

Agenda Item 4.4

Priorities in the Implementation of the  
Triennium Work Plan (2010-2012)  
Review of New Information on the Extent of  
Negative Effects of Sound

Document 4-08 rev.1

**Report of the Noise Working Group**

**Action Requested**

- Take note of the report
- Comment

Submitted by

Noise Working Group



**NOTE:**  
IN THE INTERESTS OF ECONOMY, DELEGATES ARE KINDLY REMINDED TO BRING THEIR  
OWN COPIES OF DOCUMENTS TO THE MEETING



# Report of the open-ended Inter-sessional Working Group

## on Noise

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***I Relevant activities and developments including in other international bodies (e.g. ACCOBAMS, HELCOM and OSPAR) and under the EU Marine Strategy Framework Directive;***

**EU Marine Strategy Framework Directive**

In the light of the new EU Marine Strategy Framework Directive (2008/56/EC - descriptor 11: "Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.") the impact of noise needs to be carefully and fully evaluated with the aim to achieve or maintain a good environmental status in the marine environment by 2020. The member states are obliged to conduct assessments to define status and describe a good environmental status by 15 July 2012, by:

- conducting an initial assessment
- making a determination of good environmental status
- establishment of environmental targets

There is a COMMISSION DECISION (1 September 2010) on criteria and methodological standards on good environmental status of marine waters (notified under document C(2010) 5956) which point out: *The criteria for the achievement of good environmental status are the starting point for the development of coherent approaches in the preparatory stages of marine strategies, including the determination of characteristics of good environmental status and the establishment of a comprehensive set of environmental targets, to be developed in a coherent and coordinated manner in the framework of the requirement of regional cooperation.*

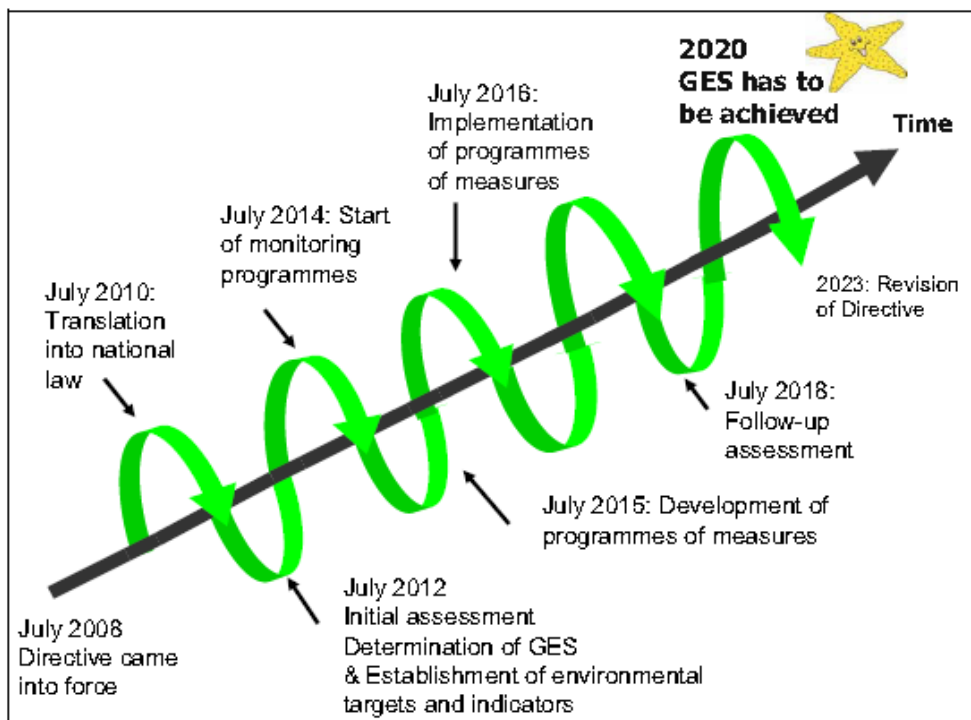
The criteria and indicators are developed by a task group. The first approach<sup>1</sup> of that task group was discussed controversially and therefore the working group (EC Technical Subgroup Noise) was reestablished and met the first time on 16 and 17 February 2011 at TNO in Delft (The Netherlands). Attendance of this meeting was high, with over 20 participants. The representative of the EC (Leo de Vrees) explained the process that has led to establishment of the TSG noise (and litter). The MSFD requires MS to work towards Good Environmental Status (GES) in 2020, this is only possible by managing human activities. However, the pressures and impacts on the ecosystem have to be known.

The TSG noise is foreseen to run until the end of 2011, but it may very well continue in 2012 or even further (keeping in mind that in 2014 MS have to establish a monitoring program and in 2015 proposals for measures). It was stressed that defining Good Environmental Status is the responsibility of Member States and not of the TSG noise. The TSG noise will meet the next time in October 2011.

Considering the clear point of view that member states have to define what is good or not (in the light of the good environmental status) there is a great opportunity for ASCOBANS and ACCOBAMS to play a key role.

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## Implementing the Marine Strategy Framework Directive<sup>2</sup>

### ACCOBAMS

Karsten Brensing attended at the SC7 of ACCOBAMS (Monaco, 29-31 March 2011).

Yanis Souami the chair of the ACCOBAMS noise working group introduced the document SC7\_Doc18<sup>3</sup> concerning the Terms of Reference (which are quite similar to the Terms of Reference of the ASCOBANS noise working group) and composition of the working group on noise. He reminded the participants that during the last Meeting of the Parties, the Resolution 4.17 was adopted with the task for the working group to go ahead with this issue. Due to their complexity, in terms of important financial, technologic and human supports, guidelines seem unworkable for the Parties. The role of the working group is to simplify and clarify guidelines to facilitate their implementation by the Parties and shipping operators. The next step of the working group would be to define concrete action to be lead in the next few months. This will be done in close cooperation with the ASCOBANS noise working group (please see potential joint initiatives).

A major issue in the noise related discussion was an atypical mass stranding of Cuvier's beaked whales occurred last February along the eastern coast in Sicily, in concomitance with a major NATO

<sup>2</sup> FRITZ HOLZWARTH<sup>1</sup>, WERA LEUJAK<sup>2</sup>, JENS ARLE<sup>2</sup> & ULRICH CLAUSSEN<sup>2</sup> (2009) Implementing the Marine Strategy Framework Directive (MSFD) in Germany - Moving towards an assessment framework for "good environmental status" in Progress in Marine Conservation in Europe 2009 BfN-Skripten 287 (2011) - 1Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), 2Federal Environment Agency, Germany

<sup>3</sup> [http://www.accobams.org/index.php?option=com\\_content&view=article&id=1111%3Asc7-meeting-documents&catid=34&Itemid=79](http://www.accobams.org/index.php?option=com_content&view=article&id=1111%3Asc7-meeting-documents&catid=34&Itemid=79) (please approach the ACCOBAMS Secretariat for the password)

naval exercise in the area. Giuseppe Notarbartolo di Sciara presented SC7\_Doc28 provided by Gianni Pavan and others. He remarked that although it was impossible to establish a certain causal link between military activities and the strandings, such link was extremely likely, and in any case it was a fact that the exercises had happened in an area which was known to contain Ziphius habitat. Ana Cañadas presented SC7\_Doc15. The modelling initiative is a collaborative effort with all those holding suitable effort and sightings data of Cuvier's beaked whales in the area. Giuseppe Notarbartolo di Sciara remarked that the result of five years of work based on a large base of data should be considered sufficiently robust to provide recommendations that can be used for management and mitigation purposes. He further suggested that a Working Group be created to formulate the consequences of Ana Cañadas' report.

## HELCOM

Currently there is no sufficient data available to allow for an evaluation of the noise pollution of the Baltic Sea as required by the MSFD. This concerns the entire Baltic area and was as such mentioned and agreed at the HELCOM ministry meeting in May 2010:

- *“To develop common methodologies and appropriate indicators”;*
- *“to facilitate national and international coordinated monitoring of noise and identification of sources of noise”;*
- *“to further investigate the potential harmful impacts to wildlife from noise.”*

In addition the CORESET project of HELCOM and herewithin the Sub-Working-Group developing indicators for marine mammals suggested one indicator on the “Impacts of anthropogenic underwater Noise on Marine Mammals.” As an outcome of the CORESET BD meeting in Gothenburg in February it was decided to wait for the outcome of the work of the EC-TSG on noise before developing this aspect any further.

Furthermore a “Baltic Sea Information on Acoustic Status project” (BIAS) is proposed by the Swedish Defence Research Agency (FOI) and AquaBiotaWaterResearch. The deployment of about 30-40 autonomous sensors in the Baltic Sea that measure sound in regular intervals during a full year is proposed in order to model the soundscape of different Baltic regions providing “cause-and-effect” interpretation of different anthropogenic activities in order to meet the requirements of the MSFD.

## OSPAR

As for HELCOM the overall lack of reliable data on the anthropogenic inputs of underwater noise also concerns for the OSPAR-area including the wider North Sea and is mentioned in the OSPAR “Quality Status Report 2010”:

*„Because there are relatively intense concentrations of human activities in some part of the OSPAR area, especially in region II (Greater North Sea) and III and the probability that these will increase, it is important that the effects of increased levels of underwater sound are fully considered...There is an urgent need to standardise methods for assessing the impacts of sound on marine species and to address the cumulative effects of different sources.”*

The 2009 JAMP Assessment on the environmental impact of underwater noise recommended amongst others that OSPAR Contracting Parties in a next step should develop guidance on measures to mitigate noise emissions and the environmental impacts of underwater noise on the marine environment (OSPAR 2009a). In the QSR 2010 all OSPAR Contracting Parties are invited to develop

guidance on best environmental practices (BEP) and best available techniques (BAT) for mitigating noise emissions and their environmental impacts (OSPAR 2010).

Therefore an OSPAR "Guidance on Measures to Mitigate the Emission and Environmental Impact of Underwater Noise" is now being developed (until EIHA 2012) which aims at describing appropriate methods (Best Available Techniques and Best Environmental Practise) that should be applied with the view of mitigating impacts of different underwater noise emitting human activities.

To provide advice on "Good Environmental Status" which shall be reached by 2020 for the European Marine Waters an advice document and background report for descriptors 10 was currently provided by the OSPAR secretariat, which is now circulated between Contracting Parties for comments.

## **IMO**

In October 2008, the Marine Environment Protection Committee (MEPC) of IMO included noise from commercial shipping and its adverse impact on marine life in its work program. A correspondence group has since been working to identify and address ways to minimize the introduction of incidental noise into the marine environment from commercial shipping to reduce the potential adverse impact on marine life and, in particular, develop voluntary technical guidelines for ship-quieting technologies as well as potential navigation and operational practices[1]. A widely endorsed target, including by the Scientific Committee of the IWC, is to reduce the contribution of shipping to ambient noise levels in the 10-300Hz range by 3dB in 10 years and by 10dB in 30 years relative to current levels[2]. Reducing noise output from a vessel can be most effectively achieved at design stage but in some cases there may be noise reduction measures that can be implemented on existing vessels. The overall contribution to ambient noise from shipping is likely to be dominated by the noisiest 10% of vessels[3] which are also the vessels for which noise reduction measures will be the most effective[4] and may be achievable at the same time as improvements in vessel efficiency[5]. In July 2009, the IMO urged governments to review to review of their merchant fleets in order to identify vessels that would benefit most from efficiency improving technologies that are also likely to reduce underwater noise output. The MEPC correspondence group is due to finish its work in 2011 but the issue may also be taken up by the IMO's Design and Equipment committee. The International Standards Organisation (ISO) has also been developing standards for the measurement of underwater noise from ships.

Following on from the IMO recommendation, MCR Ltd with support from the International Fund for Animal Welfare is planning to make recordings of the acoustic profile of ships. This work will be conducted in summer 2011 and aims to contribute to efforts to introduce ISO standards for ship noise measurement in addition to providing data on individual vessels.

## **Further agreements**

Furthermore there were a couple of developments at the COP10 of the CBD. Resolution X/13 identifies ocean noise as a "new and emerging issue" and Decision X/29 on Marine and Coastal Biodiversity in paragraph 12 acknowledges that "regional progress has been made in analysing the impacts of underwater noise on marine and coastal biodiversity".

## ***II Relevant developments and new literature especially with respect to***

6 Veröffentlichungen

### **Technologies aimed at mitigating the propagation of marine noise**

**2011**

A. Azzellino, , , C. Lanfredia, A. D'Amico, G. Pavanc, M. Podestà and J. Haune (2010) Risk mapping for sensitive species to underwater anthropogenic sound emissions: Model development and validation in two Mediterranean areas

[www.sciencedirect.com](http://www.sciencedirect.com)

Recent observations of cetacean mass strandings, coincident with anthropogenic sounds emissions, have raised concerns on the potential environmental impact of underwater noise. Cuvier's beaked whale (*Ziphius cavirostris*) was reported in all the cited stranding events. Within the NATO Marine Mammal Risk Mitigation project (MMRM), multiple interdisciplinary sea trials have been conducted in the Mediterranean Sea with the objective of developing tools and procedures to mitigate the impact of underwater sound emissions. During these cruises, visual observations, passive acoustic detections and environmental data were collected. The aim of this study was to evaluate "a priori" predictions of Cuvier's beaked whale presence in the Alboran Sea, using models developed in the Ligurian Sea that employ bathymetric and chlorophyll features as predictors. The accuracy of these predictions was found adequate and elements are given to account for the uncertainties associated to the use of models developed in areas different from their calibration site.

**Caroline Hoeschle (1), Miriam J. Brandt (1), Ansgar Diederichs (1), Klaus Betke (2), Georg Nehls (1) (2011) TESTING THE EFFECTS OF AN ACOUSTIC HARASSMENT DEVICE ON THE BEHAVIOUR OF HARBOUR PORPOISES (*PHOCOENA PHOCOENA*). ABSTRACT BOOK 25th CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY 21st – 23rd MARCH 2011, CÁDIZ/SPAIN**

[http://www.circe.biz/files/Abstract\\_book\\_ECS2011-11.pdf](http://www.circe.biz/files/Abstract_book_ECS2011-11.pdf)

Acoustic harassment devices (AHD) are regularly used to deter seals from fish farms. While seals can quickly habituate to such devices, previous studies found that the deterring effect on harbour porpoises may reach much further. This is an unwanted side effect in fisheries, but on the other hand AHDs may be an effective way to deter porpoises before the start of potentially harmful noise emissions from offshore pile driving. However, the spatial scale of deterrence effects of AHDs on porpoises is not sufficiently documented to ensure the prevention of hearing impairment. Using a combination of visual observations and passive acoustic monitoring (C-PODs) we investigated the spatial effects of a Lofitech seal scarer on harbour porpoises. Sighting rates of porpoises significantly declined within the whole 1 km observation radius, and recordings of porpoise echolocation signals by C-PODs were significantly reduced out to a distance of 7 km, with the strongest effect at the nearest PODs and a weak one at further distances. Minimum observed approach distance during 28 hours of AHD activity was 700 m. A response study revealed clear avoidance reactions by porpoises out to the maximum studied distance of 2.6 km. Results show that there is indeed a far reaching effect on porpoise behaviour. This raises concern about unwanted large scale habitat exclusion of porpoises in fisheries, where AHDs are used over long periods of time. On the other hand, the use of AHDs seems to be effective in reducing the number of harbour porpoises exposed to pile driving noise. However, our results also reveal that it is not sufficient to exclude all porpoises from potentially harmful sound.

**Ansgar Diederichs (1), Miriam J. Brandt (1), Georg Nehls (1) (2011) DURATION OF RAMMING PROCEDURE HAS A CLEAR EFFECT ON DISPLACEMENT OF HARBOUR PORPOISES. ABSTRACT BOOK 25th CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY 21st – 23rd MARCH 2011, CÁDIZ/SPAIN**

[http://www.circe.biz/files/Abstract\\_book\\_ECS2011-11.pdf](http://www.circe.biz/files/Abstract_book_ECS2011-11.pdf)

In 2009 the first German offshore wind farm "alpha ventus" was built approximately 45km north of the island of Borkum in 30m water depth. The wind farm consists of 12 turbines of which 6 were built on tripod foundations and 6 on jacket foundations, which all had to be rammed into the sea floor. Noise emissions from offshore pile driving may injure marine mammals in the vicinity and cause large-scale disturbance and habitat displacement. We studied the effect of these pile driving activities on harbour porpoises using acoustic dataloggers (T-PODs) that record harbour porpoise echolocation signals and were deployed at different distances to the construction site. We found a clear impact of pile driving on harbour porpoise click recordings. Analysis of relative porpoise activity measured as porpoise positive minutes per hour and waitingtime between consecutive porpoise recordings further revealed a clear difference between the two types of



foundations. After the few on average more than five hour lasting piling periods for the tripod foundations animals stayed away from the impact area for a longer time period than after the only one hour lasting piling periods of the jacket foundations. Further the displacement of porpoises during the long lasting ramming periods reached up to greater distances. Consequences of this finding on further development of offshore wind farm constructions in the German Bight will be discussed.

## 2010

**Report of the Working Group on Marine Mammal Ecology (WGMME) ToR 4: Review the effects of wind farm construction and operation on marine mammals and provide advice on monitoring and mitigation schemes**

[http://www.ices.dk/reports/ACOM/2010/WGMME/wgmme\\_final\\_2010.pdf](http://www.ices.dk/reports/ACOM/2010/WGMME/wgmme_final_2010.pdf)

Significant gaps exist in our knowledge of the possible impacts on the environment from the construction and operation of offshore windfarms. Given the number of windfarms being constructed or planned for realization in the near future, many research projects are currently assessing possible and actual effects of windfarm construction and operation on the different components of ecosystems, such as marine mammals. Also in the near future, developments in tidal turbines and wave generators are likely to increase and although some issues relating to marine mammals may be different from those of offshore windfarms, the general issues of concern remain the same.

**Sarah Dolman and Mark Simmonds (2010) Towards best environmental practice for cetacean conservation in developing Scotland's marine renewable energy. Marine Policy, Volume 34, Issue 5, September 2010, Pages 1021-1027**

[www.sciencedirect.com](http://www.sciencedirect.com)

Marine renewable energy is seen as an important component of the UK's future energy strategy and contribution to reducing the greenhouse gas emissions responsible for climate change. The UK aims to generate a total of 33 GW (gigawatts) of offshore wind energy. Its implementation strategy includes the development of ten offshore wind farms within Scottish territorial waters. In addition, between 1000 MW (megawatts) and 2600 MW of marine renewable energy generating capacity could be achieved in Scotland using wave and tidal power devices. However, there are negative environmental impacts associated with marine renewable energy. Intense noise is produced during pile driving, drilling and dredging operations with potential consequences for cetaceans. There are also increases in vessel activities during exploration, maintenance and construction with associated risks of disturbance and collisions. Some underwater devices will be large and may be positioned in arrays across the habitats that cetaceans frequent. The consequences of encounters between cetaceans and such devices are as yet unknown. It is recommended that the Scottish Government complete full and transparent Marine Spatial Planning, including consideration of cumulative impacts, before moving to license appropriate sites.

**Andrew J. Wright, Terrence Deak and E.C.M. Parsons (2010) Size matters: Management of stress responses and chronic stress in beaked whales and other marine mammals may require larger exclusion zones Original Research Article. Marine Pollution Bulletin, In Press, Corrected Proof, Available online 4 January 2010,**

[www.sciencedirect.com](http://www.sciencedirect.com)

Marine mammal management traditionally focuses on lethal takes, but non-lethal (or not immediately lethal) impacts of human disturbance, such as prolonged or repeated activation of the stress response, can also have serious conservation implications. The physiological stress response is a life-saving combination of systems and events that maximises the ability of an animal to kill or avoid being killed. However, "chronic stress" is linked to numerous conditions in humans, including coronary disease and infertility. Through examples, including beaked whales and sonar exposure, we discuss increasing human disturbance, mal-adaptive stress responses and chronic stress. Deep-diving and coastal species, and those targeted by whalewatching, may be particularly vulnerable. The various conditions linked with chronic stress in humans would have troubling implications for conservation efforts in endangered species, demands management attention, and may partly explain why some species have not recovered after protective measures (e.g., smaller protected areas) have been put into place.

**Nedwell J R , Brooker A G, Bryant S A H and Barham R J (2010) Measurements of Underwater Noise Generated by Acoustic Mitigation Devices. Subacoustech Environmental Report No. E238R0122 to COWRIE. ISBN: 978-0-9565843-2-8**

<http://www.offshorewind.co.uk/Assets/Final%20report.pdf>

This report has been prepared by Subacoustech Environmental Ltd for Collaborative Offshore Research into the Environment (COWRIE) to investigate the acoustic output of a number of Acoustic Mitigation Devices (AMDs). These devices were initially developed for the fisheries industry to prevent predation of farmed fish by marine mammals. Subsequently, however, their use has been expanded into the marine construction sector in order to reduce the potential for injury to marine mammals as a result of exposure to high levels of underwater noise from construction activities such as impact piling or blasting. This study presents the results of a series of measurements of underwater noise during typical operation of several AMDs in carefully controlled experimental conditions. ....

**Mark Peter Simmonds A B, Vicki C. Brown A (2010) Is there a conflict between cetacean conservation and marine renewable-energy developments? Wildlife Research 37(8) 688–694 doi:10.1071/WR10020**

<http://www.publish.csiro.au/paper/WR10020>

There is currently an unprecedented expansion of marine renewable-energy developments, particularly in UK waters. Marine renewable-energy plants are also being developed in many other countries across Europe and in the wider world, including in the USA, Canada, New Zealand and Australia. Large-scale developments, in UK waters, covering thousands of square kilometres are now planned; however, data on the likely impact of this expansion on the 28 cetacean species found in UK waters are lacking, or at best limited. However, the available information, including inferences drawn from the impact of other human activities in the marine environment, indicates a significant risk of negative consequences, with the noise from pile driving highlighted as a major concern. The marine renewable-energy industry will also deploy some novel technologies, such as large submerged turbines, with unknown consequences for marine wildlife. Further research is urgently required, including distributional and behavioural studies, to establish baselines against which any changes may be measured. Precautionary actions, particularly with respect to pile driving, are advocated to minimise impacts on cetaceans.

**Sarah J. Dolmana, b, , Peter G.H. Evansc, d, , Giuseppe Notarbartolo-di-Sciarae, f, and Heidrun Frischg, (2010) Active sonar, beaked whales and European regional policy. Marine Pollution Bulletin**

[www.sciencedirect.com](http://www.sciencedirect.com)

Various reviews, resolutions and guidance from international and regional fora have been produced in recent years that acknowledge the significance of marine noise and its potential impacts on cetaceans. Within Europe, ACCOBAMS and ASCOBANS have shown increasing attention to the issue. The literature highlights concerns surrounding the negative impacts of active sonar on beaked whales in particular, where concerns primarily relate to the use of mid-frequency active sonar (1–10 kHz), as used particularly in military exercises. The authors review the efforts that European regional policies have undertaken to acknowledge and manage possible negative impacts of active sonar and how these might assist the transition from scientific research to policy implementation, including effective management and mitigation measures at a national level.

**E. Ashe, D. P. Noren, R. Williams (2010) Animal behaviour and marine protected areas: incorporating behavioural data into the selection of marine protected areas for an endangered killer whale population. Animal Conservation Volume 13, Issue 2, pages 196–203, April 2010**

<http://onlinelibrary.wiley.com/doi/10.1111/j.1469-1795.2009.00321.x/full>

Like many endangered wildlife populations, the viability and conservation status of ‘southern resident’ killer whales *Orcinus orca* in the north-east Pacific may be affected by prey limitation and repeated disturbance by human activities. Marine protected areas (MPAs) present an attractive option to mitigate impacts of anthropogenic activities, but they run the risk of tokenism if placed arbitrarily. Notwithstanding recreational and industrial marine traffic, the number of commercial vessels in the local whalewatching fleet is approaching the number of killer whales to be watched. Resident killer whales have been shown to be more vulnerable to vessel disturbance while feeding than during resting, travelling or socializing activities, therefore protected-areas management strategies that target feeding ‘hotspots’ should confer greater conservation benefit than those that protect habitat generically. Classification trees and spatially explicit generalized additive models were used to model killer whale habitat use and whale behaviour in inshore waters of Washington State (USA) and British Columbia (BC, Canada). Here we propose a candidate MPA that is small (i.e. a few square miles), but seemingly important. Killer whales were predicted to be 2.7 times as likely to be engaged in feeding activity in this site than they were in adjacent waters. A recurring challenge for cetacean MPAs is the need to identify areas that are large enough to be biologically meaningful while being small enough to allow effective management of human activities within those boundaries. Our approach prioritizes habitat that animals use primarily for the activity in which they are most responsive to anthropogenic disturbance.

**Paul M. Thompsona , David Lusseaua, Tim Bartona, Dave Simmonsb, Jan Rusinb and Helen Bailey, (2010) Assessing the responses of coastal cetaceans to the construction of offshore wind turbines Marine Pollution Bulletin Volume 60, Issue 8, August 2010, Pages 1200-1208**

[www.sciencedirect.com](http://www.sciencedirect.com)

The expansion of offshore renewables has raised concerns over potential disturbance to coastal cetaceans. In this study, we used passive acoustic monitoring to assess whether cetaceans responded to pile-driving noise during the installation of two 5 MW offshore wind turbines off NE Scotland in 2006. Monitoring was carried out at both the turbine site and a control site in 2005, 2006 and 2007. Harbour porpoises occurred regularly around the turbine site in all years, but there was some evidence that porpoises did respond to disturbance from installation activities. We use these findings to highlight how uncertainty over cetacean distribution and the scale of disturbance effects constrains opportunities for B-A-C-I studies. We explore alternative approaches to assessing the impact of offshore wind farm upon cetaceans, and make recommendations for the research and monitoring that will be required to underpin future developments.

**E. A. Becker, K. A. Forney, M. C. Ferguson, D. G. Foley, R. C. Smith, J. Barlow, J. V. Redfern (2010) Comparing California Current cetacean-habitat models developed using in situ and remotely sensed sea surface temperature data. Mar Ecol Prog Ser Vol. 413: 163–183, 2010**

[http://137.110.142.7/uploadedFiles/Divisions/PRD/Programs/Coastal\\_Marine\\_Mammal/Beckeretal\\_MEPS\\_2010.pdf](http://137.110.142.7/uploadedFiles/Divisions/PRD/Programs/Coastal_Marine_Mammal/Beckeretal_MEPS_2010.pdf)

Generalized linear and generalized additive habitat models were used to predict cetacean densities for 10 species in an 818000 km<sup>2</sup> area off California. The performance of models built with remotely sensed oceanic data was compared to that of models built with in situ measurements. Cetacean sighting data were collected by the Southwest Fisheries Science Center on 4 systematic line-transect surveys during the summer and fall of 1991, 1993, 1996, and 2001. Predictor variables included temporally dynamic, remotely sensed environmental variables (sea surface temperature and measures of its variance) and more static geographical variables (water depth, bathymetric slope, and a categorical variable representing oceanic zone). The explanatory and predictive power of different spatial and temporal resolutions of satellite data were examined and included in the models for each of the 10 species. Alternative models were built using in situ analogs for sea surface temperature and its variance. The remotely sensed and in situ models with the highest predictive ability were selected based on a pseudo-jackknife cross validation procedure. Environmental predictors included in the final models varied by species, but, for each species, overall explanatory power was similar between the remotely sensed and in situ models. Cetacean-habitat models developed using satellite data at 8 d temporal resolution and from 5 to 35 km spatial resolution were shown to have predictive ability that generally met or exceeded models developed with analogous in situ data. This suggests that the former could be an effective tool for resource managers to develop near real-time predictions of cetacean density.

**Wilson, Jennifer C.; Elliott, Mike; Cutts, Nick D.; Mander, Lucas; Mendão, Vera; Perez-Dominguez, Rafael; Phelps, Anna (2010) Coastal and Offshore Wind Energy Generation: Is It Environmentally Benign? Energies 2010, 3, 1383-1422; doi:10.3390/en3071383**

<http://dlc.dlib.indiana.edu/dlc/bitstream/handle/10535/6621/Coastal%20and%20Offshore%20Wind%20Energy.pdf?sequence=1>

"Offshore and coastal wind power is one of the fastest growing industries in many areas, especially those with shallow coastal regions due to the preferable generation conditions available in the regions. As with any expanding industry, there are concerns regarding the potential environmental effects which may be caused by the installation of the offshore wind turbines and their associated infrastructure, including substations and subsea cables. These include the potential impacts on the biological, physical and human environments. This review discusses in detail the potential impacts arising from offshore wind farm construction, and how these may be quantified and addressed through the use of conceptual models. It concludes that while not environmentally benign, the environmental impacts are minor and can be mitigated through good siting practices. In addition, it suggests that there are opportunities for environmental benefits through habitat creation and conservation protection areas."

**Lucke, K., Lepper, P., Blanchet, M.-A. and Siebert, U. The use of an air bubble curtain to reduce the received sound levels for harbor porpoises (*Phocoena phocoena*) J. Acoust. Soc. Am. (accepted)**

In December 2005 construction work was started to replace a harbor wall in Kerteminde harbor, Denmark. A total of 175 wooden piles were piled into the ground at the waters edge over a period of three months. During the same period three harbor porpoises were housed in a marine mammal facility on the opposite side of the harbor. All animals showed strong avoidance reactions after the start of the piling activities. As a measure to reduce the sound exposure for the animals an air bubble curtain was constructed and operated in a direct path between the piling site and the opening of the animals' semi-natural pool. The sound attenuation effect achieved with this system was determined by quantitative comparison of pile driving impulses simultaneously measured in front of and behind the active air bubble curtain. Mean levels of sound attenuation over a sequence of 95 consecutive pile strikes were 14 dB (sd. 3.4 dB) for peak to peak values

and 13 dB (sd. 2.5 dB) for SEL values. As soon as the air bubble curtain was installed and operated, no further avoidance reactions of the animals to the piling activities were apparent.

**Kastelein, R.A., Hoek, L., Jennings, N., de Jong, C.A.F., Terhune, J.M. & Dieleman, M, (2010) ACOUSTIC MITIGATION DEVICES (AMDs) TO DETER MARINE MAMMALS FROM PILE DRIVING AREAS AT SEA: AUDIBILITY & BEHAVIOURAL RESPONSE OF A HARBOUR PORPOISE & HARBOUR SEALS. COWRIE Ref: SEAMAMD-09, Technical Report 31st July 2010.**

<http://www.offshorewindfarms.co.uk/Assets/Final%20report%20COWRIE%20Ref%20SEAMAMD-09%20reviewed%20Subac.pdf>

For the sustainable development of the offshore renewable energy industry, it is necessary to reduce or avoid the damaging effects of noise (such as death or permanent hearing damage), from activities which produce high sound pressure levels, such as pile driving, on marine mammals. One way to achieve this is to ensure that marine mammals are not present in areas where loud noises are being produced, by deterring them by means of safe sounds produced by Acoustic Mitigation Devices (AMDs). Research is needed to determine whether AMDs can mitigate immediate vicinity impacts of loud sounds, which could give rise to temporary or permanent hearing damage, injury or death of marine mammals. In the North Sea, the two most abundant marine mammal species are the harbour porpoise (*Phocoena phocoena*) and the harbour seal (*Phoca vitulina*). COWRIE commissioned SEAMARCO to carry out four studies on the audibility of sounds produced by three selected AMDs and their effect on the behaviour of harbour porpoises and harbour seals (playback experiments). In addition to achieving these aims, SEAMARCO estimated the distances at which sounds from AMDs are audible to, and elicit behavioural responses in, harbour porpoises and harbour seals.

## Noise sources that may present a threat to small cetaceans

2011

Tyack PL, Zimmer WMX, Moretti D, Southall BL, Claridge DE, et al. (2011) Beaked Whales Respond to Simulated and Actual Navy Sonar. *PLoS ONE* 6(3): e17009. doi:10.1371/journal.pone.0017009

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0017009>

Beaked whales have mass stranded during some naval sonar exercises, but the cause is unknown. They are difficult to sight but can reliably be detected by listening for echolocation clicks produced during deep foraging dives. Listening for these clicks, we documented Blainville's beaked whales, *Mesoplodon densirostris*, in a naval underwater range where sonars are in regular use near Andros Island, Bahamas. An array of bottom-mounted hydrophones can detect beaked whales when they click anywhere within the range. We used two complementary methods to investigate behavioral responses of beaked whales to sonar: an opportunistic approach that monitored whale responses to multi-day naval exercises involving tactical mid-frequency sonars, and an experimental approach using playbacks of simulated sonar and control sounds to whales tagged with a device that records sound, movement, and orientation. Here we show that in both exposure conditions beaked whales stopped echolocating during deep foraging dives and moved away. During actual sonar exercises, beaked whales were primarily detected near the periphery of the range, on average 16 km away from the sonar transmissions. Once the exercise stopped, beaked whales gradually filled in the center of the range over 2–3 days. A satellite tagged whale moved outside the range during an exercise, returning over 2–3 days post-exercise. The experimental approach used tags to measure acoustic exposure and behavioral reactions of beaked whales to one controlled exposure each of simulated military sonar, killer whale calls, and band-limited noise. The beaked whales reacted to these three sound playbacks at sound pressure levels below 142 dB re 1  $\mu$ Pa by stopping echolocation followed by unusually long and slow ascents from their foraging dives. The combined results indicate similar disruption of foraging behavior and avoidance by beaked whales in the two different contexts, at exposures well below those used by regulators to define disturbance.

Elena McCarthy, David Moretti, Len Thomas, Nancy DiMarzio, Ronald Morrissey, Susan Jarvis, Jessica Ward, Annamaria Izzi, Ashley Dille (2011) Changes in spatial and temporal distribution and vocal behavior of Blainville's beaked whales (*Mesoplodon densirostris*) during multiship exercises with mid-frequency sonar. *Marine Mammal Science* first published online: 24 FEB 2011

<http://onlinelibrary.wiley.com/doi/10.1111/j.1748-7692.2010.00457.x/abstract>

The number and distribution of vocalizing groups of Blainville's beaked whales (*Mesoplodon densirostris*) were analyzed before, during, and after multiship mid-frequency active sonar operations at the US Navy's Atlantic Undersea Test and Evaluation Center (AUTECE) in the Bahamas. Groups of foraging animals were isolated by detecting their echolocation clicks using an array of bottom-mounted hydrophones. Two data sets were evaluated consisting of 115 and 240 h of acoustic data in May 2007 and 2008, respectively. Vocal activity was observed to decline during active sonar exercises and increase upon cessation of sonar transmissions in both data sets. Vocal activity did not recover to preexposure levels in the postexposure time period in 2007 nor in the initial postexposure period in the 2008 data set. Clicks detected during sonar operations were generally found to be on the periphery of the hydrophone field and vocal durations declined for those groups that remained on the range in that time period. Receive levels were calculated for several vocal groups of whales and indicated that animals continued to forage when exposed to sonar at levels as high as 157 dB re:  $\mu$ Pa.

Purser J, Radford AN (2011) Acoustic Noise Induces Attention Shifts and Reduces Foraging Performance in Three-Spined Sticklebacks (*Gasterosteus aculeatus*). *PLoS ONE* 6(2): e17478. doi:10.1371/journal.pone.0017478

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0017478>

Acoustic noise is known to have a variety of detrimental effects on many animals, including humans, but surprisingly little is known about its impacts on foraging behaviour, despite the obvious potential consequences for survival and reproductive success. We therefore exposed captive three-spined sticklebacks (*Gasterosteus aculeatus*) to brief and prolonged noise to investigate how foraging performance is affected by the addition of acoustic noise to an otherwise quiet environment. The addition of noise induced only mild fear-related behaviours - there was an increase in startle responses, but no change in the time spent freezing or hiding compared to a silent control - and thus had no significant impact on the total amount of food eaten. However, there was strong evidence that the addition of noise increased food-handling errors and reduced discrimination between food and non-food items, results that are consistent with a shift in attention. Consequently, noise resulted in decreased foraging efficiency, with more attacks needed to consume the same number of prey

items. Our results suggest that acoustic noise has the potential to influence a whole host of everyday activities through effects on attention, and that even very brief noise exposure can cause functionally significant impacts, emphasising the threat posed by ever-increasing levels of anthropogenic noise in the environment.

**Laurent Seuront and Nardi Cribb (2011) Fractal analysis reveals pernicious stress levels related to boat presence and type in the Indo-Pacific bottlenose dolphin, *Tursiops aduncus* Physica A: Statistical Mechanics and its Applications, In Press, Corrected Proof, Available online 18 February 2011,**

[www.sciencedirect.com](http://www.sciencedirect.com)

The stress induced in the Indo-Pacific bottlenose dolphin, *Tursiops aduncus*, by boat presence and type was investigated in a highly urbanized coastal environment, the Port Adelaide River-Barker Inlet Estuary, South Australia. The level of stress experienced by bottlenose dolphins was inferred from the distribution patterns of their dive durations. Dive duration has previously been shown to increase under boat traffic conditions, and is considered as a typical avoidance behavior. Dive durations were opportunistically recorded from land-based stations between January 2008 and October 2010 in the absence of boat traffic, and in the presence of kayaks, inflatable motor boats, powerboats and fishing boats. Subsequent analyses were based on nearly 6000 behavioral observations. No significant differences in dive durations were found between control observations (i.e. absence of boats) and boat interferences, which could erroneously lead to conclude that boat traffic did not induce any stress in *T. aduncus*. In contrast, the scaling exponents of the cumulative probability distribution of dive durations obtained in the absence of boat traffic and under different conditions of boat interferences show (i) that the presence of boats affected the complexity of dive duration patterns and (ii) that stress levels were a function of boat type. Specifically, the complexity of dive duration patterns (estimated by the scaling exponent) did not significantly differ between control behavioral observations and behavioral observations conducted in the presence of kayaks. A significant increase in behavioral stress (i.e. decreasing values of  $\beta$ ) was, however, induced by the presence of fishing boats, motorized inflatable boats and powerboats. This demonstrates that traditional approaches based on the analysis of averaged behavioral metrics may not be sensitive enough to detect changes in the distribution pattern of behavioral sequences, hence underestimate the potential consequences of e.g. chronic exposure to low levels of stress. It is finally emphasized that fractal analyses of behavioral variables, and in particular the analysis of their cumulative probability distribution function, may provide a non-invasive, objective and quantitative framework that can be used to assess the changes in stress response, and subsequently evaluate the welfare status of organisms under various conditions of abiotic and/or biotic stress.

**A. Azzellino, C. Lanfredi, A. D'Amico, G. Pavan, M. Podestà and J. Haun (2011) Risk mapping for sensitive species to underwater anthropogenic sound emissions: Model development and validation in two Mediterranean areas Original Research Article. Marine Pollution Bulletin, In Press, Corrected Proof, Available online 24 February 2011,**

[www.sciencedirect.com](http://www.sciencedirect.com)

Recent observations of cetacean mass strandings, coincident with anthropogenic sounds emissions, have raised concerns on the potential environmental impact of underwater noise. Cuvier's beaked whale (*Ziphius cavirostris*) was reported in all the cited stranding events. Within the NATO Marine Mammal Risk Mitigation project (MMRM), multiple interdisciplinary sea trials have been conducted in the Mediterranean Sea with the objective of developing tools and procedures to mitigate the impact of underwater sound emissions. During these cruises, visual observations, passive acoustic detections and environmental data were collected. The aim of this study was to evaluate "a priori" predictions of Cuvier's beaked whale presence in the Alboran Sea, using models developed in the Ligurian Sea that employ bathymetric and chlorophyll features as predictors. The accuracy of these predictions was found adequate and elements are given to account for the uncertainties associated to the use of models developed in areas different from their calibration site.

**Lucke, K., Dähne, M., Peschko, V., Müller, S., Adler, S., Gilles, A., Krügel, K., Brandecker, A., Sundermeyer, J., Verfuss, U., Benke, H. and Siebert, U. (2011) StUKplus: Investigations in addition to the effects monitoring – marine mammals. Proceedings of the Meeresumwelt-Symposium, Hamburg, p.61-62.**

During the construction phase of the offshore test site alpha ventus, aerial and ship surveys were conducted to monitor the abundance and distribution of harbour porpoises in the study area. Moreover, their presence and behaviour were monitored using C-PODs, automatic cetacean echolocation loggers. The aim of these efforts was to find out whether the construction had any significant effect on the presence and habitat use of harbour porpoises in the study. The results show a significant negative correlation between pile driving activities and porpoise presence in a wide area around alpha ventus during the construction activities in 2008 and the first part of the 2009 construction phase. The effect was monitored over a range of at least 8 km and up to 25 km. An aerial survey conducted immediately after pile driving at one of the first turbine foundation sites showed a different porpoise distribution: no animals were sighted close to alpha ventus, and many animals were sighted at greater distances. Thus acoustic and visual data concordantly showed that harbor porpoises initially avoid

the pile driving area over wide ranges for an extended period of time (hours to days). Of special importance is the fact that the number of acoustic detections of harbour porpoises in the vicinity of the pile driving sites increased during the construction of the last wind turbines in 2009. The increased presence of harbour porpoises in the impact area implies that these animals were exposed to a large number of piling impulses (several thousand impulses per pile on average) at high received sound levels. Such a multiple exposure poses the risk of impairing the animals' hearing. It is most likely that porpoises in the vicinity of the construction site have been physically impaired.

**Jakob Tougaard , Line Anker Kyhn , Mats Amundin, Daniel Wennerberg , Carolina Bordin (2011) HARBOUR PORPOISES ARE DETERRED BY SIMULATED PILE DRIVING NOISE. ABSTRACT BOOK 25th CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY 21st – 23rd MARCH 2011, CÁDIZ/SPAIN**

[http://www.circe.biz/files/Abstract\\_book\\_ECS2011-11.pdf](http://www.circe.biz/files/Abstract_book_ECS2011-11.pdf)

Many studies have shown that harbour porpoises react to loud underwater sound, including impact noise from pile driving of large diameter monopiles, such as those used as foundations for offshore wind turbines. Previous studies showed that fewer echolocation clicks are recorded following pile drivings, but it remains unclear whether the porpoises vacated the area around the construction site or remained in the area, but with an altered acoustic behaviour. To address this question a controlled exposure study was conducted. Pile driving sounds were played back at reduced levels (about 180 dB re. 1 uPa peak-peak at 1 m) from underwater loudspeakers (Lubell 9162) located close to shore at Fyns Hoved, Great Belt, Denmark. The swimming behaviour of porpoises was tracked visually by a theodolite from a nearby cliff-top. Porpoises were tracked continuously for long periods and playback occurred as 2-hour blocks with one pile driving sound being played back every second. Playback occurred from one of two identical loudspeakers, separated by about 200 m and without observers being aware whether the sound was on or not, to avoid observer bias. A maximum of 2 playback blocks occurred per day. Results show that porpoises avoided a zone with a distance of c. 200m around the loudspeakers when these were transmitting. Received levels of sound at this distance was around 140 dB re. 1 uPa (peak-peak). This threshold level for reactions is consistent with the results from the real pile drivings. Thus, even though the source levels in the controlled exposure study was 50-60 dB lower than a real pile driving and hence the size of the impact area greatly reduced, the thresholds for reaction are consistent. This gives confidence to concluding that porpoises likely react in a similar way to real pile drivings, i.e. by vacating the area.

**Sylvia Eke van der Woude (2011) ACOUSTIC AND LOCOMOTIVE RESPONSES OF BOTTLENOSE DOLPHINS, *TURSIOPS TRUNCATUS*, TO AN ACOUSTIC MARINE GEOPHYSICAL SURVEY. ABSTRACT BOOK 25th CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY 21st – 23rd MARCH 2011, CÁDIZ/SPAIN**

[http://www.circe.biz/files/Abstract\\_book\\_ECS2011-11.pdf](http://www.circe.biz/files/Abstract_book_ECS2011-11.pdf)

Investigations of the effects of anthropogenic noise on marine mammals often lack full experimental control. This study provides detailed data on the noise source and the receiver, namely a geophysical survey and bottlenose dolphins. The seismic and bathymetric survey was shot on 19 days in November 2006 in the Red Sea. The area included an extensive open-sea enclosure accommodating 10 dolphins. Five different sound producing devices were simultaneously applied. GPS log files supplied information on their distance to the enclosure, speed, and direction. The dolphins' behaviour was monitored both visually and acoustically. Commented visual recordings were made from an observation tower and linked to acoustic recordings obtained from a spacious hydrophone-array. Recordings were analyzed in 10s-intervals. Acoustic recordings (15h) were examined for the slightest indication of vocal activity discernable below 24kHz, including whistles and echolocation clicks. Visual recordings (3h) were examined for the position, velocity, swimming association, and behavior of each individual within sight. All vocalizations analyzed were dramatically reduced on survey days compared to control days. This reduction was the more pronounced the closer the devices were and the faster they were approaching. Also locomotive behavior was clearly affected by noise. At shorter distances (below 2.2km) swimming speed increased and other behaviors such as social interactions were reduced if not fully absent. At highest speeds mother-calve separations occurred. Both, the reduction or frequency shift of signals used for communication and orientation and the changes of locomotive behaviors must be considered as costly. Although there were no indications for injuries like deafness (TTS/PTS), the changes in behavior observed in captive animals may have even more profound or long term consequences in the wild. This study cannot suggest a critical distance between noise and dolphins, however, it can provide suggestions to future geophysical surveyors and effect assessors.

**REPORT OF THE SEVENTH MEETING OF THE SCIENTIFIC COMMITTEE OF ACCOBAMS (2011) ACCOBAMS-SC7/2011/Doc29**

[http://www.accobams.org/index.php?option=com\\_content&view=article&id=1107:seventh-meeting-of-the-scientific-committee&catid=52:meetings-of-the-sc&Itemid=79](http://www.accobams.org/index.php?option=com_content&view=article&id=1107:seventh-meeting-of-the-scientific-committee&catid=52:meetings-of-the-sc&Itemid=79)

51. Ana Cañadas presented SC7\_Doc15. The modelling initiative is a collaborative effort with all those holding suitable effort and sightings data in the area. This work has used habitat preference modelling as tool for data analysis. The approach uses physical and environmental data to help explain variation in cetacean distribution and predict areas that are important for target species. A list with all data contributors to this initiative was provided.

52. The best model selected three covariates: depth, average sea surface temperature, and latitude, with a total deviance explained of 57.8%. Maps with the predicted relative densities of beaked whales in the Mediterranean were presented. The best model highlights three



areas with the highest relative density of beaked whales: the Alboran Sea, the Northern Ligurian Sea, and the Hellenic Trench and north of Crete. In addition, the Tyrrhenian Sea, the Southern Adriatic Sea and some areas to the north of the Balearic Islands and south of Sicily show relatively high predicted density compared to the rest of the Mediterranean. Nevertheless, it is very important to highlight that this analysis used a compilation of 21 years of very heterogeneous data. In particular, there are large areas where there are little or no data. Therefore, this analysis should be considered as a preliminary exploration and the results should be taken with considerable caution.

53. Giuseppe Notarbartolo di Sciara remarked that the result of five years of work based on a large base of data should be considered sufficiently robust to provide recommendations that can be used for management and mitigation purposes. He further suggested that a Working Group be created to formulate the consequences of Ana Cañadas' report.

54. After having met, the Working Group proposed the following:

- a. a large portion of slope and deep waters (deeper than 600 m) throughout the Mediterranean contained suitable Ziphius habitat;
- b. based on existing knowledge of noise disturbance thresholds, beaked whales should not be exposed to received levels greater than SPL 140 dB re 1  $\mu$ Pa @ 1 m;
- c. it was therefore recommended to apply a safety buffer around the preferred habitat mentioned in a) so that the threshold would not be exceeded.

55. The Scientific Committee approved the outcome of the Working Group.

56. Ana Cañadas informed the Committee that after consultation with all the data providers, she was going to produce a final report inclusive of the Scientific Committee recommendations, for wider circulation, as appropriate.

**Michel André, Marta Solé, Marc Lenoir, Mercè Durfort, Carme Quero, Alex Mas, Antoni Lombarte, Mike van der Schaar, Manel López-Bejar, Maria Morell, Serge Zaugg, and Ludwig Houégnigan. 2011. Low-frequency sounds induce acoustic trauma in cephalopods. *Frontiers in Ecology and the Environment***

<http://www.esajournals.org/doi/abs/10.1890/100124?prevSearch=%5Ball%3A+Andr%C3%A9%5D+AND+%5Bauthor%3A+Andr%C3%A9%5D+AND+%5Babstract%3A+noise%5D&searchHistoryKey=>

There is currently relatively little information on how marine organisms process and analyze sound, making assessments about the impacts of artificial sound sources in the marine environment difficult. However, such assessments have become a priority because noise is now considered as a source of pollution that increasingly affects the natural balance of the marine ecosystems. We present the first morphological and ultrastructural evidence of massive acoustic trauma, not compatible with life, in four cephalopod species subjected to low-frequency controlled-exposure experiments. Exposure to low-frequency sounds resulted in permanent and substantial alterations of the sensory hair cells of the statocysts, the structures responsible for the animals' sense of balance and position. These results indicate a need for further environmental regulation of human activities that introduce high-intensity, low-frequency sounds in the world's oceans.

## 2010

**Mann D, Hill-Cook M, Manire C, Greenhow D, Montie E, et al. (2010) Hearing Loss in Stranded Odontocete Dolphins and Whales. *PLoS ONE* 5(11): e13824. doi:10.1371/journal.pone.0013824**

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0013824>

The causes of dolphin and whale stranding can often be difficult to determine. Because toothed whales rely on echolocation for orientation and feeding, hearing deficits could lead to stranding. We report on the results of auditory evoked potential measurements from eight species of odontocete cetaceans that were found stranded or severely entangled in fishing gear during the period 2004 through 2009. Approximately 57% of the bottlenose dolphins and 36% of the rough-toothed dolphins had significant hearing deficits with a reduction in sensitivity equivalent to severe (70–90 dB) or profound (>90 dB) hearing loss in humans. The only stranded short-finned pilot whale examined had profound hearing loss. No impairments were detected in seven Risso's dolphins from three different stranding events, two pygmy killer whales, one Atlantic spotted dolphin, one spinner dolphin, or a juvenile Gervais' beaked whale. Hearing impairment could play a significant role in some cetacean stranding events, and the hearing of all cetaceans in rehabilitation should be tested.

**Christina Mueller-Blenkle, Peter K. McGregor, Andrew B. Gill, Mathias H. Andersson, Julian Metcalfe, Victoria Bendall, Peter Sigray, Daniel Wood, Frank Thomsen (2010) EFFECTS OF PILE-DRIVING NOISE ON THE BEHAVIOUR OF MARINE FISH COWRIE Ref: Fish 06-08 / Cefas Ref: C3371 Technical Report 31th March 2010**

[http://www.offshorewindfarms.co.uk/Assets/COWRIE%20FISH%2006-08\\_Technical%20report\\_Cefas\\_31-03-10.pdf](http://www.offshorewindfarms.co.uk/Assets/COWRIE%20FISH%2006-08_Technical%20report_Cefas_31-03-10.pdf)



Studies on the effects of offshore wind farm construction on marine life have so far focussed on behavioural reactions in porpoises and seals. The effects on fish have only very recently come into the focus of scientists, regulators and stakeholders. Pile-driving noise during construction is of particular concern as the very high sound pressure levels could potentially prevent fish from reaching breeding or spawning sites, finding food, and acoustically locating mates. This could result in longterm effects on reproduction and population parameters. Further, avoidance reactions might result in displacement away from potential fishing grounds and lead to reduced catches. However, reaction thresholds and therefore the impacts of pile-driving on the behaviour of fish are completely unknown. ....

**Authors J.L. Michael, SPE, Chevron; L. Notor, SPE, ConocoPhillips Company; J. Campbell, SPE, OGP; D. Hedgeland, SPE, PGS; M. Jenkerson, ExxonMobil; R. Melton, SPE, ExxonMobil Upstream Research Company; R.D. Tait, SPE, ExxonMobil Production Company; S. Tsoflias SPE, IAGC (2010) Title Joint Industry Programme on Exploration and Production Sound and Marine Life: Update on Research Progress. Source SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, 12-14 April 2010, Rio de Janeiro, Brazil Copyright 2010. Society of Petroleum Engineers**

<http://www.onepetro.org/mslib/servlet/onepetroreview?id=SPE-127092-MS&soc=SPE>

A group of 14 oil and gas companies and the International Association of Geophysical Contractors (IAGC) through the International Association of Oil and Gas Producers (OGP) have been funding the Joint Industry Programme on Exploration and Production (E&P) Sound and Marine Life (JIP). The JIP funds research to reduce the uncertainty around the risk of negatively impacting marine animal populations during E&P activities. While there is little to no scientific evidence showing significant negative impacts, there are gaps in scientific knowledge that create uncertainty in industry risk assessments. In the absence of complete data, environmental regulators may, and do impose, conservative restrictions on E&P activities aimed to prevent or mitigate the possibility of significant impacts. ....

**Helen Bailey, , , Bridget Seniora, Dave Simmons, Jan Rusin, Gordon Pickens and Paul M. Thompson (2010) Assessing underwater noise levels during pile-driving at an offshore windfarm and its potential effects on marine mammals. Marine Pollution Bulletin. Volume 60, Issue 6, June 2010, Pages 888-897**

[www.sciencedirect.com](http://www.sciencedirect.com)

Marine renewable developments have raised concerns over impacts of underwater noise on marine species, particularly from pile-driving for wind turbines. Environmental assessments typically use generic sound propagation models, but empirical tests of these models are lacking. In 2006, two 5 MW wind turbines were installed off NE Scotland. The turbines were in deep (>40 m) water, 25 km from the Moray Firth Special Area of Conservation (SAC), potentially affecting a protected population of bottlenose dolphins. We measured pile-driving noise at distances of 0.1 (maximum broadband peak to peak sound level 205 dB re 1  $\mu$ Pa) to 80 km (no longer distinguishable above background noise). These sound levels were related to noise exposure criteria for marine mammals to assess possible effects. For bottlenose dolphins, auditory injury would only have occurred within 100 m of the pile-driving and behavioural disturbance, defined as modifications in behaviour, could have occurred up to 50 km away.

**Katz, Richard A. ; Cipriano, Nicholas J. ; Pearson, David J. ; Dunkleberger, Steve R. (2010) The Decibel Report: Acoustic Sound Measurement Modeling and the Effects of Sonar on Marine Mammals. NAVAL UNDERSEA WARFARE CENTER DIV NEWPORT RI Accession Number : ADA530137**

<http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA530137&Location=U2&doc=GetTRDoc.pdf>

Abstract : This report is an authoritative and comprehensive explanation of sound-level quantities, metrics, and sonar models; its purpose is to provide best available science to acoustics and marine biology subject matter experts, sonar and environmental planners, and policy decision-makers so they can be better informed of the terminology, usage, and practices undertaken for modeling underwater sound energy effects pertinent to U.S. Naval sonar operations and the marine habitat.

**Sarah J. Dolmana, Eunice Pinna, Robert J. Reid, Jason P. Barley, Rob Deaville, Paul D. Jepson, Mick O'Connell, Simon Berrow, Rod S. Penrose, Peter T. Stevicka, Susannah Calderana, Kevin P. Robinson, Robert L. Brownell Jr and Mark P. Simmonds (2010) A note on the unprecedented strandings of 56 deep-diving whales along the UK and Irish coast. Marine Biodiversity Records (2010), 3: e16**

<http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=7285852>

In the first seven months of 2008, eighteen Cuvier's beaked whales (*Ziphius cavirostris*), four Sowerby's beaked whales (*Mesoplodon bidens*), five unidentified beaked whales and twenty-nine long-finned pilot whales (*Globicephala melas*) were reported stranded in the UK and Ireland. Decomposition of those animals investigated puts the predicted time of death at mid-January. Concerns that an unusual

mortality event had taken place prompted further investigations. Most carcasses were too decomposed for necropsy. A summary of findings is presented here. Although the initial stranding of five Cuvier's beaked whales in Scotland shared some similarities with atypical mass stranding events linked in time and space to mid-frequency naval sonars, there were two important differences with the remaining strandings during this period. First, the geographical range of the event was very wide and second, the strandings occurred over a prolonged period of several months. Both of these factors could be related to the fact that the mortalities occurred offshore and the carcasses drifted ashore. The cause(s) of this high number of strandings of mixed offshore cetacean species during this period remain undetermined

**James J. Finneran; Donald A. Carder; Carolyn E. Schlundt; Randall L. Dear (2010) Temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) exposed to intermittent tones. *J. Acoust. Soc. Am.* / Volume 127 / Issue 5 / BIOACOUSTICS**

<http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=JASMAN000127000005003267000001&idtype=cvips&gifs=yes&ref=no>

Temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) exposed to intermittent tones Temporary threshold shift (TTS) was measured in a bottlenose dolphin exposed to a sequence of four 3-kHz tones with durations of 16 s and sound pressure levels (SPLs) of 192 dB re 1  $\mu$ Pa. The tones were separated by 224 s of silence, resulting in duty cycle of approximately 7%. The resulting growth and recovery of TTS were compared to experimentally measured TTS in the same subject exposed to single, continuous tones with similar SPLs. The data confirm the potential for accumulation of TTS across multiple exposures and for recovery of hearing during the quiet intervals between exposures. The degree to which various models could predict the growth of TTS across multiple exposures was also examined.

**Melcon ML, Cummins AJ, Wiggins SM, Hildebrand JA (2010) Assessing the effects of mid-frequency sonar on cetaceans in Southern California. *Canadian Acoustics* 38:24-25**

Mid-frequency active sonar (MFA) is regularly used during naval exercises to provide an acoustic image of subsurface features, including natural and anthropogenic targets. Because MFA is often operated at high intensities, its sounds can be heard for thousands of square kilometers. MFA signal characteristics can vary considerably over its frequency band, 1-10 kHz, which coincidentally happens to be in the audible band for most, if not all, marine mammal species. Over the past decade, correlations have been found between MFA and anomalous mass strandings of beaked whales (Cox et al., 2006). However, the mechanisms by which MFA affects beaked whales are not well understood.

**Thompson PM, Lusseau D, Barton T, Simmons D, Rusin J, Bailey H (2010) Assessing the responses of coastal cetaceans to the construction of offshore wind turbines. *Marine Pollution Bulletin* 60:1200-1208**

The expansion of offshore renewables has raised concerns over potential disturbance to coastal cetaceans. In this study, we used passive acoustic monitoring to assess whether cetaceans responded to pile-driving noise during the installation of two 5MW offshore wind turbines off NE Scotland in 2006. Monitoring was carried out at both the turbine site and a control site in 2005, 2006 and 2007. Harbour porpoises occurred regularly around the turbine site in all years, but there was some evidence that porpoises did respond to disturbance from installation activities. We use these findings to highlight how uncertainty over cetacean distribution and the scale of disturbance effects constrains opportunities for B-A-C-I studies. We explore alternative approaches to assessing the impact of offshore wind farm upon cetaceans, and make recommendations for the research and monitoring that will be required to underpin future developments

**Faerber, M.M., and Baird, R.W. 2010. Does a lack of observed beaked whale strandings in military exercise areas mean no impacts have occurred? A comparison of stranding and detection probabilities in the Canary and main Hawaiian Islands. *Mar. Mamm. Sci.* 26, 602–613**

<http://onlinelibrary.wiley.com/doi/10.1111/j.1748-7692.2010.00370.x/abstract>

Anthropogenic activities must be monitored to determine effects on marine mammal species, but the difficulty lies in how to measure impact. Mass strandings of beaked whales have occurred in association with naval exercises, with two species most affected, Cuvier's (*Ziphius cavirostris*) and Blainville's (*Mesoplodon densirostris*) beaked whales. Six such events have occurred in the Canary Islands but there have been no reported mass strandings in Hawai'i. We assess the hypothesis that factors that influence the likelihood of strandings occurring and/or being detected differ between the Canary and main Hawaiian Islands, such that beaked whale stranding/detection probabilities will be lower in Hawai'i. On an archipelago-wide basis, nearshore bathymetric comparisons indicate that the Canaries have a greater proportion and a total greater amount of appropriate beaked whale habitat closer to shore, with a steeper slope. Hawaiian shorelines are more dominated by steep cliffs, human population density is much lower, and human population per kilometer of shoreline is 53% lower than in the Canaries. All of these factors suggest that there is a higher probability of a carcass washing onshore and being detected in the Canary Islands. It cannot be concluded that the lack of mass strandings in Hawai'i is evidence of no impact.

## General publication which should be considered

2011

Simpson SD, Radford AN, Tickle EJ, Meekan MG, Jeffs AG (2011) Adaptive Avoidance of Reef Noise. *PLoS ONE* 6(2): e16625. doi:10.1371/journal.pone.0016625

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0016625>

Auditory information is widely used throughout the animal kingdom in both terrestrial and aquatic environments. Some marine species are dependent on reefs for adult survival and reproduction, and are known to use reef noise to guide orientation towards suitable habitat. Many others that forage in food-rich inshore waters would, however, benefit from avoiding the high density of predators resident on reefs, but nothing is known about whether acoustic cues are used in this context. By analysing a sample of nearly 700,000 crustaceans, caught during experimental playbacks in light traps in the Great Barrier Reef lagoon, we demonstrate an auditory capability in a broad suite of previously neglected taxa, and provide the first evidence in any marine organisms that reef noise can act as a deterrent. In contrast to the larvae of species that require reef habitat for future success, which showed an attraction to broadcasted reef noise, taxa with a pelagic or nocturnally emergent lifestyle actively avoided it. Our results suggest that a far greater range of invertebrate taxa than previously thought can respond to acoustic cues, emphasising yet further the potential negative impact of globally increasing levels of underwater anthropogenic noise.

Rob Williams, Shane Gero, Lars Bejder, John Calambokidis, Scott D. Kraus, David Lusseau, Andrew J. Read, Jooke Robbins. (2011) Underestimating the damage: interpreting cetacean carcass recoveries in the context of the Deepwater Horizon/BP incident. *Conservation Letters*,

<http://onlinelibrary.wiley.com/doi/10.1111/j.1755-63X.2011.00168.x/abstract;jsessionid=62C151E1131B2B8C3927DC25861DC2F3.d03t04>

Evaluating impacts of human activities on marine ecosystems is difficult when effects occur out of plain sight. Oil spill severity is often measured by the number of marine birds and mammals killed, but only a small fraction of carcasses are recovered. The Deepwater Horizon/BP oil spill in the Gulf of Mexico was the largest in the U.S. history, but some reports implied modest environmental impacts, in part because of a relatively low number (101) of observed marine mammal mortalities. We estimate historical carcass-detection rates for 14 cetacean species in the northern Gulf of Mexico that have estimates of abundance, survival rates, and stranding records. This preliminary analysis suggests that carcasses are recovered, on an average, from only 2% (range: 0–6.2%) of cetacean deaths. Thus, the true death toll could be 50 times the number of carcasses recovered, given no additional information. We discuss caveats to this estimate, but present it as a counterpoint to illustrate the magnitude of misrepresentation implicit in presenting observed carcass counts without similar qualification. We urge methodological development to develop appropriate multipliers. Analytical methods are required to account explicitly for low probability of carcass recovery from cryptic mortality events (e.g., oil spills, ship strikes, bycatch in unmonitored fisheries and acoustic trauma).

Michel André (1), Mike van der Schaar (1), Serge Zaugg (1), Ludwig Houégnigan (1), Antonio M. Sánchez (1), Alex Mas (1) (2011) FROM OFFLINE RECORDINGS TO REAL-TIME ANALYSIS OF OCEAN NOISE AND ACOUSTICS EVENTS AT UNDERWATER OBSERVATORIES. ABSTRACT BOOK 25th CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY 21st – 23rd MARCH 2011, CÁDIZ/SPAIN

[http://www.circe.biz/files/Abstract\\_book\\_ECS2011-11.pdf](http://www.circe.biz/files/Abstract_book_ECS2011-11.pdf)

Passive acoustic monitoring has the potential to be implemented continuously and over long time periods, resulting in large and representative datasets. However, this inevitably leads to a high rate of audio data acquisition that could be problematic when the data needs to be transmitted, stored or analyzed. For observatories with a limited power supply, transmission, storage or additional data processing (e.g. automated classification, data compression) have to be optimized, which may imply the loss of potentially interesting information. For cabled observatories where power and communication are not an issue, limitations arise with storage. In any case, the need for immediate mitigation actions when facing acoustic events that could result harmful to individuals or populations, and the necessity of long-term monitoring of noise, calls for the development of a robust technique able to provide both historical statistical data on noise and alarms on specific acoustic events: i.e. a fully automated real-time detection and classification system that would be able to provide this information while minimizing technical costs. The approach proposed here divides the recording bandwidth in frequency bands that cover the acoustic niche of most species and secondly applies to these bands a series of detectors and classifiers (as well as localization and tracking algorithms), that also allow to assess the short-, medium- and long-term contribution of noise sources in these acoustic niches. The Laboratory of Applied Bioacoustics (LAB) of the Technical University of Catalonia has developed and implemented at

several underwater observatories in Europe (ESONET, European Sea-Floor Observatories Network of Excellence) and Canada (NEPTUNE, NorthEast Pacific Time-Series Undersea Networked Experiments) an automated real-time DCL system that has proven to be reliable and efficient. The live audio data stream as well as the output of the statistical analysis can be accessed online at <http://listentothedeep.com>

**Lucia Martina Martin (2, 3), Ricardo Sagarminaga (1), Ana Tejedor (1), Albert López-Larrosa (4), Natacha Aguilar (2, 5) (2011) AREA MARINE PROTECTED (AMP) AREAS FREE OF ACOUSTIC POLLUTION? CASE EXAMPLES OF NOISE FROM FISHING AND SHIPPING ACTIVITIES IN DEEPWATER AREAS OF THE MEDITERRANEAN. ABSTRACT BOOK 25th CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY 21st – 23rd MARCH 2011, CÁDIZ/SPAIN**

[http://www.circe.biz/files/Abstract\\_book\\_ECS2011-11.pdf](http://www.circe.biz/files/Abstract_book_ECS2011-11.pdf)

Cetaceans and other marine fauna use sound for vital functions such as communication, foraging and predator detection. Signals mediating these functions can be masked by increased levels of ambient noise. Therefore, buffering from acoustic pollution should be considered when designing MPA. Some sources of noise can increase background noise levels at large distances. This is most relevant for “chronic” activities occurring repeatedly in an area. Here we analyze two chronic sources of anthropogenic noise in some areas of the Mediterranean: bottom-trawling fishing and shipping lines. The study was performed within the context of the EU project LIFE+INDEMARES and we present

case examples showing that noise produced outside MPA has the potential to affect marine life within the borders of MPA. Recordings were taken in two key areas for the Natura2000Network: Cap de Creus (Catalunya) and Alboran Sea. Point sound samples (30min) were gathered with a calibrated hydrophone (Reson TC4032). In Cap de Creus, broadband (100Hz-40kHz) noise levels increased by 15dB re 1µPaRMS in recordings performed at 0.5, 1.2 and 1.4km from trawling boats over recordings in the same area with no boats in a 6nm radius. Under the conservative assumptions of the closest boat dominating the noise signature and spherical sound transmission, the radius at which trawling noise exceeds usual background noise in this area is around 3km. The Alboran Sea is crossed by over 25% of the World’s shipping activity, with the main shipping line located north of the Alboran Island. We performed recordings following a north-south transect and low frequency noise (<150Hz) broadband sound levels in the most northern point (18km from Alboran Is.) exceeded in 10dB re 1µPaRMS the levels in the other recordings. This examples point to the need of gathering long-term datasets of acoustic levels in MPA and create “acoustic buffer zones” around them.

**Ursula Verfuss (1), Sven Adler (1), Anja Brandecker (1), Michael Dähne (2), Ansgar Diederichs (3), Anja Gallus (1), Anne Herrmann (1), Kathrin Krügel (1), Klaus Lucke (2011) AMPOD: APPLICATIONS AND ANALYSIS METHODS FOR THE DEPLOYMENT OF T-PODS IN ENVIRONMENTAL IMPACT STUDIES FOR WIND FARMS: COMPARABILITY AND DEVELOPMENT OF STANDARD METHODS. ABSTRACT BOOK 25th CONFERENCE OF THE EUROPEAN CETACEAN SOCIETY 21st – 23rd MARCH 2011, CÁDIZ/SPAIN**

[http://www.circe.biz/files/Abstract\\_book\\_ECS2011-11.pdf](http://www.circe.biz/files/Abstract_book_ECS2011-11.pdf)

In the expansion of regenerative energy, offshore-wind farms take up a special relevance. Construction and operation of wind farms, however, influence the marine environment. In German waters, the German Federal Maritime and Hydrographic Agency commit wind farm project applicants to conduct environmental impact studies (EIS) by regulations outlined in the “Standards for the Environmental Impact Assessment” (StUK3). Amongst others, StUK3 is describing how to investigate the habitat use of harbour porpoises with acoustic data loggers (porpoise detectors, PODs). These register echolocation clicks used for orientation, foraging and communication. The AMPOD-project aimed for developing standard methods and guidelines for the application of PODs in static acoustic monitoring (SAM) programs in EIS for wind farms. We investigated the influences of different parameters on data retrieval with T-PODs (Timing porpoise detectors), and compared different analysis methods. This knowledge helps for a better interpretability and comparability of results obtained - not only with TPODs - in SAM studies. The results show the importance of calibrating SAM-devices. Adjusting the devices to a standard sensitivity helps to gather comparable data. Other issues: T-PODs with different deployment depths retrieved significantly different data in water depths greater than 20m, most likely caused by the porpoises’ preference of certain water depths or by thermoclines interfering with the T-POD detection abilities. Above a certain level of background noise received by the monitoring devices, noise affects data by masking true detections or raising the number of false positives. Analysis of data should therefore consider recorded background noise, either by excluding or adjusting data retrieved at certain noise levels. We tested a model that may be applicable under certain conditions to align data recorded with devices of different sensitivity. We will introduce recommendations and guidelines on how to conduct SAM with PODs and propose standard procedures for POD application and data analysis.

**MARINE TOP PREDATORS AND RENEWABLES; SURVEY AND RESEARCH REQUIREMENTS Workshop Report 18-19th**

<http://www.masts.ac.uk/documents/MASTSPredReneWshop.pdf>

There is a growing and urgent need to better understand the potential impacts of offshore wind, tidal and wave devices on seabirds and marine mammals, and for advice on the most appropriate techniques for baseline surveys and impact studies. This two day workshop, organised through the MASTS Marine Predators Joint Research Theme ([www.masts.ac.uk](http://www.masts.ac.uk)), brought together researchers, regulators and industry to identify survey and research requirements, and opportunities for knowledge transfer

2010

**Cranford TW, Krysl P, Amundin M (2010) A New Acoustic Portal into the Odontocete Ear and Vibrational Analysis of the Tympanoperiotic Complex. PLoS ONE 5(8): e11927. doi:10.1371/journal.pone.0011927**

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0011927>

Global concern over the possible deleterious effects of noise on marine organisms was catalyzed when toothed whales stranded and died in the presence of high intensity sound. The lack of knowledge about mechanisms of hearing in toothed whales prompted our group to study the anatomy and build a finite element model to simulate sound reception in odontocetes. The primary auditory pathway in toothed whales is an evolutionary novelty, compensating for the impedance mismatch experienced by whale ancestors as they moved from hearing in air to hearing in water. The mechanism by which high-frequency vibrations pass from the low density fats of the lower jaw into the dense bones of the auditory apparatus is a key to understanding odontocete hearing. Here we identify a new acoustic portal into the ear complex, the tympanoperiotic complex (TPC) and a plausible mechanism by which sound is transduced into the bony components. We reveal the intact anatomic geometry using CT scanning, and test functional preconceptions using finite element modeling and vibrational analysis. We show that the mandibular fat bodies bifurcate posteriorly, attaching to the TPC in two distinct locations. The smaller branch is an inconspicuous, previously undescribed channel, a cone-shaped fat body that fits into a thin-walled bony funnel just anterior to the sigmoid process of the TPC. The TPC also contains regions of thin translucent bone that define zones of differential flexibility, enabling the TPC to bend in response to sound pressure, thus providing a mechanism for vibrations to pass through the ossicular chain. The techniques used to discover the new acoustic portal in toothed whales, provide a means to decipher auditory filtering, beam formation, impedance matching, and transduction. These tools can also be used to address concerns about the potential deleterious effects of high-intensity sound in a broad spectrum of marine organisms, from whales to fish.

**Kot CY, Fujioka E, Hazen LJ, Best BD, Read AJ, et al. (2010) Spatio-Temporal Gap Analysis of OBIS-SEAMAP Project Data: Assessment and Way Forward. PLoS ONE 5(9): e12990. doi:10.1371/journal.pone.0012990**

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0012990>

The OBIS-SEAMAP project has acquired and served high-quality marine mammal, seabird, and sea turtle data to the public since its inception in 2002. As data accumulated, spatial and temporal biases resulted and a comprehensive gap analysis was needed in order to assess coverage to direct data acquisition for the OBIS-SEAMAP project and for taxa researchers should true gaps in knowledge exist. All datasets published on OBIS-SEAMAP up to February 2009 were summarized spatially and temporally. Seabirds comprised the greatest number of records, compared to the other two taxa, and most records were from shipboard surveys, compared to the other three platforms. Many of the point observations and polyline tracklines were located in northern and central Atlantic and the northeastern and central-eastern Pacific. The Southern Hemisphere generally had the lowest representation of data, with the least number of records in the southern Atlantic and western Pacific regions. Temporally, records of observations for all taxa were the lowest in fall although the number of animals sighted was lowest in the winter. Oceanographic coverage of observations varied by platform for each taxa, which showed that using two or more platforms represented habitat ranges better than using only one alone. Accessible and published datasets not already incorporated do exist within spatial and temporal gaps identified. Other related open-source data portals also contain data that fill gaps, emphasizing the importance of dedicated data exchange. Temporal and spatial gaps were mostly a result of data acquisition effort, development of regional partnerships and collaborations, and ease of field data collection. Future directions should include fostering partnerships with researchers in the Southern Hemisphere while targeting datasets containing species with limited representation. These results can facilitate prioritizing datasets needed to be represented and for planning research for true gaps in space and time.

**Yovel Y, Au WWL (2010) How Can Dolphins Recognize Fish According to Their Echoes? A Statistical Analysis of Fish Echoes. PLoS ONE 5(11): e14054. doi:10.1371/journal.pone.0014054**

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0014054>

Echo-based object classification is a fundamental task of animals that use a biosonar system. Dolphins and porpoises should be able to rely on echoes to discriminate a predator from a prey or to select a desired prey from an undesired object. Many studies have shown that dolphins and porpoises can discriminate between objects according to their echoes. All of these studies however, used unnatural objects that can be easily characterized in human terminologies (e.g., metallic spheres, disks, cylinders). In this work, we collected real fish echoes from many angles of acquisition using a sonar system that mimics the emission properties of dolphins and porpoises. We then tested two alternative statistical approaches in classifying these echoes. Our results suggest that fish species can be classified according to echoes returning from porpoise- and dolphin-like signals. These results suggest how dolphins and porpoises can classify fish based on their echoes and provide some insight as to which features might enable the classification.

**Hans Slabbekoorn, , Niels Bouton, Ilse van Opzeeland, Aukje Coers, Carel ten Cate<sup>1</sup> and Arthur N. Popper (2010) A noisy spring: the impact of globally rising underwater sound levels on fish Trends in Ecology & Evolution Volume 25, Issue 7, July 2010, Pages 419-427**

<http://epic.awi.de/Publications/Sla2010a.pdf>

The underwater environment is filled with biotic and abiotic sounds, many of which can be important for the survival and reproduction of fish. Over the last century, human activities in and near the water have increasingly added artificial sounds to this environment. Very loud sounds of relatively short exposure, such as those produced during pile driving, can harm nearby fish. However, more moderate underwater noises of longer duration, such as those produced by vessels, could potentially impact much larger areas, and involve much larger numbers of fish. Here we call attention to the urgent need to study the role of sound in the lives of fish and to develop a better understanding of the ecological impact of anthropogenic noise.

**Barber, Crooks, Fristrup. (2010) The costs of chronic noise exposure for terrestrial organisms. Trends in Ecology and Evolution Volume 25, Issue 3**

[www.sciencedirect.com](http://www.sciencedirect.com)

Growth in transportation networks, resource extraction, motorized recreation and urban development is responsible for chronic noise exposure in most terrestrial areas, including remote wilderness sites. Increased noise levels reduce the distance and area over which acoustic signals can be perceived by animals. Here, we review a broad range of findings that indicate the potential severity of this threat to diverse taxa, and recent studies that document substantial changes in foraging and anti-predator behavior, reproductive success, density and community structure in response to noise. Effective management of protected areas must include noise assessment, and research is needed to further quantify the ecological consequences of chronic noise exposure in terrestrial environments.

**Wade, Whitehead, Weilgart. (2010) Conflict of interest in research on anthropogenic noise and marine mammals: Does funding bias conclusions? Marine Policy 34 320-327.**

[www.sciencedirect.com](http://www.sciencedirect.com)

The U.S. Navy, whose sonars kill marine mammals, provides approximately 50% of the funds for marine mammal research worldwide. We examined six reviews of research on the effects of anthropogenic sound on marine mammals, as well as the primary papers cited in the reviews. These reviews cite references showing noise has no effect on marine mammals at an increasing frequency as their funding moves from a conservation organization to independent to partial U.S. military sources. Primary papers are 2.3 times more likely to be cited in the reviews as concluding no effect of noise if the research was militarily-funded than if not. Thus, conflict of interest may have led to a misrepresentation of the effects of noise on marine mammals in both the primary and secondary literature, and thus misinform public policy decisions.

**Hemilae S, Nummela\* S, Reuter T (2010) Anatomy and physics of the exceptional sensitivity of dolphin hearing (Odontoceti: Cetacea). Journal of Comparative Physiology, A 196:165-179**

<http://www.springerlink.com/content/b2652797833p3538>

During the past 50 years, the high acoustic sensitivity and the echolocation behavior of dolphins and other small odontocetes have been studied thoroughly. However, understanding has been scarce as to how the dolphin cochlea is stimulated by high frequency echoes, and likewise regarding the ear mechanics affecting dolphin audiograms. The characteristic impedance of mammalian soft tissues is similar to that of water, and thus no radical refractions of sound, nor reflections of sound, can be expected at the water/soft tissue interfaces. Consequently, a sound-collecting terrestrial pinna and an outer ear canal serve little purpose in underwater hearing. Additionally, compared to terrestrial mammals whose middle ear performs an impedance match from air to the cochlea, the impedance match performed by the odontocete middle ear needs to be reversed to perform an opposite match from water to the cochlea. In this paper, we discuss anatomical adaptations of dolphins: a lower jaw collecting sound, thus replacing the terrestrial outer ear pinna, and a thin and large tympanic bone plate replacing the tympanic membrane of terrestrial mammals. The paper describes the lower jaw anatomy and hypothetical middle ear mechanisms explaining both the high sensitivity and the converted acoustic impedance match.

### ***III The potential for joint initiatives on noise and disturbance with ACCOBAMS and/or OSPAR:***

#### **ACCOBAMS**

Karsten attended at the SC7 of ACCOBAMS (Monaco, 29-31 March 2011) and discussed possible noise related joint initiatives (please see notes underneath) with Yanis Souami (chair of the ACCOBAMS noise working group). There was a general understanding that it makes absolutely sense to coordinate the work of both groups and to approach the tasks in a corporative manner.

Here is what we discussed so fare:

- 1) Linking the two Noise Working Groups
  - Karsten will contact Gianni Pavan to see whether he agrees to be a “task manager” for seismic surveys (see below)
  - Yanis will contact Michel André to see whether he agrees to be a “task manager” for shipping (see below)
  - Yanis will prepare an overview of the structure foreseen for joint noise work and the tasks assigned
  - Karsten and Yanis will send a joint message to the members of both working groups, informing them about our meeting and the suggested joint actions, to get their endorsement
  - In future, Yanis and Karsten will always coordinate themselves before messages are sent to the groups
  
- 2) Approach to Parties for information
  - Karsten will adapt the offshore wind farm construction questionnaire used by ASCOBANS for ACCOBAMS purposes (timeframe: 2 weeks from now); ACCOBAMS Secretariat to send out to the focal points
  - Yanis will draft a similar questionnaire for military activities, which will include questions about mitigation measures already taken, planned, as well as data sources/maps used (timeframe: 4 weeks from now); to be sent out by ACCOBAMS and ASCOBANS Secretariats to their respective focal points
  - Focal points will be asked in both questionnaires to provide information on contributors to the report to get an overview of people involved in relevant work
  - Similar questionnaires on seismic surveys and shipping will be done later; Gianni Pavan and Michel André suggested as lead experts
  
- 3) Approach to other stakeholders for gathering of information on actions taken and available data:
  - Karsten will approach the German navy about the EDA POMM project
  - Yanis will approach the NATO RC
  - Other members of the noise working groups will be asked to approach institutions they have direct contact with, e.g. IWC
  
- 4) Use of information gathered under 2) and 3)
  - Compile overview of projects related to mapping density of species, data sources, etc.

- Drafting of summaries of the noise guidelines for specific stakeholders, which should be applicable for the stakeholders (i.e. avoid unrealistic demands) and science-based; to be done by “task managers” of each topic (renewable energy, military, seismic surveys, shipping) in consultation with stakeholders, then to be sent to joint working group for comments
- 5) Development of pilot projects for testing the implementation of the noise guidelines (e.g. test detection devices and software) and when necessary refinement

## **OSPAR**

Needs to be developed



#### ***IV Potential terms of reference for a report (or reports) that might***

**Examine ways in which ASCOBANS can assist Parties in meeting the requirements of the relevant European Directives (i.e. the Marine Strategy Framework Directive and the Habitats Directive) and other bodies that countries have elected to adhere to which are concerned with marine noise;**

This section depends strongly on the work of the EU technical subgroup noise. This work is still in progress and therefore this section needs to be filled later this year.

However, the SC7 of ACCOBAMS (Monaco, 29-31 March 2011) suggested to create a common ASCOBANS / ACCOBAMS working group on the EU Marine Strategy Framework Directive to work on general aspects of the directive (not limited to noise). This working group will go deeper on this issue to collect more material for the next ACCOBAMS Scientific Committee. The Representative of ASCOBANS Heidrun Frisch welcomed the idea to have a common working group, and informed the Meeting that she will suggest the idea to the next ASCOBANS Advisory Meeting.

**Provide Parties with information about mitigating technologies and management measures, and their effectiveness and cost.**

Please see OSPAR on page 6

***V The assessment of the implementation by Parties of the different aspects of the Resolution No. 2 on adverse effects of underwater noise on marine mammals during offshore construction activities for renewable energy production, as adopted at the 6th Meeting of the Parties of ASCOBANS.***

(Evaluation was done by Karsten Brensing, supported by some members of the group but not approved by the whole group)

All member states responded to the questionnaire.

Poland mentioned the following:

Please be informed that there are no offshore wind farms (Construction Activities for Renewable Energy Production) on Polish waters. There are some projects, but their legal procedure is not finished so they are not approved. That's why we can not deliver you more detailed answers to questions listed in the questionnaire. According to our law offshore wind farms must have Environmental Impact Assessment in phase of planning. Report of EIA must be verified and also provided to the public opinion for consultation.

The color of the highlights represents the following:

**Green:** positive in the light of conservation

**Yellow:** possibly meaningless or neutral

**Red:** response is problematic or even dangerously in light of conservation

It is not always the case that a YES means a positive response. For instance question 1c: Yes means renewables are allowed in MPAs. Compared to a ban of renewables this is a negative answer in the light of conservation and is therefore highlighted in red.

## 1) EIA and MPAs

- a) Is an Environmental Impact Assessment carried out prior to every project on marine renewable energy development, and does it include the construction phase?
- b) Does this EIA contain an environmental assessment of the sitting of the project in which marine mammals are considered?
- c) Are marine renewable energy projects allowed within Marine Protected Areas?

	a	b	c
Belgium	Yes	No	Yes
Denmark	Yes	Yes	Yes
Finland	Yes	Yes	No
France	Yes	Yes	Yes/No
Germany	Yes	???	No
Lithuania	Yes	Yes	Yes
Netherlands	Yes	Yes	Yes
Poland	Yes	???	???
Sweden	Yes	Yes	Yes
UK	Yes	Yes	Yes

## 2) Current measures

2. *Requests* Parties and Range States that have not yet done so to introduce precautionary guidance on measures and procedures for all activities surrounding the development of renewable energy production in order to minimise risks to populations, and mitigate possible effects to small cetaceans following current best practice;

3. *Recommends* that these guidelines should include where possible and relevant:

- (a) Appropriate siting of devices to minimise impacts on small cetaceans;
- (b) Measures for avoiding construction activities with high underwater noise source levels during the periods of the year with the highest densities of small cetaceans, and in so doing limiting the number of animals exposed, if potentially significant adverse effects on small cetaceans cannot be avoided by other measures;
- (c) Measures for avoiding construction activities with high underwater noise source levels when small cetaceans are present in the vicinity of the construction site;
- (d) Measures for alerting small cetaceans to the onset of potentially harmful construction noise; and
- (e) Technical measures for reducing the sound emission during construction works, if potentially significant adverse effects on small cetaceans cannot be avoided by other measures.

- a) Are measures taken to avoid construction activities with high underwater noise source levels during the periods of the year with the highest densities of small cetaceans?
- b) Are observers present on pile driving sites, or are they monitored at pile driving sites with passive acoustic devices? Is the pile driving area monitored for cetaceans prior to pile driving? Is pile driving allowed at night or in conditions with bad visibility or bad sighting conditions for cetaceans?
- c) Are measures taken for alerting small cetaceans to the onset of potentially harmful construction noise, and in which way? Is a ramp-up or soft start procedure in place for pile driving activities, and what are the standards or requirements in this procedure?
- d) Have noise limitations for pile driving been set, and which ones (noise limits, distance, etc.)?
- e) Are technical measures taken, considered or tested which reduce sound emission during construction works?

	a	b	c	d	e
<b>Belgium</b>	???	No	Yes	No	No
<b>Denmark</b>	No	No	???	No	No
<b>Finland</b>	No	No	No	No	No
<b>France</b>	Yes but*	Yes but*	Yes but*	Yes but*	Yes but*
<b>Germany</b>	No	No	Yes	Yes	Yes
<b>Lithuania</b>	No	No	No	No	No
<b>Netherlands</b>	Yes	???	???	No	Yes

<b>Poland</b>	???	???	???	???	???
<b>Sweden</b>	Yes	No	Yes	No	Yes
<b>UK</b>	No	Yes	Yes	Yes but**	Yes

\* This issue is taken into consideration in the ongoing EIA studies.

\*\* The 'mitigation zone' represents the area in which a marine mammal could be exposed to sound that could cause auditory injury.... The radius of the mitigation zone should be no less than 500 metres.

### 3) New measures, research, evaluation of measures

- a) Are, in your country, new mitigation measures, guidelines and technological adaptations developed to minimise any potentially significant adverse effects on small cetaceans due to offshore construction in the framework of marine renewable energy production?
- b) Is your country developing and implementing procedures to assess the effectiveness of any guidelines or management measures introduced?
- c) Does your country continue to conduct research into the effects on small cetaceans of marine renewable energy production, including on physical and behavioural effects, and at the individual and population level?
- d) In which way is information on methods and results (internationally) shared?
- e) In which way are measures reviewed and adapted in view of results of research or changed techniques?

	a	b	c	d*	e
<b>Belgium</b>	No	Yes	Yes	<a href="http://www.mumm.ac.be">www.mumm.ac.be</a>	Yes
<b>Denmark</b>	Yes	Yes	Yes	web sites of the Energy Agency and/or developer/power company	Yes
<b>Finland</b>	No	No	No	No	No
<b>France</b>	No	Yes	Yes	No	Yes
<b>Germany</b>	Yes	Yes	Yes	???	Yes
<b>Lithuania</b>	No	No	No	???	???
<b>Netherlands</b>	Yes	???	Yes	Online	???
<b>Poland</b>	???	???	???	???	???
<b>Sweden</b>	Yes	Not yet	Yes	Nordvind	No
<b>UK</b>	Yes	Yes	Yes	web, reports, seminars	Yes

\*ICES recommendation 2010<sup>4</sup>: The risks and potential impacts of many offshore developments are similar. It is obviously inefficient that EIAs are carried out entirely independent from each other because this will result in the duplication of effort and repetition of the same mistakes.

With regard to wind farm developments, establishment of means for efficient dissemination of results of common interest and means of making previous EIA reports and previously collected baseline data available for subsequent studies and assessments.

<sup>4</sup> [http://www.ices.dk/reports/ACOM/2010/WGMME/wgmme\\_final\\_2010.pdf](http://www.ices.dk/reports/ACOM/2010/WGMME/wgmme_final_2010.pdf)

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