Coastal Squeeze? Seabird nesting success and loafing behaviour in response to cliff-top- and water-based visitors at St Abb's Head, Berwickshire

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Populations of nesting seabirds have been declining for many species, for several reasons. There is concern that tourists may impose additional stress to frequently visited seabird colonies, affecting their behaviour, and possibly also nesting success. St Abb's Head at the Scottish Borders coast has one of the largest onshore breeding seabird colonies in the UK, and was designated an SPA in 1997 (extended in 2009 to include a 1km zone offshore). The site is visited by > 20,000 clifftop visitors during the breeding season. Likewise, the coves underneath the cliffs are popular boating destinations and frequently visited. To investigate whether the seabirds are suffering from "coastal squeeze" at St Abb's Head, which would call for mitigation through visitor management, a longer-term study was started in 2015, in collaboration with the National Trust for Scotland. The success of Kittiwake (*Rissa tridactyla*) nests is assessed annually at 9 plots with differing degree of human encroachment (~25 nests monitored per plot), and in 2017 the number of loafing guillemots (*Uria aalge*) in response to visual as well as auditory "disturbance" (i.e. boat noise) was recorded. Kittiwake nest success probability at both the egg stage and the chick stage was unrelated to any measured index of cliff-top visitor activity in all three study years (2015-2017, 2018 data analysis in progress). In contrast, in 2016 a significant negative relationship existed between nest success at the egg stage and "boat minutes". Boat presence in the coves significantly reduced the number of loafing guillemots, and distinct, presumably energetically very costly escape responses were observed.

In conclusion, the so far available data evidence no major negative effect of clifftop visitors on Kittiwake nesting success, suggesting that the current respective site management (no restriction of visitor numbers, times or distances to the birds) is justifiable, which will be welcomed by the NTS and the visitors. We will continue monitoring cliff-top visitor effects in forthcoming years, since other (possibly increasing) environmental stressors may influence (and change) the bird's vulnerability towards this stressor. The results regarding the effects of boating presence /activities on Kittiwake nesting success are partly contradictive, and also more nuanced, clearly requiring more studies. The preliminary finding that boating affected Guillemot loafing behaviour and triggered significant escape responses (investigated in 2016) suggests that these birds may benefit from improved site management within the SPA. We will now study the birds' response patterns, boat presence/activity and severity of effects in more detail and also aim to disentangle visual from auditory effects.

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Absorption coefficients derived from in situ radiometry using Gershun's law

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Absorption of sunlight is a fundamental physical process in the ocean. Absorption influences underwater and water-leaving light fields and, hence, remote sensing signals. Accurate measurements of absorption are, therefore, required for the interpretation of ocean colour remote sensing signals (Lee et al. 2002). However, *in situ* absorption coefficients are difficult to measure accurately with currently available instruments (e.g. WET Labs ac-9/s, Zaneveld, 1990) due to the presence of scattering material and limited sample volumes. An alternative, but seldom used technique to determine *in situ* absorption spectra uses Gershun's (1939) equation to derive absorption coefficients from *in situ* radiometry measurements (Hojerslev, 1975; Voss, 1989; Pegau et al., 1995). However, the number of datasets and studies using this technique is extremely limited. Given significant developments in radiometric sensor technology over the past two decades, it is timely to re-assess the quality of absorption data calculated using Gershun's law.

Here, we show good performance of the Gershun method with average agreement within 30%, when compared to independent high quality absorption data (measured with a point-source integrating cavity absorption meter - PSICAM), for two contrasting water types: 1) from the Indian River Lagoon, FL, in early January and 2) the Barents Sea in April. Expected maximum deviations were observed at red wavelengths, where inelastic processes have significant effect, confirming previous theoretical considerations (Berwald et al., 1998). Potential sources of uncertainty such as systematic errors in both Gershun's and PSICAM data are explored taking into account inelastic scattering effects and potential impact of large, relatively sparse coloured particles (such as zooplankton, fish eggs or larvae).

A major advantage of the Gershun method compared to established instruments is that absorption is determined from much larger sample volumes because radiometry measurements are integrated through the water column. This difference in sample volume might be significant when comparing field data to data from satellites, which detect large surface areas.

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Interconnecting the North Sea: Transnational Maritime Spatial Planning and cross-border energy exchange: Findings from the NorthSEE project

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The North Sea has seen a substantial growth in offshore wind developments in recent years, as well as the introduction of newer technologies such as floating wind. Ambitious environmentally-friendly energy policies and targets such as increased renewable energy share and reduction in carbon emissions have been set by the EU and Member States which act as a driving force for this expansion in the renewable energy industry. Growth scenarios for offshore wind have been predicted for 2020, 2030 and 2050 and the spatial requirements required to fulfil these growth targets have been analysed. The increase in energy production results in an increased interconnection demand. This is coupled with the European Commission's desire to create an integrated internal energy market where energy can flow freely across Member States.

This cross-border energy exchange comes in the form of interconnectors, which between North Sea Region (NSR) countries ((Belgium, Denmark, Germany, Netherlands, Norway, Sweden, and the United Kingdom (England and Scotland)), will ensure energy stability and security. However, the current approach to the development of offshore electricity infrastructure is characterised by limited coordination. Wind farms tend to be connected individually to shore, increasing the infrastructure and space required, also increasing CO_2 emissions.

There is therefore an increasing need to understand the current and future spatial demands for submarine cables in the NSR. This demand on space will need to be balanced against potential spatial conflicts with other marine users such as commercial fishing, shipping and offshore energy. Maritime Spatial Planning (MSP) has been identified as a main tool to coordinate the sustainable development of offshore linear energy infrastructure in the NSR and the European-funded NorthSEE project addresses this challenge directly.

The NorthSEE project promotes a better exchange of information among NSR MSP authorities and related experts and institutions. The NorthSEE project aims at achieving greater coherence in MSP across the NSR for three topics of transnational nature: environmental aspects, shipping routes, and energy infrastructure. Here, the focus of our presentation will be on the results of our published status quo report on offshore energy planning provisions in the NSR, showing the predicted growth of the offshore wind industry along with future energy trends. This knowledge will then be applied to offshore linear energy infrastructure and the associated planning provisions in the NSR.

We will present an overview of the state-of-the-art of planning provisions for the transportation of energy in the North Sea, including:

- identifying interconnection demand;
- identifying grid connection points on land;
- identifying future trends in the linear infrastructure policy landscape and industry developments across the NSR;
- consider the spatial implications of interconnectors for MSP in the NSR; and
- developing proposals for routes and gates in the NSR.

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Optimal-detail circulation models for fjords and sea lochs: an application to the Puget Sound

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The Puget Sound, a fjord near Seattle in the USA, has suffered a dramatic decline in its wild salmon population over the last 30 years. A possible explanation for this decline is the impact of water circulation and salinity variations on plankton production. Here we create a new circulation model for fjords that runs over several decades in order to investigate the long-term changes in estuarine circulation due to regional climate variabilities.

The approach is based on the eta2d model for coastal plain estuaries developed by MacCready 2007. It includes a vertical and longitudinal fixed Cartesian grid with momentum and salinity equations averaged over the channel cross-section and the tidal cycle to improve speed-efficiency. The model uses an analytical solution for the quasi-steady momentum equation and a numerically solved tracer equation which takes in to account the adjustment time for salinity.

However, a new mixing parametrization for the eddy viscosity is required due to the presence of sills and the distinctive deep bathymetry of fjords. Using the MoSSea simulation from Sutherland et al 2011, a detailed 3D model of the Puget Sound, the mixing pattern is analysed to build an efficient equivalent tuning for subtidal estuarine dynamics. As a result, we show that far away from the sills, where the estuary reaches its largest depth, different physical processes drive the mixing in the bottom and surface layers. For the bottom layer the eddy viscosity relies only on the tidal velocity. However, for the surface layer, wind stress also needs to be considered. Near the sills, the mixing is enhanced through the water column and the eddy viscosity variance is well explained by the tidal velocity alone.

To validate the resulting model we use the 2001 drought, an event responsible for producing a unique salinity profile. Using a few decades hindcast with historic data of the river discharge, the wind and the tides as forcings, the reproducibility of this particular event is tested.

Finally, this model implementation has a number of potential applications, including the provision of a physical base which can be coupled with a bio-chemical model to discern long term drivers for the degradation of salmon food-webs in the Puget Sound.

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