Seabirds have been declining across the British Isles in recent years. One of the species showing the most rapid decline is the kittiwake (Rissa tridactyla). This is thought to be a result of the reduction in the availability of their key prey, the lesser sandeel (Ammodytes marinus). However, the patterns of kittiwake population change are not consistent across the British Isles. Understanding this spatial variation is key for being able to identify the factors governing colony dynamics.

In this study, we used data from the JNCC’s Seabird Monitoring Programme to identify spatial patterns in trends for kittiwake colonies across the British Isles, looking at both colony size (n ≈ 100) and breeding success (n ≈ 60). We identified a strong negative trend and a low long-term average in breeding success in northern Scotland (see also JNCC 2016). The trends were more variable further south, but colonies showing both recent declines and a low long-term average breeding success were identified across the British Isles. Many colonies showed a lower average breeding success than what is estimated as necessary to maintain breeding numbers (Coulson 2017). The patterns we identified in breeding success were reflected in changes in colony size, which was expected as breeding success has been identified as a strong driver of kittiwake population dynamics (e.g. Coulson 2017). Finally, we found that the colony size and breeding success often, but not always, tended to be synchronised across colonies in the same region.

The spatial patterns in kittiwake trends will be discussed in relation to region-specific studies on kittiwake diet and sandeel abundance, to assess whether low sandeel availability corresponds to negative trends in kittiwake colonies. The results will later be used to inform a detailed investigation into the role of bottom-up effects in the decline of kittiwakes in and around the British Isles.

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References


Diurnal Trends in Bottlenose Dolphin Echolocation Click Detections

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Diurnal trends in activity are common in a variety of species. Bottlenose dolphins (Tursiops truncatus) are a marine top predator found in temperate and tropical waters worldwide. They are known for their diverse repertoire of foraging behaviours specific to each environment and local prey availability. The population inhabiting the coastal waters of eastern Scotland ranges widely between frequently visited “hot-spots” linked to foraging, but broad scale habitat use is still poorly understood. Here we investigated spatial and temporal occupancy across the entire range of this population using 30 moored acoustic monitoring devices to detect echolocation clicks. We then used generalised estimating equations to model click detections as a function of spatial (e.g., deployment location) and temporal covariates (e.g., tidal phase, hour of the day and solar elevation). Our models suggested a strong crepuscular trend in detections consistent with previous studies at all but one survey site (p<0.01). At the remaining site, which was located within a special area of conservation, we instead found a linear relationship between echolocation click detections and solar elevation. We discuss multiple hypotheses for these disparate trends including spatial and temporal-dependent foraging and/or socialising behaviors.
Using DTAGS to investigate the stereotyped structure of long-finned pilot whale vocalizations

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Social delphinids use a complex repertoire of sounds for communication that often includes series of apparently stereotyped acoustic calls (or repeated calls that occur over time). Bottlenose dolphins (Tursiops truncatus) are known to produce stereotyped, individually distinctive signature whistles that allow individual animals to be identified, while killer whales (Orcinus orca) produce group-specific calls. In long-finned pilot whales, repeated calls have been described, but both long-term stability and possible function remain unknown.

Here we used over 100 hours of acoustic recordings obtained from Digital Acoustic Recording Tags (DTAGs) attached to 18 individuals from nine known groups of long-finned pilot whales in the Strait of Gibraltar. This allowed us to investigate the variability and stability in repeated calls over time using both human classification trials (where judges were asked to sort pictures of the calls into categories) and quantitative similarity measures.

Ten human judges categorized 42 different call types with a minimum of 80% agreement. Results suggest less than 10 call types (24%) were shared between two groups, and no call types were shared between three or more groups. Statistical analysis indicates that calls that were shared between groups were generally just as similar as calls shared within groups, suggesting few structural changes in calls produced by multiple groups. We identified five call types that reappeared in recordings of individuals tagged multiple times with intervals between two days to five months, indicating some repeated calls may persist across time.

While the function of repeated calls deserves more attention, this study highlights the usefulness of DTAGS in call classification studies where the repertoires of different social groups (and in the future different populations) can be compared. We conclude that 1) long-finned pilot whales produce repeated calls with low variation that may persist over time and 2) limited call sharing occurs between pilot whale social groups.

Acknowledgements: Thank you to the Tagging and Playback Studies to Toothed Whales project, led by Peter and Frants, which provided the data for this study. Thank you also to the CIRCE (Conservation, Information and Research on Cetaceans) team who assisted with the fieldwork, including but not limited to Philippe Verborgh, Renaud de Stephanis, Pauline Gauffier, Nicholas Macfarlane, and other CIRCE observers.
Design of a low drag universal frame for subsea data acquisition in high energy tidal sites

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Preferred presentation medium: oral.

Are you a student? No

For the marine renewable energy sector, it is very important to have an extensive, complete and accurate characterization of marine development sites. In fact, obtaining sufficient and reliable data from such sites represents an important preliminary step for the design of any marine renewable energy device. To measure sea data (i.e. tidal currents, wave amplitudes, etc.), sensors are deployed into properly designed seabed frames. Sites with higher energy content are the most attractive candidate for installing renewable energy devices; but, gathering reliable and sufficient data is challenging, and sometimes, of limited success.

This talk presents the design process of an innovative and more efficient frame for deployments in strong flow marine energy development sites (e.g. Pentland Firth in Scotland (UK)). Using Computational Fluid Dynamics (CFD) numerical simulations, it discusses some interesting findings and shows all the design process, from a standard bottom frame to a new optimized frame shape. Indeed, the target of this research has been to obtain some design principles for improving frame performance (i.e., reducing manufacturing and deployment effort) as well as data reliability (i.e. reducing turbulence and drag generated by the frame), finally resulting in an improved quality of the measured datasets.

Starting from a standard NORTEK bottom frame for sensor deployment, its performance, in terms of drag and lift forces and eddies over and around the sensor head, have been investigated. Using extensive three-dimensional CFD simulations, several modifications of such standard frame have been compared. Initially, those frames have been tested using steady high-speed flow condition and their aerodynamic data have been used to set-up a ballast evaluation process, taking into account frame forces and different seabed friction coefficients: in this way, it has been possible to assess the deployment effort related to each frame shape under test.

Using a parametrical CAD and two-dimensional simulations, an optimization procedure has been carried out on several parameters: monitoring how the lift-to-drag ratio is affected by each parameter, several improved shapes have been obtained. Even if some optimized shapes have shown interesting results, e.g. in terms of lift-to-drag ratio, some of these results have been rejected for ease of manufacturability. Thus, the final result is more of a conventional frame shape, but with advantageous modifications.

The final frame design is a square based shape, with a reduced height and a precise inclination of the side panels. All frame sides are closed, to protect the sensor from flow unsteadiness and seabed debris, whereas the sensor is installed inside a gimbal to be always oriented in the correct direction. The increased total weight of such frame and the improved aerodynamic performance allow an easier sensor deployment, as a very low amount of ballast is needed. To improve the measured data quality and increase the separation area over the sensor head (pushing away eddies from the sensor head and, in turn, decreasing sensor tilting), some vortex generators have been tested with some beneficial effects on lift-to-drag ratio as well.

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The Authors thank also the other partners involved as the Lewis Castle College UHI, Hebrides Marine Services (HMS) and Seapower scrl which supported this research in different ways.
Changing tides: predicting the impact of Scottish tidal energy on sediment levels in British waters

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Tidal arrays are a potentially important source of carbon-free energy. However, the extraction of tidal energy from waters will inevitably lead to changes in tidal velocities. Marine ecosystems will therefore be impacted by the development of tidal energy, and it is important to anticipate and mitigate negative consequences. Here we assess the possible impacts of the large-scale introduction of tidal turbines in Scottish waters on water column turbidity and seafloor sediment levels across the northwest European shelf. Two scenarios are used: one where tidal energy is maximized in Scottish waters, and one where turbines are restricted to the Pentland Firth. We use an existing model of turbidity (Heath et al. 2017), which was re-tuned to reflect the geographic pattern of turbidity shown by satellite data across the European shelf. Turbidity is modeled as an increasing function of bed shear stress and mud content on the seafloor. This turbidity model is then driven by predicted tidal velocities from an FVCOM model created as part of the EcoWatt2050 project, ECMWF wave data, and a recently synthesized map of seabed mud across the shelf. Extraction of tidal energy largely leads to reductions in turbidity levels, with declines of over 10% in some areas. However, other areas see increased tidal velocities which cause pronounced increases in turbidity. Finally, we show that there will potentially be significant reductions in mud levels in some nephrops’ habitats, which could impact this species.

References

An improved understanding of seasonal trends in distributions, particularly for species of conservation value, greatly enhances the management of these species. Seasonal shifts in distribution likely represent changes in prey availability, yet obtaining data on prey species for marine top predators is often difficult.

Here we investigate shifts in the overall distribution and the distribution of foraging events for harbour porpoise (Phocoena phocoena) using passive acoustic data collected using C-PODs in the Moray Firth (MF) in July-October 2009-2011. There were between 48 and 65 C-PODs deployed in each month. The distribution of harbour porpoise was modelled using hierarchical Bayesian methods using integrated nested Laplace approximation. The highest number of detection positive hours for porpoise (20-24 hours/day) was on a sand bank in the outer MF (Smith Bank) during July-September; however, this shifted to the central MF in October in 2009 and 2010. This trend was slightly different in 2011, occurring earlier in the year, which is likely related to different prey availability or abundance. There were marked differences in sea surface temperature and chlorophyll recorded by satellites in 2011 which could have influenced prey species.

The high detections of porpoise on the Smith Bank are expected to be due to favorable foraging conditions on sandeel, which are one of the primary prey species for harbour porpoise in Scotland, particularly during the summer (Santos et al. 2004). However, very little foraging (~10% of clicks) was actually detected on the Smith Bank, with more foraging detected in the inner and central parts of the MF (up to 60% of clicks), where relative density was lower. There are several potential reasons for this: porpoise could travel to specific locations to forage or spend less time foraging in good habitats. However, porpoise are small with a high metabolism they are thought to need to eat regularly to survive. Porpoise echolocation clicks are also highly directional so changes in body orientation during foraging bouts could cause clicks to be missed by the C-PODs. Therefore we propose that this apparent shift in foraging detections is likely caused by porpoise using alternative foraging strategies for different prey in different habitats, which are not equally detectable by the C-PODs. This suggest that while C-PODs are a useful tool to assess overall distribution, their ability to capture foraging behaviour may vary in different habitats.

We have shown that harbour porpoise are exhibiting different distributions throughout the summer and early autumn. Our data also suggest that porpoise may exhibit different foraging behaviours in different locations. An increased understanding of seasonal habitat use and important areas for foraging such as this can have implications for spatio-temporal management of activities and development.

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References

A harbour seal Individual Based Model: a useful management tool?

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A quantification and modelling of harbour seal movement is required to predict the consequence of environmental change on both population distribution and connectivity. One approach to this challenge is a mechanistic individual based model (IBM) of seal movement. IBMs predict emergent behaviour from physiological capabilities and constraints using a set of biologically realistic rules within a simulated environment. Given that these rules can be sufficiently guided and tuned by data, IBMs offer the potential to explore plausible future scenarios to investigate the likely effects of environmental change on seal movements.

A simple prototype harbour seal IBM has been constructed with two currencies: energy and information (Nabe-Nielsen et al., 2013). It has been run for the Pentland Firth / Orkney region. It captures some of the emergent properties of real track data (for example foraging trip length and extent). However, two important challenges remain. The first is to refine the current model and improve parameter estimates such that it can provide informative, reliable predictions. The second is to adequately characterise the distribution and dynamics of prey resources that seals require. We will demonstrate the current model and suggest validation methods that may allow us to improve this prototype IBM, creating a robust predictive management tool (Thiele et al., 2014).


Developing new acoustic tags to study the foraging strategies of Antarctic marine predators.

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How predators find, select and capture prey are central themes in foraging ecology; but for many aquatic animals, information on these behaviours is difficult to obtain. In a rapidly changing environment, contrasting foraging strategies between different predators could provide insights into their ecosystem function, and their resilience to environmental change. Animal-borne tags have been a key tool for studying the foraging behaviour of marine species that inhabit remote areas such as the Southern Ocean. These devices gather information about the surface tracks, dive patterns, body condition and physical environment of animals over periods of months enabling inferences about where and how efficiently animals forage and how foraging efficiency varies spatially. However, little is still known about how marine predators such as seals and penguins find and select prey within dives. This information is critical to understand how changing prey availability will impact central place foragers with restricted scope for movement, e.g. when provisioning young.

Living in water, many aquatic species have evolved to use sound actively or passively as their primary sensory modality. This and the need to understand the impact of man-made noise on marine mammals drove the development of high resolution tags (DTags) that could simultaneously record an animal’s movements, vocalisations and acoustic environment over a period of 1 to 2 days. However, until recently the sensor and battery technologies did not exist to allow these tags to record such information over longer ecologically relevant temporal scales of weeks to months, nor have they been able to reliably record cues associated with other sensory modalities, such as vision. We present a new set of DTags designed to be deployed on top predators, initially in the Southern Ocean. The collected data will potentially help us to understand how these animals find prey patches and will enable a detailed comparison of their foraging strategies.

Southern Elephant Seals (SES) are central place foragers, and single foraging trips can last several months. They feed in the deep scattering layer and their diet consists of myctophid fish and cephalopods. Myctophids bioluminesce for counter shading (predator avoidance) and communication, and it is thought that SES use bioluminescence as visual cues for foraging. However, linking light intensity to prey abundance, size and behaviour is difficult without additional information provided by a camera or echosounder. We have developed two novel DTags that will be deployed on Southern Elephant Seals & also under ice on Weddell Seals in November 2017. The first tag is a sound-bioluminescence DTag which incorporates a Hanamatsu photodiode sampled at 50 Hz to measure bioluminescence, and a single hydrophone sampled at 196 kHz. The second tag incorporates a miniature single beam, 1.5 MHz, echosounder, with a ping rate of up to 50Hz to record in-situ echoes from prey enabling quantification of prey density and behaviour. The operating frequency of the echosounder was chosen to be well beyond the hearing range of seals however audibility tests on captive seals are being conducted to ensure that sidelobes from the sonar do not affect behaviour. Both tags are designed to record continuously for 2 months, and data from these novel sensors are tightly integrated with GPS, pressure, and triaxial accelerometer and magnetometer sensors. The compact tag (58x97x x37mm) is designed to be glued to the head of seals so that the light and sonar sensors sample the water in front of the animal.

Finally, a miniaturised version of the DTag has been developed for smaller species such as penguins. The short duration of foraging trips in the species of interest allowed us to use a rechargeable battery to record data for up to 5 days. The resulting 67x30x20mm device comprises hydrophone, GPS, accelerometers, magnetometers and depth sensors and is to be deployed on fur seals and macaroni penguins breeding on South Georgia.