The potential for tracking aquatic animals to support sustainable progress in marine renewables

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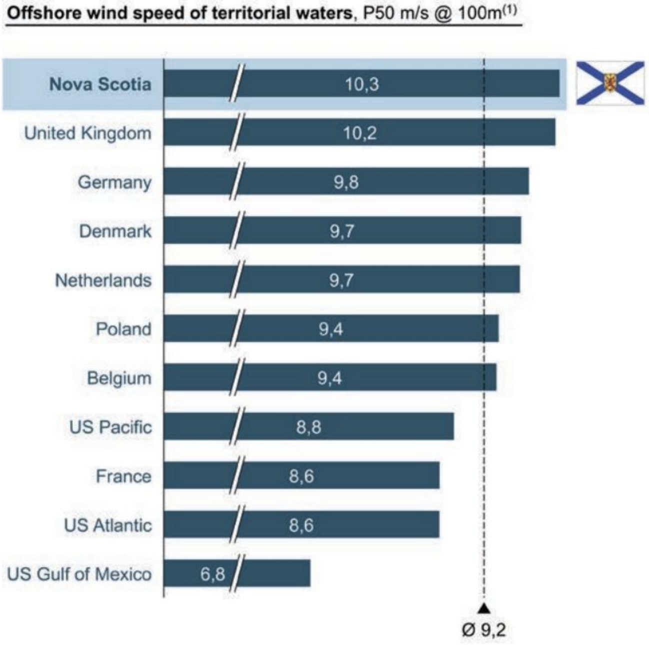
Nova Scotia is a hotspot for wind



Nova Scotia offers one of the world's most competitive untapped offshore wind resources

Nova Scotia is a hotspot for wind

Nova Scotia

Legislation to regulate offshore wind development in N.S. and N.L. clears Senate

Bids for offshore wind projects could begin as early as next year

Michael Gorman · CBC News · Posted: Oct 02, 2024 5:19 PM ADT | Last Updated: October 2

Nova Scotia charges ahead with offshore wind regulator, aims to open bids next year

Province looks to sidestep Ottawa's mirror legislation, saying it's going too slowly

Taryn Grant · CBC News · Posted: Sep 10, 2024 3:37 PM ADT | Last Updated: September 10

Nova Scotia

New report finds offshore wind development in Nova Scotia could be a decade away

Interim report makes recommendations for six potential development areas

Michael Gorman · CBC News · Posted: Mar 26, 2024 2:46 PM ADT | Last Updated: March 26

Nova Scotia

Fishers want 'incredibly important' Georges Bank protected against offshore wind development

Minister says the rich fishing ground will be protected, but not in law

Taryn Grant · CBC News · Posted: Sep 17, 2024 2:13 PM ADT | Last Updated: September 17

Some optimism for a win-win scenario

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The potential of offshore windfarms to act as marine protected areas – A systematic review of current evidence

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ABSTRACT

As offshore windfarm (OWF) construction in the UK is prog[…] and ecological effects of these developments is urgently n[…] and where necessary mitigation in an increasingly cro[…] mitigation is co-location of OWFs and marine protected[…] objective to inform this co-location proposal and iden[…] number of studies addressing marine renewable ener[…] coastal waters were found. The results of these stu[…] artificial structures in comparison to naturally oc[…] associated species, especially benthic bivalves, crus[…] algae abundance were the dominant trends. Assem[…] revealed greater similarity to natural hard sub[…] To consider marine renewable energy sites, espe[…] of assemblages on the structures themselves t[…] positive effects were recorded on the abundan[…] suggests potential for incorporation of OWFs […] MPA to aid fisheries augmentation. The l[…] significant further research involving long[…] management options.

1. Introduction

Over the next 10 years a rapid expansion of offshore windfarm (OWF) development is planned in part to attain the EU target of 20% of energy generation from renewables by 2020 [1]. This will lead to OWF and marine renewable energy installations (MREIs) covering an extensive area of coastal waters, especially in the North East Atlantic and the Baltic Sea where current developments and leased areas propose to cover between twenty eight thousand and twenty nine thousand square kilometres of sea bed [2]. The largest European projects include individual OWFs with footprints covering leased areas of over eight thousand square kilometres [2]. Despite the scale of development the environmental, economic and social effects to existing resources and activities in develop[…] ment areas are not widely understood.

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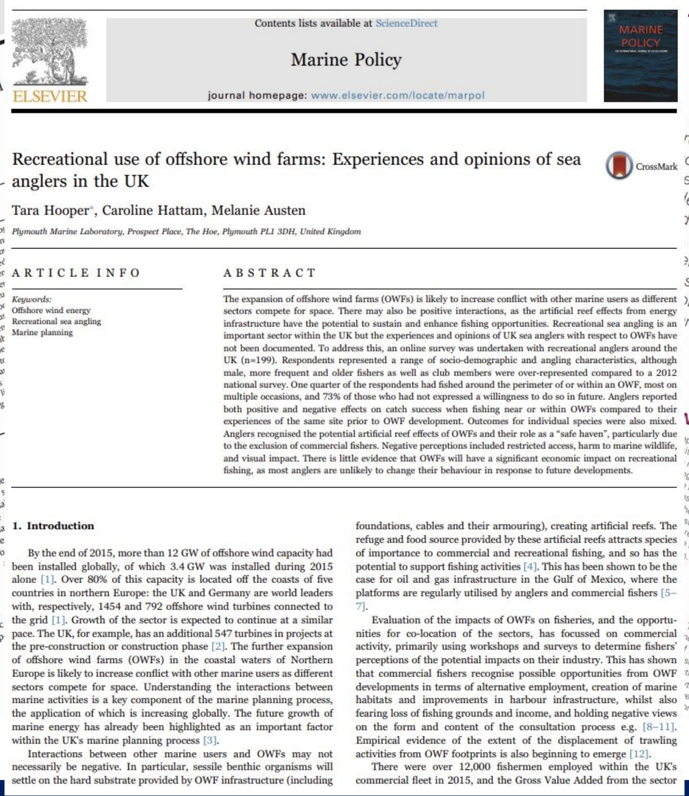

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MARINE POLICY

CrossMark

Recreational use of offshore wind farms: Experiences and opinions of sea anglers in the UK

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ABSTRACT

The expansion of offshore wind farms (OWFs) is likely to increase conflict with other marine users as different sectors compete for space. There may also be positive interactions, as the artificial reef effects from energy infrastructure have the potential to sustain and enhance fishing opportunities. Recreational sea angling is an important sector within the UK but the experiences and opinions of UK sea anglers with respect to OWFs have not been documented. To address this, an online survey was undertaken with recreational anglers around the UK (n=199). Respondents represented a range of socio-demographic and angling characteristics, although male, more frequent and older fishers as well as club members were over-represented compared to a 2012 national survey. One quarter of the respondents had fished around the perimeter of or within an OWF, most on multiple occasions, and 73% of those who had not expressed a willingness to do so in future. Anglers reported both positive and negative effects on catch success when fishing near or within OWFs compared to their experiences of the same site prior to OWF development. Outcomes for individual species were also mixed. Anglers recognised the potential artificial reef effects of OWFs and their role as a "safe haven", particularly due to the exclusion of commercial fishers. Negative perceptions included restricted access, harm to marine wildlife, and visual impact. There is little evidence that OWFs will have a significant economic impact on recreational fishing, as most anglers are unlikely to change their behaviour in response to future developments.

1. Introduction

By the end of 2015, more than 12 GW of offshore wind capacity had been installed globally, of which 3.4 GW was installed during 2015 alone [1]. Over 80% of this capacity is located off the coasts of five countries in northern Europe: the UK and Germany are world leaders with, respectively, 1454 and 792 offshore wind turbines connected to the grid [1]. Growth of the sector is expected to continue at a similar pace. The UK, for example, has an additional 547 turbines in projects at the pre-construction or construction phase [2]. The further expansion of offshore wind farms (OWFs) in the coastal waters of Northern Europe is likely to increase conflict with other marine users as different sectors compete for space. Understanding the interactions between marine activities is a key component of the marine planning process, the application of which is increasing globally. The future growth of marine energy has already been highlighted as an important factor within the UK's marine planning process [3].

Interactions between other marine users and OWFs may not necessarily be negative. In particular, sessile benthic organisms will settle on the hard substrate provided by OWF infrastructure (including foundations, cables and their armouring), creating artificial reefs. The refuge and food source provided by these artificial reefs attracts species of importance to commercial and recreational fishing, and so has the potential to support fishing activities [4]. This has been shown to be the case for oil and gas infrastructure in the Gulf of Mexico, where the platforms are regularly utilised by anglers and commercial fishers [5–7].

Evaluation of the impacts of OWFs on fisheries, and the opportunities for co-location of the sectors, has focussed on commercial activity, primarily using workshops and surveys to determine fishers' perceptions of the potential impacts on their industry. This has shown that commercial fishers recognise possible opportunities from OWF developments in terms of alternative employment, creation of marine habitats and improvements in harbour infrastructure, whilst also fearing loss of fishing grounds and income, and holding negative views on the form and content of the consultation process e.g. [8–11]. Empirical evidence of the extent of the displacement of trawling activities from OWF footprints is also beginning to emerge [12].

There were over 12,000 fishermen employed within the UK's commercial fleet in 2015, and the Gross Value Added from the sector

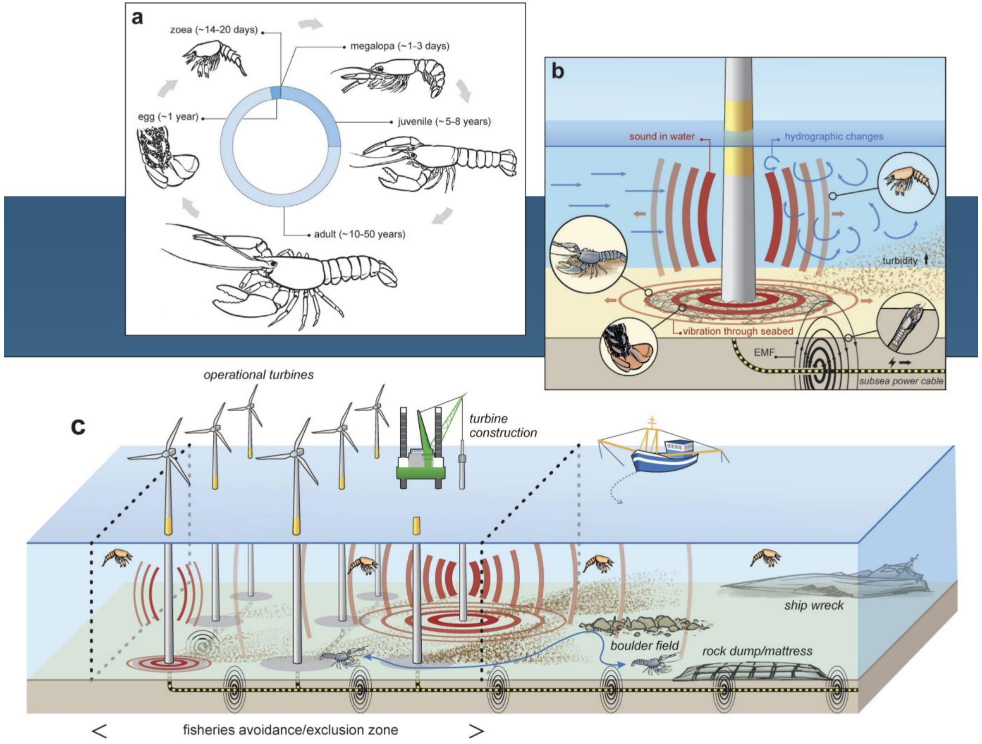
Offshore wind farms as productive sites for fishes?

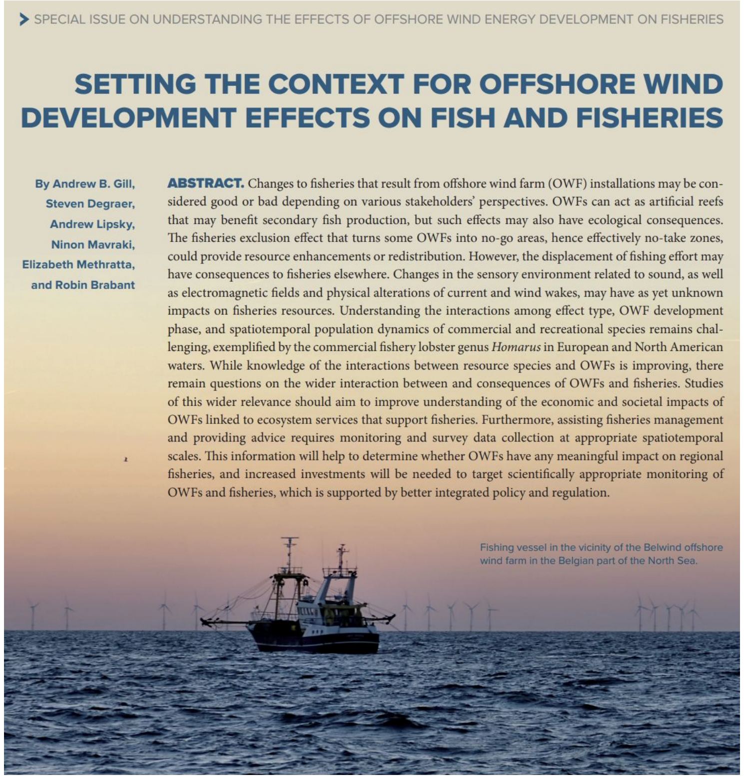
Sofie Vandendriessche*, Jan Reubens*, Jozefien Derweduwen, Steven Degraer and Magda Vincx

* shared first authorship

Artificial hard substrates in the marine environment have an influence on the local fish community. The new envi[…]ronment may induce some costs or benefits for the fish [p]opulations. Since the local evolution of fish stocks and [th]e value of wind farms as management tools complete[ly d]epend on the extent of the artificial reef effects at the [wind] farms, it is essential to identify the processes at […]. Consequently, community structure, reef ecology [and b]ehavioural ecology were investigated for a number [of] species present at the offshore wind farms. The [results o]btained were integrated and a viewpoint on at[…][p]roduction was formulated.

Many questions about offshore wind (here's one example)





SPECIAL ISSUE ON UNDERSTANDING THE EFFECTS OF OFFSHORE WIND ENERGY DEVELOPMENT ON FISHERIES

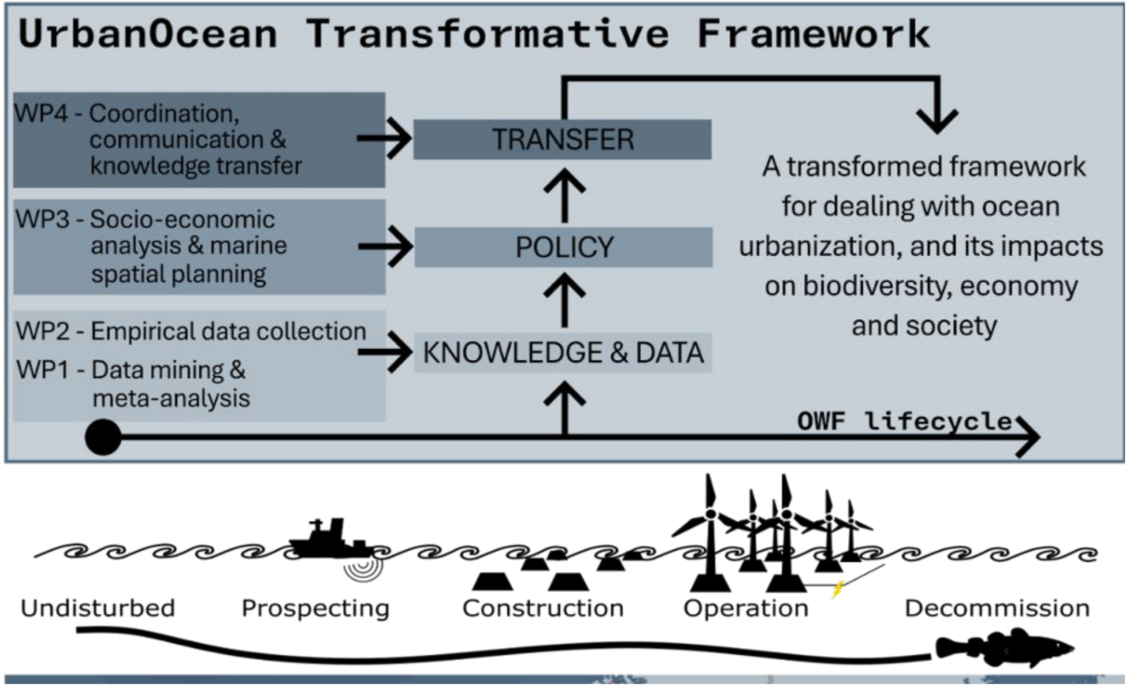
SETTING THE CONTEXT FOR OFFSHORE WIND DEVELOPMENT EFFECTS ON FISH AND FISHERIES

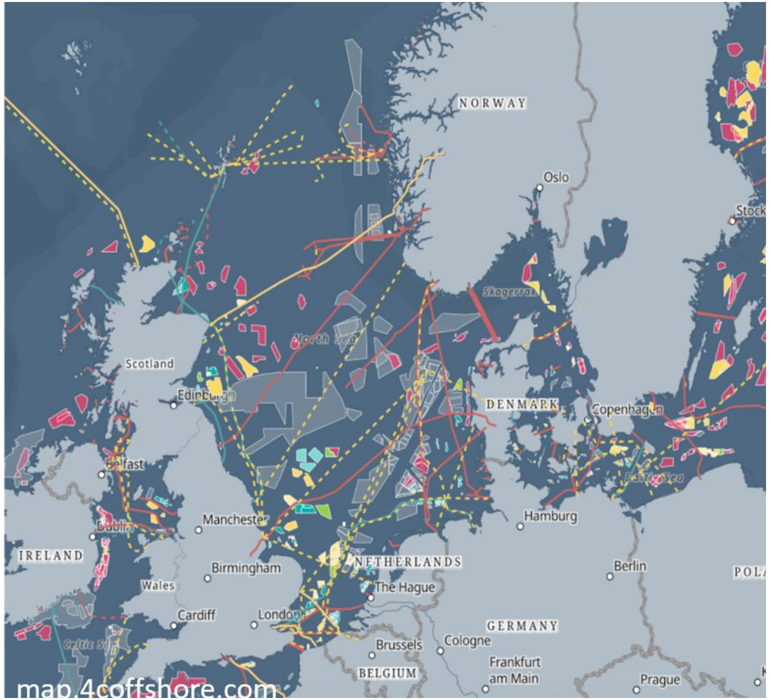
By Andrew B. Gill, Steven Degraer, Andrew Lipsky, Ninon Mavraki, Elizabeth Methratta, and Robin Brabant

ABSTRACT. Changes to fisheries that result from offshore wind farm (OWF) installations may be considered good or bad depending on various stakeholders' perspectives. OWFs can act as artificial reefs that may benefit secondary fish production, but such effects may also have ecological consequences. The fisheries exclusion effect that turns some OWFs into no-go areas, hence effectively no-take zones, could provide resource enhancements or redistribution. However, the displacement of fishing effort may have consequences to fisheries elsewhere. Changes in the sensory environment related to sound, as well as electromagnetic fields and physical alterations of current and wind wakes, may have as yet unknown impacts on fisheries resources. Understanding the interactions among effect type, OWF development phase, and spatiotemporal population dynamics of commercial and recreational species remains challenging, exemplified by the commercial fishery lobster genus *Homarus* in European and North American waters. While knowledge of the interactions between resource species and OWFs is improving, there remain questions on the wider interaction between and consequences of OWFs and fisheries. Studies of this wider relevance should aim to improve understanding of the economic and societal impacts of OWFs linked to ecosystem services that support fisheries. Furthermore, assisting fisheries management and providing advice requires monitoring and survey data collection at appropriate spatiotemporal scales. This information will help to determine whether OWFs have any meaningful impact on regional fisheries, and increased investments will be needed to target scientifically appropriate monitoring of OWFs and fisheries, which is supported by better integrated policy and regulation.

Fishing vessel in the vicinity of the Belwind offshore wind farm in the Belgian part of the North Sea.

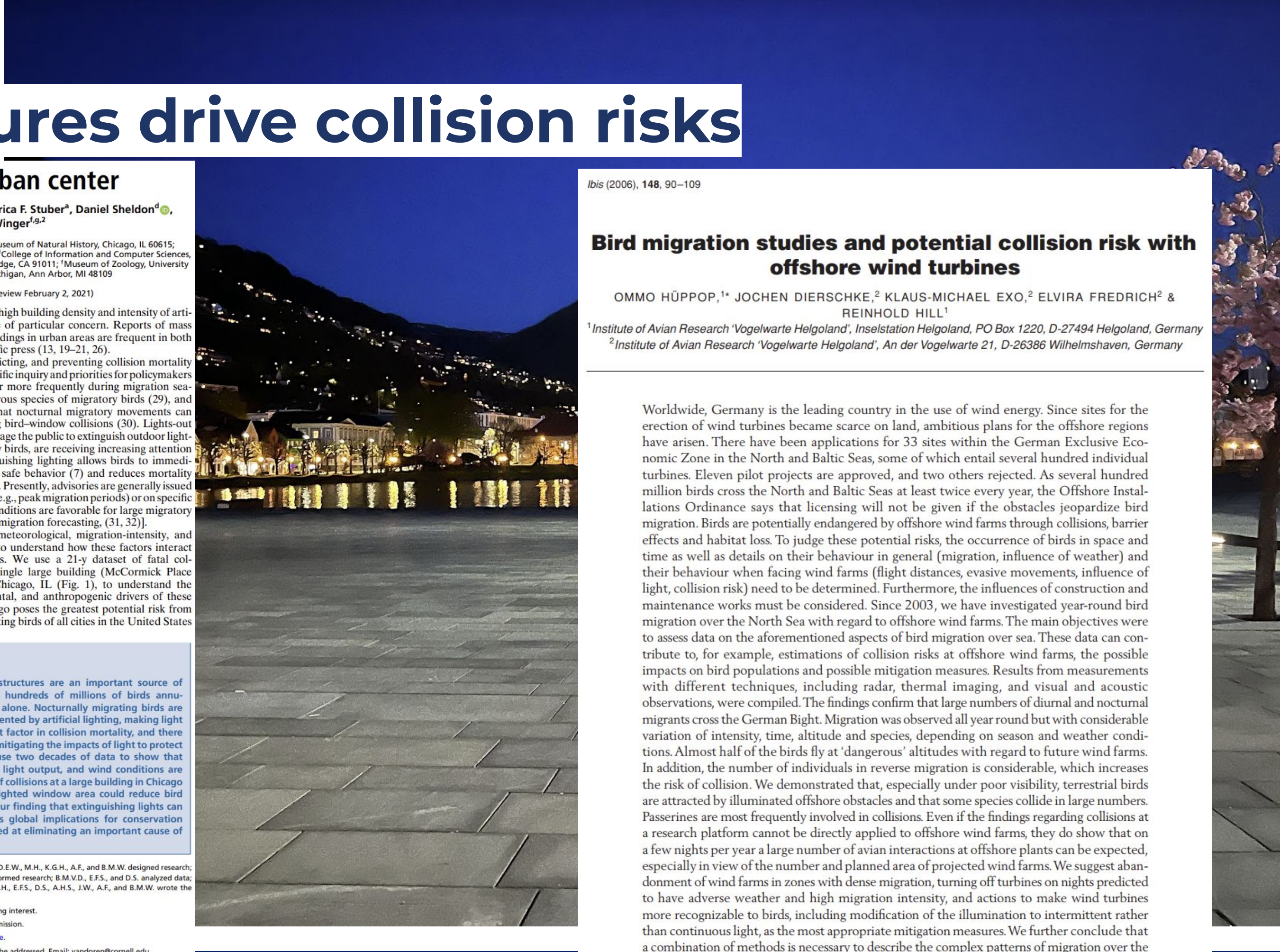
Need for a new framework: marine urbanisation





KIM BIRNIE-GAUVIN

Vertical structures drive collision risks



Drivers of fatal bird collisions in an urban center

Benjamin M. Van Doren[a,1], David E. Willard[b], Mary Hennen[b], Kyle G. Horton[c], Erica F. Stuber[a], Daniel Sheldon[d], Ashwin H. Sivakumar[e], Julia Wang[a], Andrew Farnsworth[a,2], and Benjamin M. Winger[f,g,2]

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Millions of nocturnally migrating birds die each year from collisions with built structures, especially brightly illuminated buildings and communication towers. Reducing this source of mortality requires knowledge of important behavioral, meteorological, and anthropogenic factors, yet we lack an understanding of the interacting roles of migration, artificial lighting, and weather conditions in causing fatal bird collisions. Using two decades of collision surveys and concurrent weather and migration measures, we model numbers of collisions occurring at a large urban building in Chicago. We find that the magnitude of nocturnal bird migration, building light output, and wind conditions are the most important predictors of fatal collisions. The greatest mortality occurred when the building was brightly lit during large nocturnal migration events and when winds concentrated birds along the Chicago lakeshore. We estimate that halving lighted window area decreases collision counts by 11× in spring and 6× in fall. Bird mortality could be reduced by ∼60% at this site by decreasing lighted window area to minimum levels historically recorded. Our study provides strong support for a relationship between nocturnal migration magnitude and urban bird mortality, mediated by light pollution and local atmospheric conditions. Although our research focuses on a single site, our findings have global implications for reducing or eliminating a critically important cause of bird mortality.

light pollution | conservation | bird migration | urban planning | mortality

North America has lost nearly one-third of its birdlife in the last half-century, with migratory species experiencing particularly acute declines (1). Fatal collisions with built structures represent a major source of direct, human-caused bird mortality across North America, second only to predation by domestic cats (2). Estimates indicate that between 365 million and 988 million birds die annually in collisions with buildings in the United States, with another 16 million to 42 million annual deaths in Canada (2, 3). Birds may collide with glass windows because they reflect the surrounding environment or allow birds to perceive a seemingly open pathway to the interior of the building (4). For the billions of birds that migrate at night, outdoor lighting (e.g., streetlights and floodlights) and interior lighting from buildings may be disorienting and draw birds into built-up areas, at high risk to collide with infrastructure (5–8). Light pollution not only alters nocturnal migratory behavior on a large scale (5, 7), but is also an acute conservation concern. Nocturnal collisions with well-lit communication towers alone are estimated to kill appreciable percentages of the populations of sensitive species (9).

Avian collisions with lighted structures have been documented in the scientific literature as early as the 19th century (10–12). In recent decades, this link between collisions and light pollution has been the subject of detailed investigation (8, 13–16). Observers of bird–building collisions and tower kills have long remarked on the apparent influence of meteorological factors such as cloud ceiling, fog, frontal passage, and abrupt changes in conditions, all of which have been associated with large mortality events (10, 13, 17–24). Steady-burning lights may be particularly hazardous (25). Due to high building density and intensity of artificial lighting, cities are of particular concern. Reports of mass collisions at lighted buildings in urban areas are frequent in both the popular and scientific press (13, 19–21, 26).

Understanding, predicting, and preventing collision mortality are areas of active scientific inquiry and priorities for policymakers (1, 13). Collisions occur more frequently during migration seasons and impact numerous species of migratory birds (29), and recent work suggests that nocturnal migratory movements can be useful for predicting bird–window collisions (30). Lights-out programs, which encourage the public to extinguish outdoor lighting to protect migratory birds, are receiving increasing attention (13). The act of extinguishing lighting allows birds to immediately return to normal, safe behavior (7) and reduces mortality at lighted buildings (13). Presently, advisories are generally issued for a given time period (e.g., peak migration periods) or on specific nights when weather conditions are favorable for large migratory movements [e.g., using migration forecasting, (31, 32)].

Here, we integrate meteorological, migration-intensity, and window-radiance data to understand how these factors interact to cause bird collisions. We use a 21-y dataset of fatal collisions recorded at a single large building (McCormick Place Lakeside Center) in Chicago, IL (Fig. 1), to understand the behavioral, environmental, and anthropogenic drivers of these mortality events. Chicago poses the greatest potential risk from light pollution to migrating birds of all cities in the United States

Significance

Collisions with built structures are an important source of bird mortality, killing hundreds of millions of birds annually in North America alone. Nocturnally migrating birds are attracted to and disoriented by artificial lighting, making light pollution an important factor in collision mortality, and there is growing interest in mitigating the impacts of light to protect migrating birds. We use two decades of data to show that migration magnitude, light output, and wind conditions are important predictors of collisions at a large building in Chicago and that decreasing lighted window area could reduce bird mortality by ∼60%. Our finding that extinguishing lights can reduce bird death has global implications for conservation action campaigns aimed at eliminating an important cause of bird mortality.

Author contributions: B.M.V.D., D.E.W., M.H., K.G.H., A.F., and B.M.W. designed research; B.M.V.D., D.E.W., and M.H. performed research; B.M.V.D., E.F.S., and D.S. analyzed data; and B.M.V.D., D.E.W., M.H., K.G.H., E.F.S., D.S., A.H.S., J.W., A.F., and B.M.W. wrote the paper.

The authors declare no competing interest.

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Bird migration studies and potential collision risk with offshore wind turbines

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Worldwide, Germany is the leading country in the use of wind energy. Since sites for the erection of wind turbines became scarce on land, ambitious plans for the offshore regions have arisen. There have been applications for 33 sites within the German Exclusive Economic Zone in the North and Baltic Seas, some of which entail several hundred individual turbines. Eleven pilot projects are approved, and two others rejected. As several hundred million birds cross the North and Baltic Seas at least twice every year, the Offshore Installations Ordinance says that licensing will not be given if the obstacles jeopardize bird migration. Birds are potentially endangered by offshore wind farms through collisions, barrier effects and habitat loss. To judge these potential risks, the occurrence of birds in space and time as well as details on their behaviour in general (migration, influence of weather) and their behaviour when facing wind farms (flight distances, evasive movements, influence of light, collision risk) need to be determined. Furthermore, the influences of construction and maintenance works must be considered. Since 2003, we have investigated year-round bird migration over the North Sea with regard to offshore wind farms. The main objectives were to assess data on the aforementioned aspects of bird migration over sea. These data can contribute to, for example, estimations of collision risks at offshore wind farms, the possible impacts on bird populations and possible mitigation measures. Results from measurements with different techniques, including radar, thermal imaging, and visual and acoustic observations, were compiled. The findings confirm that large numbers of diurnal and nocturnal migrants cross the German Bight. Migration was observed all year round but with considerable variation of intensity, time, altitude and species, depending on season and weather conditions. Almost half of the birds fly at 'dangerous' altitudes with regard to future wind farms. In addition, the number of individuals in reverse migration is considerable, which increases the risk of collision. We demonstrated that, especially under poor visibility, terrestrial birds are attracted by illuminated offshore obstacles and that some species collide in large numbers. Passerines are most frequently involved in collisions. Even if the findings regarding collisions at a research platform cannot be directly applied to offshore wind farms, they do show that on a few nights per year a large number of avian interactions at offshore plants can be expected, especially in view of the number and planned area of projected wind farms. We suggest abandonment of wind farms in zones with dense migration, turning off turbines on nights predicted to have adverse weather and high migration intensity, and actions to make wind turbines more recognizable to birds, including modification of the illumination to intermittent rather than continuous light, as the most appropriate mitigation measures. We further conclude that a combination of methods is necessary to describe the complex patterns of migration over the sea. The recordings are to be continued with the aim of refining the results presented here, and of developing a model for 'forecasting' bird migration over the German Bight. We expect more information on avoidance behaviour and collisions after the construction of a pilot wind park.

Light and sound pollution in cities and platforms

Biological Conservation 236 (2019) 17–28

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Light pollution at the urban forest edge negatively impacts insectivorous bats

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A B S T R A C T

Connectivity and quality of vegetation in cities, including urban forests, can promote urban biodiversity. However the impact of anthropogenic pressures at the forest-matrix edge, particularly artificial light at night (ALAN), on connectivity has received little attention. We assessed the influence of artificial light at forest edges on insectivorous bats. We acoustically surveyed 31 forest edges across greater Sydney, Australia, half with mercury vapour streetlights and half in ambient darkness, and compared the bat assemblage and activity levels to urban forest interiors. We also sampled the flying insect community to establish whether changes in insect densities under lights drive changes in insectivorous bat activity. We recorded 9965 bat passes from 16 species or species groups throughout our acoustic survey. The activity of all bats, and bats hypothesised to be sensitive to artificial light, was consistently higher in forest interiors as opposed to edges. We found that slower flying bats adapted to cluttered vegetation or with a relatively high characteristic echolocation call frequency; *Chalinolobus morio*, *Miniopterus australis*, *Vespadelus vulturnus*, and *Nyctophilus* spp., were negatively affected by artificial light sources at the forest edge. The emergence time of *Vespadelus vulturnus* was also significantly delayed by the presence of streetlights at the forest edge. Conversely, generalist faster flying bats; *Chalinolobus gouldii*, *Ozimops ridei*, *Austronomous australis*, *Saccolaimus flaviventris*, and *Miniopterus orianae oceanensis*, were unaffected by artificial light at the edge of urban forest, and used light and dark forest edges in a similar way. Insect surveys showed that larger lepidopterans seemed to be attracted to lit areas, but in low numbers. Artificial light sources on the edges of urban forest have diverse effects on bats and insects, and should be considered an anthropogenic edge effect that can reduce available habitat and decrease connectivity for light-sensitive species.

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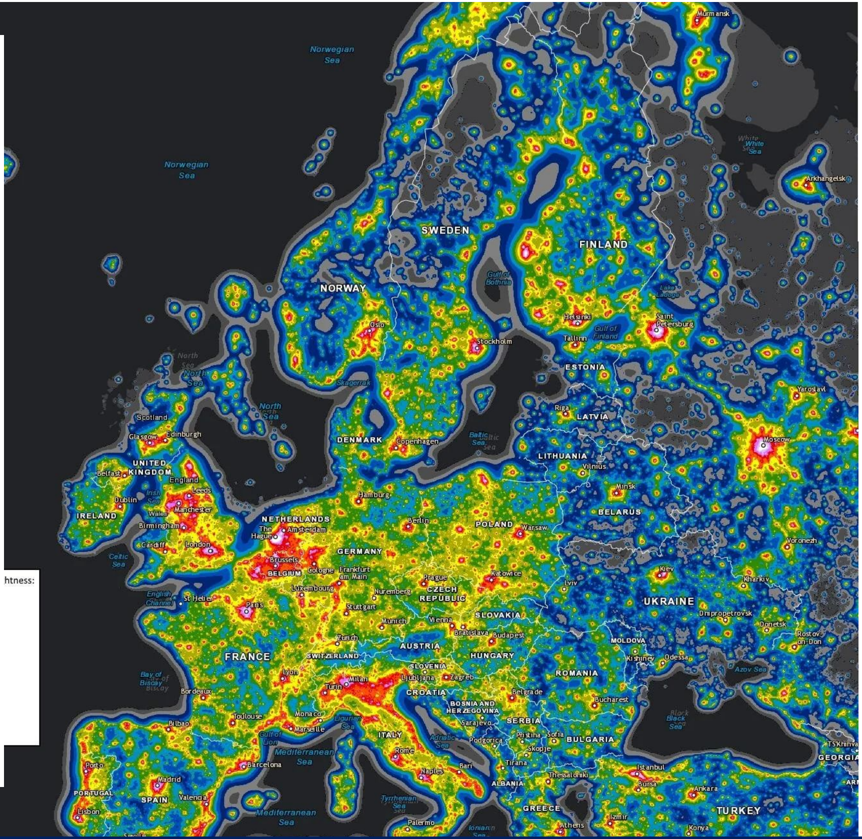
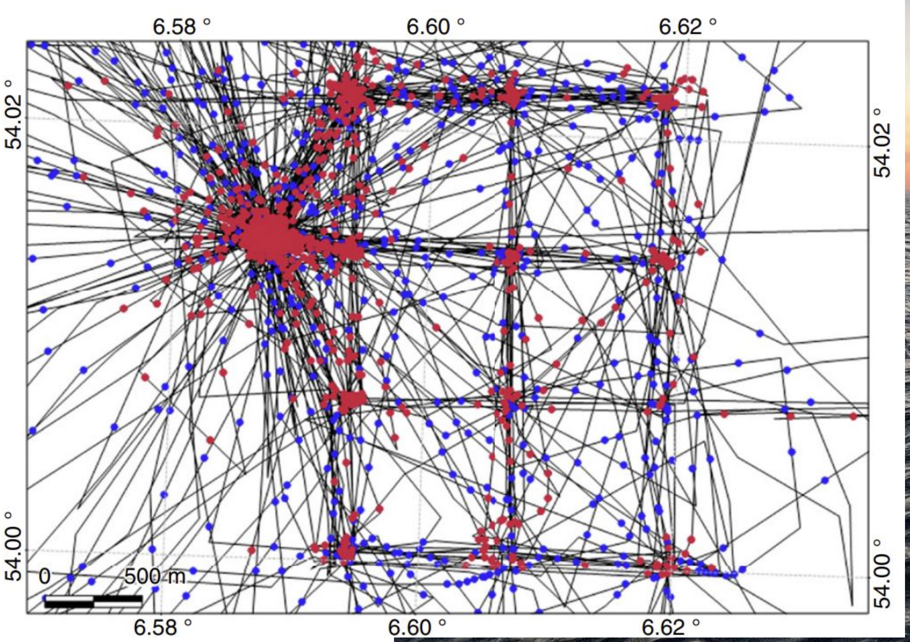


Platforms create foraging hotspots and linearity



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Marine mammals trace anthropogenic structures at sea

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Gordon D. Hastie[1], Vincent M. Janik[1],
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Cities protect from hunting, platforms from fishing

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The potential of offshore windfarms to act as marine protected areas – A systematic review of current evidence

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ABSTRACT

As offshore windfarm (OWF) construction in the UK is progressing rapidly, monitoring of the economic and ecological effects of these developments is urgently needed. This is to enable both spatial planning and where necessary mitigation in an increasingly crowded marine environment. One approach to mitigation is co-location of OWFs and marine protected areas (MPAs). This systematic review has the objective to inform this co-location proposal and identify areas requiring further research. A limited number of studies addressing marine renewable energy structures and related artificial structures in coastal waters were found. The results of these studies display a change in species assemblages at artificial structures in comparison to naturally occurring habitats. An increase in hard substrata associated species, especially benthic bivalves, crustaceans and reef associated fish and a decrease in algae abundance were the dominant trends. Assemblages associated with complex concrete structures revealed greater similarity to natural hard substrata compared to those around steel structures. To consider marine renewable energy sites, especially large scale OWFs as MPAs, the dissimilar nature of assemblages on the structures themselves to natural communities should be considered. However positive effects were recorded on the abundance of commercially important crustacean species. This suggests potential for incorporation of OWFs as no fishing, or restricted activity zones within a wider MPA to aid fisheries augmentation. The limited available evidence highlights a requirement for significant further research involving long term monitoring at a variety of sites to better inform management options.

1. Introduction

Over the next 10 years a rapid expansion of offshore windfarm (OWF) development is planned in part to attain the EU target of 20% of energy generation from renewables by 2020 [1]. This will lead to OWF and marine renewable energy installations (MREIs) covering an extensive area of coastal waters, especially in the North East Atlantic and the Baltic Sea where current developments and leased areas propose to cover between twenty eight thousand and twenty nine thousand square kilometres of sea bed [2]. The largest European projects include individual OWFs with footprints covering leased areas of over eight thousand square kilometres [2]. Despite the scale of development the environmental, economic and social effects to existing resources and activities in development areas are not widely understood.

The spatial extent of the OWF footprint combined with increases in hard substrate within offshore areas will inevitably lead to alterations of habitats and communities at a variety of spatial scales [3,4]. There are also inevitable consequences for economic activities utilising the marine environment including aggregates, shipping and fisheries sectors [5–9]. Previous reviews have highlighted the potential environmental advantages and disadvantages from construction, operation and decommissioning of MREIs [6,9–12]. Specifically these identify that these installations have the potential to act as de-facto marine protected areas (MPAs) by providing artificial reefs, fish aggregating devices and exclusion zones to destructive fishing activities therefore augmenting fisheries and benefiting coastal areas [9,11]. Within these reviews such possibilities are largely theoretical, drawn from the findings of species behaviour, artificial reef and MPA studies. Assessments of environmental impacts of MREIs have also identified potential conflicts that management decisions will be required to address as well as benefits that will only be realised with consideration of the layout and design of MREI arrays [13]. A well recorded evidence base relating to the effects of MREIs (and comparable artificial structures) on marine fauna and flora, habitats and resource

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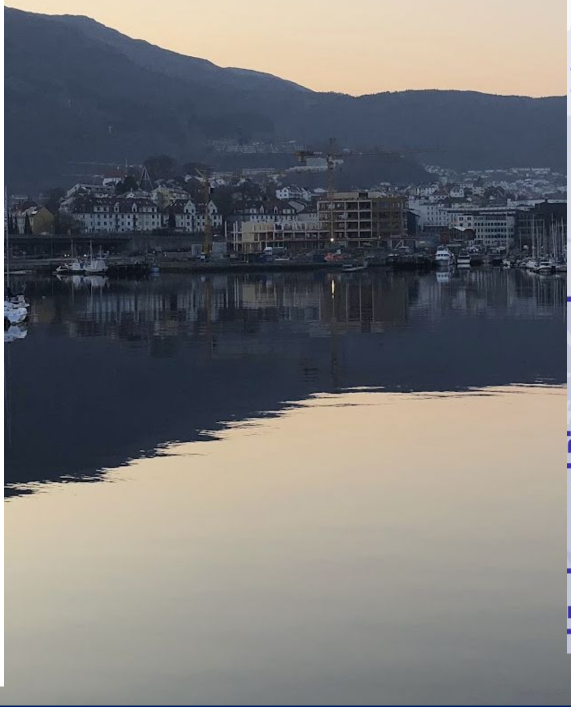

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RESEARCH PAPER

Cities are hotspots for threatened species

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ABSTRACT

Aim Although urbanization impacts many species, there is little information on the patterns of occurrences of threatened species in urban relative to non-urban areas. By assessing the extent of the distribution of threatened species across all Australian cities, we aim to investigate the currently under-utilized opportunity that cities present for national biodiversity conservation.

Location Australian mainland, Tasmania and offshore islands.

Methods Distributions of Australia's 1643 legally protected terrestrial species (hereafter 'threatened species') were compiled. We assessed the extent to which they overlapped with 99 cities (of more than 10,000 people), with all non-urban areas, and with simulated 'dummy' cities which covered the same area and bioregion as the true cities but were non-urban. We analysed differences between animals and plants, and examined variability within these groups using species accumulation modelling. Threatened species richness of true versus dummy cities was analysed using generalized linear mixed-effects models.

Results Australian cities support substantially more nationally threatened animal and plant species than all other non-urban areas on a unit-area basis. Thirty per cent of threatened species were found to occur in cities. Distribution patterns differed between plants and animals: individual threatened plant species were generally found in fewer cities than threatened animal species, yet plants were more likely to have a greater proportion of their distribution in urban areas than animals. Individual cities tended to contain unique suites of threatened species, especially threatened plants. The analysis of true versus dummy cities demonstrated that, even after accounting for factors such as net primary productivity and distance to the coast, cities still consistently supported a greater number of threatened species.

Main conclusions This research highlights that Australian cities are important for the conservation of threatened species, and that the species assemblages of individual cities are relatively distinct. National conservation policy should recognize that cities play an integral role when planning for and managing threatened species.

Keywords
Australia, biodiversity, conservation policy, species distributions, threatened species, urbanization.

Range sizes are smaller in cities

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Review Article

Changes in the home range sizes of terrestrial vertebrates in response to urban disturbance: a meta-analysis

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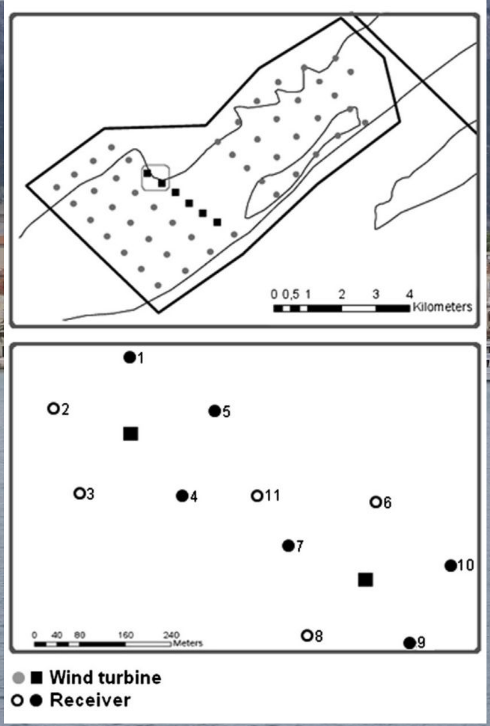
Abstract

The unprecedented growth rate in human population and the increasing movement of people to urban areas is causing a rapid increase in urbanisation globally. Urban environments may restrict or affect the behaviour of many animal species. Importantly, urban populations may change their spatial movement, particularly decreasing their home ranges in response to habitat fragmentation, the presence of landscape barriers and the availability and density of resources. Several species-specific studies suggest that urban animals decrease their home ranges compared with their non-urban counterparts; however, it remained unclear whether this pattern is widespread across taxa or is instead restricted to specific taxonomic groups. Consequently, we conducted a meta-analysis, collecting 41 sets of data comparing home ranges in both natural and urban environments in 32 species of reptiles, birds and mammals. We calculated effect sizes as the difference in animal home range sizes between natural and urban environments. We found that the home ranges were smaller in urban environments compared with natural environments (mean effect size = −0.844), and we observed a similar result when considering birds and mammals separately. We also found that home range sizes were not significantly affected when disturbance in urban areas was minimal, which suggests that many species may be able to tolerate low levels of disturbance without changing their movement patterns. Our study thus indicates that increasing levels of urbanisation restrict the spatial movement of species across taxa; this information is relevant for ecological studies of further urban species as well as for the development of management strategies for urban populations.

Key words: urban disturbance, habitat fragmentation, home range, terrestrial vertebrates, urban environments, urbanisation

Introduction

Natural habitats are rapidly being converted into urban and highly anthropogenic landscapes to accommodate and sustain the increasing global human population (United Nations Population Division 2018). Urbanisation is changing the environment available to animals by increasing temperature, noise and air pollution, the number of barriers preventing wildlife movement and the percentage of impervious surfaces (Pickett et al. 2001; Johnson and Munshi-South 2017). Urbanisation also impacts species through multiple changes in food resource availability, habitat composition, intra- and inter-specific competition and predation rates (Luck and Smallbone 2010; Sol, Lapiedra, and González-Lagos 2013; Boggie and Mannan 2014). As a response to these ecological changes, urban animals can adjust their behaviour (e.g. feeding, activity patterns, responses



Contents lists available at ScienceDirect

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ELSEVIER

Residency, site fidelity and habitat use of Atlantic cod (*Gadus morhua*) at an offshore wind farm using acoustic telemetry

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A B S T R A C T

Because offshore wind energy development is fast growing in Europe it is important to investigate the changes in the marine environment and how these may influence local biodiversity and ecosystem functioning. One of the species affected by these ecosystem changes is Atlantic cod (*Gadus morhua*), a heavily exploited, commercially important fish species. In this research we investigated the residency, site fidelity and habitat use of Atlantic cod on a temporal scale at windmill artificial reefs in the Belgian part of the North Sea. Acoustic telemetry was used and the Vemco VR2W position system was deployed to quantify the movement behaviour. In total, 22 Atlantic cod were tagged and monitored for up to one year. Many fish were present near the artificial reefs during summer and autumn, and demonstrated strong residency and high individual detection rates. When present within the study area, Atlantic cod also showed distinct habitat selectivity. We identified aggregation near the artificial hard substrates of the wind turbines. In addition, a clear seasonal pattern in presence was observed. The high number of fish present in summer and autumn alternated with a period of very low densities during the winter period.

1. Introduction

Offshore wind energy development is the fastest growing energy technology in Europe to produce marine renewable energy (Shaw et al., 2002). In recent years offshore wind farms arose all across the North Sea (Krone, 2012; Reubens et al., 2013a; van Deurs et al., 2012) and member states are planning a further monumental development in the North-East Atlantic Ocean (Wilhelmsson and Malm, 2008).

As a result thousands of wind turbines will be present in the North Sea in the near future. The foundations of these turbines form artificial hard substrates, which in time may turn into artificial reefs (so-called windmill artificial reefs, WARs). The offshore wind farms (OWFs) induce some changes in the marine environment which may influence local biodiversity and ecosystem functioning (Andersson et al., 2009). As a consequence, the OWFs have some environmental costs and benefits (Langhamer et al., 2009) including habitat alteration, changes in sediment characteristics, electromagnetic fields, underwater noise and hydrodynamics. All these ecosystem changes interact with the colonization by epi-fouling organisms; community composition of soft substrate macro- and epibenthos, demersal and benthic fish; spatio-temporal distribution and migration routes of demersal fish, seabirds and marine mammals (Degraer et al., 2012; Petersen and Malm, 2006; Reubens et al., 2013a; Wilhelmsson et al., 2006). However, the ecological impacts on the marine ecosystem on the longer term are still poorly known and scientific peer-reviewed documentation is just slowly increasing (van Deurs et al., 2012).

Atlantic cod (*Gadus morhua* L., 1758) is one of the species that is affected by some of these ecosystem changes in OWFs. Reubens et al. (2013a) revealed the presence of large aggregations of juvenile Atlantic cod at the foundations of wind turbines during summer and autumn. During these periods Atlantic cod exhibited crepuscular movements related to feeding activity (Reubens et al., 2013b).

Atlantic cod is a demersal fish species that occurs in the North Atlantic Ocean. It is widely distributed throughout the North Sea in a variety of habitats and is a highly valued commercial species, suffering from overexploitation (ICES, 2010). They have a flexible diel cycle in feeding activity and habitat utilization linked to

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Environmental homogenisation -> biotic homogenisation

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ELSEVIER

BIOLOGICAL CONSERVATION

Urbanization as a major cause of biotic homogenization

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ABSTRACT

When measured by extent and intensity, urbanization is one of the most homogenizing of all major human activities. Cities homogenize the physical environment because they are built to meet the relatively narrow needs of just one species, our own. Also, cities are maintained for centuries in a disequilibrium state from the local natural environment by the importation of vast resources of energy and materials. Consequently, as cities expand across the planet, biological homogenization increases because the same "urban-adaptable" species become increasingly widespread and locally abundant in cities across the planet. As urbanization often produces a local gradient of disturbance, one can also observe a gradient of homogenization. Synanthropic species adapted to intensely modified built habitats at the urban core are "global homogenizers", found in cities worldwide. However, many suburban and urban fringe habitats are occupied by native species that become regionally widespread. These suburban adapters typically consist of early successional plants and "edge" animal species such as mesopredator mammals, and ground-foraging, omnivorous and frugivorous birds that can utilize gardens, forest fragments and many other habitats available in the suburbs. A basic conservation challenge is that urban biota is often quite diverse and very abundant. The intentional and unintentional importation of species adapted to urban habitats, combined with many food resources imported for human use, often produces local species diversity and abundance that is often equal to or greater than the surrounding landscape. With the important exception of low-income areas, urban human populations often inhabit richly cultivated suburban habitats with a relatively high local floral and faunal diversity and/or abundance without awareness of the global impoverishment caused by urbanization. Equally challenging is that, because so many urban species are immigrants adapting to city habitats, urbanites of all income levels become increasingly disconnected from local indigenous species and their natural ecosystems. Urban conservation should therefore focus on promoting preservation and restoration of local indigenous species.

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Available online at ww

SCIENCE @

The influence of offshore windpower on demersal fish

Dan Wilhelmsson, Torleif Malm, and Marcus C. Öhman

Wilhelmsson, D., Malm, T., and Öhman, M. C. 2006. The influence of offshore windpower on demersal fish. — ICES Journal of Marine Science, 63: 775–784.

A significant expansion of offshore windpower is expected in northwestern Europe in the near future. Little is known about the impacts it may have on the marine environment. Here, we investigate the potential for wind turbines to function as artificial reefs and fish aggregation devices (FADs), i.e. whether they would locally increase fish densities or alter fish assemblages. Fish communities and habitat composition were investigated using visual transects at two windpower farms off the southeastern coast of Sweden, central Baltic Sea. Fish abundance was greater in the vicinity of the turbines than in surrounding areas, while species richness and Shannon–Wiener diversity (H') were similar. On the monopiles of the turbines, fish community structure was different, and total fish abundance was greater, while species richness and diversity (H') were lower than on the surrounding seabed. Blue mussels and barnacles covered most of the submerged parts of the turbines. On the seabed, more blue mussels and a lesser cover of red algae were recorded around the power plants than elsewhere. Results from this study suggest that offshore windfarms may function as combined artificial reefs and fish aggregation devices for small demersal fish.

Keywords: artificial reefs, biodiversity, fishery, Gobidae, human disturbance, marine protected area, wind power.

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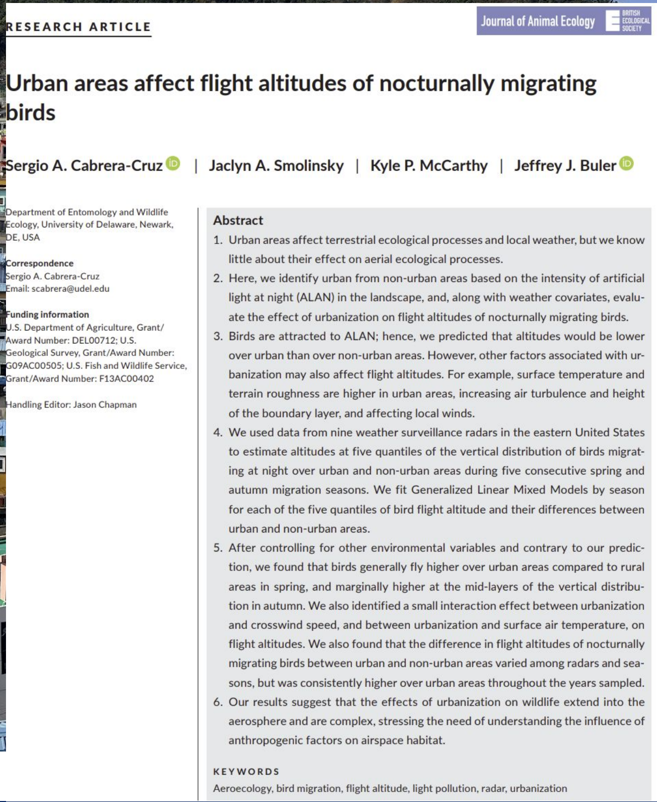
Urban areas impact migration routes



RESEARCH ARTICLE

Journal of Animal Ecology | BRITISH ECOLOGICAL SOCIETY

Urban areas affect flight altitudes of nocturnally migrating birds

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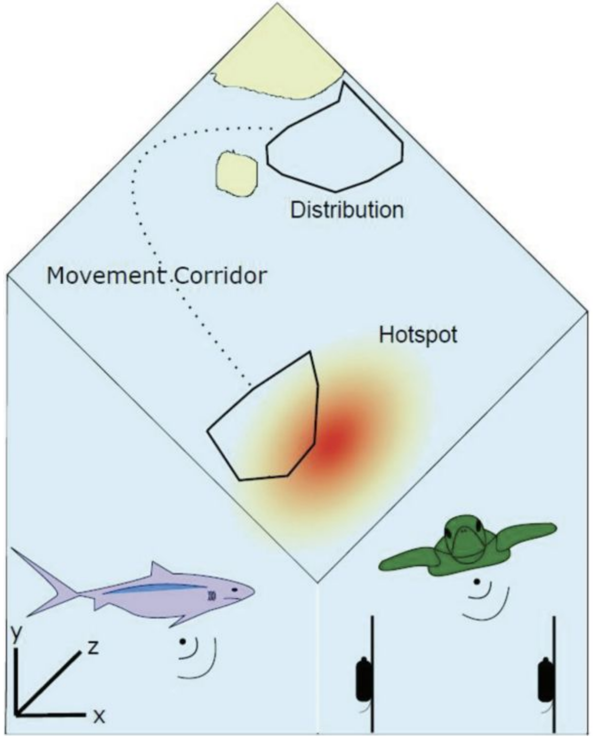
Abstract

1. Urban areas affect terrestrial ecological processes and local weather, but we know little about their effect on aerial ecological processes.
2. Here, we identify urban from non-urban areas based on the intensity of artificial light at night (ALAN) in the landscape, and, along with weather covariates, evaluate the effect of urbanization on flight altitudes of nocturnally migrating birds.
3. Birds are attracted to ALAN; hence, we predicted that altitudes would be lower over urban than over non-urban areas. However, other factors associated with urbanization may also affect flight altitudes. For example, surface temperature and terrain roughness are higher in urban areas, increasing air turbulence and height of the boundary layer, and affecting local winds.
4. We used data from nine weather surveillance radars in the eastern United States to estimate altitudes at five quantiles of the vertical distribution of birds migrating at night over urban and non-urban areas during five consecutive spring and autumn migration seasons. We fit Generalized Linear Mixed Models by season for each of the five quantiles of bird flight altitude and their differences between urban and non-urban areas.
5. After controlling for other environmental variables and contrary to our prediction, we found that birds generally fly higher over urban areas compared to rural areas in spring, and marginally higher at the mid-layers of the vertical distribution in autumn. We also identified a small interaction effect between urbanization and crosswind speed, and between urbanization and surface air temperature, on flight altitudes. We also found that the difference in flight altitudes of nocturnally migrating birds between urban and non-urban areas varied among radars and seasons, but was consistently higher over urban areas throughout the years sampled.
6. Our results suggest that the effects of urbanization on wildlife extend into the aerosphere and are complex, stressing the need of understanding the influence of anthropogenic factors on airspace habitat.

KEYWORDS
Aeroecology, bird migration, flight altitude, light pollution, radar, urbanization

Telemetry can support marine spatial planning



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NRC Research Press

DISCUSSION

Optimizing marine spatial plans with animal tracking data[1]

Robert J. Lennox, Cecilia Engler-Palma, Katie Kowarski, Alexander Filous, Rebecca Whitlock, Steven J. Cooke, and Marie Auger-Méthé

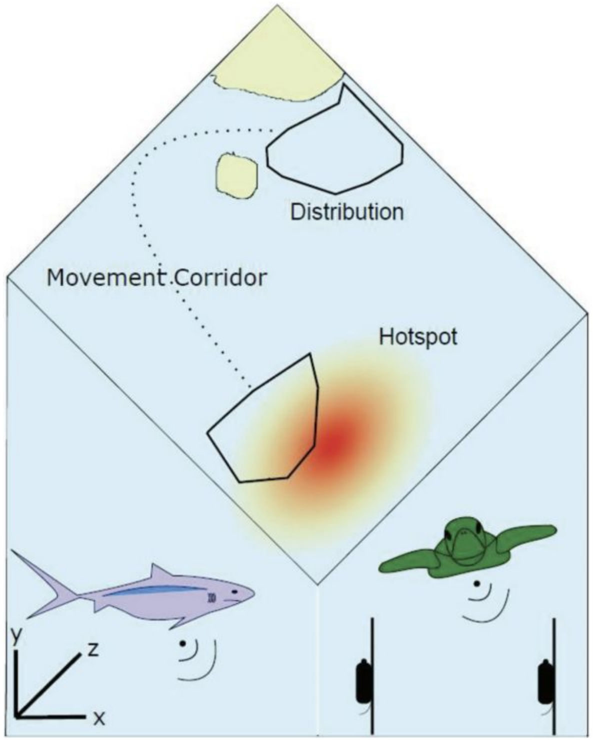
Abstract: Marine user–environment conflicts can have consequences for ecosystems that negatively affect humans. Strategies and tools are required to identify, predict, and mitigate the conflicts that arise between marine anthropogenic activities and wildlife. Estimating individual-, population-, and species-scale distributions of marine animals has historically been challenging, but electronic tagging and tracking technologies (i.e., biotelemetry and biologging) and analytical tools are emerging that can assist marine spatial planning (MSP) efforts by documenting animal interactions with marine infrastructure (e.g., tidal turbines, oil rigs), identifying critical habitat for animals (e.g., migratory corridors, foraging hotspots, reproductive or nursery zones), or delineating distributions for fisheries exploitation. MSP that excludes consideration of animals is suboptimal, and animal space-use estimates can contribute to efficient and responsible exploitation of marine resources that harmonize economic and ecological objectives of MSP. This review considers the application of animal tracking to MSP objectives, presents case studies of successful integration, and provides a look forward to the ways in which MSP will benefit from further integration of animal tracking data.

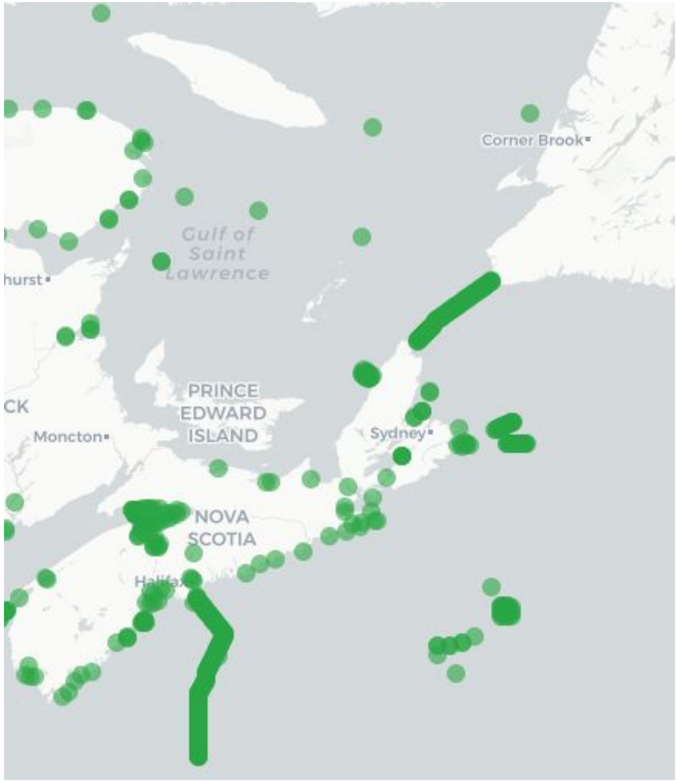
Résumé : Les conflits entre les utilisateurs du milieu marin et l'environnement peuvent avoir des conséquences sur les écosystèmes qui, elles, ont des effets négatifs sur les humains. Des stratégies et outils sont nécessaires pour cerner, prédire et atténuer de tels conflits entre les activités humaines en mer et les espèces marines. L'estimation de la répartition d'animaux marins à l'échelle des individus, des populations et des espèces s'est avérée difficile par le passé, mais des technologies électroniques de marquage et de suivi (c.-à-d. la biotélémétrie et l'enregistrement de données biologiques) et des outils analytiques font leur apparition qui peuvent soutenir les efforts de planification de l'espace marin (PEM) en documentant les interactions d'animaux avec les infrastructures marines (p. ex. turbines marémotrices, plateformes pétrolières), en cernant les habitats essentiels d'animaux (p. ex. couloirs de migration, aires d'approvisionnement, de reproduction ou de croissance) ou en délimitant leurs répartitions pour les fins de la pêche. Une PEM qui n'intègre pas les animaux n'est pas optimale, et les estimations de l'utilisation de l'espace par les animaux peuvent contribuer à une exploitation efficiente et responsable des ressources marines qui répond à la fois aux objectifs économiques et écologiques de la PEM. La présente synthèse examine l'application du suivi d'animaux à la PEM, présente des études de cas d'intégrations réussies et se penche sur les avantages qu'entraînera pour la PEM l'intégration plus poussée de données de suivi d'animaux. [Traduit par la Rédaction]

Introduction

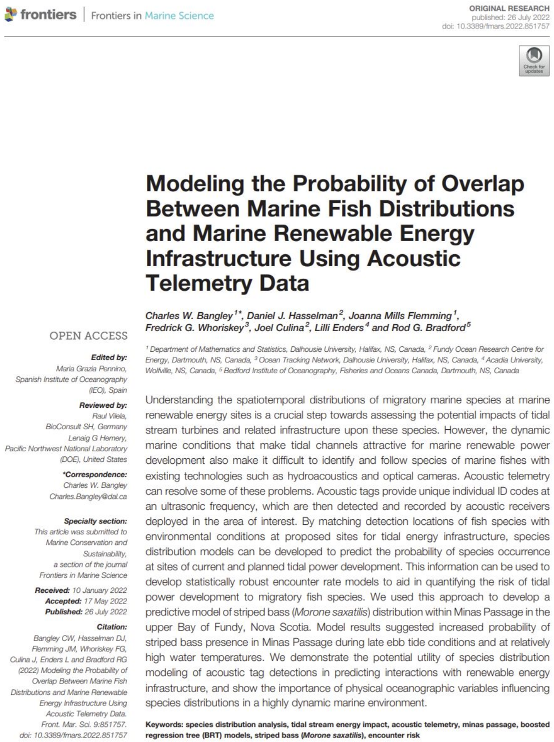
The marine realm is composed of highly diverse three-dimensional habitats with variation in depth and substrate, creating a heterogeneous aquascape for plants and animals. Humans are terrestrial animals but are reliant on these marine ecosystems, evidenced by the aggregation of settlements near coasts worldwide (Small and Nicholls 2003). There is an inherent cultural value of natural environments reflected in high property values of coastal real estate (Benson et al. 1998; Luttik 2000), and water has broad aesthetic appeal and recreational value for boating, beach-going, swimming, diving, and recreational fishing (Jennings 2007). Marine ecosystems are also direct sources of goods and services supporting a myriad of economic activities. Lucrative fisheries, aquaculture sites, access to global trade, oil and gas deposits, tidal or offshore wind turbines, and cable and pipeline deployment are all examples of the extensive and intensive human use of the marine environment that continues to expand (Pimentel et al. 1997; Pagiola et al. 2004; e.g., Fedler 2013; Schwoerer et al. 2016; Haas et al. 2017). More indirect, but valuable, regulating services include climate moderation, flood regulation, coastal protection, carbon sinking, and oxygen production (Falkowski et al. 2000). To facilitate human activities within the oceans, the environment has been heavily modified by dredging harbours, constructing seawalls, excavating canals, and installing various infrastructure (Hinrichsen 1999). Now, growing human populations (Cohen 2003) and increasing pressure placed on ma-

Telemetry can support marine spatial planning





And it does!



frontiers | Frontiers in Marine Science

ORIGINAL RESEARCH
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Check for updates

Modeling the Probability of Overlap Between Marine Fish Distributions and Marine Renewable Energy Infrastructure Using Acoustic Telemetry Data

Charles W. Bangley[1*], *Daniel J. Hasselman*[2], *Joanna Mills Flemming*[1], *Fredrick G. Whoriskey*[3], *Joel Culina*[2], *Lilli Enders*[4] *and Rod G. Bradford*[5]

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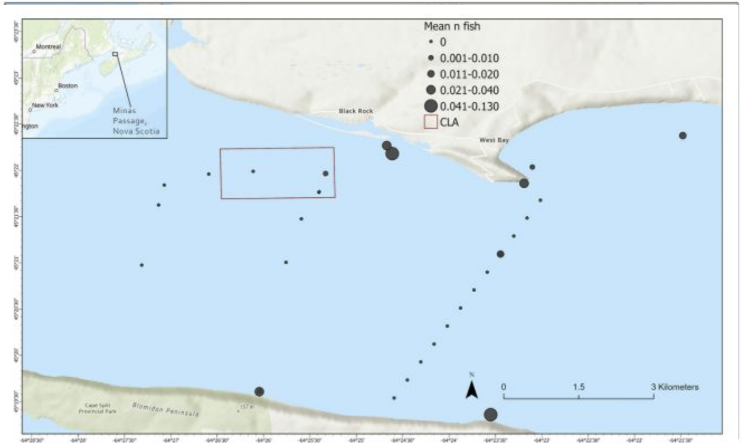
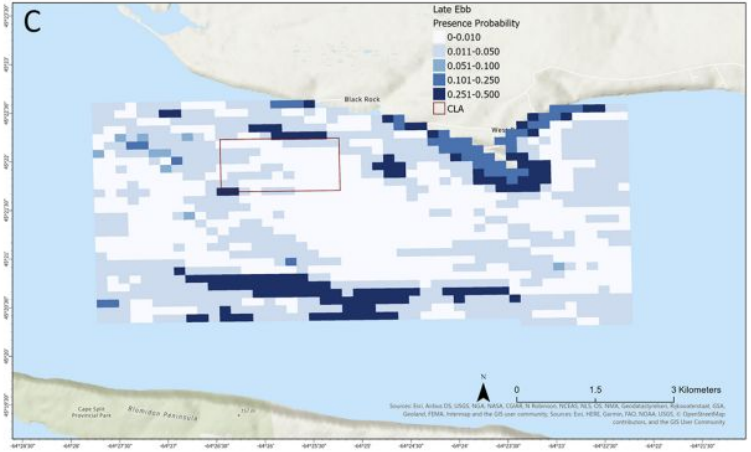
Understanding the spatiotemporal distributions of migratory marine species at marine renewable energy sites is a crucial step towards assessing the potential impacts of tidal stream turbines and related infrastructure upon these species. However, the dynamic marine conditions that make tidal channels attractive for marine renewable power development also make it difficult to identify and follow species of marine fishes with existing technologies such as hydroacoustics and optical cameras. Acoustic telemetry can resolve some of these problems. Acoustic tags provide unique individual ID codes at an ultrasonic frequency, which are then detected and recorded by acoustic receivers deployed in the area of interest. By matching detection locations of fish species with environmental conditions at proposed sites for tidal energy infrastructure, species distribution models can be developed to predict the probability of species occurrence at sites of current and planned tidal power development. This information can be used to develop statistically robust encounter rate models to aid in quantifying the risk of tidal power development to migratory fish species. We used this approach to develop a predictive model of striped bass (*Morone saxatilis*) distribution within Minas Passage in the upper Bay of Fundy, Nova Scotia. Model results suggested increased probability of striped bass presence in Minas Passage during late ebb tide conditions and at relatively high water temperatures. We demonstrate the potential utility of species distribution modeling of acoustic tag detections in predicting interactions with renewable energy infrastructure, and show the importance of physical oceanographic variables influencing species distributions in a highly dynamic marine environment.

Keywords: species distribution analysis, tidal stream energy impact, acoustic telemetry, minas passage, boosted regression tree (BRT) models, striped bass (*Morone saxatilis*), encounter risk





ABOUT OTN

OTN is a global aquatic research, data management and partnership platform headquartered at Dalhousie University in Nova Scotia, Canada.

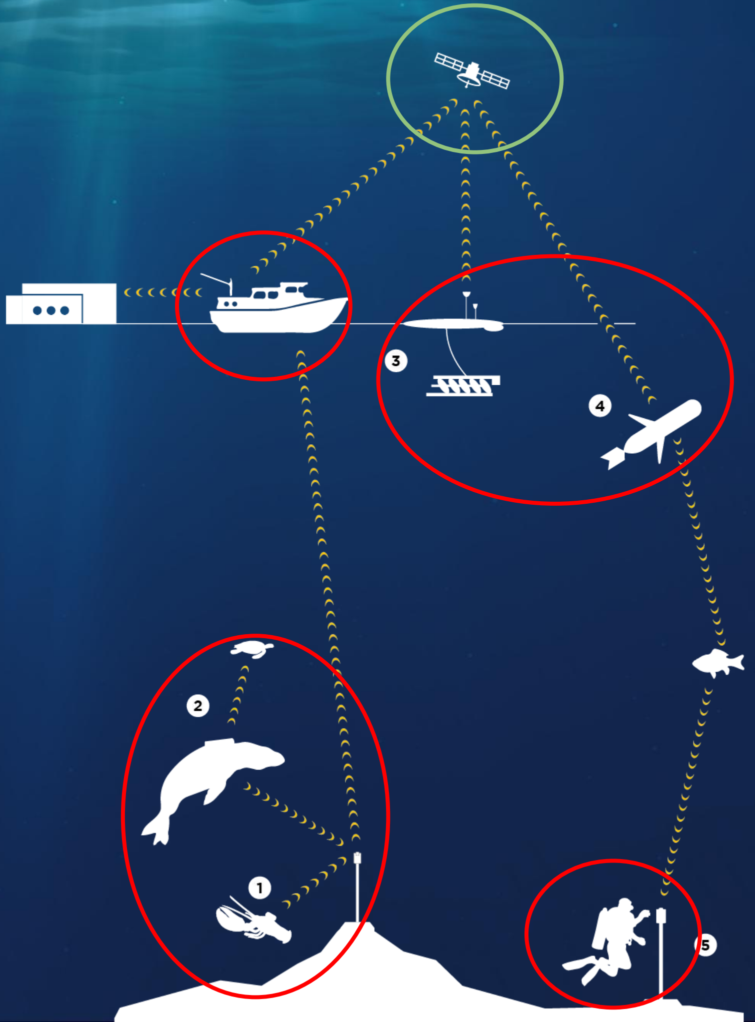
Since 2008, OTN has been deploying state-of-the-art ocean monitoring equipment and marine autonomous vehicles (gliders) in key aquatic locations.

A global community of researchers is using OTN's infrastructure and analytical tools to track the movements and survival of keystone, commercially important and endangered species.

Knowledge generated by OTN is used by scientists, managers, policy-makers, industry, Indigenous and coastal communities and public stakeholders.

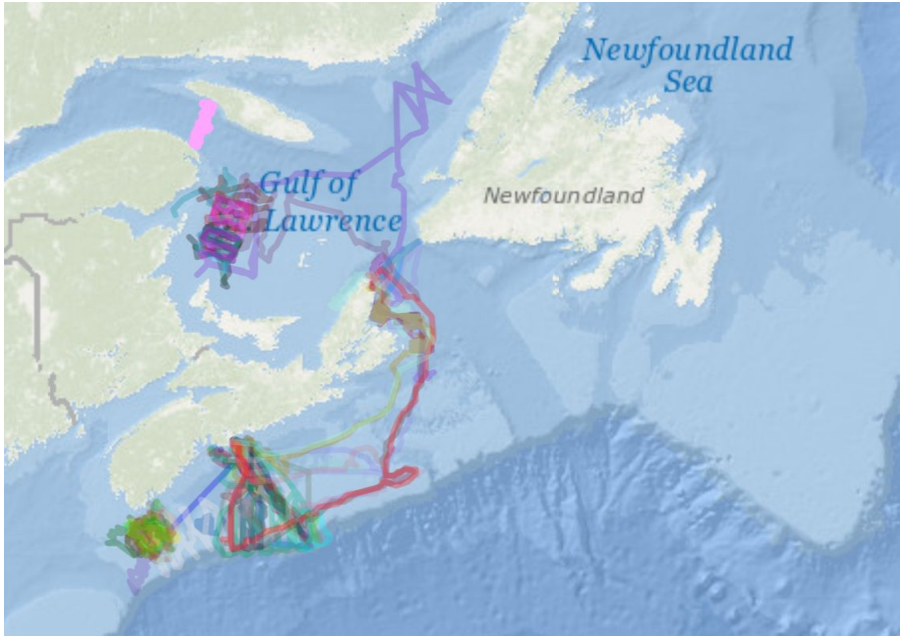
HOW OTN TRACKS

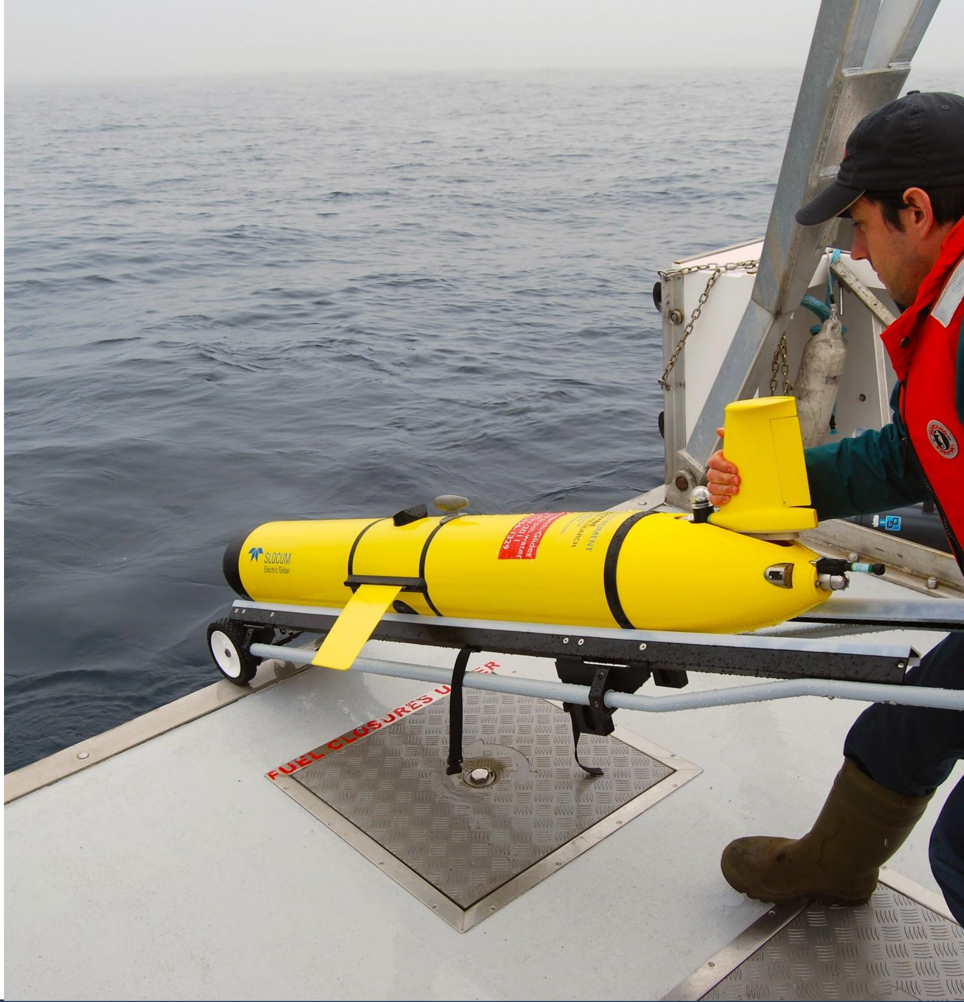
1. Acoustic tags
2. Larger animals can carry Vemco Mobile Transceivers (VMTs)
3. Wave Gliders
4. Slocum Gliders
5. Acoustic receivers



GLIDERS

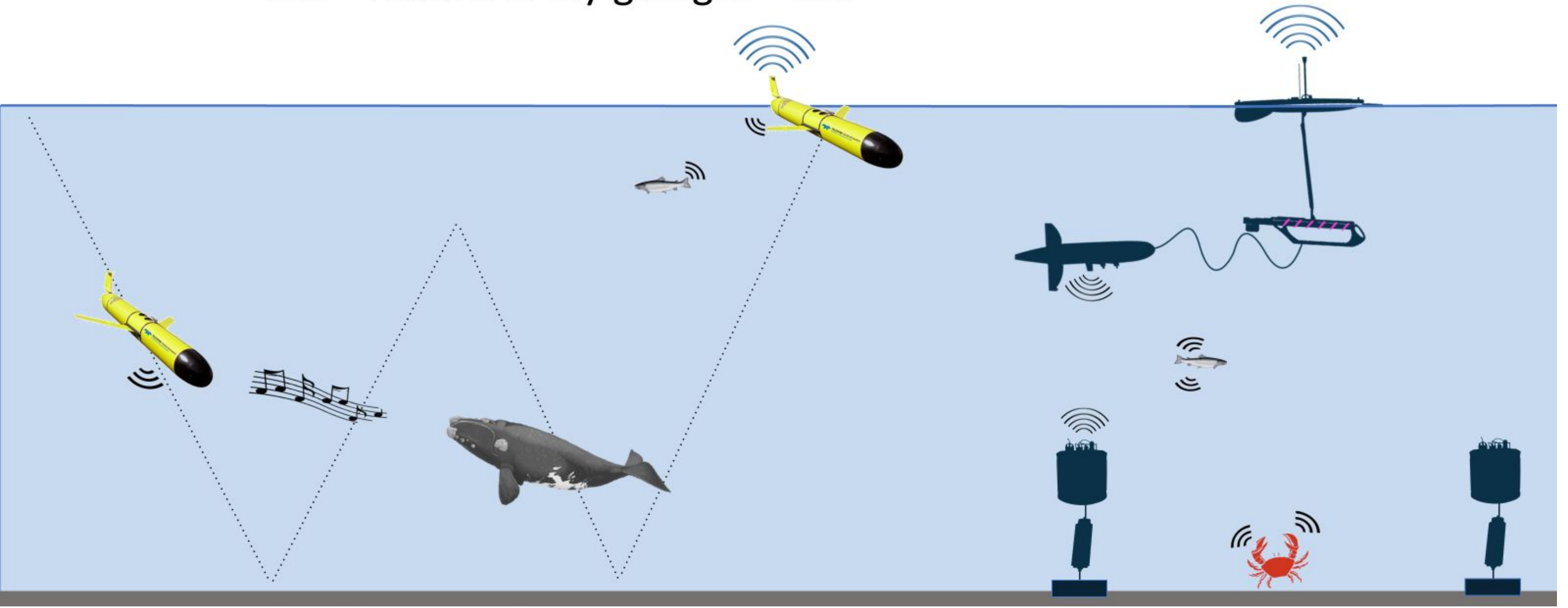
Mobile tracking with towed hydrophones

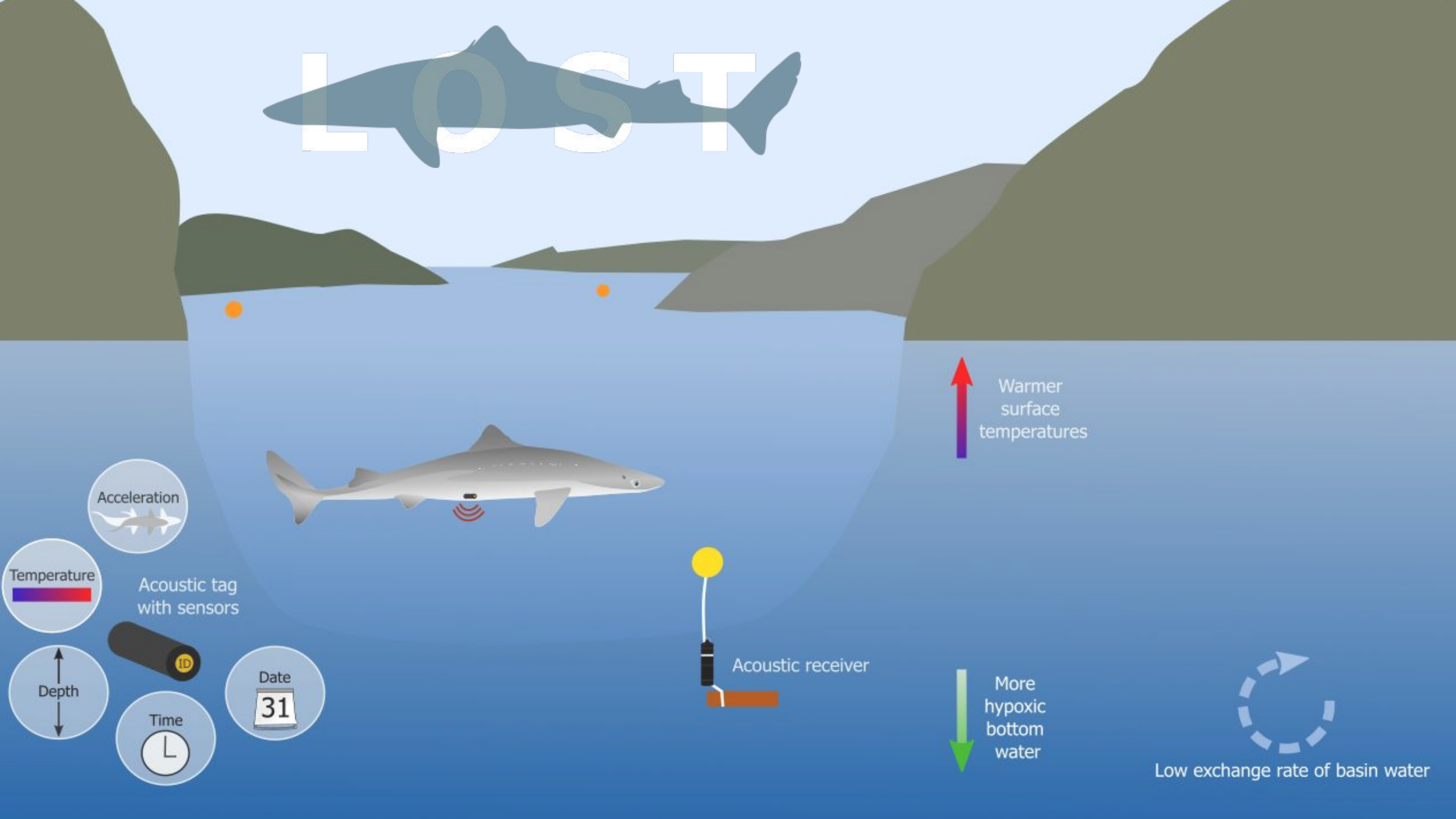




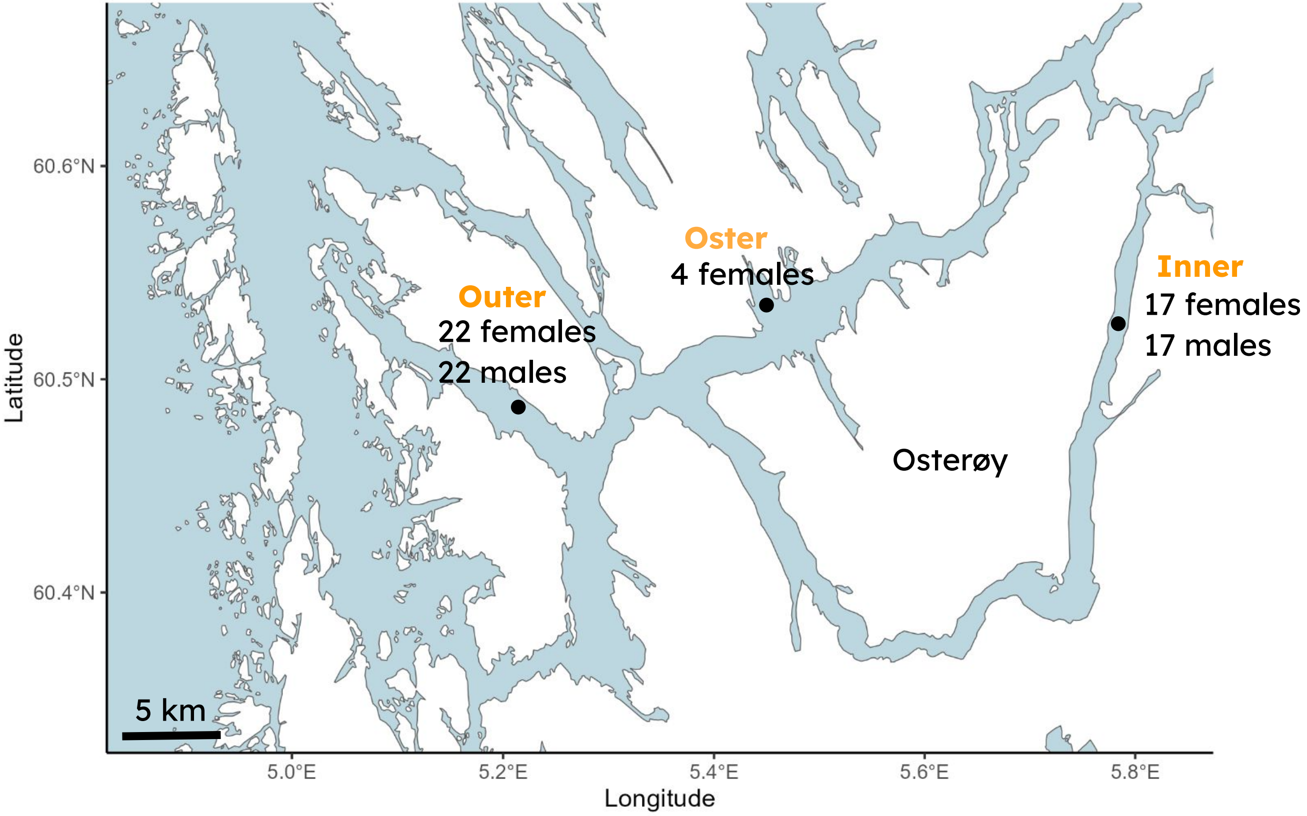
OTN Glider Team

The "What's in my garage?" talk



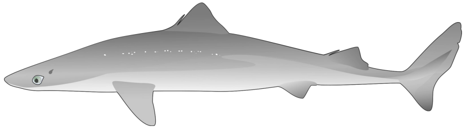

LOST
Warmer surface temperatures
Acceleration
Temperature
Acoustic tag with sensors
ID
Depth
Time
Date
31
Acoustic receiver
More hypoxic bottom water
Low exchange rate of basin water

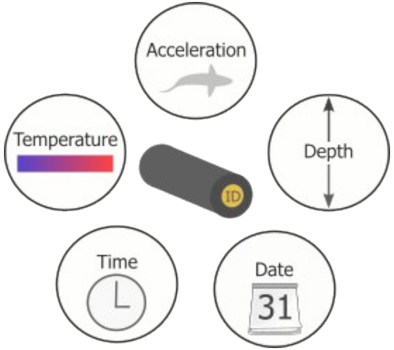
Fjord system



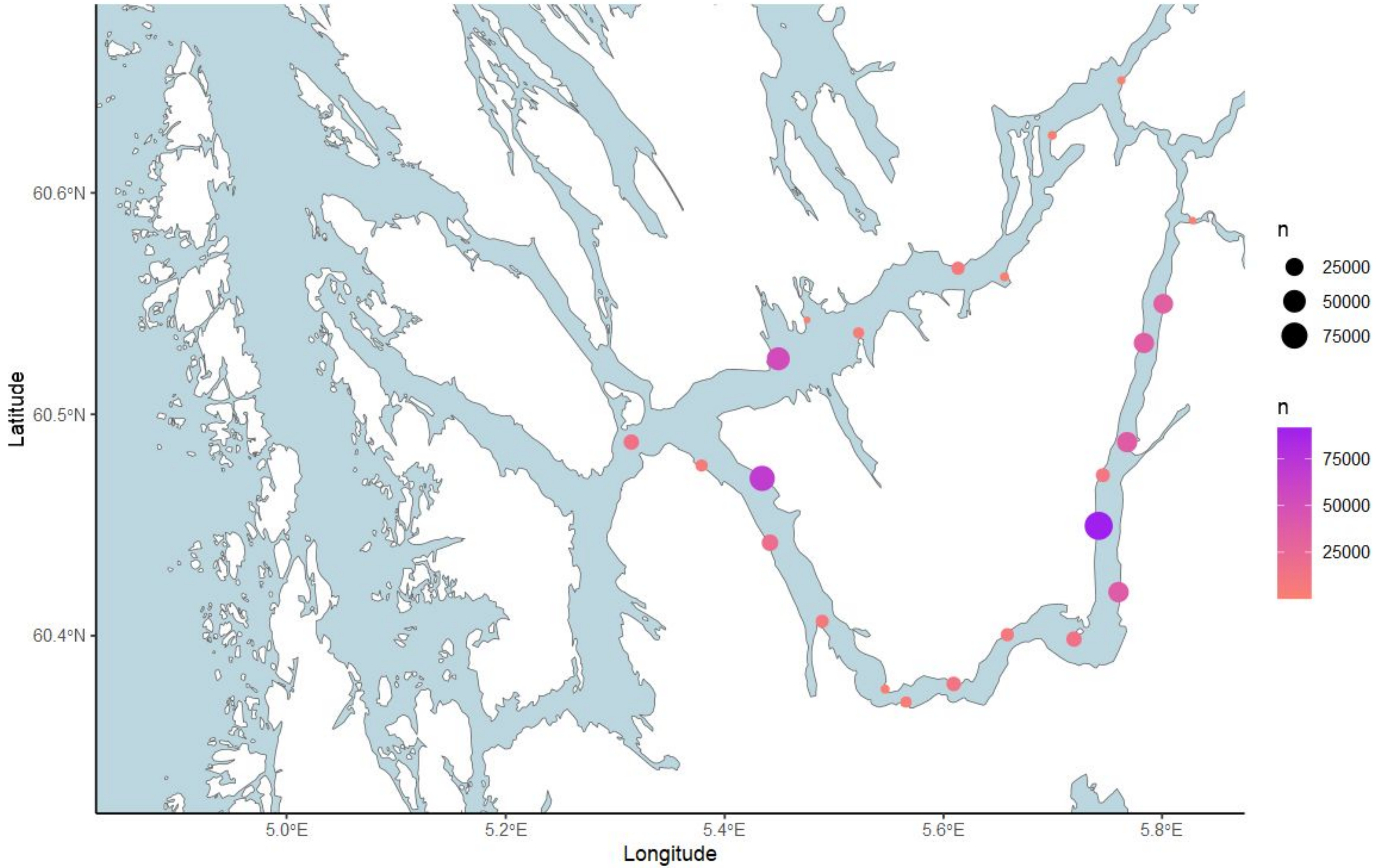
6 females also tagged with PSAT!

82 spiny dogfish tagged!

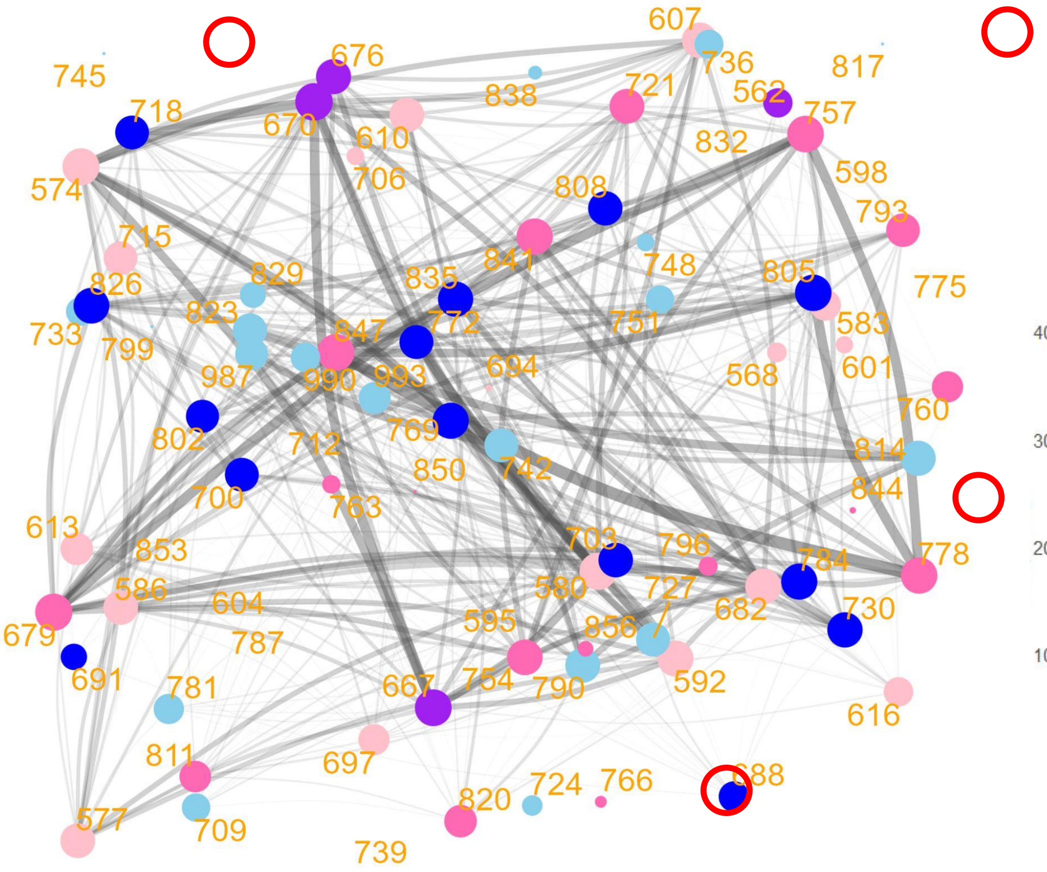




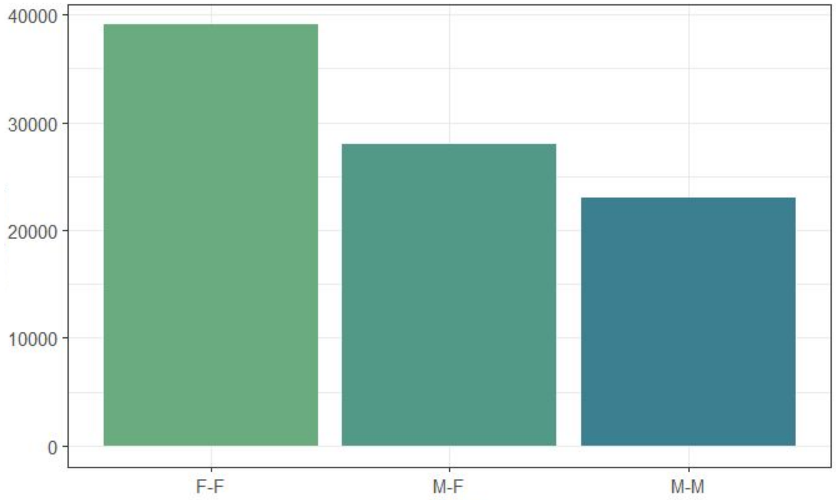
Number of detections per receiver



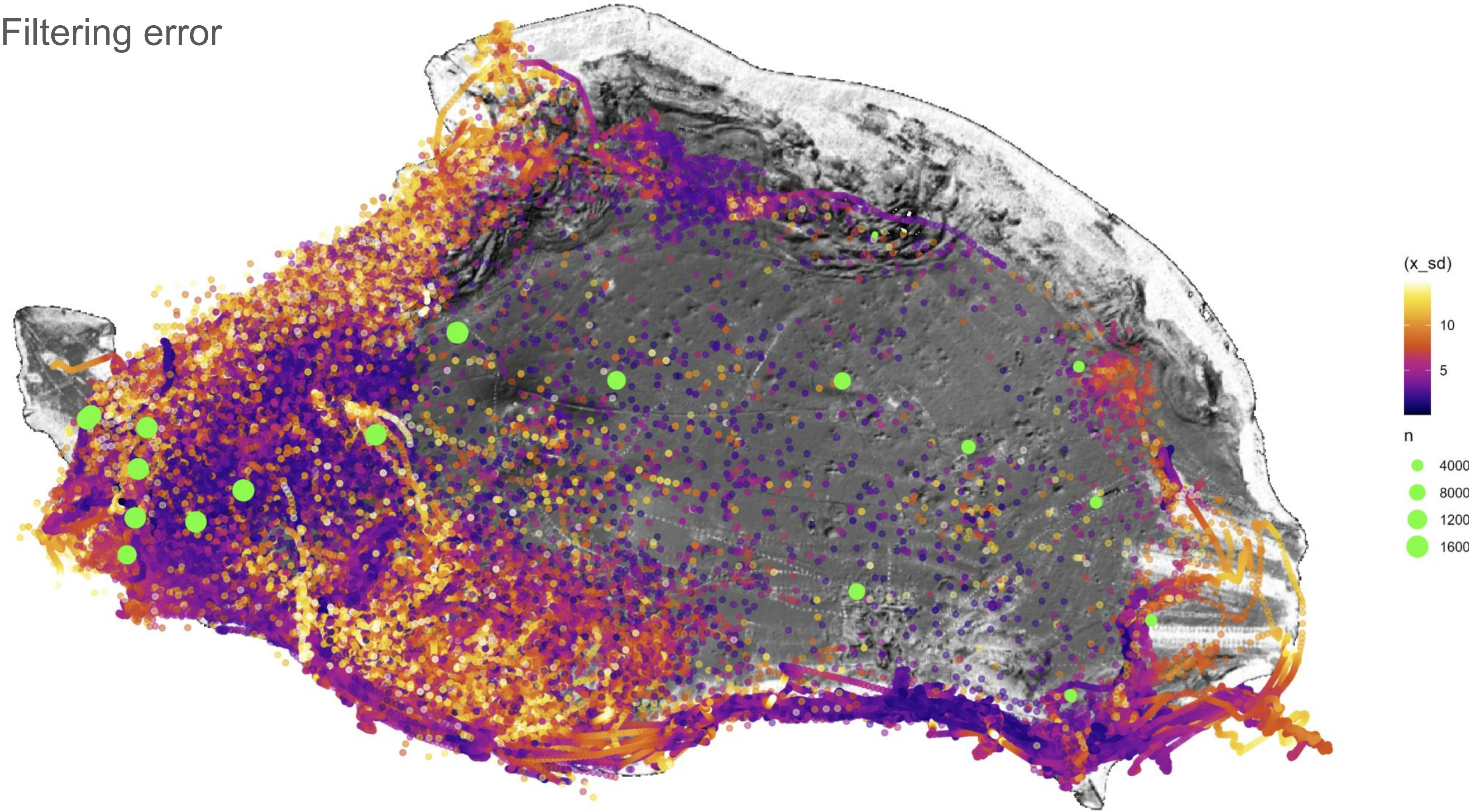
Social Network Analysis



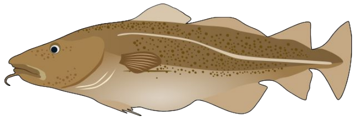
- Female - Inner
- Female - Oster
- Female - Outer
- Male - Inner
- Male - Outer

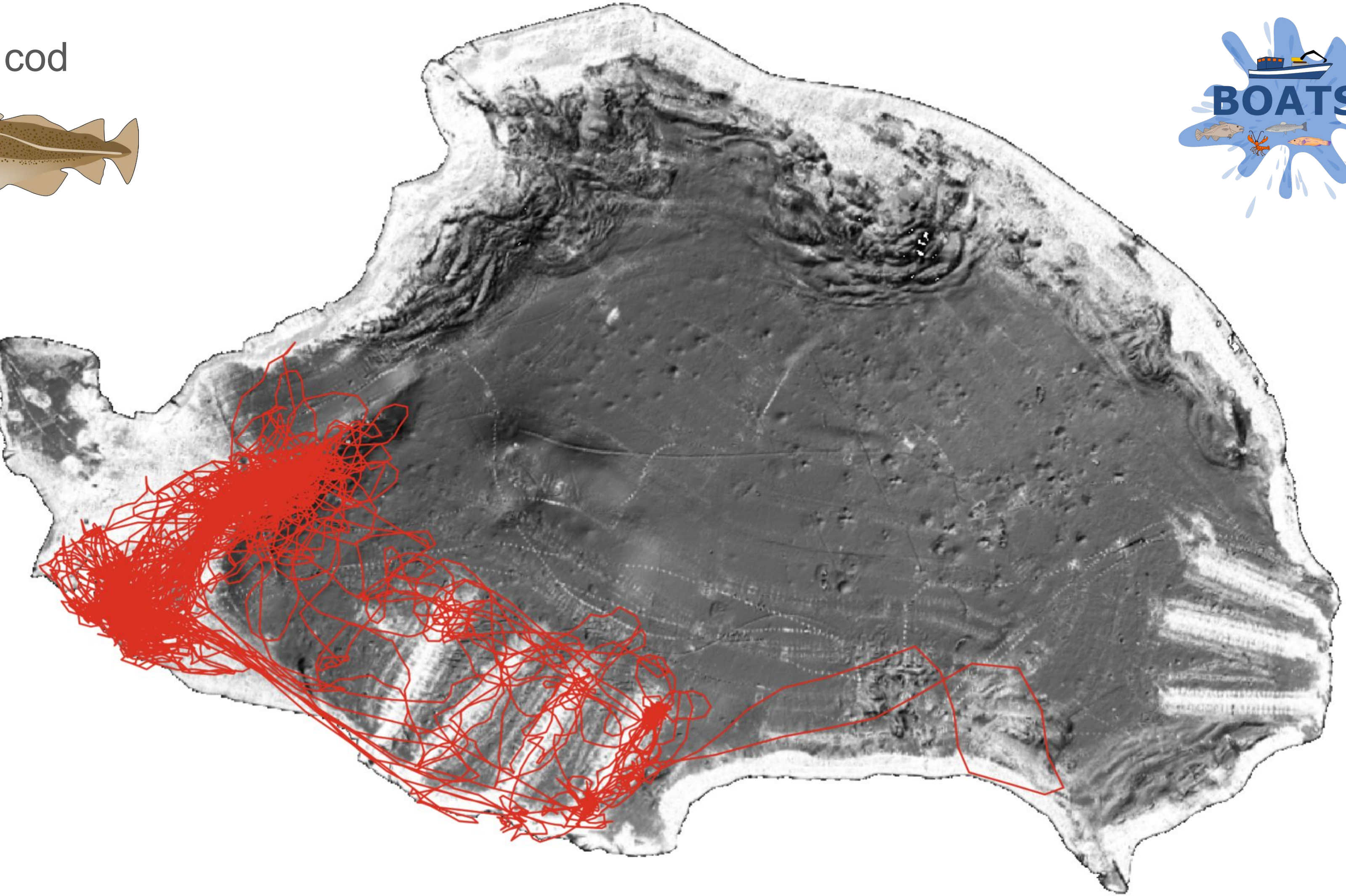


Filtering error

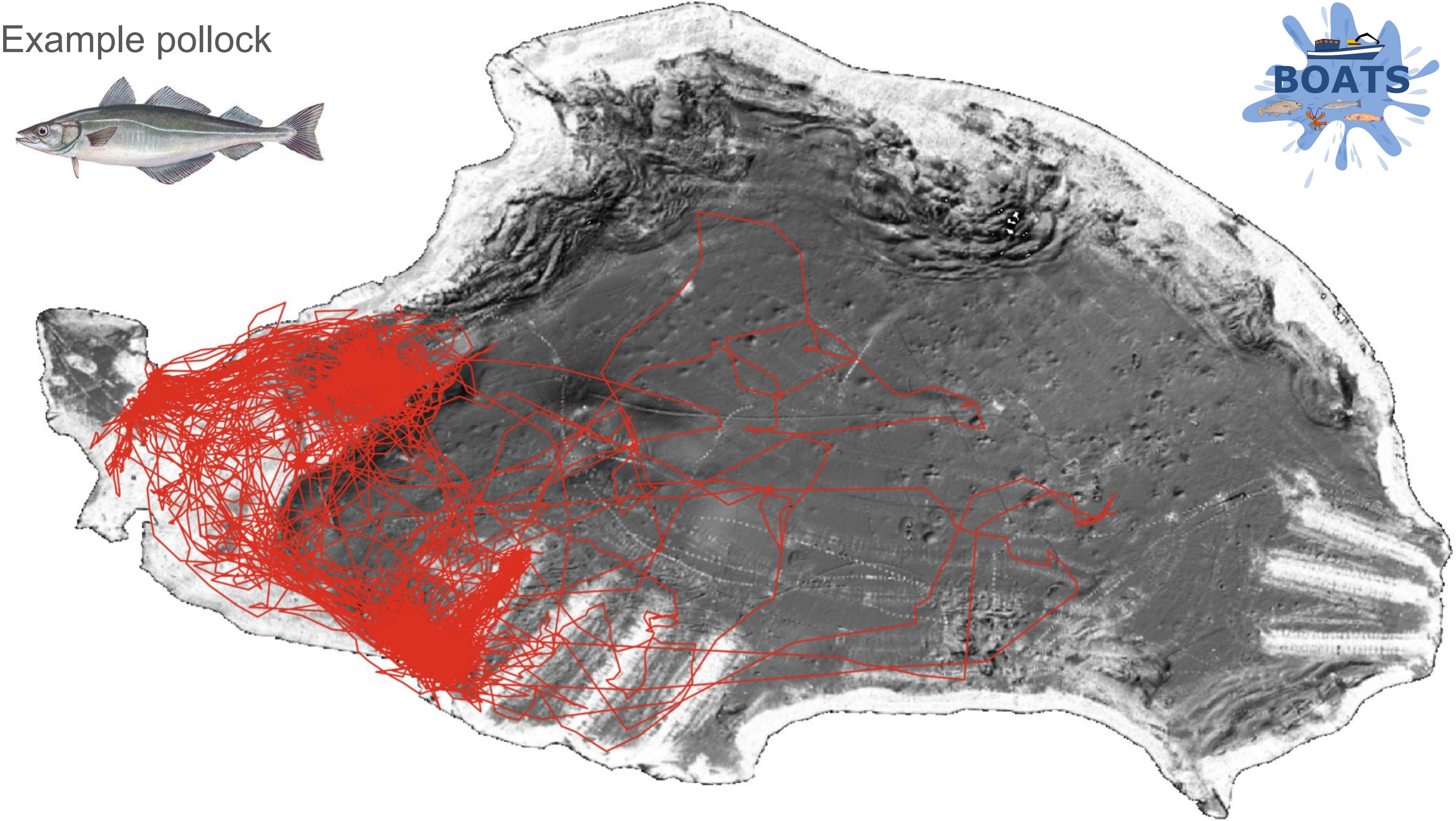


Example cod





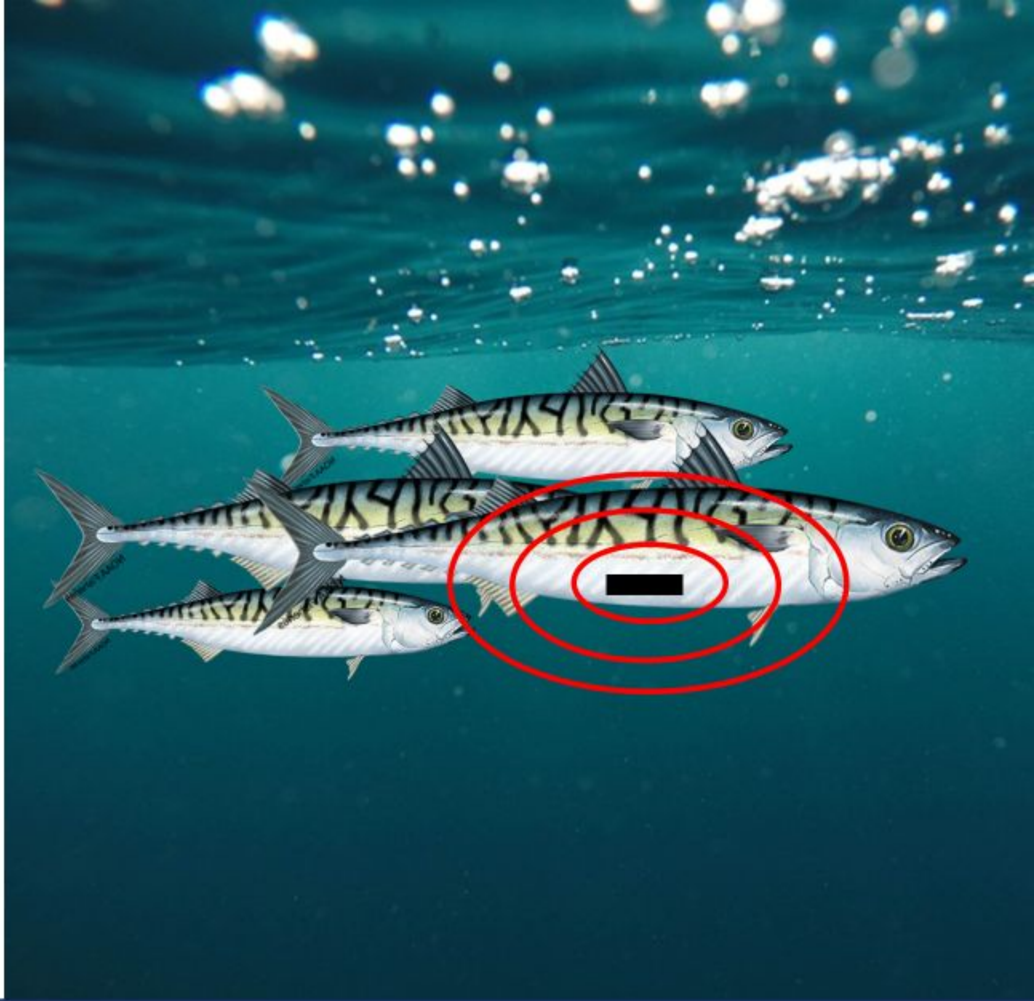
Example pollock



Tracking Movements

Acoustic telemetry can reveal migration routes & habitat use

- Tag burden can influence natural behaviours & swimming performance
- Impacts on welfare from surgery
- Traditionally chemical anesthetics are used
    - MS-222 or clove oil
    - Recovery time required
    - Short-term effects



Mackerel tracking!

- Preliminary data from the 2024 mackerel tracking project
- Mackerel detected migrating up the coast towards spawning grounds
- First ever mackerel tracking at this scale

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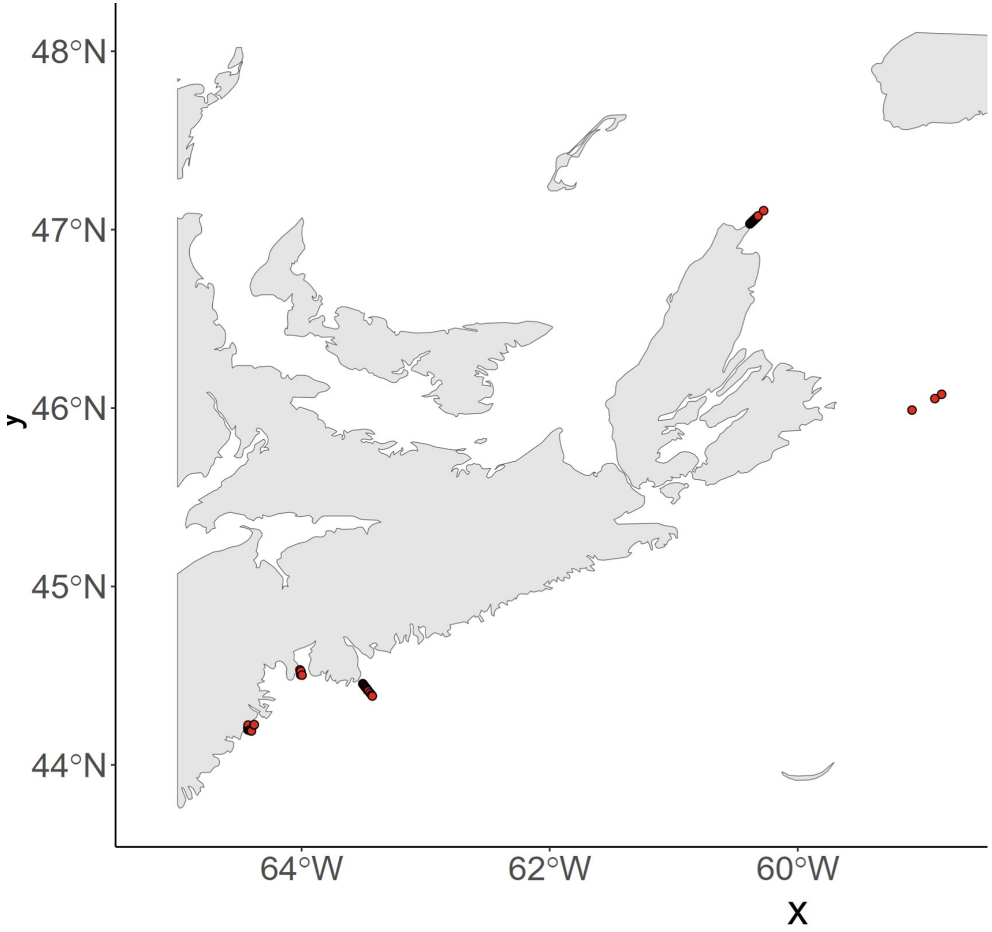
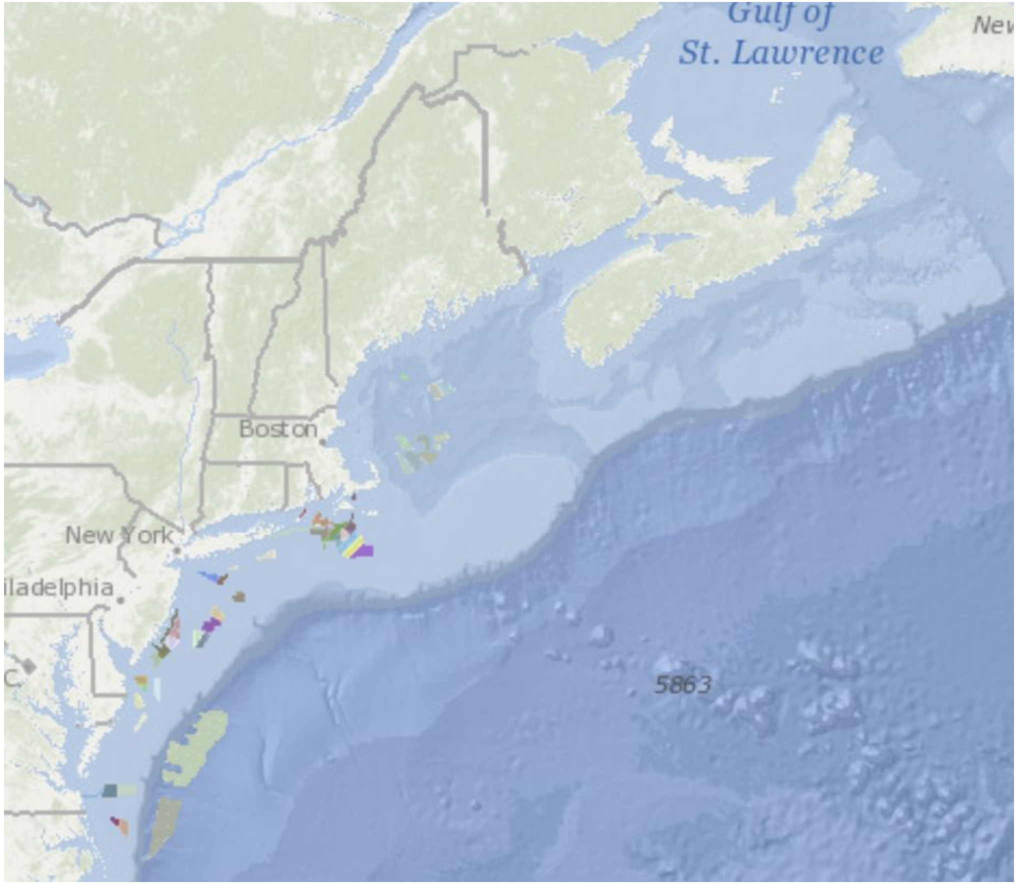


US-based initiative

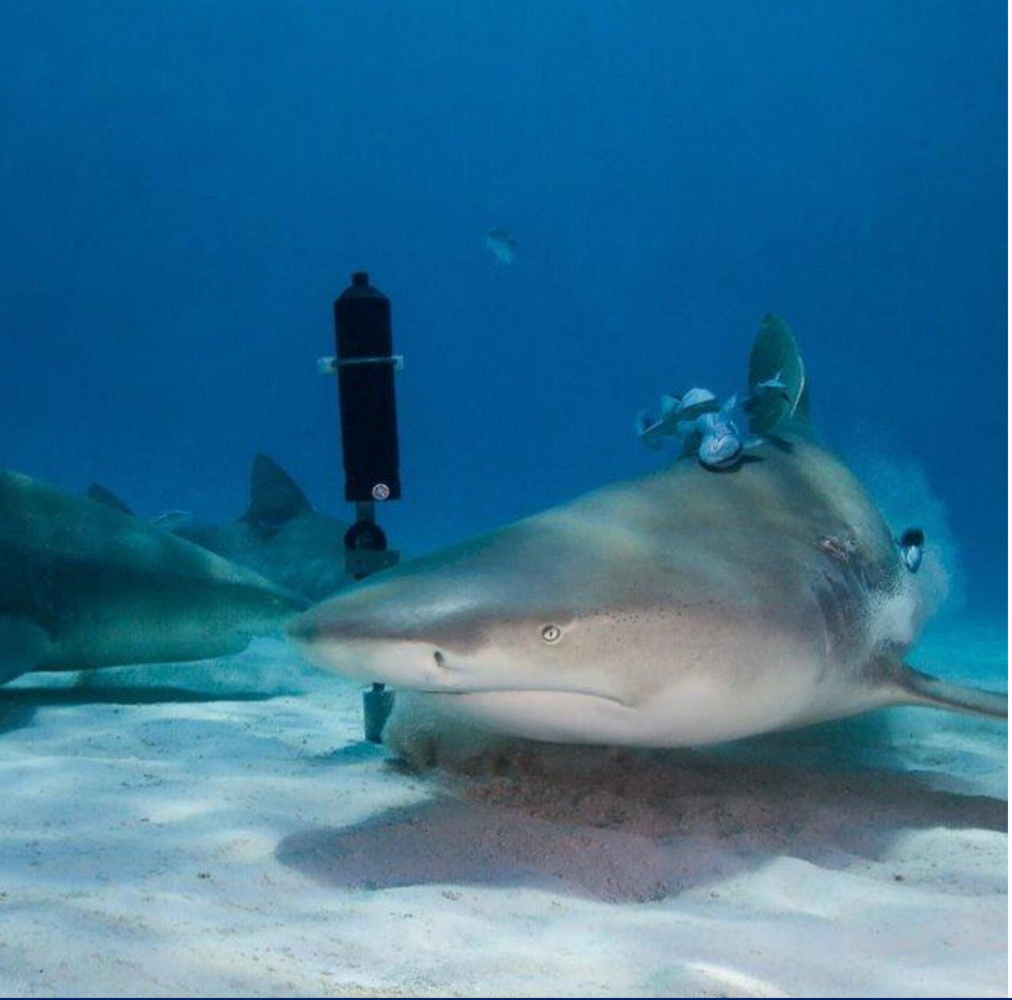
- Call to action
- RWSC and ROSA recommend that your entity joins the regional acoustic telemetry network
- submits its acoustic telemetry data (receiver metadata, tag metadata, downloaded detection files)



OTN LOANER PROGRAM

- Animal telemetry equipment loans for partners around the world
- Loans are evaluated for scientific merit and equipment is distributed on a first-come-first-serve basis

OTN Loaner program: https://members.oceantrack.org/data/otn-equipment-loaner-program



GET IN TOUCH

With me!

lennox@dal.ca

Loans and collaborations:

chartery@dal.ca

OTN Data Centre (including study hall link!):

otndc@dal.ca

Facebook & Instagram:

@oceantrackingnetwork

Twitter:

@OceanTracking