Development of an Agent-based model to compare the impacts from different OWF development scenarios on Divers

Ib Krag Petersen & Chris Topping

Univ. of Aarhus

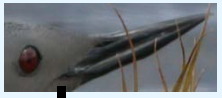
Denmark

Red-throated Diver, offshore wind farms and cumulative effects

To assess the cumulative effect on Red-throated Divers of different offshore wind farm scenarios in Denmark and the Baltic area

The currency is ”energy”, and only indirectly translate into ”the amount of divers lost from a population”

It simulates one year cycle, not generations of diver life cycles



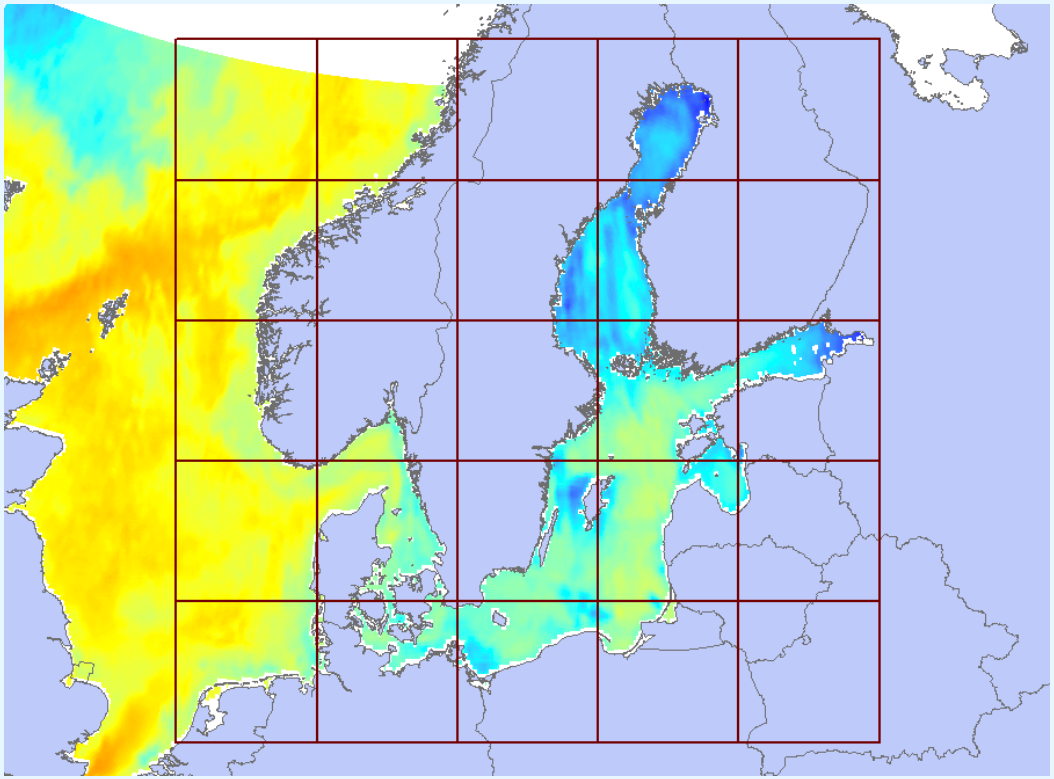
The project hinges on development of an agent-based model

- **Agents are individuals that take information from their local environment and use it to make decisions**
- **This is a simulation approach rather than an analytical one**
- **Our aim is to obtain the most realistic (emergent) pattern of diver space usage possible using biologically realistic mechanisms**

Red-throated Diver Individual-based Model

In order to achieve a realistic simulation we need to incorporate environmental data. Currently this is comprised of:

- **Bathymetry**
- **Distance to shore**
- **Temperature**

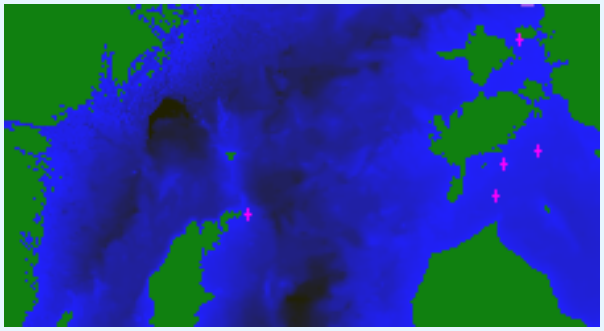


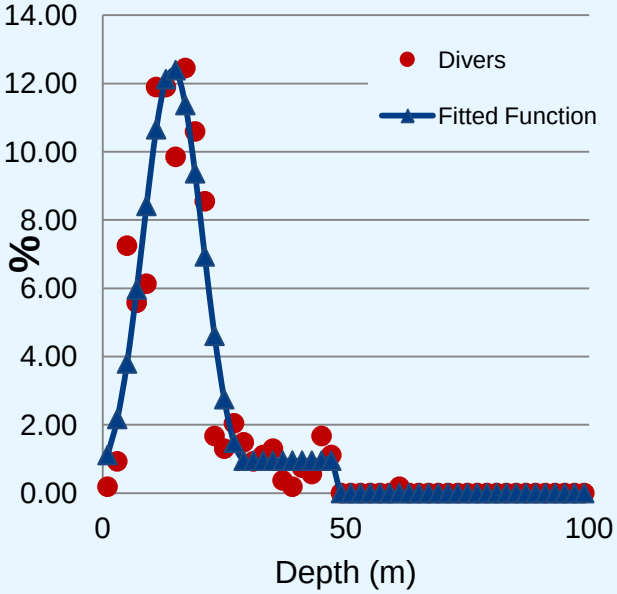
The resolution of the data is 500m x 500m, giving us a current world view of 3200 x 3200 units or 1600 x

Basic diver behaviour

“Diver drivers”:

- **Water Temperature**
- **Water Depth**
- **Distance to shore**

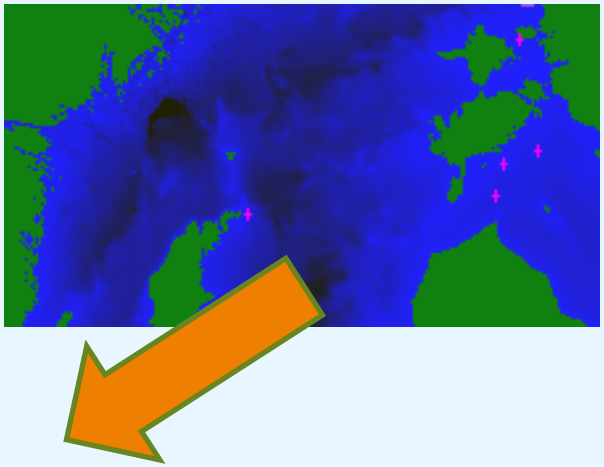




Basic diver behaviour

“Diver drivers”:

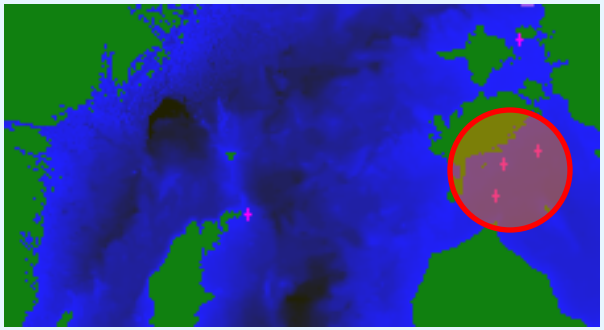
- **Water Temperature**
- **Water Depth**
- **Distance to shore**
- **Migration urge – inbuilt behaviour for migration direction**



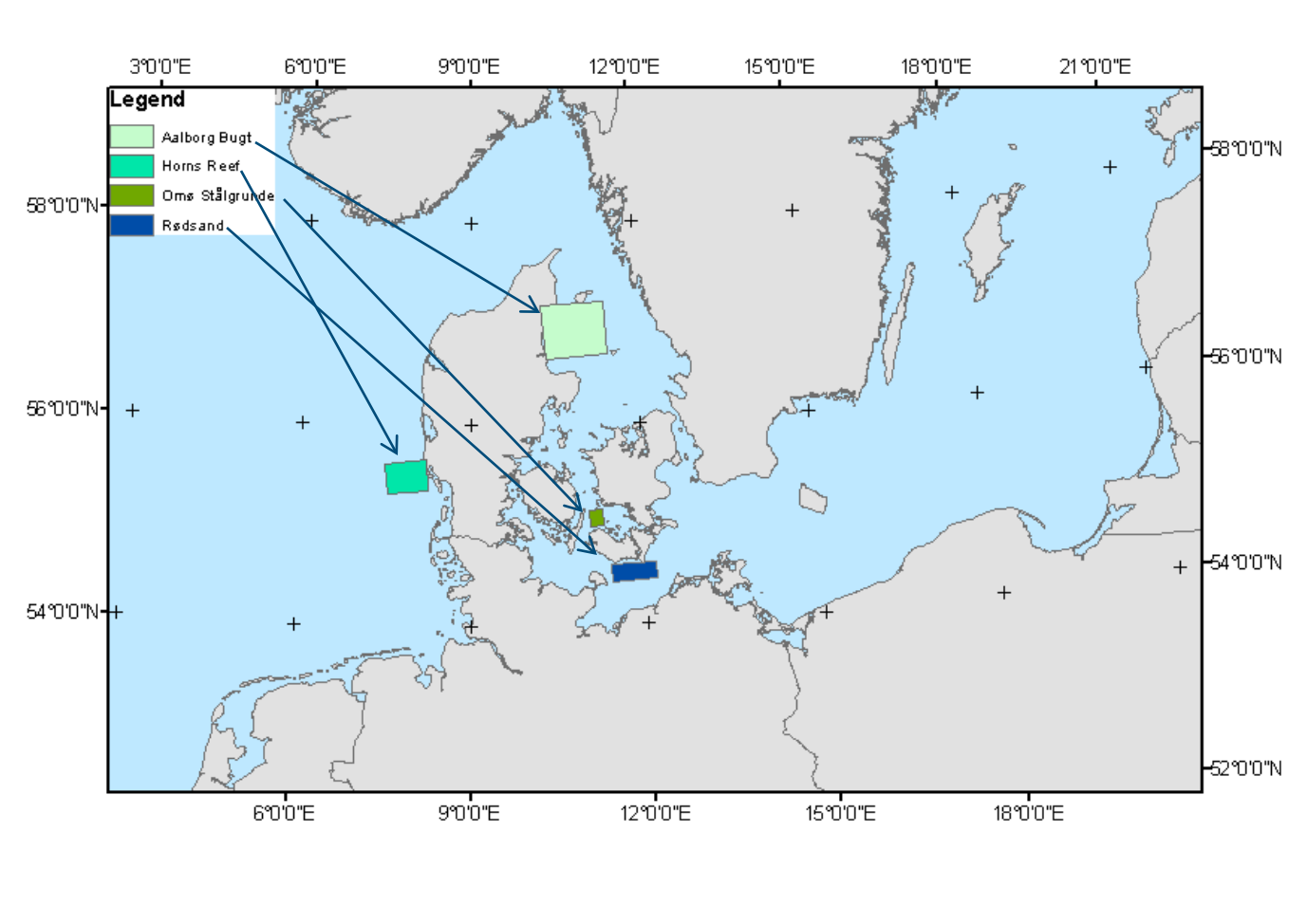
Basic diver behaviour

“Diver drivers”:

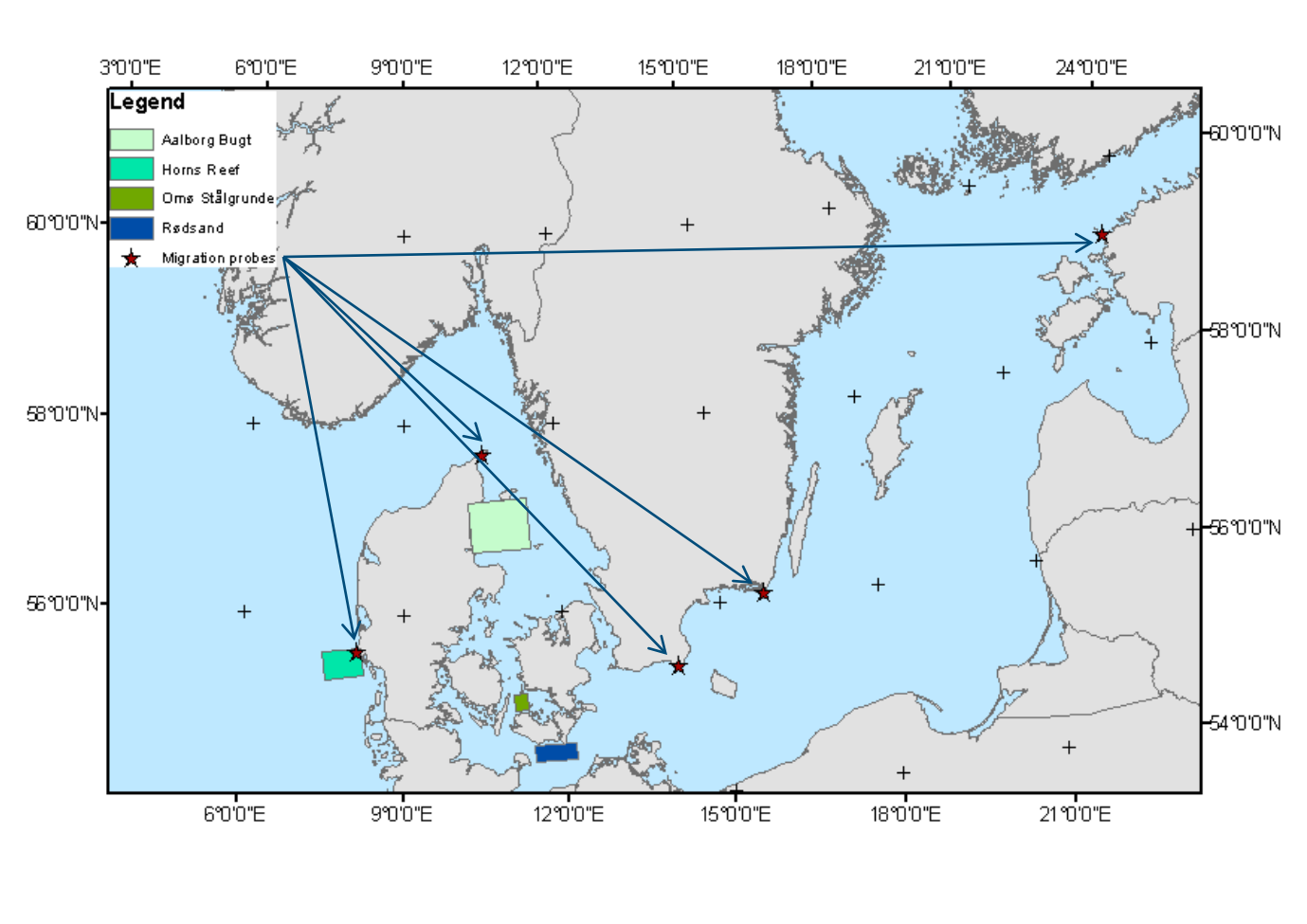
- **Water Temperature**
- **Water Depth**
- **Distance to shore**
- **Migration urge – inbuilt behaviour for migration direction**
- **Local density – diver numbers within a 2km radius**
- **Energetics – dispersal costs and foraging gains**



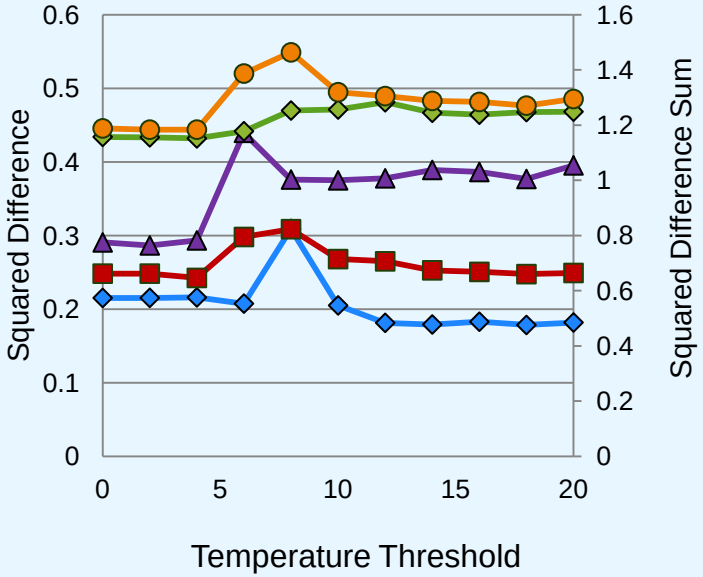
Diver test data (aerial counts)

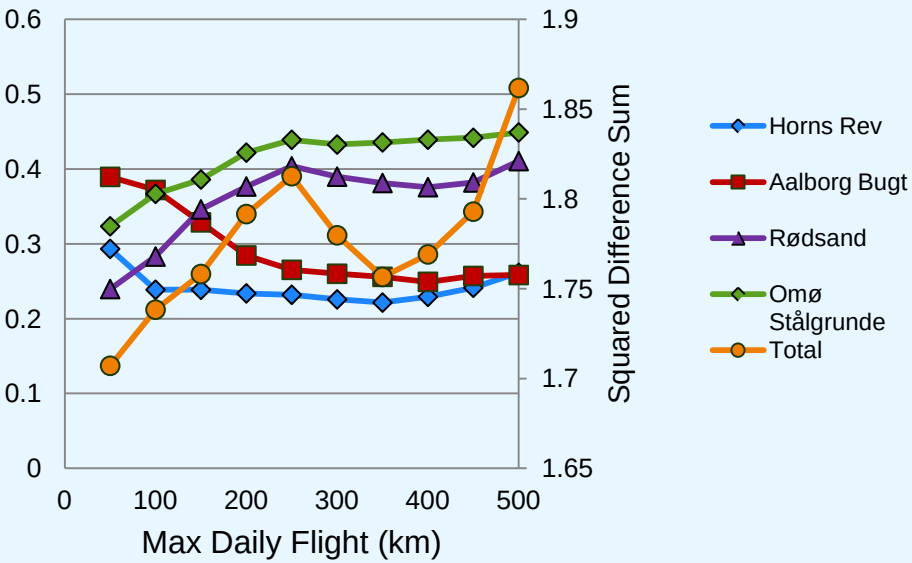


Diver test data (migration observations)



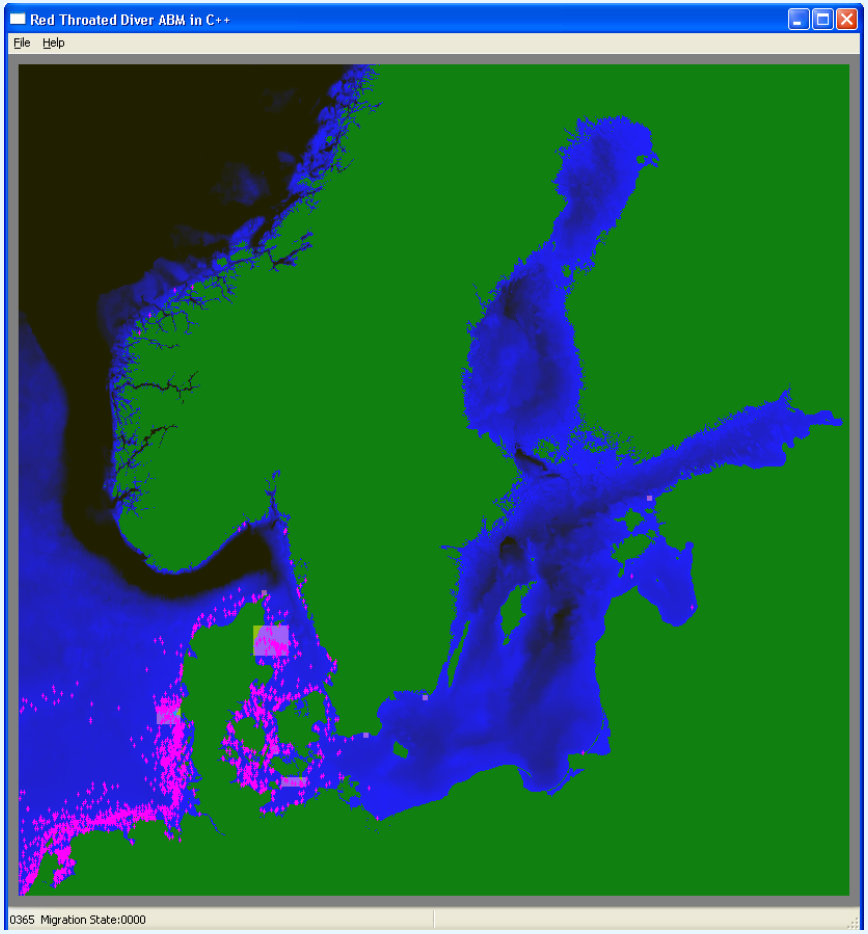
Model testing results

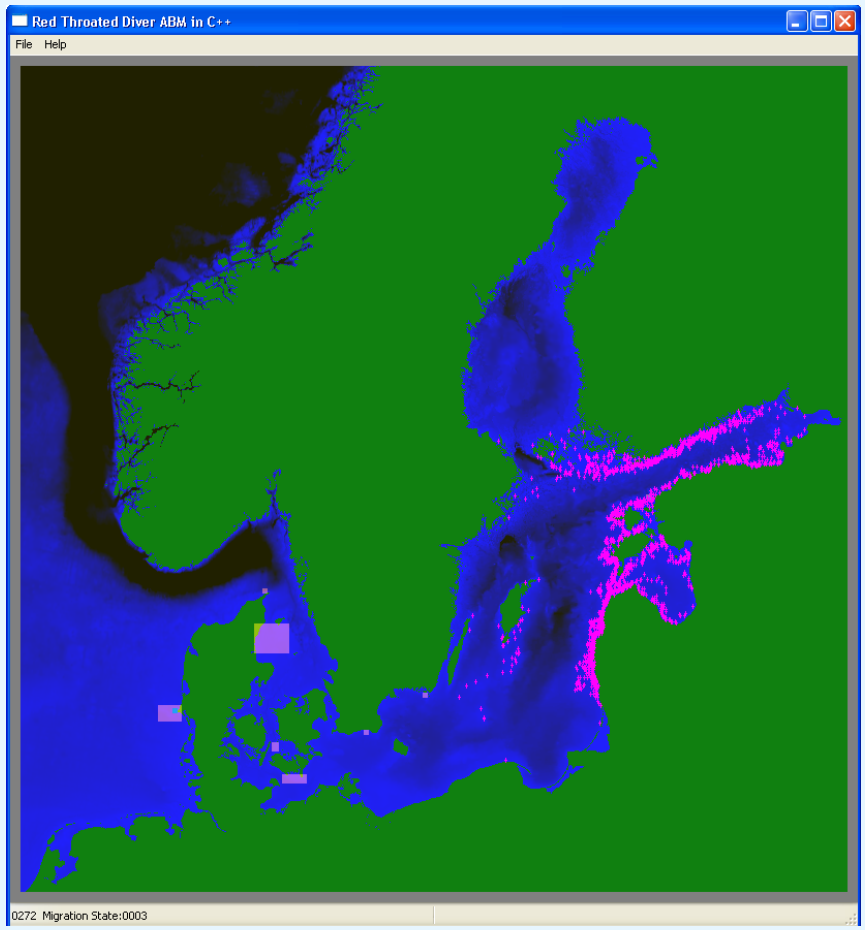




The stationary birds appear to be divided into two types of responses – it is not possible to find a solution that fits both

The running model





Model fit compared to real world

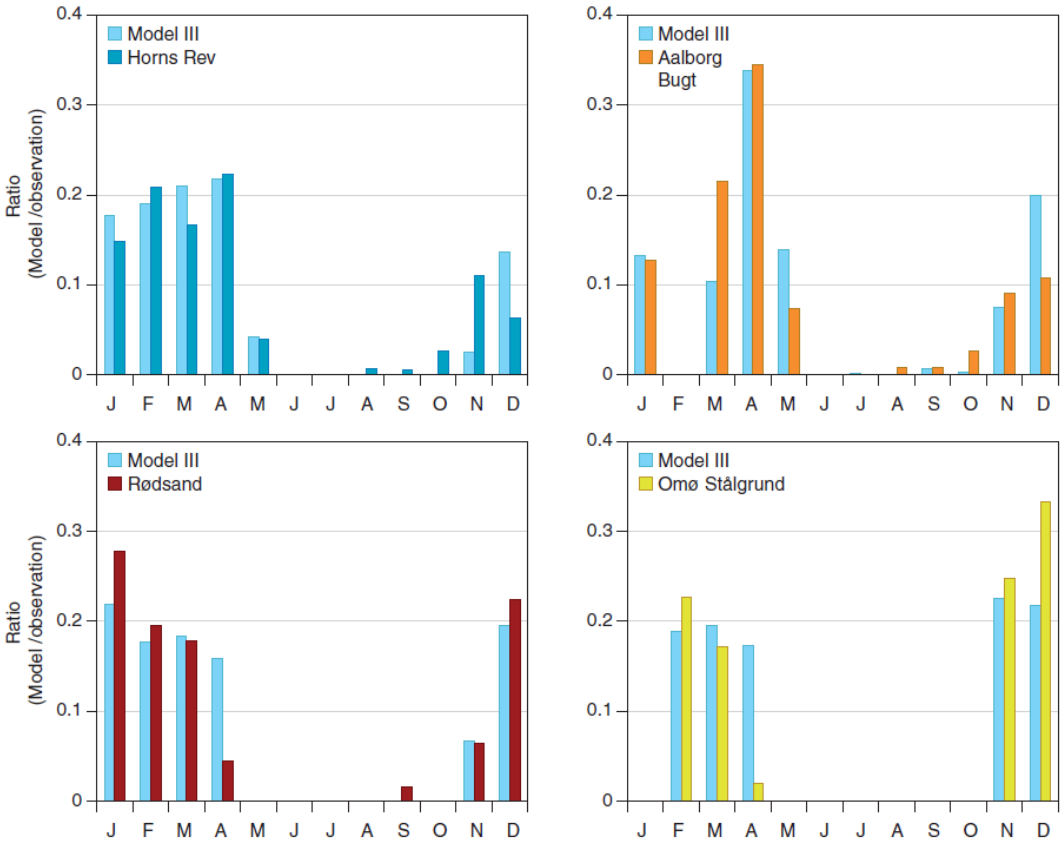
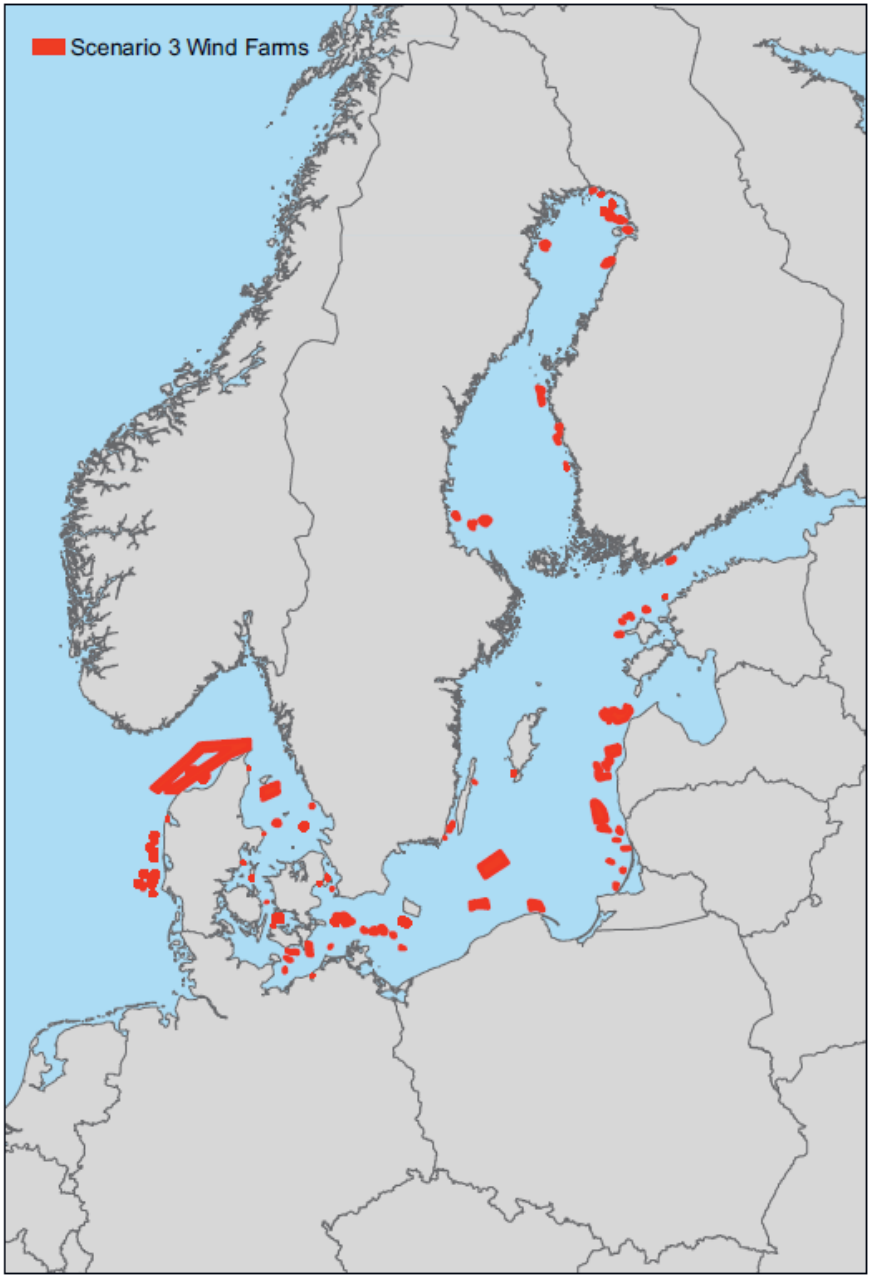


Figure 7. Version III best fit between model and observational data of stationary birds. A – Horns Rev; B – Aalborg Bugt; C – Rødsand; D – Omø Stålgrund. There are still some inconsistencies but these were not considered critical due to the innate variability of real world counts.

Table 2. The mean population estimates for 180 model iterations for scenario 1 (S1), scenario 2 (S2) and scenario 3 (S3) respectively, modelled for the entire model population. Standard deviation and 95% confidence intervals are given. "Difference" indicates the modelled change in population size, where negative values indicates a population decline.

	S1	S2	S3
Mean	8790.0	8782.7	8639.9
SD	159.0	134.6	132.2
N	180	180	180
95% ci	23.2	19.7	19.3
Difference	NA	-0.1%	-1.7%



How can this be improved?

Proposal that we develop an open-science project with the following advantages:

- **Integrating breeding, disturbance and migration data**
- **Creating an open platform into which diver data can be placed**
- **Combining data from many sources to test the model**
- **Eventually providing an independent peer reviewed model for use in EIAs**