assessments are considered to be very important for the development of a quantifiable health assessment for this population. The need for a health assessment is outlined in the CMS concerted action plan, but currently no funds have been allocated or identified to support the work. There is also a strong desire to establish a baseline of suitable metrics for future monitoring of the population's health over time. Although funding for fieldwork in the ASHW range is currently very limited, implementing a field based health assessment critical is considered critical.

Deliverables

The study will result in at least two peer-reviewed publications, and will inform Conservation needs in Oman and other parts of the ASHW.

(C) METHODOLOGICAL APPROACH/WORK PLAN/ADMINISTRATIVE DETAILS

Specify the methods to be applied (novel methods require more explanation than standard ones) and the broad workplan – the detailed timetable appears under Item 5 below.

In the case of workshops and meetings, include the broad work plan including any pre-requisites for the workshop/meeting to take place (apart from funding, e.g. completed analyses, papers etc.) and administrative details (e.g. location, dates, number of participants).

Dataset

No new fieldwork will be conducted for this project. Analyses will focus on images taken for Photo-Identification (Photo-ID) purposes during dedicated surveys, images recorded during exploratory UAV work in 2017 and additional images recorded by third parties in Oman and elsewhere in the range.

Photo-ID data were collected using standard procedures during small-boat surveys completed in Oman in the Gulf of Masirah and Dhofar between 2000-2006 and 2010-2017. These images were used to resolve a catalogue of individual sighting histories by using the distinctive pigmentation pattern and scarring marks on the underside of their flukes, as well as the left and right sides of the dorsal fin (Katona & Whitehead, 1981). The sex of whales in the catalogue was determined through observations of singers (only males), the presence of a calf (typically associated by the mother) or genetic sampling (Palsboll, Vader, Bakke, & El-Gewely, 1992; Rosenbaum *et al.*, 2009; Minton *et al.*, 2011). Whales estimated to measure 11 meters and over are considered adults.

UAV images were collected with a custom unoccupied hexacopter (APH-22; Aerial Imaging Solutions) during survey work in 2017. The UAV was used to collect high-resolution aerial photographs of surfacing ASHWs from directly overhead. A laser

altimeter was used to estimate altitude and include data suitable for estimating body size parameters (i.e., girth measured at 60% of total body length, relative to length) indicative of body condition. UAV images provide a radically different perspective from that acquired from vessels, and may facilitate improved estimation of the prevalence of particular conditions, including the TSD-like condition, as well as a means to quantify the prevalence, extent and putative origin of scars.

Several images of humpback whales have been provided to the Oman team from other areas of the populations range. These include Pakistan, Iran and India. These images will be assessed by the PI's, and will be incorporated into the analysis if they are of suitable quality.

Analyses of anthropogenic threats

Images will be examined for evidence of entanglement scarring using the systematic assessment and scoring system developed by Robbins et al. (Robbins and Mattila, 2000; Robbins, 2012) and used in previous assessments of the ASHW catalogue (Minton et al. 2011) in order to allow detection of potential changes in the prevalence of entanglement scarring in the population over time. Photos of all available body areas will be examined, with an emphasis on photos showing the caudal peduncle, the area determined to most consistently retain and reveal evidence of fisheries gear interactions (Robbins and Mattila, 2000; Robbins, 2012). Photos will also be examined for other sources of anthropogenic scarring including ship strikes (Van Waerebeek et al. 2007) or following other established methods (e.g. Bradford et al. 2009).

Analyses of ectoparasites and scars of natural origin

Systematic scoring systems, similar to those used to evaluate entanglement scarring will be applied in order to allow quantification and classification of the likely origin and prevalence of external parasites, including barnacles, barnacle scarring, *Penella* sp. and cyamids, as well as scarring caused by cookie cutter sharks or predators such as killer whales. Photos of all visible body parts will be examined but one chosen body part (most likely the tail fluke) will be chosen to standardize comparisons between individuals.

Analysis of TSD-like lesions

All suitable images in the Oman photo-ID catalogue will be examined for the presence of tattoo-like skin lesions. Each image will be rated on a four point quality scale through an evaluation of focus, clarity and proximity. Individual whales will only be included in the analysis if they meet the basic criterion of having at least one image of one flank of suitable image quality available. As the aetiology of the lesions has not yet been studied in Oman (for lack of samples), we conservatively call them 'tattoo-like'. Lesion size (LS) will be estimate in comparison to body parts (e.g. dorsal fin), according to its widest diameter. This includes small (LS<50 mm), medium-sized (50 mm<LS<100 mm), large (100 mm<LS<200 mm) or very large (LS>200 mm). Differences in prevalence between sexes and time periods will be tested with a two-tailed Z-test.

Analyses of TSD-like lesions in UAV images will include an attempt to validate the analyses presented in paper SC/67B/CMP13_rev1). Analyses will also explore a means to cross validate analyses of TSD prevalence using either boat based or UAV imagery.

(D) SUGGESTIONS FOR OUTREACH

Please, note that successful proponents will be requested to produce ad hoc material that will be used by the IWC Secretariat for dissemination and outreach.

This project focuses on the world's smallest and most isolated population of humpback whales. It also focuses on a beautiful region of the world that is not typically associated with marine mammals. The IWC SC has supported work on this population for many years and recent work has greatly improved the available information. The project has been documented throughout with thousands of images (including UAV images and professional video footage), and many of these are suitable for public outreach. Publishing the results of this project is also an explicit objective of this project, and the proponents have a strong history of completing projects with publication.

6. TIMETABLE FOR ACTIVITIES AND OUTPUTS

Specify the timetable for project activities and expected outputs separately. For projects with multiple distinct elements please indicate interim goals and timeframes. Add as many rows as you need to the tables below. If publications are an expected output please note whether you will submit the manuscript to the IWC's Journal of Cetacean Research and Management.

Activity to be undertaken	Key person(s)	Start(mm/yy)	Finish (mm/yy)
Data collation, verification and cross-verification (between PIs)	GM, MFB	01/19	01/19
Analysis of scarring, ectoparasites	GM, MFB	02/19	02/19
Analysis of TSD incidence and extent	MFB	01/19	03/19
Report development	GM and MFB	03/19	05/19
Submission to IWC SC 68A	GM	05/19	05/19

Expected outputs	Completion date (mm/yy)
Completion of report/paper for IWC SC 68A	05/19
Submission to relevant journal	01/20

7. RESEARCHERS' (OR STEERING GROUP) NAME(S) AND AFFILIATION

Please, also specify if the project team has any direct connection (e.g. same research group or institute, collaborator on common project) with people involved or likely to be involved in taking the funding decision (e.g. IWC SC heads of delegations, SC convenors, etc.). Add as many rows as you need to the table below.

Name	Affiliation	Connection with decision
Gianna Minton	Independent Researcher	None
Marie van Bresseem	Independent Researcher	None

8. TOTAL BUDGET

Breakdown into: (1) salaries/wages (include name/position of each individual and breakdown of time and duties i; (2) travel/subsistence expenses (breakdown by person and justification) unless for IPs for workshops where a total estimate based on an average for the total number of IPs is acceptable; (3) services (e.g. aircraft/vessel time, consultancy fees, ARGOS fees, etc.); (4) reusable capital equipment (e.g. reusable equipment such as a hydrophone, cameras, etc. Note that this equipment will have to be registered at the IWC Secretariat and will remain property of the IWC at the end of the project), (5) expendable capital equipment (e.g. consumables, tags, stationery), (6) shipping costs, (7) insurance costs, (8) in kind co-funding (specify whether other funding is available for personnel/name, equipment, venues, etc.). Note that "Overheads" are not admissible. Add as many rows as you need to the table below.

Type	Detailed description	Cost in GB pounds
(1) Salaries (by person)	Dr Gianna Minton Dr Marie Van Bresseem	4,500 4,500
(2) Travel/subsistence (by person or est. total for IPs)	To facilitate a meeting of the two PI's prior to the assessment. The meeting will serve as a means to agree a detailed workplan, as well as ensure that standard protocols/codes and conventions are used. Minton is based in Holland, Van Bresseem in Germany, so one would travel to see the other.	500
(3) Services (by item)		
(4) Reusable equipment		
(5) Consumables		
(6) Shipping (by Item)		
(7) Insurance (by item)		
(8) Co-funding		
(9) Other		
Total		9,500

9. DATA ARCHIVING/SHARING

Please state your plans for data archiving and sharing. Note that data collected primarily under IWC grants are considered publicly available after an agreed period of time for publication of papers, usually about two years. The work of the IWC depends on the voluntary contribution of data to the various databases and catalogues IWC supports. Please consult the Secretariat (secretariat@iwc.int).

All relevant data will be added to the Oman photo-ID catalogue, which is curated by the Environment Society of Oman.

10. PERMITS (PLEASE TICK)

Do you have the necessary permits to carry out the field work and have animal welfare considerations been appropriately considered?	N/A
---	-----

Do you have the appropriate permits (e.g. CITES) for the import/export of any samples?	N/A
--	-----

If 'Yes' please provide further details and enclose copies where appropriate:

Appendix 2 – DRAFT SCORING SHEET

If a project presents multiple primary objectives which are achieved using sub-projects, a sheet should be used to evaluate each single sub-project. Note that not all criteria are equally applicable depending on the nature of the project (e.g. field work versus workshops).

IWC SCIENTIFIC COMMITTEE PROPOSALS FOR FUNDING - REVIEW CRITERIA - TEST			
TITLE OF THE PROJECT/sub-projects:			
PRINCIPAL INVESTIGATOR:			
Key criteria	Explanation of scoring	Score	Supporting Remarks
<i>Relevance to Scientific Committee priorities</i>			
1	How well aligned are the scientific outcomes of the project/activity with the current SC priority areas?	1 - Not aligned/poorly aligned (e.g. too vague or generic reference to general SC priorities) 2 - Reasonably aligned (e.g. some aspects may be vague or links are not clear) 3 - Well aligned (e.g. outcomes clearly deliver in the most part on priority areas, may also address longer term or potential future issues). 4 - Closely aligned (e.g. of interest for multiple sub-groups or delivers on specific SC high priority topics/recommendations in the immediate or short term).	
2	To what extent will the outcomes of the project/activity contribute to improvements in the conservation and management of cetaceans?	1 - Not at all 2 - Poorly 3 - Reasonably or over the longer term 4 - Well or over the medium term 5 - Excellently or to almost immediate effect	
Note: if in each of the two above key criteria under this section the project does not score singularly at least 2 points, do not proceed in further evaluation. Of course, proposals within a sub-group would only be developed if in their estimation scores were of 4 or above.			
<i>Approach and methodology</i>			
3	What degree of scientific merit/value is there in carrying out the work?	1 - Not demonstrated or of low scientific value 2 - Useful/basic scientific value 3 - Very good scientific value 4 - Excellent/innovative scientific value	
4	Is the proposed methodology scientifically sound and feasible in terms of field and analytical methods?	1 - Feasibility unrealistic & poor methodology or not properly addressed 2 - Feasibility & methodology acceptable but would benefit from some substantial amendments	

CMP WP15

		3 - Feasibility & methodology good, some small changes beneficial 4 - Feasibility & methodology excellent or a highly promising innovative approach to an important question facing the Committee		
5	What is the likelihood of success based on the proposed overall approach and methodology?	1 - No chance of success 2 - Low chance of success/better approaches available 3 - Medium chance of success/some changes to the approach necessary 4 - High chance of success/little or no changes to the approach necessary		
5a	Are objectives of the research likely to be achieved within the proposed time-frame?	1 - No or unlikely 2 - Partially or potentially ambitious 3 - Yes with some minor suggestions 4 - Yes		
5b	Are any proposed intermediary targets timely and achievable?	1 - No or unlikely 2 - Partially 3 - Probably 4 - Yes		
5c	Is the proposed time-frame/work necessary (e.g. can the project produce results in a shorter time period)?	1 - No or unlikely 2 - Partially 3 - Probably 4 - Yes		
5d	Is the sample size adequate to achieve the stated objectives?	1 - Not demonstrated/not properly addressed 2 - No or unlikely (too low/too high) 3 - Probably (additional analysis needed) 4 - Yes		
6	Is the project likely to affect adversely the population(s) involved?	1 - Not properly addressed/ unknown 2 - Yes severely 3 - Possibly at a low level 4 - No		
6a	IF YES , are analyses provided on simulations of the effects using different time-frames for the project if applicable?	1 - No 2 - Partially 3 - Yes		
<p>Note: if in each of the above key criteria under this section the project does not score singularly at least 2 points, do not proceed in further evaluation. Of course, proposals within a sub-group would only be developed if in their estimation scores were of 3 or above.</p>				
<p>Project team and Project management</p>				

7	To what extent does the team have the relevant expertise, experience, and balance?	1 – Poor or not demonstrated 2 – Sufficient 3 - Very good 4 - Excellent		
8	Contingency plan: To what extent have potential problems/risks been considered and appropriate mitigation proposed?	1 – Poor or not demonstrated 2 – Sufficient but could be improved 3 - Fully or requiring only minor suggestions or not applicable		
Value for Money				
10	Does the project represent good value for money?	1 – No or significant amendments would be needed 2 – Yes but with some minor amendments 3 – Yes		
11	Have sufficient links been made to the wider research community/other organisations/capacity building.	1 – No 2 – Some but significant amendments needed 3 – Yes but with some minor additions 4 – Yes or not applicable		

- Baldwin, R., Willson, A. and Collins, T. J. Q. 2015. *Watching out for whales: industry responsibility to address threats to Arabian Sea humpback whales, Gulf of Masirah, Oman*.
- Bradford, A.L., Weller, D.W., Ivashchenko, Y.V., Burdin, A.M. and Brownell Jr, R.L., 2009. Anthropogenic scarring of western gray whales (*Eschrichtius robustus*). *Marine Mammal Science*, 25(1), pp.161-175.
- Durban, J., Fearnbach, H., Barrett-Lennard, L., Perryman, W. and Leroi, D. 2015. Photogrammetry of killer whales using a small hexacopter launched at sea. *Journal of Unmanned Vehicle Systems* **3 (3)**: 131-135.
- Durban, J. W., Moore, M. J., Chiang, G., Hickmott, L. S., Bocconcelli, A., Howes, G., Bahamonde, P. A., Perryman, W. L. and LeRoi, D. J. 2016. Photogrammetry of blue whales with an unmanned hexacopter. *Marine Mammal Science* **32 (4)**: 1510-1515.
- IWC. 2016. *Report of the Scientific Committee of the International Whaling Commission 2016: Annex H: Report of the Sub-Committee on Other Southern Hemisphere Whale Stocks*. 66b International Whaling Commission.
- Mehta, A. V., Allen, J., Constantine, R., Garrigue, C., Jann, B., Jenner, C., Marx, M. K., Matkins, C. O., Mattila, D. K., Minton, G., Mizroch, S. A., Olavarria, C., Robbins, J., Russell, K., Seton, R. E., Steiger, G. H., Vikingsson, G. A., Wade, P. R., Witteveen, B. H. and Clapham, P. J. 2007. Baleen whales are not important as prey for killer whales *Orcinus orca* in high-latitude regions. *Marine Ecology Progress Series* **348** 297-307.
- Mikhalev, Y. A. 1997. Humpback whales, *Megaptera novaeangliae* in the Arabian Sea. *Marine Ecology Progress Series* **149** 13-21.
- Mikhalev, Y. A. 2000. Whaling in the Arabian Sea by the whaling fleets Slava and Sovetskaya Ukraina. In: Tormosov, D. D., Mikhalev, Y. A., P.B., B., Zemsky, V. A., Sekiguchi, K. and Brownell Jr, R. L. (eds.) *Soviet Whaling Data [1949-1979]*. pp 141-181, Center for Russian Environmental Policy, Marine Mammal Council. Moscow.

- Miller, C. A., Reeb, D., Knowlton, A. R., Brown, M. W. and Moore, M. J. 2011. Blubber thickness in right whales *Eubalaena glacialis* and *Eubalaena australis* related with reproduction, life history status and prey abundance.
- Miller, C. A., Best, P. B., Perryman, W. L., Baumgartner, M. F. and Moore, M. J. 2012. Body shape changes associated with reproductive status, nutritive condition and growth in right whales *Eubalaena glacialis* and *E. australis*. *Marine Ecology Progress Series* **459** 135-156.
- Palsbøll, P.J., Vader, A., Bakke, I. and El-Gewely, M.R., 1992. Determination of gender in cetaceans by the polymerase chain reaction. *Canadian Journal of Zoology*, **70**(11), pp.2166-2170.
- Pomilla, C., Amaral, A. R., Collins, T., Minton, G., Findlay, K., Leslie, M. S., Ponnampalam, L., Baldwin, R. and Rosenbaum, H. 2014. The World's Most Isolated and Distinct Whale Population? Humpback Whales of the Arabian Sea. *PLoS ONE* **9** (12): e114162.
- Robbins, J. 2012. Scar-based inference into Gulf of Maine humpback whale entanglement: 2010. Report to the National Marine Fisheries Service. *Order number EA133F09CN0253*.
- Robbins, J. and Mattila, D. K. 2000. *Gulf of Maine humpback whale entanglement scar monitoring results 1997-1999*. 40ENNF900253 Center for Coastal Studies.
- Thomas, P. O., Reeves, R. R. and Brownell, R. L. 2015. Status of the world's baleen whales. *Marine Mammal Science*.
- Van Bresseem, M.-F., Minton, G., Collins, T., Willson, A., Baldwin, R. and Van Waerebeek, K. 2014. Tattoo-like skin disease in the endangered subpopulation of the Humpback Whale, *Megaptera novaeangliae*, in Oman (Cetacea: Balaenopteridae). *Zoology in the Middle East* **61** (1): 1-8.
- Van Bresseem, M.-F., Minton, G., Collins, T., Willson, A., Baldwin, R. and Van Waerebeek, K. 2015. Tattoo-like skin disease in the endangered subpopulation of the Humpback Whale, *Megaptera novaeangliae*, in Oman (Cetacea: Balaenopteridae). *Zoology in the Middle East* **61** (1): 1-8.
- Van Bresseem, M.-F., Raga, J. A., Di Guardo, G., Jepson, P. D., Duigan, P. J., Siebert, U., Barrett, T., de Oliveira Santos, M. C., Moreno, C. A., Siciliano, S., Aguilar, A. and Van Waerebeek, K. 2009. Emerging infectious diseases in cetaceans worldwide and the possible role of environmental stressors. *Diseases of Aquatic Organisms* **86** 143–157.