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INTRODUCTION

During winter and spring, large numbers of Red-throated diver occur in offshore areas of the German North Sea. Offshore wind farm development is increasing in this area which can lead to conflicts as divers are very sensitive to anthropogenic disturbance. The project DIVER aims to study these interactions between divers and offshore wind farms.



METHODS AND RESULTS

The distribution of divers was modelled in relation to the dynamic offshore environment and anthropogenic pressures (OWF and shipping traffic) using GAMMs. Results from two independent datasets, satellite telemetry and digital aerial surveys, are compared.

Satellite Telemetry

45 Red-throated divers were captured and tagged (PTT satellite transmitters) in the area west of Sylt (German EEZ) during 2015–2017.

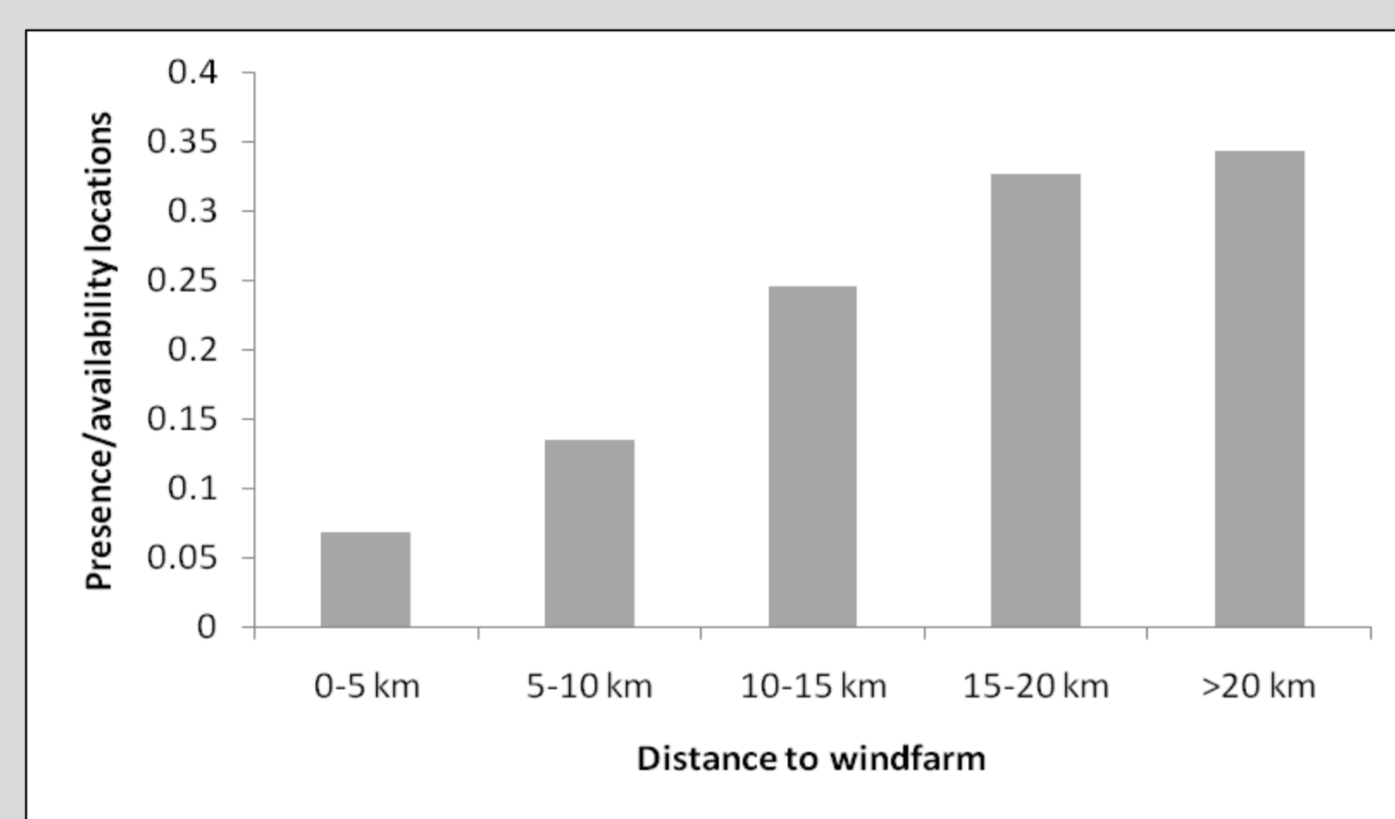
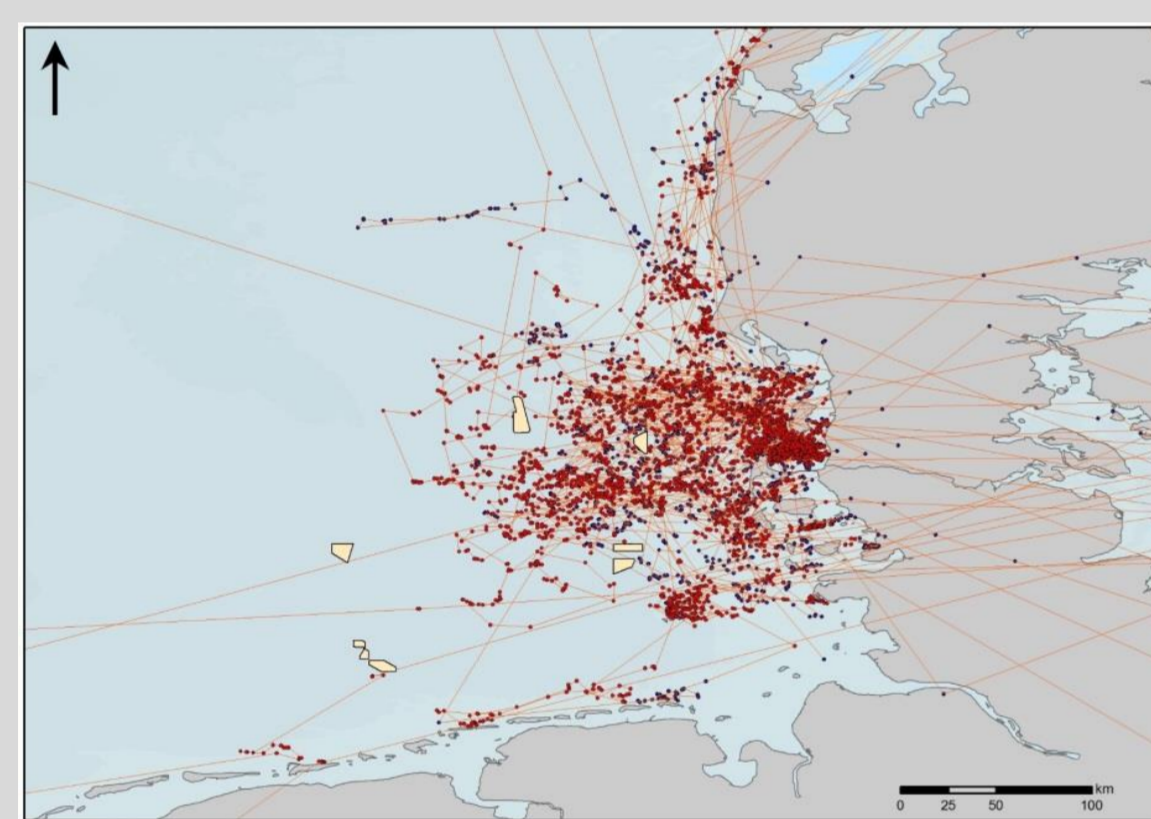


Abb. 1: Distribution of tracking positions relative to the distance from OWF, corrected for the available area.

Digital Aerial Surveys

Four large-scale digital aerial surveys were conducted during spring 2016 and 2017.

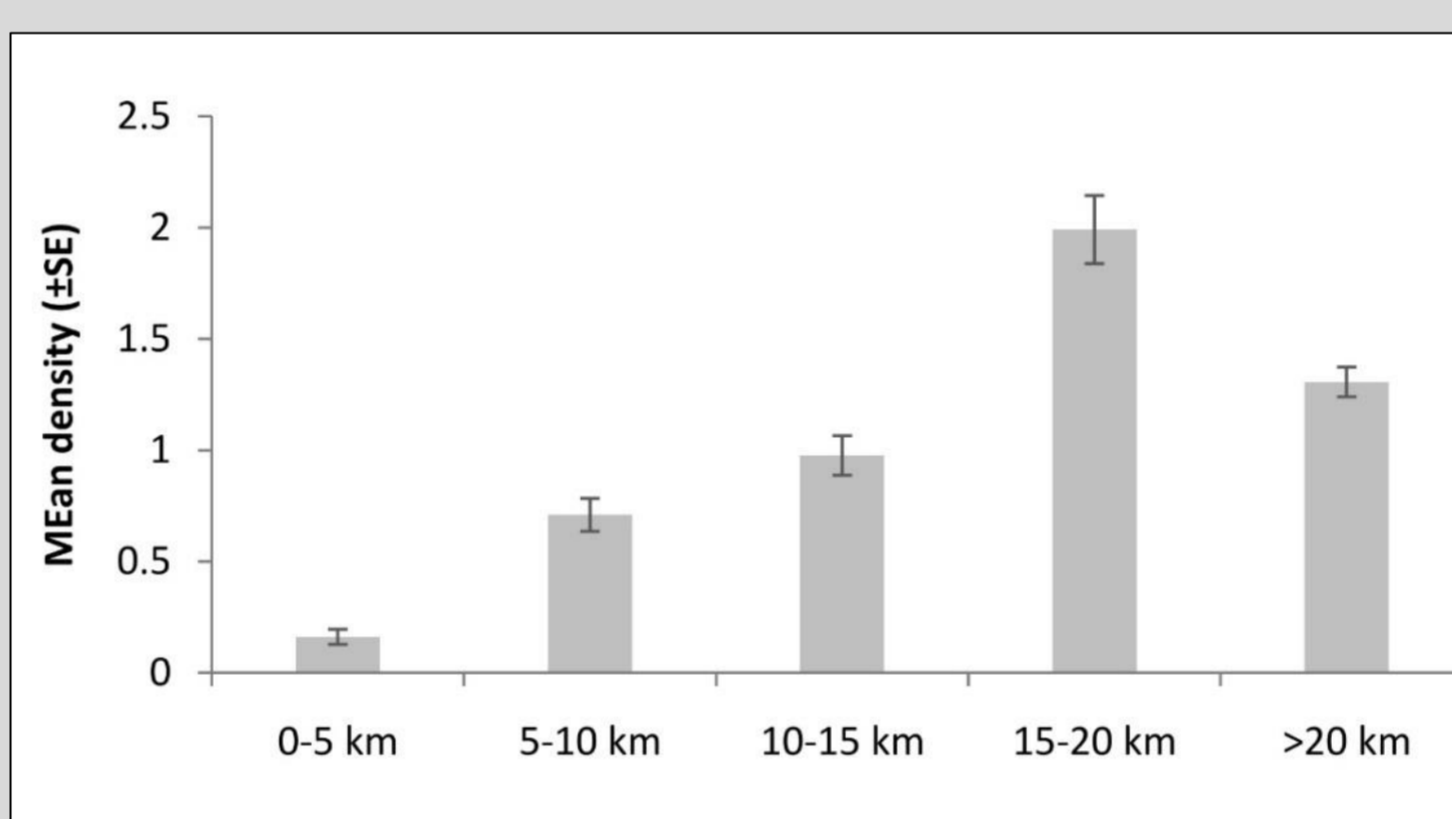


Abb. 2: Mean density (Ind./km²) of divers for distance classes relative to OWF, based on digital aerial surveys.

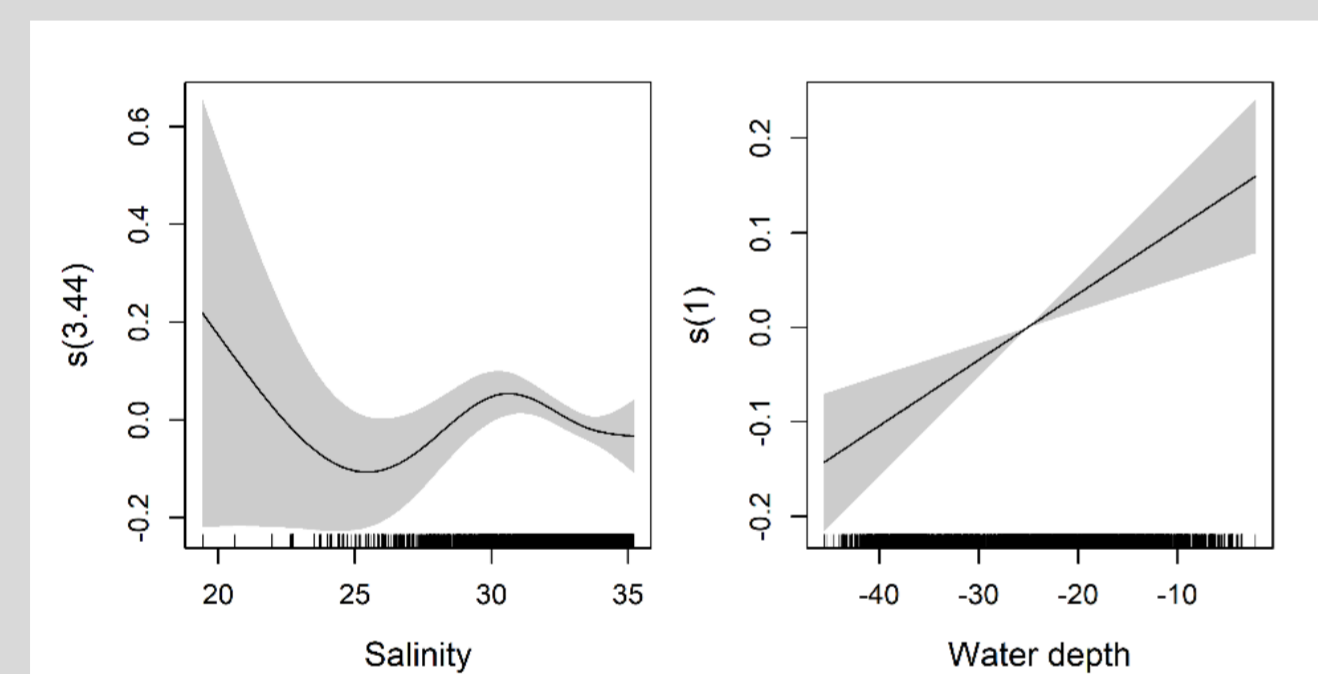
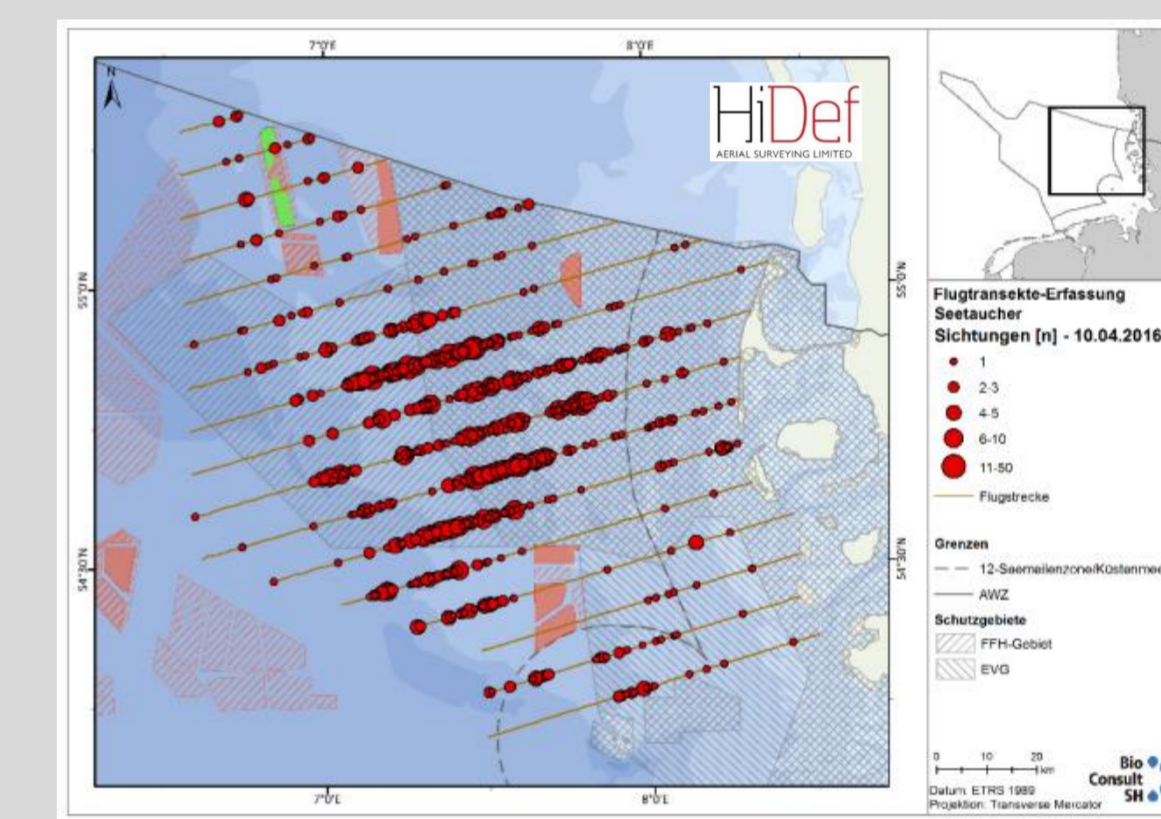


Abb. 3: GAMM smoothed curves for salinity and water depth, based on satellite telemetry data.

Both methods consistently show significant effects of 'distance to wind farm' up to a distance class of 10-15 km.

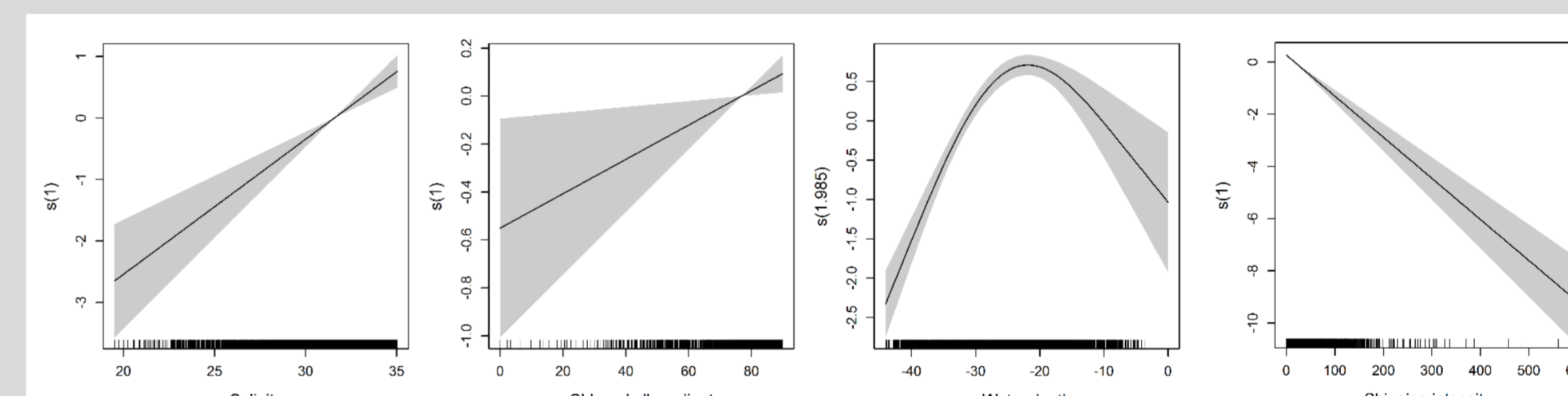
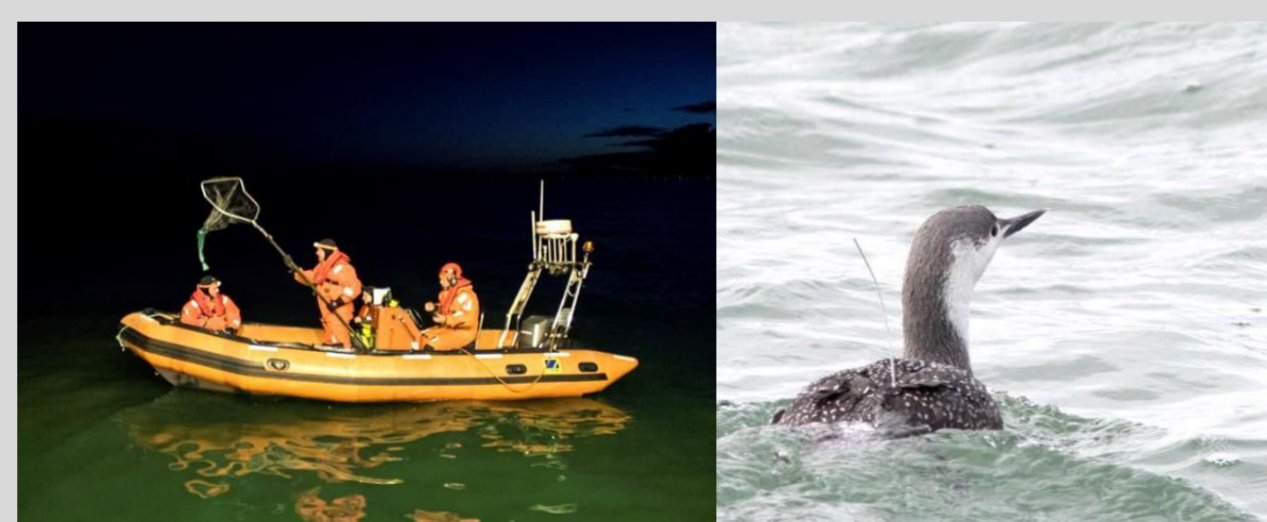


Abb. 4: GAMM smoothed curves (2-step hurdle-model) based on digital aerial surveys (binomial part of the model) for salinity, chlorophyll concentration, water depth and shipping traffic.



Effects of ship traffic on individual movements

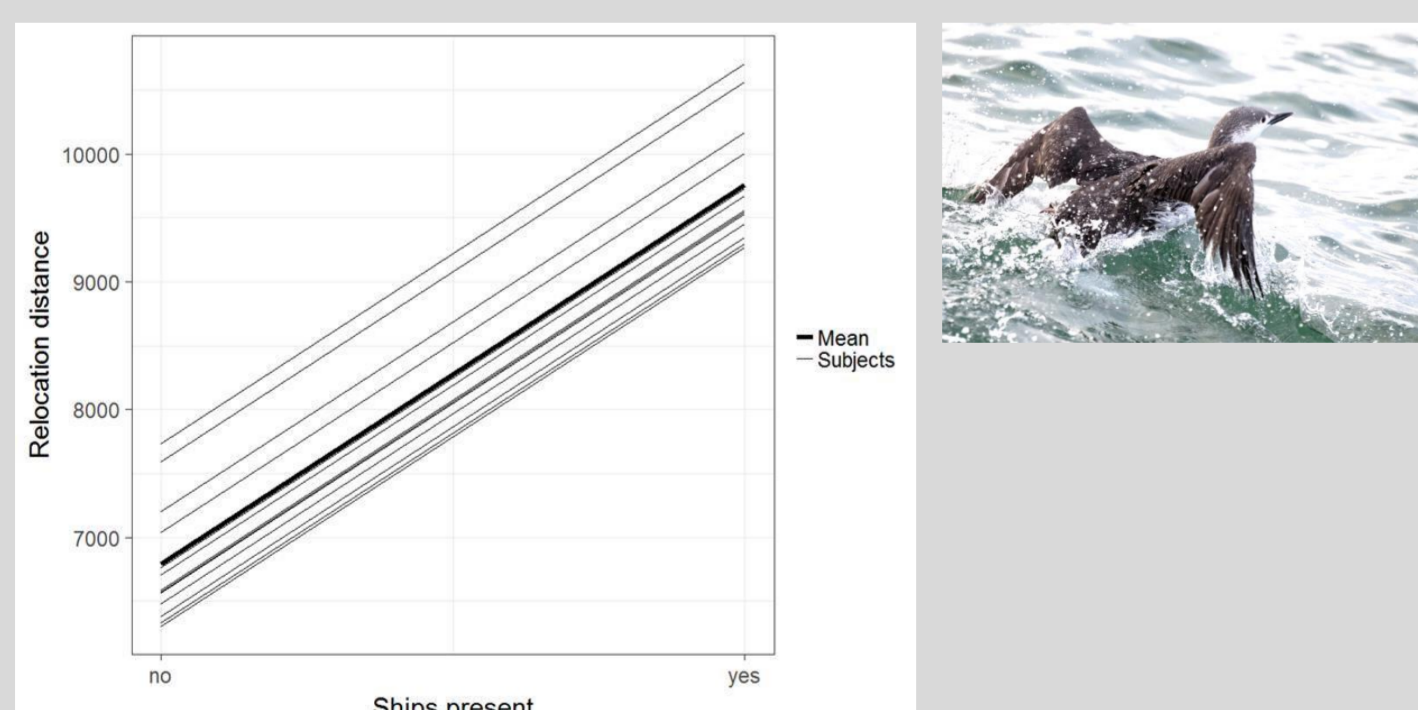


Abb. 5: Effect of ship presence in a radius of 3 km around tracking positions on relocation distances during the subsequent lag. Predicted lines are given per subject. Bold line is the population-level prediction.

Relocation distances of divers are larger when ships are present in the vicinity

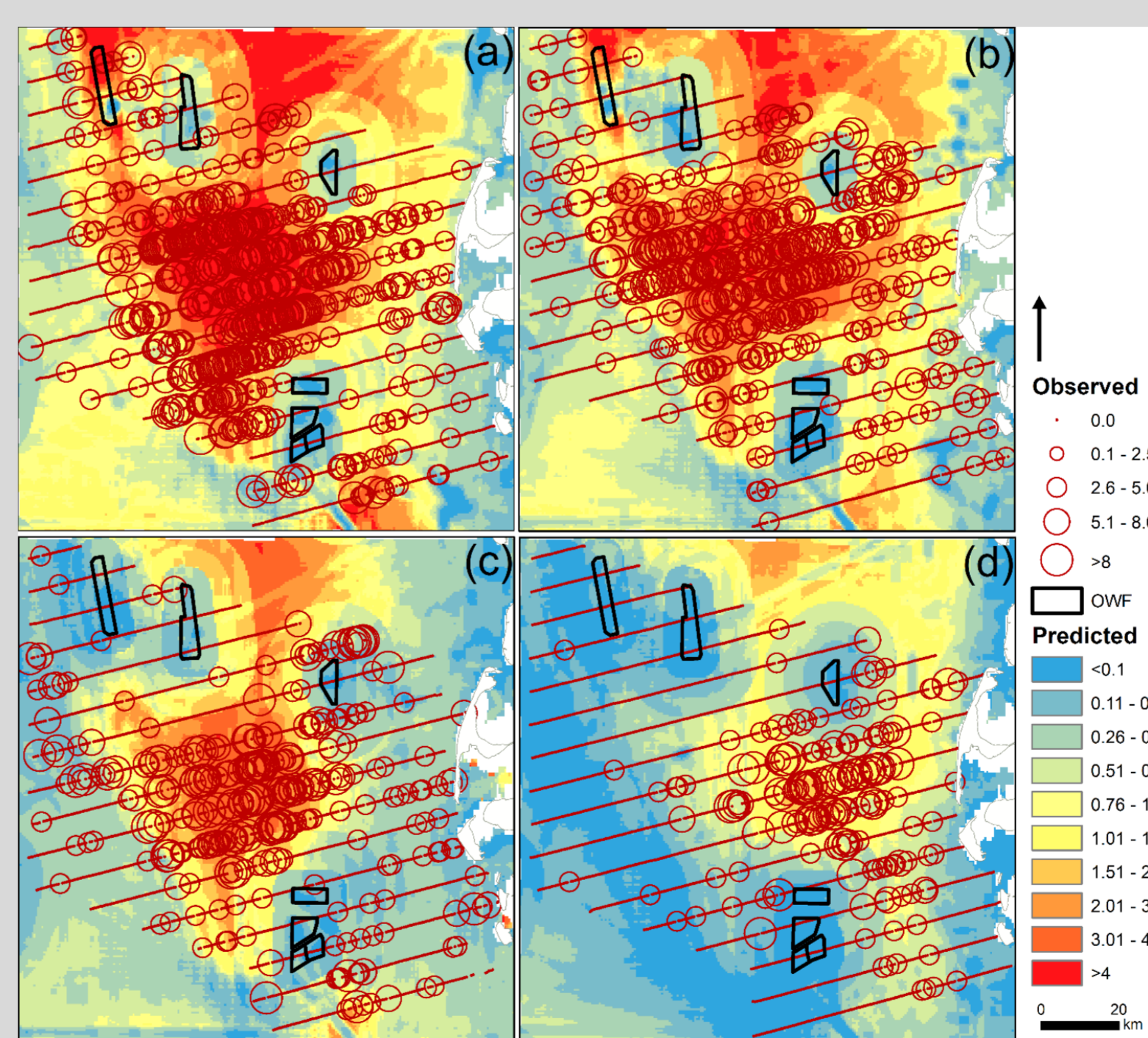


Abb. 6: Predicted mean density (birds/km²) distribution of red-throated divers based on digital aerial video survey data for average conditions in the whole study area during the specific survey days with observed densities overlaid, a) 10 April 2016, b) 1 May 2016, c) 25 March 2017 and d) 11 May 2017.

Highest densities of divers were found in the center of the study area, away from existing wind farms.

CONCLUSIONS

- Modelling results show consistent displacement up to 10-15 km, and identify important environmental parameters (salinity, water depth)
- Results from digital aerial surveys were confirmed by independent data from satellite telemetry
- Diver distribution and individuals movements indicate strong avoidance of ships