Applying the novel *pangeo-fish* geolocation modelling framework to demersal and anadromous migratory fish biologging data

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Background

- To investigate migration routes of mobile marine animals that never breach the water surface and thus make GPS-logging impossible, archival biologgers are commonly used. These devices are attached to the animals and log water pressure and temperature over several months.
- To infer the location of the tagged animals, geolocation modelling is employed. Hidden Markov Models (HMMs) are widely used, inferring the 'hidden' state (the organism's location) using observations, namely environmental data such as bathymetry and temperature fields, and tidal information.

Objective

learn to use the user-friendly, efficient *pangeo-fish* geolocation modelling framework, developed at Ifremer, by implementing two organism lifestyles not yet used in the model framework.

Method

- Geolocation modelling: Per time step (here: 1h), the data log (water pressure and temperature) is compared with selected environmental reference fields that are separated into grids in the horizontal and vertical axis. For each environmental input, likelihoods are computed by comparing the logged value with the environmental reference, and all likelihoods are multiplied for a total likelihood per grid cell. After forward and backward smoothing, the most likely trajectory of the organism is computed by chaining together the obtained likelihoods across all time steps with specific algorithms.
- Pangeo-fish: This geolocation modelling framework employs high performance computing and aims to be computationally efficient. Moreover, it strives to be user friendly and easily extendable/adaptable to users' needs.

Case Studies

- **Starry smooth-hound** *Mustelus asterias*: Demersal shark present in the Northeast Atlantic, strong diel cycle, annual migration of ~1000km.

- **Twaite Shad** *Alosa fallax*: Critically endangered species that returned to the Belgian river Scheldt in ~2012 after >100 years of absence. Spawns in the river in spring and spends the remaining time in the North Sea.

Results (*M. asterias* SN1293310)

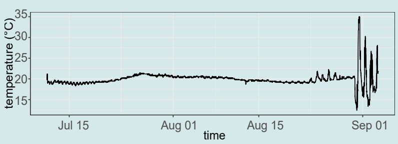

Fig1: Temperature log of SN1293310.

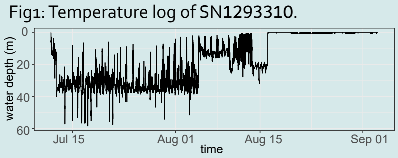

Fig2: Depthlog of SN1293310.

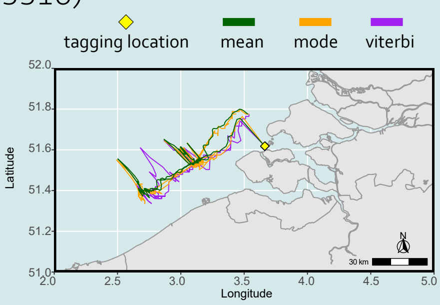

Fig. 3: Modelled trajectory for individual SN1293310.

Next Steps

- Implement more biological traits into the model, e.g. demersal behaviour.
- Model trajectories of more species.
- Implement more environmental data, e.g. freshwater datasets.

Literature

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3. Odaka, T., *et al.* (2020). In *Tools and Techniques for High Performance Computing, Revised Selected Papers* 6 (pp. 190-204).

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