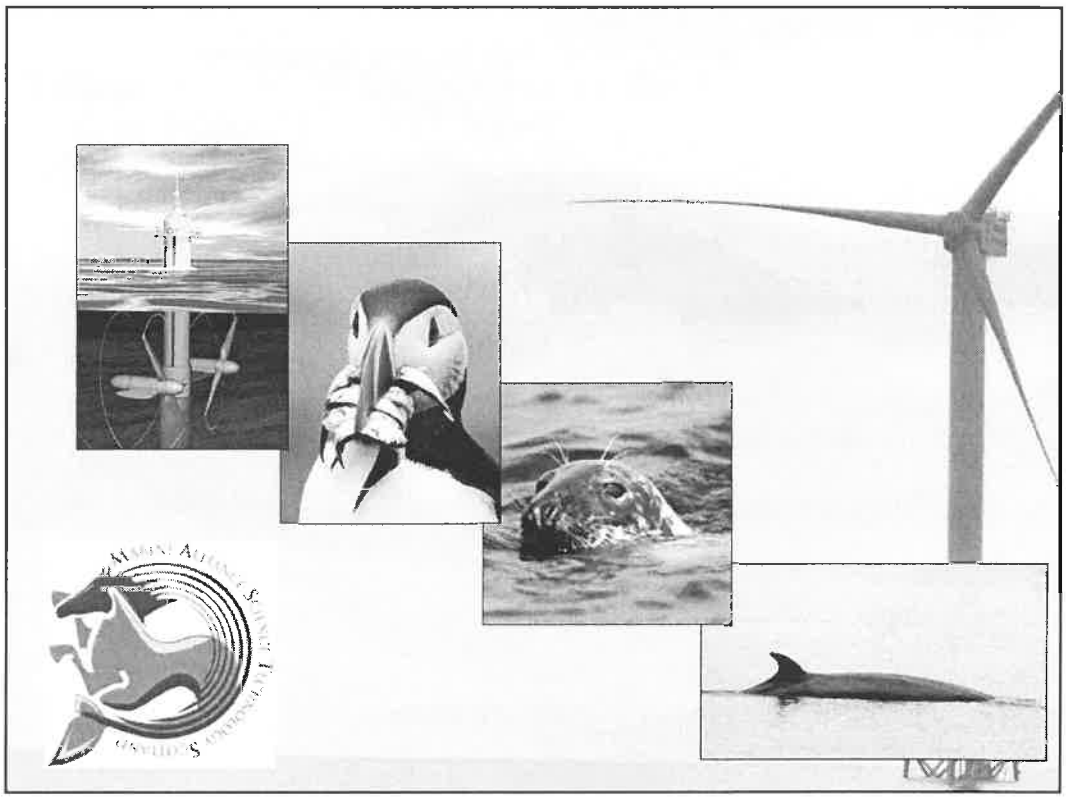
MARINE TOP PREDATORS AND RENEWABLES;

SURVEY AND RESEARCH REQUIREMENTS



MASTS Marine Predator JRT

Workshop Report

18-19th March 2010, Perth

Contents

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For further information on any aspect of the workshop, please contact either the facilitator of specific scoping papers or one of the workshop organisers below.

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1. Executive Summary

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), brought together researchers, regulators and industry to identify survey and research requirements, and opportunities for knowledge transfer (see Annex I for attendees).

Key drivers for the workshop included:

- The imminent requirements for extensive survey work, particularly at Round 3 windfarm sites, and the dramatic increase in scale of proposed developments.
- Concerns that survey protocols developed for terrestrial or shallow water sites may be less appropriate for offshore or tidally active areas, and that the resulting data may be unsuitable for predicting or assessing environmental impacts or benefits.
- Recognition that carefully co-ordinated research in key areas is required to evaluate environmental impacts or benefits.
- The opportunities that the development of infrastructure and monitoring capacity at offshore sites provide for understanding our marine environment.

The first day of the workshop identified key issues and data requirements. Initially we focussed on current and emerging guidelines for monitoring marine mammals and seabirds, and lessons learned from demonstration projects in Strangford Lough and the Moray Firth. Breakout groups then explored the strengths and weaknesses of monitoring guidelines, key research requirements and opportunities for capacity building and knowledge transfer.

During the second day of the workshop, feedback from breakout groups was used to identify priority issues and opportunities (Table 1), and a sub-set of these were selected for further discussion. The main body of this report consists of a series of short scoping papers on this sub-set of issues and opportunities. These vary in format, but the common aim is that they should be used to stimulate further discussion on these issues and the development of policy or funding applications.

Finally, the workshop closed with an exploration of how its outcomes could be integrated into other initiatives and used to develop funding partnerships. This highlighted the importance of linkage with research councils (through the NERC Environmental Research Scoping Study and NERC Marine Renewable Energy Thematic Programme), Scottish and UK Government initiatives (through the SEA and DECC's Offshore Renewables Research Steering Groups) and International organisations (eg. ICES Working Groups). Whilst there are clear opportunities for collaborations with specific industrial partners, these discussions also emphasised the key role that COWRIE had previously played in supporting focussed studies that benefitted the entire industry. This highlighted the need for alternative mechanisms for co-ordinating and funding the partnership projects that are required to support the development of the industry and the UK's efforts to meet its 2020 CO_2 targets.

Table 1. Summary of the priority issues and opportunities identified by MASTS workshop participants.

1. Monitoring Issues

1.1. There needs to be clearer agreement on data collection & analysis methods. This requires the identification, first, of data required both for consenting and for detecting impacts and, second, the most appropriate techniques for collecting and analysing these data.

1.2. There are clear logistic and economic benefits of integrating surveys to collect data on both seabirds and marine mammals. Further development and evaluation of integrated surveys is now required to ensure that they can provide robust data for both groups.

1.3. Regulators require the development of a risk-based modelling framework that can combine varied datasets to predict population level impacts and underpin consenting decisions.

2. Research Priorities

2.1. Assessment of the impacts of construction and operation noise on marine top predators and their prey.

2.2. Estimation of the probability of collisions with tidal and wind devices and their population consequences.

2.3. Assessment of connectivity between development sites and Natura 2000 Sites.

2.4. Development of modelling frameworks to assess the population consequences of behavioural change – including marine mammal displacement during construction and seabird displacement from operational sites.

2.5. Assessment of the impact of renewable devices on predator foraging behaviour.

2.6. Development and evaluation of mitigation measures – to reduce the impacts of piling, optimize noise from tidal devices to reduce collision risk and design lighting systems that minimise collision risk or behavioural changes.

2.7. Exploration of potential for using this new offshore infrastructure as a platform for sensor networks that will support future research and monitoring of marine environmental conditions and the occurrence and behaviour of predators and their prey.

2.8. Evaluation of the ecological costs and benefits of marine renewables.

3. Knowledge Transfer Issues

3.1. Increasing capacity – there is a need to ensure that training programmes are in place to produce new surveyors and expert advisors, and to provide CPD for existing players.

3.2. Increasing availability – in the shorter–term, provision of expert advice may require mechanisms to be developed for secondment or buy out of time.

3.3. Use of existing fora – opportunities for knowledge exchange should focus on working within existing frameworks (eg. Scottish Renewables Forum).

3.4. Science outputs – mechanisms need to be developed for the peer-review and rapid dissemination of key research findings of relevance to the industry.

Issues 1.1– Guidelines for survey data collection and analysis

Facilitator: Paul Thompson

Background

Site based surveys of marine mammals and seabirds are initially required to characterise development sites, and to support the design of mitigation measures and consenting. In addition, further survey work may be required during construction and post construction to assess impacts. Guidance for these surveys has generally been based upon work at terrestrial sites and seabird survey protocols. Whilst these may be sufficient at inshore coastal sites, they are less suitable for work at active tidal sites and offshore STW and R3 sites, particularly for marine mammals.

Currently, SNH are funding the development of more appropriate guidelines for survey work at wet renewable sites, supporting a policy of deploy and monitor. In contrast, existing guidance for windfarms has not been adapted for the more challenging environmental conditions at offshore STW and R3 sites. This poses particular problems where existing guidance for terrestrial and inshore sites expects developers to provide 2 years of year-round survey data to support applications for consent. Developers must apply for consent within the next 2 years to meet their 2020 targets. In the absence of clearer guidance on data requirements and analysis, there is a risk that the expensive survey programmes which they are now embarking upon will fail to provide suitable data to support consenting.

Key issues

- Existing guidelines tend to focus on process and techniques, rather than identifying key data requirements.
- Visual surveys require good weather conditions, severely constraining opportunities for year-round data collection in offshore areas.
- Marine mammal surveys have typically been developed as an add-on to boat-based bird surveys, for which more detailed guidance exists.
- Suitable survey platforms and experienced surveyors are in short supply, and this problem is likely to worsen as more sites develop their baseline survey programmes.
- Visual observation (by either experienced or inexperienced surveyors) cannot easily be verified, and errors in observer estimates of abundance, distance or flight heights is rarely quantified. The policy implications of uncertain species identifications are enormous in relation to connectivity with Natura sites.

Ways forward

There needs to be urgent agreement on what additional data collection is required before consenting. This should take account of the timescales faced by developers, the amount of new data that can be realistically collected given the available

methodology, and how these data will be integrated into analytical frameworks and risk-based decision making.

There is a need to provide more open access to existing data, so that all sources can be carefully scoped, and requirements for additional surveys evaluated in relation to the additional understanding they are likely to provide at particular sites.

Where boat-based visual surveys are being conducted for seabird surveys, the value of marine mammal observations could be enhanced by using passive acoustic techniques. Both boat-based and static passive acoustic monitoring of marine mammals also provide a verifiable record of species identification data.

Static acoustic monitoring may be especially suitable for temporal patterns of occurrence at key sites, and could be integrated into new infra-structure to male post-construction monitoring more cost-effective.

High definition video provides potential for integrating bird and mammal surveys and providing verifiable records of all sightings. Early efforts to evaluate this potential and compare with existing visual techniques would be of clear benefit to the industry.

Some baseline data is likely to be required at all sites. However, studies of the impact of these developments will require more detailed studies that are best focussed at selected sites.

There are clear scientific, logistic and economic benefits for conducting co-ordinated large scale surveys instead of multiple independent surveys at different sites.

Potential links with other projects

SNH funded work by Royal Haskonen on the development of monitoring techniques for wet renewable sites (due summer 2010).

TCE funded report by SMRU Ltd on marine mammal monitoring options at R3 sites – report available as final draft. There is now an urgent need to evaluate these proposals and determine how best to integrate into new or existing R3 monitoring, potentially through a technical workshop.

Funding issues

A more co-ordinated approach to baseline surveys, and the need to focus impact studies at specific sites, both require the development of consortium funding programmes to share costs.

Issue 1.3 - A model framework for considering limits to renewable energy operations to meet population level management objectives

Facilitator: Phil Hammond

Background

Almost all of the focus on the impacts of renewable energy developments in the marine environment has been on individual-level effects, driven by the legislative requirement not to disturb animals. The main focus relating to the generation of power from wind farms at sea has been on the effects of construction on marine mammal health and behaviour. Wet renewable energy (especially tidal turbines) will likely also have impacts during normal ongoing operations. However, an arguably more important consideration is the effect at the population level. Will the renewable energy industry have an impact on Favourable Conservation Status (FCS) of protected species of seabirds and marine mammals?

The renewable energy industry is developing rapidly and regulators need to make decisions on granting consent for licences in the near future. The scientific community is not in a position to give management advice on whether or not developments need to be limited based on population level concerns. However, as the industry develops and expands from a few sites to a large number of sites, impacts at the population level will become increasingly important. An issue of concern often raised is the potential for cumulative effects of renewable energy development over ever larger areas of sea. This issue can only be considered sensibly at a population level. Consideration of population level effects also means that this is a European problem, not just a Scottish or UK one.

What is needed is a science-based, risk-averse model framework that will allow regulators to set limits (if required) to renewable energy operations to meet population level management objectives, such as FCS. The development of such a framework can draw on existing work in this and related areas. The PCAD framework is a conceptual framework for considering the functional links between individual and population effects of noise in the marine environment. The ERMC is an operational framework developed for the Navy to inform the use of sonar in military exercises, based primarily on models of marine mammal density and sound propagation.

The most useful existing frameworks, however, are those for managing the exploitation of marine renewable resources: whaling and fishing. These frameworks have been developed using Management Strategy Evaluation (MSE) to establish Operational Management Procedures that allow resource managers to set limits to anthropogenic activities to achieve quantitatively defined management objectives.

A framework for managing the effects of the renewable energy industry on marine predators

A key element of such a framework is that it can incorporate the many uncertainties that exist, and will always exist, in our knowledge of the biology of the species affected, and on the effects of the renewable energy industry on these species. As

scientific knowledge increases, that uncertainty can be reduced. But it is essential in a risk-averse management framework, to incorporate uncertainty explicitly.

A good management framework should benefit from ongoing data collection (monitoring) to allow the incorporation of a feedback mechanism and to enable determination of whether or not management actions are allowing objectives to be met. Development must be in a model simulation framework. The data need to be at the level of how individuals are affected and measures of populations; determining what they should be for the framework to perform optimally is part of the development process. Development of appropriate performance statistics is also a key element.

The greatest challenge in developing this framework is to find a way to incorporate sub-lethal effects on animals. In exploitation industries in which animals are killed this is relatively straightforward to deal with. But how do we equate varying degrees of disturbance to individual animals to effects on growth, survival, reproduction and ultimately population abundance? A framework can be developed to explore various scenarios for this but the uncertainty that will flow through to management recommendations will be large until we understand these effects better.

Potential Outputs

The output of this project will be a management framework that can be used by regulators to determine whether restrictions should to be placed on the activities of the renewable energy industry and, if so, the extent of these restrictions. The management decisions will be based on a robust procedure developed explicitly to allow agreed management objectives to be met. It will be able to be applied at a national or international level, depending on how populations of impacted animals are defined.

Timescales & next steps

A key element in developing a framework is a close interaction between science, industry and regulators. A framework can only be developed to meet quantitatively defined management objectives. These must be agreed by regulators, in discussion with the industry and scientists. Once this framework has been defined, extensive collaboration will then be required by scientists with specialist modelling skills and those with an appreciation of the data that can be used to parameterise models and provide appropriate performance statistics.

As such, this will not help address short-term issues, but it could provide a robust basis for managing the impacts of this important industry for the long-term future.

A first step in this process would be to bring together a representative group of regulators, industry and scientists to develop an appropriate framework, agree management objectives and scope the work required to implement the framework.

Issue 2.1 – Assessing the impact of operational & construction noise

Facilitator: Stephen Kerr

Background

The potential impact of underwater noise on marine mammals is widely recognised, and guidelines have been developed to minimise the risk of physical damage to animals that are close to loud sources such as seismic survey vessels or pile driving activities. However, in the context of offshore renewables, a key concern is the potential for broader-scale disturbance and temporary habitat loss from pile-driving.

Understanding of the characteristics of pile driving noise is increasing, but there remain discrepancies in the standards used to measure noise levels, and the cumulative effects are not well understood. Furthermore, other noises in the marine environment (both naturally occurring and human) are not well mapped. Finally, although concerns focus on pile-driving during construction, there is limited information on the noise characteristics of different operational devices.

The major gap is in understanding the effect of different noise levels on marine mammals and birds, either through direct behavioural responses or by altering the availability of their fish prey. In particular, whilst loud noises are expected to lead to avoidance of construction sites by marine mammals, there is uncertainty over the distances at which this may occur, and how this may vary for different species.

Key research requirements

- Accurate measurements of operational noise from different designs of wind turbines, wave and tidal devices are required to characterise their acoustic footprint.
- Understanding of variations in ambient noise, and other anthropogenic noise sources, must be improved to assess likely effects of additional noise from construction or operation of marine renewable devices.
- Data are required on the spatial scale at which marine predators and their prey respond to well characterised noise sources, and whether this varies according to individual characteristics, behavioural state or other environmental variables.
- Engineering solutions are required either to develop alternatives to piling (eg. through Carbon Trust technology accelerator foundation/structures) or to decrease propagation of noise through water and/or sediments.
- Spatial modelling frameworks should be developed to mitigate cumulative effects when planning activity offshore and at ports/harbours. Incorporation of information on the patterns of occurrence of marine mammals in construction areas could also help plan construction activities to minimise costly downtime that might result from compliance with disturbance regulations.

Opportunities for addressing data gaps

Standard procedures should be developed for use at existing (EMEC) and proposed (Aberdeen Deployment Centre) test centres to characterise the noise profiles of different devices.

Development of "next generation" acoustic measurement devices could enable wide scale deployment across the UK in a cost effective programme integrated with industry. Wide scale deployment of standard devices should provide a better understanding than piecemeal measurements campaigns on a project by project basis.

Early opportunities should be identified for focussed studies of behavioural responses of marine mammals to pile driving. These could include measurements during construction of R2 sites, at the Aberdeen Deployment Centre or during early works on STW or R3 sites (e.g. during installation of met masts). Key species of interest are harbour porpoise and grey and harbour seals, which are likely to occur throughout most UK and European development sites and are therefore of broadest relevance to the industry. Studies of fine-scale behavioural response are best focussed on seals, using proven tagging technology. Static acoustic monitoring and visual survey techniques provide established methods for assessing changes in the occurrence of harbour porpoises at sampling sites at different distances from piling activity.

Suggested Actions and Timescales

2010 - Clarify measurement requirements to support consenting process
Improve modelling approaches & develop impact assessment tools
Develop "Industry standards" for measurements of noise & effects
R&D next generation acoustic devices – better lifespan, deploy-ability etc
Identify key sites for focussed behavioural studies and field measurements

2011-2012 - Wide scale deployment of next generation acoustic devices
Implement focussed studies at key sites & measurements at R2 & met masts

2013-2015 – Field measurements at R3 sites and wave & tidal sites

Throughout - explore opportunities for collaborative ventures with military and oil and gas industry research programmes on impacts of underwater sound/ measurements of ambient and other noise sources.

Funding

Need to ensure efficient use of resources rather than duplicate activity on a project by project basis. Pool funding from developers, DECC and TCE to generate fund for wide scale strategic deployment. Explore potential for partnership funding on projects with military and oil and gas industry.

Issue 2.2. Collisions with wind, wave & tidal devices

Facilitator: Rowena Langston

There is a need to assess collision impacts/validation of predictions, and the population consequences of collisions for birds, marine mammals, fish (basking shark) & bats

1. Measuring collisions

Collisions are generally rare events so the mode of measurement needs to sample continuously or at least for an extended time window to capture seasonal variation. Most interactions are considered to be either fatal or lead to serious injury or trauma, liable to result in fatality. Focusing on sites which offer the best scope for measuring actual collisions and validating collision risk predictions would be the most cost-effective approach to collecting high quality data, to permit refinement of predictive models and assess the scale of the problem for focal species.

a). Measurement of underwater collisions of marine mammals, basking sharks and birds

There remain practical difficulties of measuring collisions, requiring testing and refinement of the hardware and software tools available for measuring collision. Most approaches require supplementary species identification:

- Strain gauges – detection depends on body mass, so birds may not be detected
- Underwater infra-red cameras - short operational range
- Sonar/acoustic cameras

Currently, there is a range of possible tidal stream devices. Any research project needs to encompass the most likely broad types of device and operation. Tidal turbines tend to be located in narrows, which potentially facilitates measurement of collision but the requirement to cease operation when a marine mammal is within 50m has so far precluded measurement of collisions. Furthermore, the transition to continuing operation in the presence of marine mammals may increase collision risk for animals that have become accustomed to the presence of a stationary structure.

Existing/planned studies:

- A Glasgow/Birmingham University PhD studentship to study the response of captive marine mammals to underwater devices.
- SNH has contracted RPS to develop collision risk models for predicting underwater collision risk and a desk study to determine the suitability of sonar for bird detection underwater.

b). Measurement of collisions of birds and bats at offshore wind farms

A camera with supplementary infra-red spotlight will enable recording during day and night, albeit operation will be restricted in some weather conditions, such as fog or heavy precipitation. The installation of one camera per wind turbine, or a strategic sample of turbines, viewing along the rotor plane, whilst unable to cover the whole collision risk zone associated with each turbine, would maximise the chance of recording a sample of the airspace in the collision risk zone. Motion detection software can be used to set the parameters for image capture and store a fixed

number of frames either side of the triggered image. Images from each sampled turbine could be streamed to a central computer for analysis.
Experimental testing and refinement of camera systems needs to focus on the best orientation of the camera to maximise the field of view whilst obtaining adequate image resolution, and the software application to minimise false positives whilst also minimising omission of appropriate trigger events within the field of view. Testing would be easiest undertaken onshore initially, where visual observations can be synchronised with the camera during periods of increased bird activity, at least during daylight, to facilitate validation of the camera operation.

2. Impacts of collisions – assessing the scale of the problem
Collision may be directly with the rotors of wind turbines or tidal stream turbines – trauma, crushing & fractures for birds colliding with wind turbine rotors; the prospect of bruising and hefty blows for marine mammals - or indirectly as a result of turbulence and/or pressure differential associated with wind turbines. Additionally, some bird species onshore are known to collide with wind turbine towers.

a). Marine mammals
A 20 yr programme of recording marine mammal strandings provides some baseline on the frequency of strandings and typical injuries. There is a need to work with veterinarians to identify the clinical features most likely to be attributable to collision with tidal devices. A programme of searches is planned for the Pentland Firth and Orkney Waters, funded by Marine Scotland. Sample searches upstream and downstream of tidal devices could be useful.

b). Birds
The Beached Bird Survey has been operational for over 30 years, and could be adapted to investigate the incidence of injury/mortality attributable to wind turbines. Digital cameras would be a useful adjunct to capture images for later determination of the cause of death, using standardised assessment.

3. Assessing the population consequences of collisions
Birds and bats collide with wind turbines and there is a strong possibility that marine mammals, basking sharks and diving birds may collide with underwater devices, with fatal consequences for the individuals. However, the key determinant of impact is the biological significance for populations of different species.

Population models can be developed for all relevant species of birds and marine mammal, but the data available to parameterise these models varies markedly between species. Models need to take account of this uncertainty in the underlying data and the full range of factors influencing populations to provide the context of impacts associated with renewable energy. Possible approaches include PVA and PBR.

Funding possibilities: The Crown Estate/industry plus government departments and/or statutory nature conservation advisers; NERC.

Issue 2.3 Assessing connectivity between development sites and Natura 2000 sites

Facilitator: Francis Daunt

Background

Ship-based and aerial surveys are being employed to provide baseline data on density distributions of seabird and marine mammals in areas proposed for marine renewables, but there is a need to establish the origin of these top predators, and in particular the connectivity between marine renewable sites and Natura sites. This question is of particular relevance to the industry since they need to demonstrate no significant impact on the integrity of the Natura network.

Of relevance to this issue are certain inherent differences between seabird, seals and cetaceans with respect to the intrinsic constraints that they are operating under:

- Seabirds breeding at colony SPAs must return repeatedly to the colony for parental care duties e.g. provisioning the young, which places considerable limitations on their foraging range
- Seals use haulout sites within SACs as a central place from which to forage. However, seals can forage much more widely and may be absent for periods of days to weeks.
- Cetaceans are not central place foragers and this increased flexibility is important when considering connectivity to SACs. Currently, SAC's have been designated for only one species, bottlenose dolphin.

Current approaches to establishing connectivity to Natura sites:

- Telemetry is the most direct and representative method of demonstrating connectivity to Natura sites. Sample size must be sufficient to account for individual variation. Telemetry cannot be used at all designated sites for logistical reasons.
- Colour-dying has the advantage that much greater sample sizes can be achieved than telemetry studies; however, the quality of the data per individual are much lower and dyed animals are not always readily observed by the associated ship-based surveys
- Focal follows using boats can be successfully used to recreate foraging tracks in a limited number of species with slow travel speeds and limited foraging range from the coast (e.g. terns)
- Photo-id can be used to detect movements of individual cetaceans between sites, but detection probability will be very low in most parts of their range.
- Flight directions of fish-carrying seabirds can be recorded from ships in good weather, but can only be crudely estimated by observers, may be affected by the ship's presence and may not be a reliable indicator of final destination; furthermore, the departure location of the fish-carrying bird is not known
- Flight directions can be obtained from radar, but there may only be limited opportunities to use this approach, and animals cannot be identified to species.

- Modelling adds considerable value to telemetry data, allowing these to be integrated with at-sea and on-land survey data, including the link to oceanographic and habitat variables to predict broader movement patterns.

Further issues

- The proportion of the population at the Natura site that are using the proposed area for development is a fundamental metric
- The likely impact on Natura sites of effects such as collision and displacement is an important area for future monitoring and research. Current models will benefit from some refinement, in particular those that are based on the worst case scenario.
- Modelling approaches can enhance the value of the empirical data by predicting connectivity to Natura sites where empirical data are few or lacking
- The temporal scale of connectivity over the annual cycle needs to be quantified

Existing resources & next steps

- There are historical data for all of the above approaches, although these are patchy in time and space. A review of these data is of high priority to assess their validity to current distributions and to establish the need for further data collection.
- Some telemetry studies funded by both government and NGOs are currently ongoing or about to commence. Close co-ordination between all these studies, and better linkage between work on seabird and marine mammals, could increase both the generality and industry relevance of this work.
- Some modelling approaches have already been developed for analysing connectivity, e.g. habitat association modelling; energetic modelling. Effort should now be put into adapting these approaches to develop a framework that will incorporate new telemetry data to model connectivity with Nature sites.

Issues 2.5. Assessing the impacts of renewable devices on marine predator foraging behaviour

Facilitator: Beth Scott

Background

The introduction of large scale offshore renewables developments will impact marine animals and habitats, but there is huge uncertainty about whether these impacts will have positive or negative effects in these poorly understood ecosystems.

The EU Species and Habitat Directives, and the Marine Act requires us to protect key species and habitats, and aim to produce healthy, productive, clean seas in the near future. Therefore we need to know as rapidly as possible if there are 'significant' ecological effects of large scale marine renewable deployments.

The combined use of behavioural studies and at-sea bio-physical monitoring could allow rapid (within a season) detection of changes to typical behaviour and allow a range of possible mechanisms for this change to be tested. This study has the potential to tackle blue sky ecological questions concerning the interplay and connectedness of different trophic levels as well as providing information that is a requirement for assessment of environmental impacts.

Top predator behaviour (seabirds, mammals, large fish) and their prey (small fish, benthic habitat characteristics)

Seabird and marine mammals are highly visible compared with many marine species, and changes in their distribution and behaviour can be used as an indicator of changes in their food base or habitat quality. These visible changes in behaviour can be monitored and the energetic costs/benefits effects can be modelled such that population level consequences can be assessed in a probabilistic approach. This allows a more rapid understanding of possible longer term population level effects than solely monitoring population levels from annual colony or at-sea surveys.

However to be able to hope to answer the question of ***why*** the more visible animals changed their behaviour (i.e. the possible background effects of larger scale climate, ecosystem effects verses the local changes from the offshore renewables development) we need to know if any of the fundamental characteristics of their foraging habitats have changed.

At-Sea Research Programme

The research programme would run at 3 levels: First the background monitoring will investigate changes in indicator species at each trophic level as well as bio-physical aspects of the vertical water column. This monitoring will be done primarily though the use of data collected from the required surveys and monitoring for EIA purposes (an example EIA programme at http://www.neartnagaoithe.com/environmental-impact-assessment.asp). In addition to those requirements there needs to be monitoring of areas of ***control sites*** which are of similar habitat to the areas of development. The main background question will be *'what are the biological and physical differences between control and developed sites at each trophic level and within the vertical (daily, seasonal) bio-physical characteristics of the water column'*?

The development sites will have the added effect of having Before & After information which, when contrasted with the control sites, will lead to much greater statistical power to differentiate the background effects of climate / annual weather events and the development changes. To investigate fully the possible changes in habitat characteristics that top predators utilize for foraging, the current monitoring arrangements need additional scientific investment in the form of bio-physical instrumentation on moorings (i.e. fluorometers, temperature, salinity loggers, noise monitoring; i.e. background noise and animals via C-Pods), additional higher temporal resolution benthic monitoring.

The 2nd level of the programme will be the targeting of high frequency temporal visual surveys for birds, mammals and prey fish within the larger scale EIA surveys. These surveys would target areas of high numbers of foraging animals identified within the wider survey area and would lead to identifying the precise water column characteristics that many top predators use to forage within. The knowledge of what constitutes top predator foraging habitat will greatly improve the ability to be able to avoid or design offshore developments such that they did not affect these areas. This survey approach has been trailed in EU and NERC projects and has shown that foraging areas for a range of seabird and mammal species are very limited in space and time. Tidal speeds can have a very dramatic effect on the number and behaviours of animals and therefore survey methods need to take account of both habitat and time of tide simultaneously. This can only logistically be done in sites of < 10 km^2 and requires the use of towed oceanographic instruments to capture the vertical characteristics of the water column. Bio-physical moorings and landers could also be placed in these areas, once identified, and data collected as in level 1 for longer term seasonal variability.

The 3rd level involves tagging programmes for a range of types of tags for seabirds, mammals and large predatory fish. The addition of tagging allows fine scale and continous behaviour data to be collect as well as providing connectivity information regarding colony sites (as mentioned in Issue 2.3). For those species which use the vertically water column for foraging depth/temperature tags allow further characterisation of foraging habitat. The fish component would allow a vast improvement of our understanding of the longer term response of larger fish species to offshore structures - as the offshore oil platforms have shown a surprisingly positive effect on possible increases in larger fish species abundance and size range.

Funding and locations

It would be best to trial this approach in areas that have a lot of background data to be able to disentangle climate vs development effects and also to see this as a platform on which to build up an overall strategic research plan for offshore developments in general which can potentially rely on a wide range of scientific disciplines within the MASTS community. Individual groups within the JRTs can target appropriate Research Council, Scottish Gov, DEFRA or even EU grants for additive components.

The suggested areas to be investigated are:

- Firth of Forth and Moray Firth (offshore Wind)
- Pentland & Orkney and Islay (wave and tidal)
- Also consider at both EMEC sites and Strangford Narrows

Issues 3.1- 3.4. Knowledge Transfer

Facilitator: Dominic McCafferty

The rapid development and installation of marine renewable energy technology in Scotland requires the swift exchange of knowledge between industry, regulators and marine scientists to minimise any negative effects on natural ecosystems and maximise any opportunities for the enhancement of biodiversity associated with installations. This emerging industry will have an impact in particular on the fishing industry, navigators and the tourist industry. There is therefore also a need to disseminate high quality information on the nature of renewable energy and its impacts on marine ecosystems to a diverse range of stakeholders and to the general public. Development of KT will benefit from examining case studies and experience of other industries such as fish farming, the oil and gas industry and terrestrial wind generation that has shown equally rapid advances since the 1970s.

The following different types of knowledge transfer have been identified as priorities:

Training

(1) species identification, data collection and survey methods for purposes of environmental impact assessment (EIA)

(2) requirements for EIA and statutory regulation for developers

(3) knowledge of the technology and environmental impacts for regulators

Education

(1) open exchange of information on the technology and impacts for specific user groups (e.g fisheries, tourist industry).

(2) public understanding of technology and any known impacts on natural ecosystems

Approaches

Training

Development of a **MRes programme** delivered jointly by MASTS partners for the specific purpose of training new marine mammal and seabird data-recorders. This would have an industry or regulator placement/sponsorship of student to maximise opportunities for knowledge exchange between academic, industry and regulators. We may consider modifying existing MRes programmes to speed up the process and there are opportunities to build on expertise/facilities/research vessels across Scotland (e.g Lighthouse Field-Station, UMBS Millport) as well as research strengths in different Universities.

Continuing Professional Development (CPD)

Given the rapid pace of development there is a definite requirement for CPD of academics, regulators and industry. This could be achieved by the development of a similar consortium such as COWRIE specifically for marine renewables. Professional secondments and internships were suggested as effective mechanisms for sharing knowledge across disciplines. Consultancies would allow development of business knowledge for graduates.

Education

Engagement with existing organisations (e.g. Scottish Renewables Forum, Scottish Fisheries Federation) through joint conferences, workshops.

Publications

There is a need for synthesis and review documents involving experts who are capable of interpreting the scientific findings for different stakeholders.

There is also a need for rapid dissemination of key findings of relevance to industry and regulators (ct. ICES & IWC Working Documents). Ideally these should be subject to some level of peer review, but their early dissemination in this format should not constrain subsequent publication in academic journals.

Database/website

There was an identified need for a centrally held and maintained database of scientists, regulators and industry that could be used to link these different types of users together. Dissemination of high quality data in GIS format was also seen to be a useful (and profitable?) mechanism of making available survey data to different stakeholders.

Timescales

Short to medium term (1-3 years?): Training: data-collectors and regulators
Medium to long term (3-10 years?): Education: specific user groups and public

Funding

Industrial sponsorship of students on MRes or CASE PhD projects
Industry sponsored consortium similar to COWRIE
Knowledge Transfer Partnership Schemes (www.ktponline.org.uk)
NERC KTP Grants

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Annex II - Workshop programme & presentations

MARINE TOP PREDATORS AND RENEWABLES; SURVEY AND RESEARCH REQUIREMENTS

Ramada Jarvis Hotel, Perth, PH1 5QP

Programme

Thurs 18th March – ***Day 1: Identifying key issues and data requirements***

10.30 Coffee & Registration

11.00 Introduction (Paul Thompson)

Overview of drivers, data requirements and workshop format

11.30 Monitoring guidelines (Facilitator: George Lees)

Current approaches, developing protocols and future requirements

Seabirds (Francis Daunt)

Marine Mammals (Ben Wilson)

Discussion - strengths & weaknesses of current approaches to monitoring

12.30 Buffet Lunch

13.30 Monitoring in Practice - lessons learned (Facilitator: Stephen Kerr)

Strangford Lough (Gordon Hastie)

Beatrice Demonstrator (Paul Thompson)

Discussion & insights from other projects

14.00 Future research, survey & knowledge transfer requirements

Breakout groups will address a series of questions to identify:

a. Issues constraining endorsement of monitoring guidelines

b. Key research requirements & opportunities

c. Potential skill shortages & mechanisms for building capacity in these areas and/or improving knowledge transfer

Feedback from breakout groups

15.45 Tea break

16.15 Agreement on priority issues & research areas for development on Day 2

17.00 Workshop closes

Fri 19th March - Day 2: *Scoping solutions* (Facilitator: Paul Thompson)

10.30 Summary of Day 1 outcomes and Day 2 objectives

10.45 Working Coffee break

Interactive session to allow all participants to contribute ideas on potential solutions for each of the priority issues & research areas identified on Day 1.

11.15 Development of scoping documents/outline research proposals

Breakout groups will address each priority issue and research area. Each group will be tasked with evaluating alternative approaches to solving issues and developing appropriate research projects.

12.30 Buffet lunch in Poster Area

Feedback on Breakout group solutions & research projects

13.30 Plenary Discussion; Frameworks for implementation?

Identification of opportunities for taking workshop actions forward

eg. Scottish Renewables Forum
ICES Working Groups on Marine Mammal Ecology & Seabird Ecology
NERC Environmental Research Scoping Study

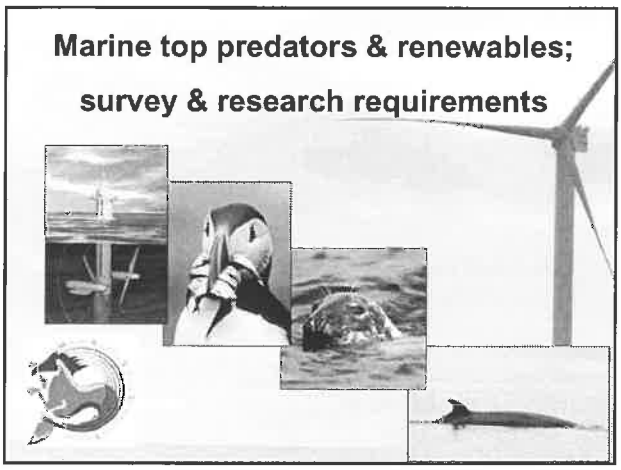
Developing partnership funding for broad scale research projects

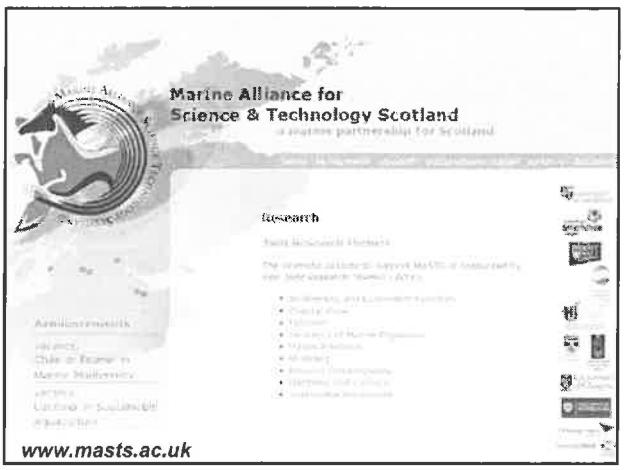
14.00 Writing groups

Breakout groups to produce draft scoping paper/outline proposal to capture key background to the issue and agreed actions.

15.30 Main workshop closes, with opportunity for writing groups to continue working on workshop outputs

Marine top predators & renewables; survey & research requirements





Drivers for this workshop

i. Industry requirement for extensive survey work

ii. Bird & mammals survey protocols developed for R1 & R2 sites less suitable for offshore/tidal areas

iii. New research required to evaluate environmental impacts & benefits of offshore renewables

iv. New infrastructure offers unique opportunities for accessing marine systems

v. MASTS offers new opportunities for collaborative research & improved knowledge transfer

Scale of development & supply chain issues

Site-base data requirements

• Baseline characterisation & environmental assessment	**What's present in the development area?**
• Management, Mitigation, & Appropriate Assessment	**Will the development impact NATURA sites?**
• Assessment of impacts from construction or operation	**Did the development have an impact?**

Site-based requirements - *stakeholder focus*

- Consultants
- Regulators
- Researchers

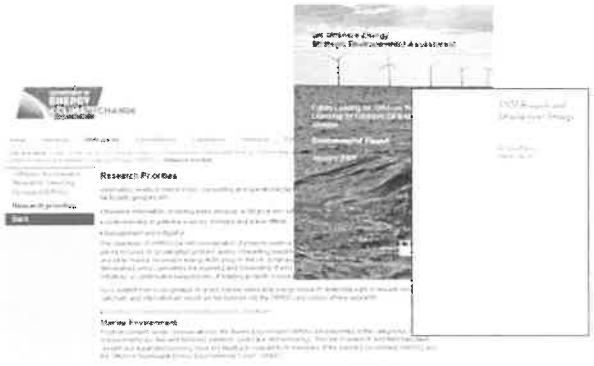
Site-based requirements - *timescales*

Required NOW

Required ~2012

2012-2020

Additional research requirements



Infrastructure support for marine research

Intended outputs of workshop

i) Facilitate development of best practice survey guidelines for birds and marine mammals

ii) Develop ideas for knowledge transfer and building capacity in ecological expertise

iii) Identify key research areas – and scope methodology and potential funding frameworks

iv) Explore opportunities to disseminate findings & develop collaborative funding packages

Workshop ground rules

- Participate openly & share knowledge
- If we're discussing something any of us could do on our own then we've gone off track
- Only one conversation at a time in plenary
- Keep jargon to a minimum (and ask for clarification when you need it)
- Use the parking lot to capture other ideas
- Keep phones on silent or vibrate mode

Workshop format

Day 1 – Identifying key issues & data requirements

workshop sessions aim to lead to agreement on priority issues & research requirements

Day 2 – Scoping solutions

sub-groups will each focus on one of these priority areas, evaluating alternative approaches to solving issues/ planning research projects

Monitoring guidelines

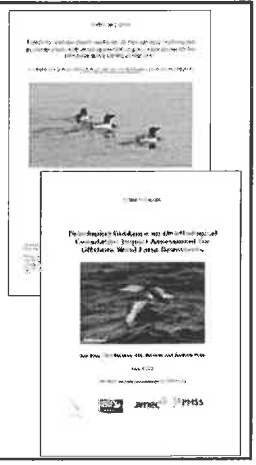
Seabirds

Areas of concern for offshore wind, wave & tidal

- Displacement
- Barrier effects
- Collision risk
- Indirect effects: habitat and prey changes

Current survey guidelines

- Offshore wind
  - At sea survey methodology developed for R1 & R2 sites
  - Cumulative impacts
- Wave & tidal
  - Methodology being developed through SNH contract to Royal Haskoning



Alternative techniques

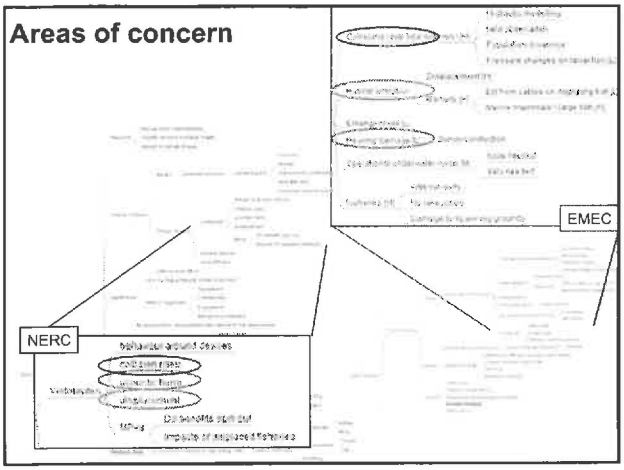
- Data collection tools:
  - Hi-Def video
  - Seabird tracking
  - Radar
  - Sonar
  - Cameras
- Modelling:
  - Habitat association
  - Energetics

Potential Issues

- Surveys primarily aim to estimate species distributions. Uncertainties:
  - Connectivity to SPAs
  - Area usage
  - Population effects
- Scaling issues to R3:
  - fewer opportunities to survey in suitable sea states
  - integrating data from Hi-def surveys and traditional surveys
- Guidance focusses on process rather than key data requirements

Marine Mammals

Areas of concern



Areas of concern

Offshore wind

- Injury/displacement during construction
- Habitat alteration
- Displacement of other activities e.g. fishing

Wave & Tidal

- Injury/displacement during construction
- Displacement/exclusion during operation
- Collision risk during operation

To address areas of concern

"Biological monitoring"

1. Pre-consent characterisation

EIA: **Developer** provide info for assessment by the **competent authority** on whether the development will have significant effects on protected species or site

Mine existing data

Carry out surveys (for species & #/density)

2. Post-consent Impact monitoring

(Injuries/deaths, changes in behaviour/local density etc)

In parallel or piggyback fundamental research to understand issues

Approaches

Visual line-transect surveys (boat/aerial)

Fixed point (shore) observations

Passive acoustics – static or towed

Telemetry

Photo-ID

Strandings

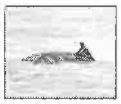
Potential Issues

Surveys establish species & densities, not necessarily function of site

Off shelf survey techniques not necessarily appropriate for high energy sites (tidal-stream: water mass moving similar speed to survey vessel, wave sites: rough)

Guidance has tended to focus on **techniques** rather than **key data requirements** – ie what questions really need answered?

Current survey guidelines



Offshore wind

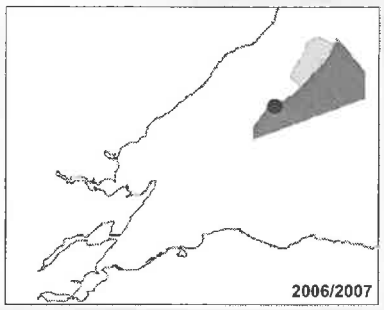
- *Ad hoc* work during R1 & R2
- Guidelines for R3 sites being developed through a CE contract to SMRU Ltd

Wave & Tidal

- Variety of methods
- Methodology currently being developed through an SNH contract to Royal Haskoning

WT 1.1.2
Birds in UK & Marine Mammals

Beatrice Demonstrator Project



Base-line data

- visual & acoustic surveys of birds & cetaceans

Evaluation of survey techniques

- radar for birds
- T-PODs

Assessing behavioural responses to pile-driving

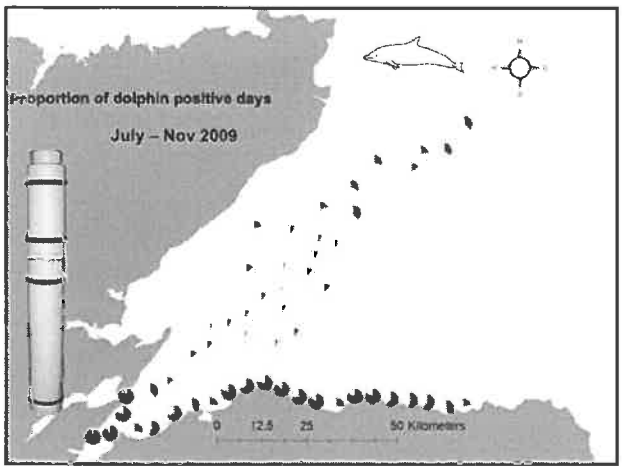
- B-A-C-I

Lessons learned

1. **It is much more difficult to work at windy offshore sites**
   - limited windows for visual surveys
   - expensive to ensure that survey boats & observers available in those short windows
   - also constrains performance of radar

Lessons learned

2. **Static passive acoustic monitoring can provide an effective monitoring tool**
   - but may need to integrate with other techniques to provide info on species ID
   - losses to fisheries



Lessons learned

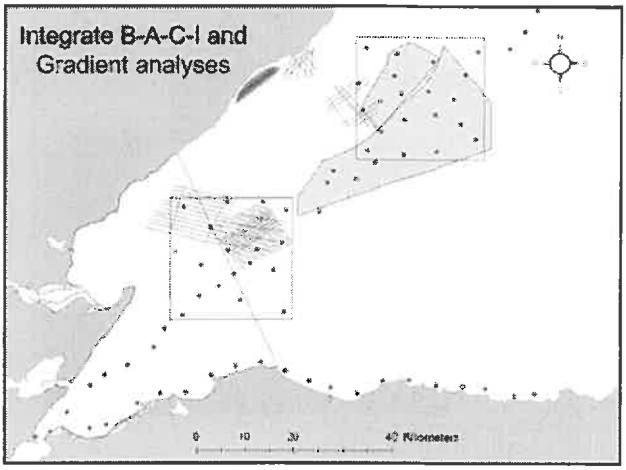
3. **Good baseline surveys required BEFORE design of impact studies**

Lessons learned

4. Weaknesses of B-A-C-I Approach

- if spatial scale of impact uncertain
- if widely spaced impact and control areas differ in ecological characteristics

+ it doesn't really tell you what you need to know

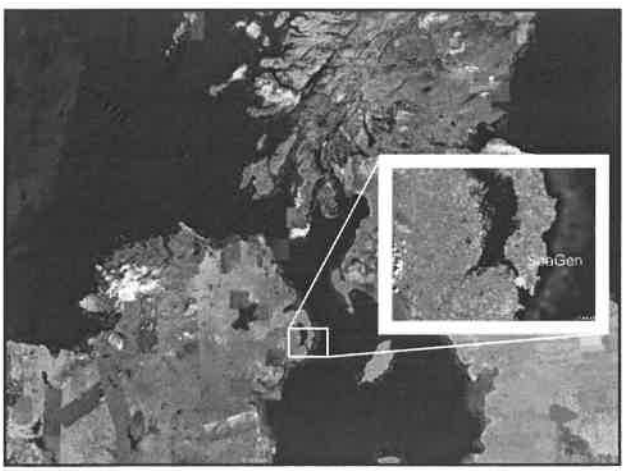


Lessons learned

5. Cumulative impacts

- can interfere with both baseline studies & impact studies

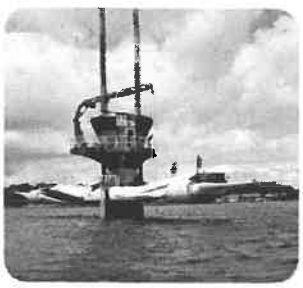
Strangford Lough: Lessons learned from monitoring around a tidal stream energy device



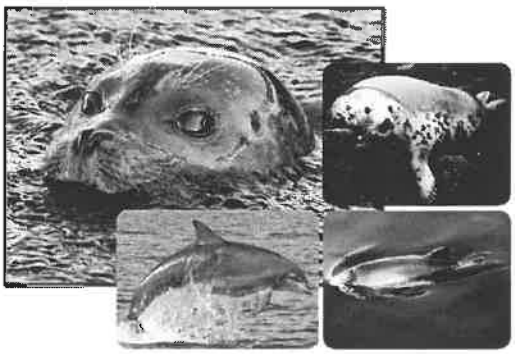
Tidal turbine

SeaGen

- 1.2MW tidal energy convertor
- Installed in Strangford Lough in April 2008
- Twin 17m diameter rotors
- Maximum tip speed 12ms^{-1}



Potential effects



Monitoring - techniques

Aerial surveys for seals

Harbour seal telemetry

C-Pod deployments for porpoises

Land based visual observations

Turbine based visual tracking

Active sonar target tracking

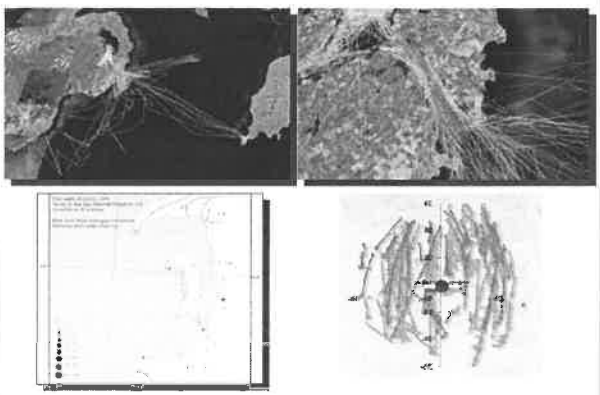
Geographical range

Irish Sea

Strangford Narrows

Turbine

Monitoring - results



Lessons learned

1. A well-structured research programme can provide the assurance everybody needs. Independence of the research is vital;
2. Adaptive multi-scale approach to monitoring appeared to work well for this site;
3. None of the monitoring results should be viewed in isolation;
4. This approach to monitoring is expensive and logistically challenging;
5. Even with relatively high levels of data collection, power to detect change can be very low;

Lessons learned

6. Even with a good suite of techniques to detect change, the population consequences of change remain poorly understood;
7. Establish formal oversight groups (Science board and Liason group) that can review approaches in an open and transparent manner. Engage with the regulators early and keep talking;
8. A well organised carcass/necropsy survey proved important;
9. If using active sonar to measure animal behaviour, ensure that acoustic signals are beyond their hearing ranges;
10. Analytical tools to allow incorporation and interpretation of different datasets would be valuable when monitoring these kinds of site.