Marine Mammals in Scotland

A summary of scientific research in support of policy

Sea Mammal Research Unit

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University of St Andrews | FOUNDED 1413

Sea Mammal Research Unit

Pages 2 & 3 – Young harbour seal in middle of grey seal group.
Front cover – Harbour seal.

Introduction

The Scottish Government recently funded a major strategic marine mammal research programme to provide advice to Scottish Ministers across a range of key marine policy areas.

The Sea Mammal Research Unit (SMRU) at the University of St Andrews worked with a number of collaborating organisations such as Marine Scotland Science, Scottish Natural Heritage, the Joint Nature Conservation Committee and the Scottish Association for Marine Science, and schemes such as the Scottish Marine Animal Stranding Scheme, to carry out this research between 2011 and 2015.

Four research themes were prioritised:

- The Impact of Marine Renewables
- Harbour Seal[1] Decline
- Unexplained Seal Deaths
- Seal and Salmon Interactions

This summary highlights the major research findings under each theme. The detailed reports describing the methods and results with more comprehensive discussion can be found on the SMRU website (www.smru.st-andrews.ac.uk).

[1]Harbour seals are also sometimes referred to as common seals

The Impact of Marine Renewables

The Scottish Government has a duty to ensure that the development of the offshore renewable energy sector is achieved in a sustainable manner in the seas around Scotland. There is therefore a need to evaluate the potential interactions between offshore renewable energy development and marine wildlife as a matter of priority.

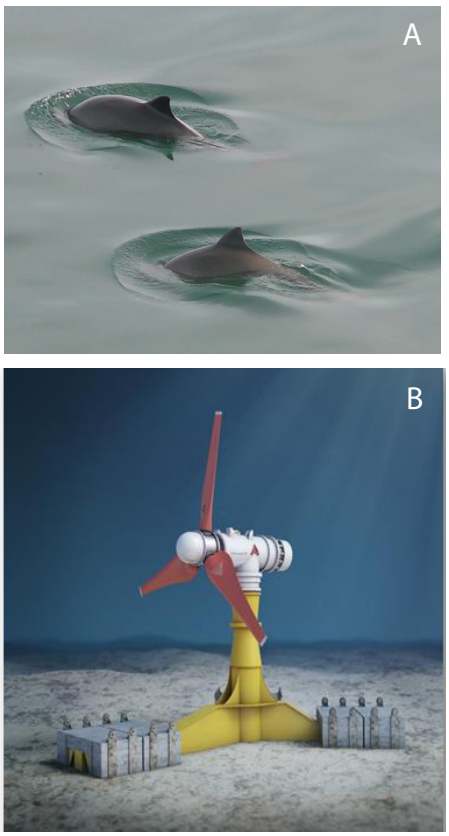
Techniques to track the detailed movements of marine mammals near tidal turbines.

The risk of marine mammals colliding with tidal turbine blades depends on how these animals behave within about 100 m of the turbines. Studies were undertaken into the technologies and techniques that could be used to assess this behaviour and to indicate whether a collision could occur.

Findings

Active and passive acoustic monitoring techniques and video surveillance are the most appropriate systems and their recommended deployment package is as follows:

- Establish a static Passive Acoustic Monitoring (PAM) array around one or more turbines to track vocalising cetaceans.
- Since seals do not regularly vocalise, a sample of seals should be tagged locally with acoustic pingers that can also be tracked using the static PAM array.
- Establish an Active Sonar System near the turbines to detect and track all marine mammal species (including baleen whales that do not vocalise).
- Establish a turbine-mounted video surveillance system that could, during daylight and periods of good visibility, detect collisions.



A. Harbour porpoises; B. Artist's impression of the AR1500 underwater turbine.

Risks from tidal turbines

Habitats with high tidal energy can be important for marine mammals, but few data exist on the potential risks that tidal turbines constructed in these areas may pose.

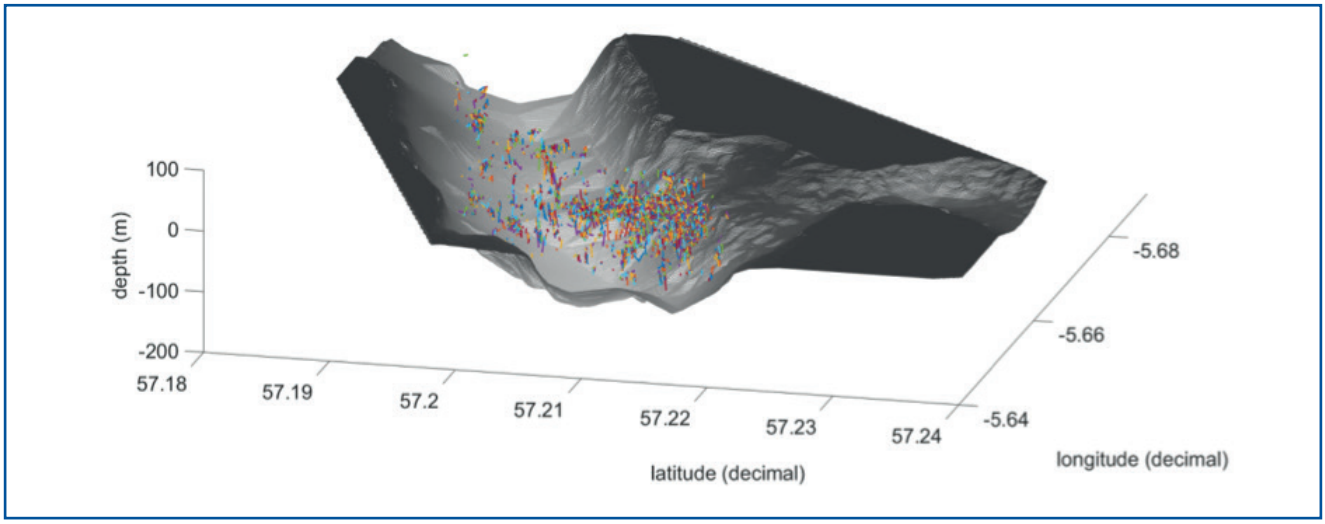
Three approaches were taken to fill this gap: (i) PAM was used to detect and track echolocation clicks from harbour porpoises in tidal rapids, (ii) a novel GPS tag was used to reveal the behaviour of harbour seals in tidal rapids, and (iii) collision risk models were developed and applied.

Findings

- Six sites with high tidal energy were assessed for harbour porpoise vocalisations using a drifting PAM hydrophone array, of which two (Kyle Rhea and Corryvreckan) had by far the highest number of harbour porpoise vocalisations per hour.
- At the Kyle Rhea and Corryvreckan sites it was discovered that porpoises spent 75% of their time in the top 30-40 m of water.
- Harbour seals used the high tidal rapids at Kyle Rhea extensively throughout the summer, in pursuit of prey. Some remained in the region for many weeks, making repeated transits through the proposed tidal array area.
- Trials with seal carcasses indicated that not all collisions with turbine blades would be fatal.
- Telemetry tracking studies of harbour seals in the Pentland Firth showed that between one and two seals per year might collide with individual turbines within arrays in that region.

In conclusion, high tidal energy sites are important habitats for seals and porpoises, and possibly other marine mammals. The data generated from this research will refine collision risk models and their outputs.

The Silurian, Hebridean Whale & Dolphin Trust, used in porpoise monitoring trials.



Distribution of porpoises in a high tidal energy location from porpoise clicks recorded using a drifting PAM hydrophone array. Coloured lines represent tracks of individual porpoises inferred from detected clicks.

Can 'seal-scarers' reduce risk?

Acoustic Deterrent Devices (ADDs), or seal-scarers, have been suggested as a means to reduce the risks of injury to marine mammals from marine renewable energy developments, but do they really work and are there any side effects?

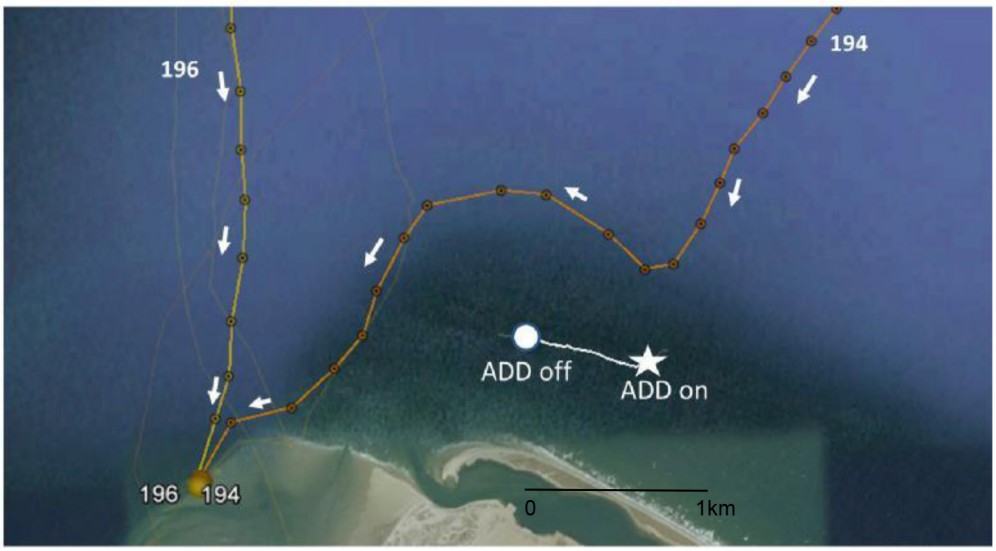
A high power ADD was tested in open water to assess how effective it would be in moving harbour seals away from potentially damaging sound sources, such as pile driving.

Findings

- The ADD elicited a behavioural response to at least one kilometre away. However, seal responses and their magnitudes varied considerably among individuals.
- There was a tendency for seals that were close inshore to move into shallower water and swim alongshore, which may reflect a generic anti-predator response.
- When the ADD was positioned directly ahead on a seal's track, the animal would usually deviate from the track to give the ADD a wide berth before returning to pursue its original direction.
- Animals returned to foraging areas soon after the ADD sound ceased, suggesting that to reduce the risk of injuring animals around marine renewable energy developments the deterrent signal should be played for a period just before any potentially damaging activity (such as pile driving) starts.
- A software tool called the 'Sound Exposure Explorer' was developed to predict the cumulative acoustic exposure of sound-sensitive animals, given a variety of sources, behaviour patterns and environmental factors.

ADDs can be used to temporarily control the local distribution of seals and therefore can be used to reduce the potential for their injury during the development and operation of marine structures.

A harbour seal tagged with a SMRU GPS/GSM transmitter.



Tracks of two seals during an ADD trial. Seal 194 avoided the area around the ADD whilst it was functioning, then resumed its original course once the ADD was off, whereas seal 196, which was further away from the ADD, showed no response to the deterrent signal during the trial.

Characterising UK seal populations

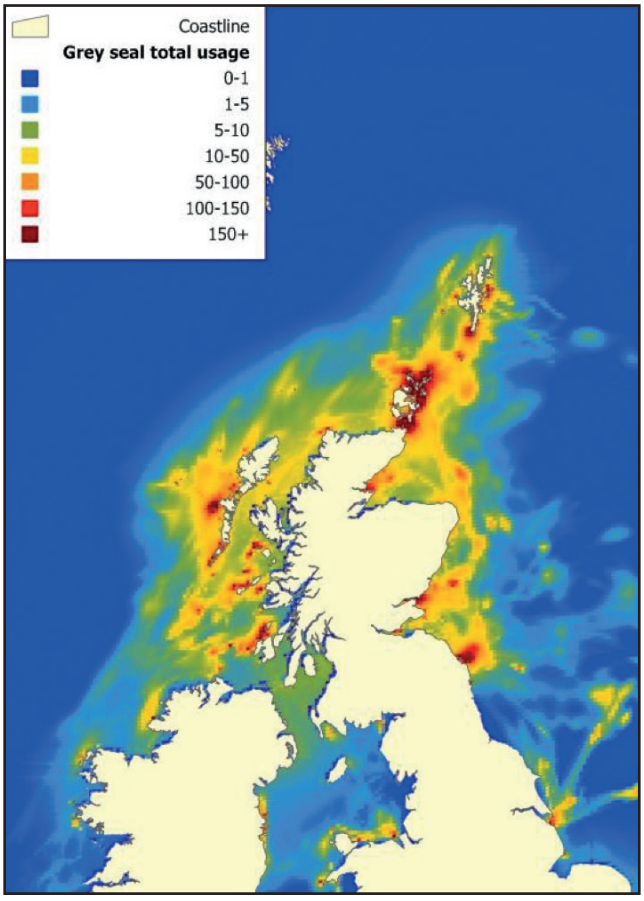
Predicting the potential impacts of marine renewable energy generation on marine mammals requires an understanding of their distribution, the factors that drive this distribution, and animal behaviour, especially in areas of high tidal energy.

SMRU has a wealth of grey and harbour seal movement and haulout survey data. These were jointly analysed to provide estimates of at-sea usage[1] and measures of habitat preference, as well as haulout site choice and behaviour.

Findings

- UK grey and harbour seal at-sea usage maps (with associated variation) have been published. The resulting density estimates can be used to inform collision risk models.
- State-space models have been developed and used to classify seal movements into resting, travelling and foraging states at six-hour and two-hour resolutions. In addition, the seal tracks were corrected for the influence of tidal currents. In both species, the proportion of time spent in the different states was influenced by sex, age, time of day, season, and region.
- Statistical modelling showed that harbour and grey seals have different habitat preferences, resulting in different predicted key areas at sea. Grey seal distribution was driven by factors including sea temperature and seabed sediment type, whereas harbour seal distribution was driven by salinity levels and seabed topography.
- A DECC[2] funded study in The Wash (SE England) showed that harbour seals were not displaced from a windfarm during the construction or operation phases as a whole, but they were displaced from the windfarm during the bouts of impact pile driving.
- Harbour seal movements between haulout sites were modelled from tracking data to predict the effect of disturbance at one site on other sites. On the basis of this work and field disturbance trials, a haulout monitoring strategy has been proposed.

This research has identified at-sea usage and habitat preference for both species of UK seal. This framework underpins our ability to measure and interpret changes due to man's activities and to design monitoring strategies to determine their impact.



Estimated at-sea density of grey seals. Seal density is the average number of seals in 5x5km grid squares.

[1] "at-sea usage" is defined as activity when not on land

[2] Department of Energy and Climate Change

Harbour Seal Decline

Over the last 15 years, many of the harbour seal populations in the Northern Isles and on the north and east coasts of Scotland have been declining.

What is causing the decline in Scottish harbour seal populations?

Two workshops were held to assess the causes, management and mitigation options in relation to the harbour seal decline and to prioritise future research directions. UK and international marine mammal experts attended and a number of potential causes, in addition to the unexplained seal deaths (see page 10), were identified. These included a reduction in the quality and quantity of prey; increased competition with grey seals; increased predation; the effect of toxins from harmful algae; and historic shooting in some regions. In order to focus conservation efforts it is crucial to understand which of these factors are most important, both individually and in combination.

Methods

A major study of the diet of harbour and grey seals around Scotland was carried out to see how much prey overlap there was between the species and if there were differences in the diet between areas where harbour seals were declining compared to stable areas. In addition, telemetry data were analysed to investigate changes in grey and harbour seal foraging trips over time to assess the potential for competition. Finally, using the Moray Firth, a particularly well-studied area, a population model was developed to estimate how harbour seal fecundity and survival depend on processes such as food shortage, competition from grey seals, and licenced shooting.

Mother and pup harbour seals.

Harbour seal.

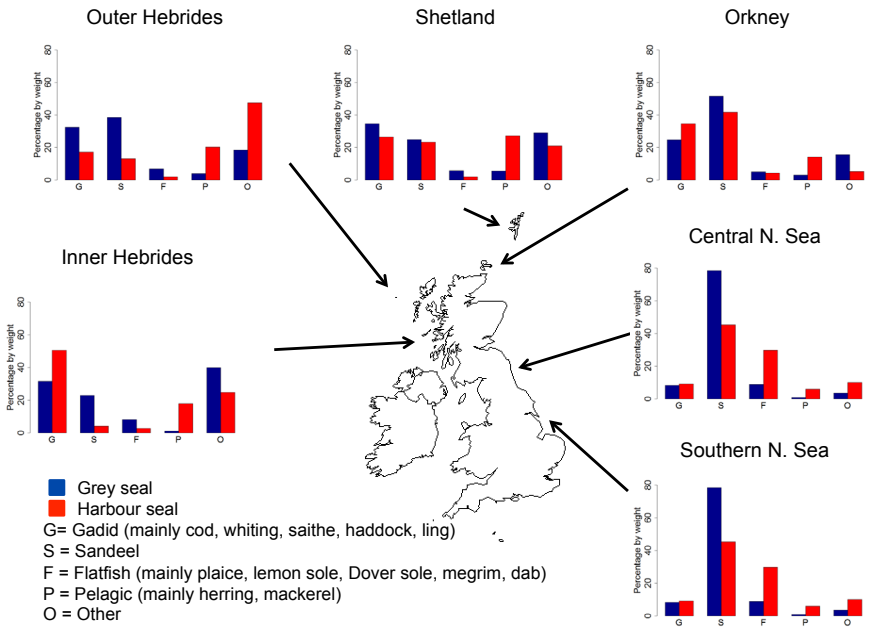
Grey seal.

Collecting seal scat.

Findings

- Both grey and harbour seals consume more than 80 different prey species of fish and cephalopods.
- Grey seal diet was dominated by sandeels (~50% of prey weight consumed); cod (8.6%) and saithe (5.4%) were also important prey species. Harbour seal diet was more diverse; sandeel was the predominant prey (15%) but whiting, cod, haddock, saithe, herring, mackerel and dragonet each contributed between 5% and 10% of the diet.
- UK grey seals are estimated to consume 130,000 tonnes of prey per year in the North Sea and 70,000 tonnes west of Scotland. Equivalent figures for UK harbour seals are 24,000 tonnes and 30,000 tonnes.
- No consistent relationship was found between harbour seal diet and population trends.
- Only limited changes in the diet were found compared to previous studies when harbour seal abundance was higher.
- Since the start of the population decline in south-east Scotland, harbour seal trip duration and extent has decreased. The reason for this change in behaviour is unclear.
- Using the Moray Firth population model, there was a positive correlation between sandeel abundance and harbour seal fecundity. In addition, there was a negative correlation between grey seal abundance and harbour seal pup survival. The reasons behind these relationships are potentially important factors relating to harbour seal decline and are currently being explored. The model also suggests that an additional mortality of 12 adult harbour seal females per year would be sufficient to cause a population decline in the Moray Firth.

The cause or causes of the regional differences in harbour seal population trends remains unclear and requires more intensive regionally based studies.



Variation in grey and harbour seal diets in six UK regions.

Unexplained Seal Deaths

The Scottish Government has a duty under the Marine (Scotland) Act 2010 and the Habitats Directive to ensure 'favourable conservation status' of the seal populations in Scottish waters. A series of unexplained deaths has caused concern as this could threaten the survival of seal populations in certain areas.

What is the cause of the unexplained seal deaths?

A number of seal carcasses (grey seal pups and harbour seals) have been washing ashore with characteristic severe 'spiral' lacerations across their bodies.

The characteristics of the injuries initially suggested a mechanical cause and through a process of elimination based on the timing and location of events, the cause appeared to be interactions with ducted propellers on ships. A series of investigations were carried out to determine how likely this was and under what conditions it would occur using scale models.

Findings

- Characteristic injuries could be mimicked on model seals in an encounter with a ducted propeller.
- Mapping the co-occurrence of shipping activity and the at-sea distribution of seals did not reflect the pattern of spiral injury seal reports around the UK. A series of behavioural response tests to identify the reasons why seals might approach propellers also failed to identify any attraction response.
- A sequence of lethal attacks on grey seal pups by a male grey seal, initially observed by Dr Amy Bishop, University of Durham, on the breeding colony at the Isle of May in December 2014, showed all of the characteristics of the spiral lacerations. This, in combination with similar observations of attacks by an adult male grey seal on harbour seals in Germany, suggests that many of the spiral injuries and deaths may be the result of grey seal predation, although encounters with ducted propellers cannot be completely discounted.

Further investigations are needed to fully resolve the extent to which grey seal predation is responsible for declines in harbour seal abundance in Scotland.

Seal carcass with characteristic severe 'spiral' lacerations.

Seal and Salmon Interactions

Seal interactions with fisheries have long been a cause of conflict across the world and such interactions in Scottish waters are no exception.

How can seals be reliably deterred from salmon nets?

Seals often interact with salmon net fisheries, but how can fishers mitigate against depredation of fish by seals without resorting to shooting?

The effectiveness of acoustic deterrent devices (ADDs) at reducing depredation and damage to salmon at bag-nets was assessed and several structural modifications to salmon bag-nets were tested. In addition, the digestive tract contents of seals shot around salmon nets were analysed.

Findings

- The number of individual seals around salmon nets was substantially lower when the ADDs were being used.
- Modifying the entrance to the fish chamber to exclude seals, whilst easing the passage of fish, may increase salmon landings and reduce depredation by seals.
- Digestive tracts from the seals shot around salmon nets frequently contained whitefish, sandeels and flatfish but not always salmon. During the time when ADDs were being used, more shot seals were found to have eaten salmon, suggesting that ADDs were an effective deterrent against "transient" seals, but not against those that habitually frequented the nets.

Seals can be deterred from salmon bag-nets using a combination of ADDs and net modifications. This combination, if used correctly, will minimise the need for lethal control.

Seal eating salmon.

Seal at salmon bag-net.

Photo credits

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Harbour seal - Richard Shucksmith; www.ecologicalphotography.co.uk
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Seal at net – Rob Harris, SMRU

The final reports for this research can be found at www.smru.st-andrews.ac.uk
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