Final Report

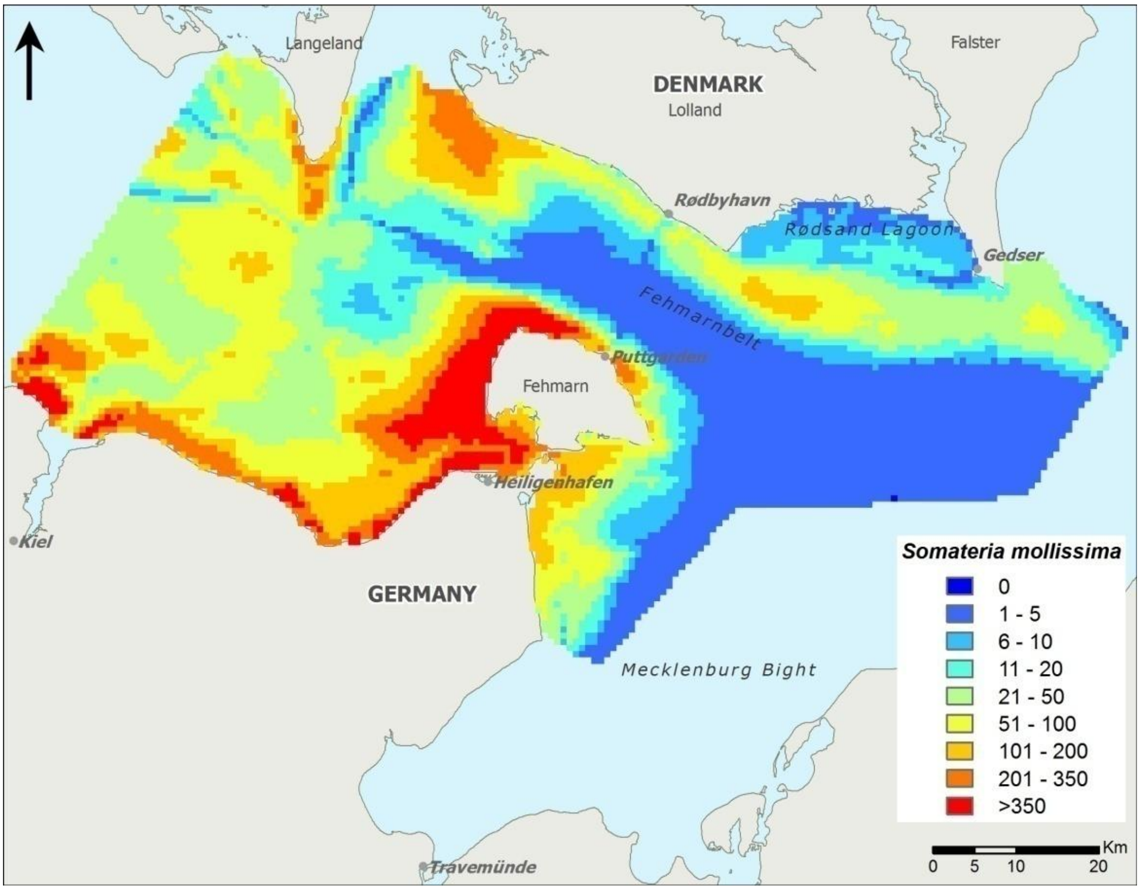
FEHMARNBELT FIXED LINK
BIRD SERVICES (FEBI)

Bird Investigations in Fehmarnbelt - Baseline

Waterbirds in Fehmarnbelt

E3TR0011 Volume II – Appendix VII

Evaluation of seaduck satellite telemetry data: sample size and representativeness



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Please cite as:
FEBI (2013). Fehmarnbelt Fixed Link EIA.
Bird Investigations in Fehmarnbelt – Baseline.
Volume II. Waterbirds in Fehmarnbelt.
Report No. E3TR0011
Appendix VII: Evaluation of seaduck satellite telemetry data: sample size and representativeness.

Appendix:10 pages

(Main Report: ISBN 978-87-92416-51-3)

May 2013

ISBN 978-87-92416-85-8

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Geodatastyrelsen (formerly Kort- og Matrikelstyrelsen), Kort10 and 25 Matrikelkort
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Co-financed by the European Union
Trans-European Transport Network (TEN-T)

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A. APPENDIX VII

Evaluation of seaduck satellite telemetry data: sample size and representativeness

Satellite telemetry is a relatively expensive wildlife investigation technique, which in addition to other factors often results that rather few individuals are tracked. Therefore, a question needs to be answered whether tracked animals are representative of a population that is being studied and whether telemetry results could be generalised (Ropert-Coudert and Wilson 2005, Burger and Shaffer 2008). If a population is very heterogeneous, several tracked individuals might represent barely a fraction of it and bigger sample size or investigation using other techniques might be required to answer the study questions. It is also possible that equipping birds with telemetry devices causes undesired effects, which result in unnatural behaviour of tagged individuals (Latty et al. 2010, Wilson 2011).

In this appendix, we present our assessment of representativeness of satellite telemetry of seaducks in the Fehmarnbelt.

Tracking Common Eiders in the Fehmarnbelt

Methods

Twenty Common Eiders have been equipped with satellite transmitters in the Fehmarnbelt, ten in March 2009 and ten in October 2009, and 19 of these tagged individuals were successfully tracked for different periods of time, while one bird has died within days after release. Telemetry details are provided in chapter 2.3.4 of this report.

Because the sample size of tracked eiders was relatively generous, as it goes for satellite telemetry datasets, and nearly each bird has transmitted numerous locations (Table 2.18 in this report), spatial modelling of habitat suitability for this species in the Fehmarnbelt area has been applied aiming to compare such results with species spatial distribution obtained from aerial and ship-based survey results.

Common Eiders were tracked through winter 2009/2010, therefore we considered the individuals, which remained in the Fehmarnbelt study area and transmitted their locations for at least 10 weeks during that season. Few birds tagged in March 2009 stopped transmitting earlier, and therefore they were not included in the analysed dataset. Also, several birds moved outside of the Fehmarnbelt study area (Figure A.1). Overall, locations of 14 individuals were used in spatial modelling.

Because telemetry fixes represent only positions of bird presence, pseudo-absence locations were obtained by randomly generating 1,960 points over the entire study area in the Fehmarnbelt (Figure A.2). Ten pseudo-absence locations were generated for each actual observation used in model fitting. Using pseudo-absences is a standard procedure when modelling presence-only data (Guisan et al. 2002, Brotons et al. 2004).

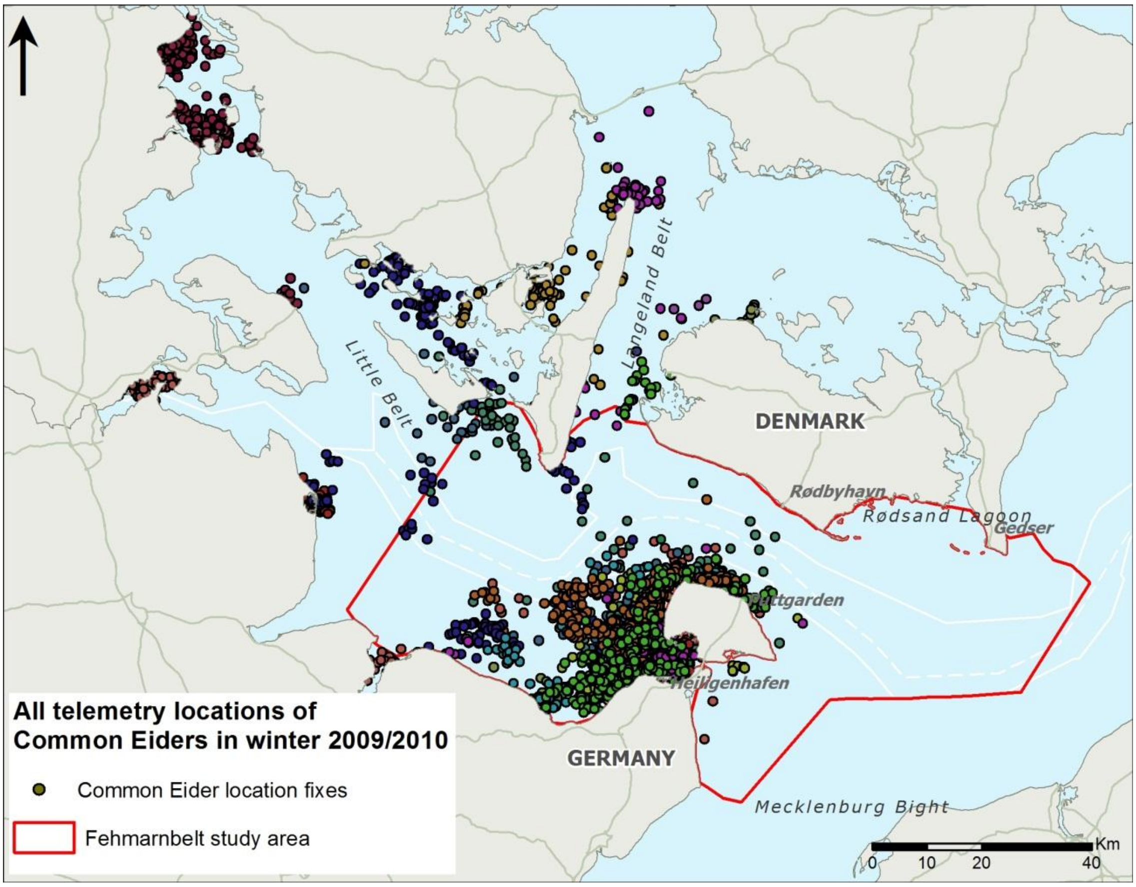


Figure A.1 All filtered locations of Common Eiders recorded using satellite telemetry in the Fehmarnbelt in winter 2009/2010.

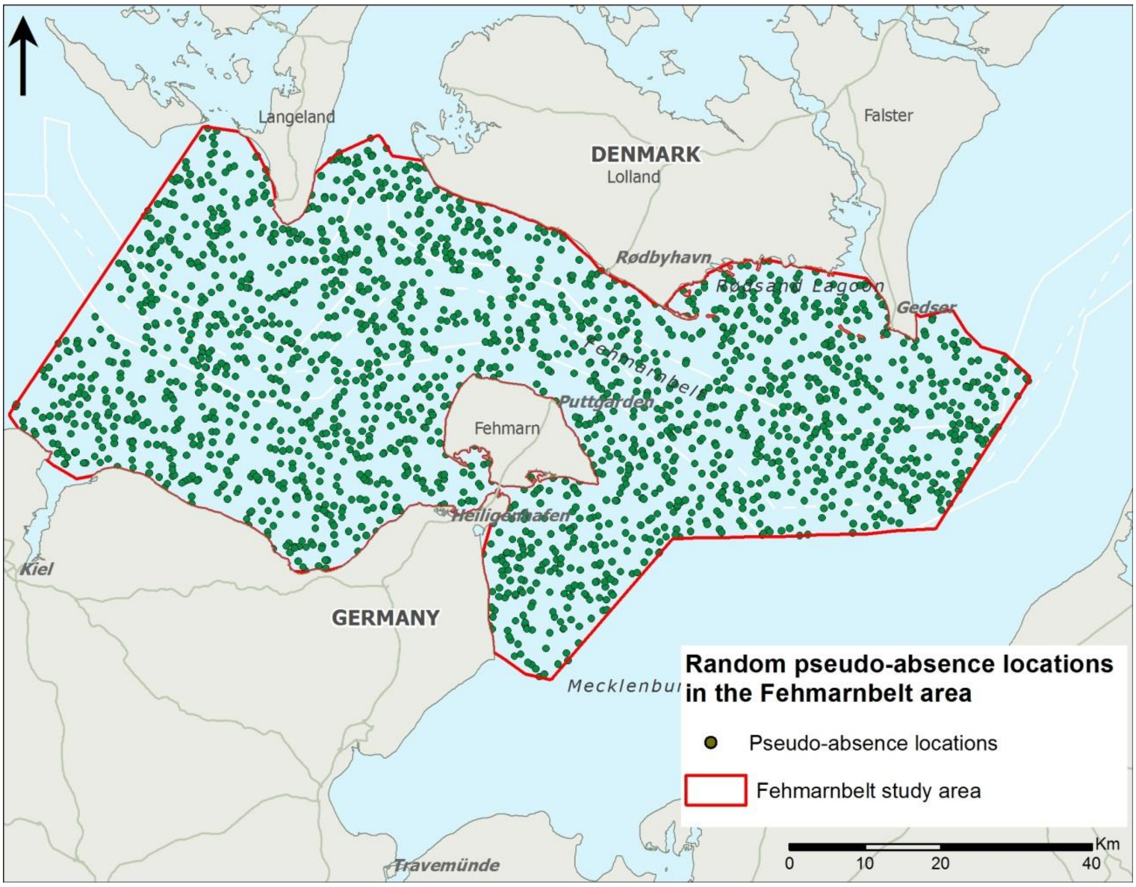


Figure A.2 Pseudo-absence locations (N=1,960) randomly generated in the Fehmarnbelt study area, which were used when fitting habitat suitability models.

Different numbers of locations were obtained from each bird using satellite telemetry and data were recorded in 'bursts', i.e. 5-20 locations per individual per transmission period of 8 hours, followed by a gap of 18-72 hours. This resulted in an imbalanced dataset with different representation of individual birds and autocorrelation among location fixes of the same bird recorded within short time intervals. Therefore further sub-sampling was required to ensure equal representation of each bird. Telemetry locations were first filtered to remove outliers (see filtering procedure described in chapter 2.3.4 of this report) and then one location was randomly drawn from each bird at weekly time intervals during the wintering period starting from the beginning of November until mid-March. Extracted locations (N=196 during each draw) were combined with pseudo-absences and resulting dataset was used to fit habitat suitability model. Once habitat model was fitted, it was used to predict Common Eiders habitat suitability in the entire Fehmarnbelt area. The same procedure consisting of random selection of weekly locations, combining drawn dataset with pseudo-absences, fitting models and creating habitat prediction grids was applied 100 times and finally, prediction results were averaged and a single habitat suitability grid was calculated (Figure A.3). This iterative sub-sampling procedure was applied aiming to reduce bias in otherwise arbitrary selection of several satellite telemetry locations and discarding the rest.

A generalised additive model (GAM) with binomial error distribution and logit link function was fitted using subsampled Common Eider telemetry data and simulated pseudo-absence locations, when predicting spatial extent of bird habitats considering the same environmental variables as used in distribution models based on survey data: water depth, bottom slope, proportion of hard substrate, mussel biomass, distance to land, distance to wind farms and number of ships. However, differently from distribution models based on survey data, we did not use coordinates (X and Y) among the predictor variables when fitting models on telemetry data. Due to this aspect telemetry models could be considered as more parsimonious because they predict habitat suitability based entirely on environmental characteristics without additional spatial forcing.

Results

Developed Common Eider habitat suitability model using satellite telemetry data closely resembled modelled species distribution using survey data (Figure A.3). Highly significant correlation (Spearman Rank) with winter distribution patterns obtained using aerial survey data ($R=0.65$, $P<0.001$) and ship-based survey data ($R=0.56$, $P<0.001$) suggests that telemetry data of tracked Common Eiders is indeed a good and representative sample characterising the species wintering in the Fehmarnbelt. The only major discrepancy between results of different models was prediction of habitat suitability at the SW coast of Lolland, where the 'telemetry model' failed to predict suitable habitats. This was most likely caused by the fact that none of the tracked birds has actually used that area, and therefore environmental characteristics of that place appeared as 'unused' in the model.

Statistical fit of habitat suitability models was satisfactory and there was no consistent spatial autocorrelation among model residuals (Figure A.4), model AUC scores averaged at 0.86 (±0.009 SD) indicating good model fit, and average deviance explained by the models was 26% (±1.72 SD).

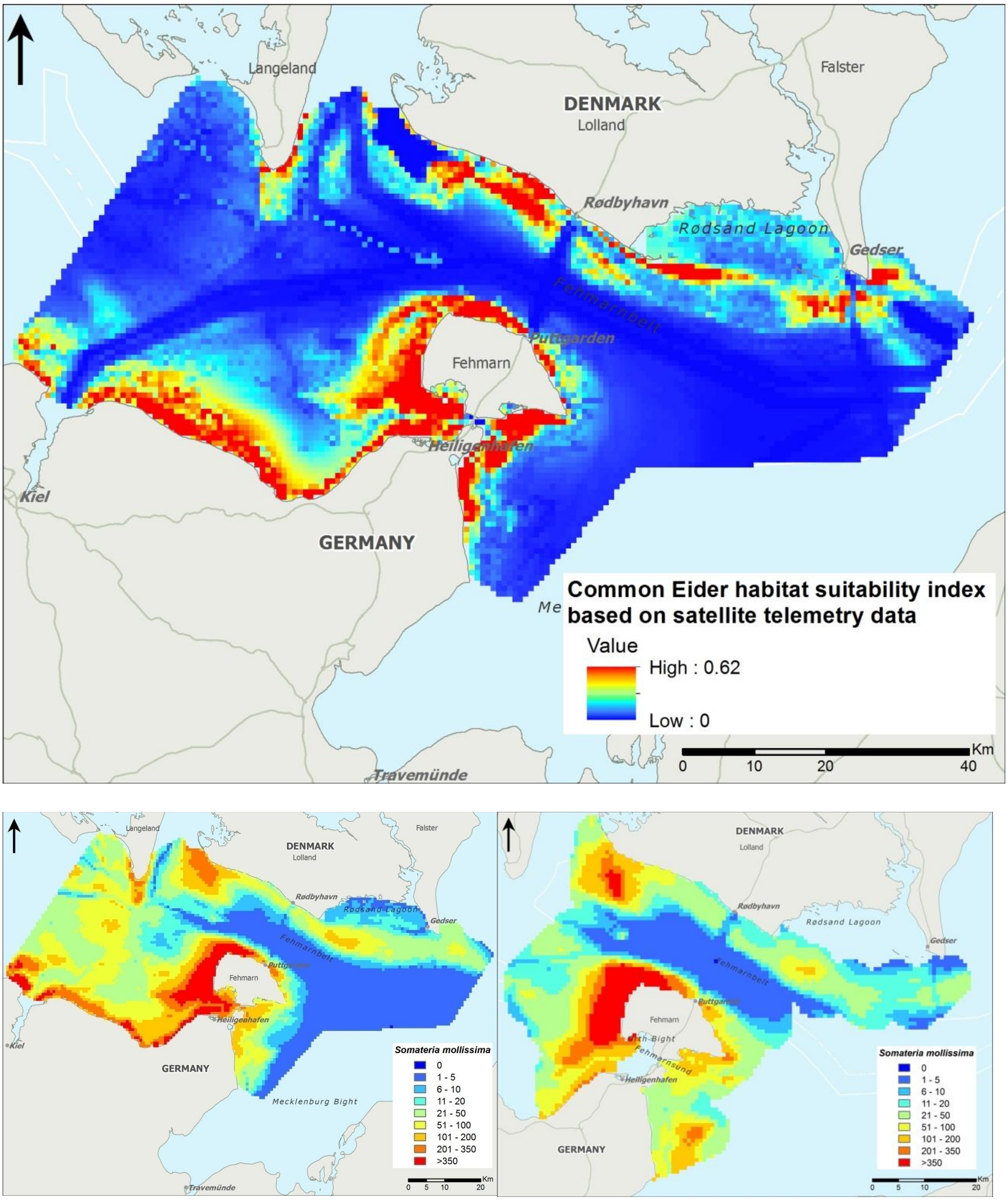


Figure A.3 Common Eider habitat suitability index modelled based on satellite telemetry data (upper map) and species distribution based on aerial surveys (lower-left map) and ship-based surveys (lower-right map).

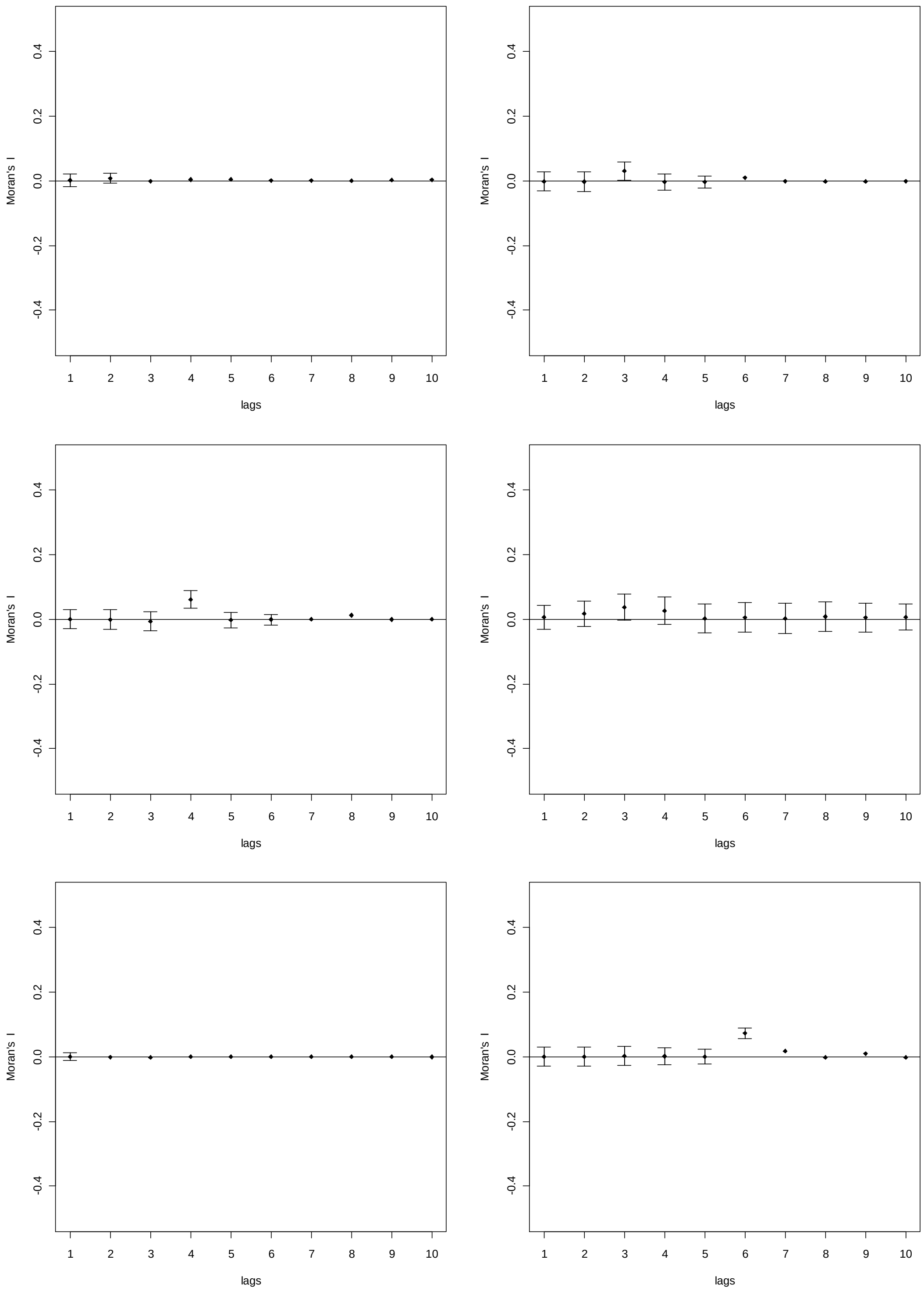


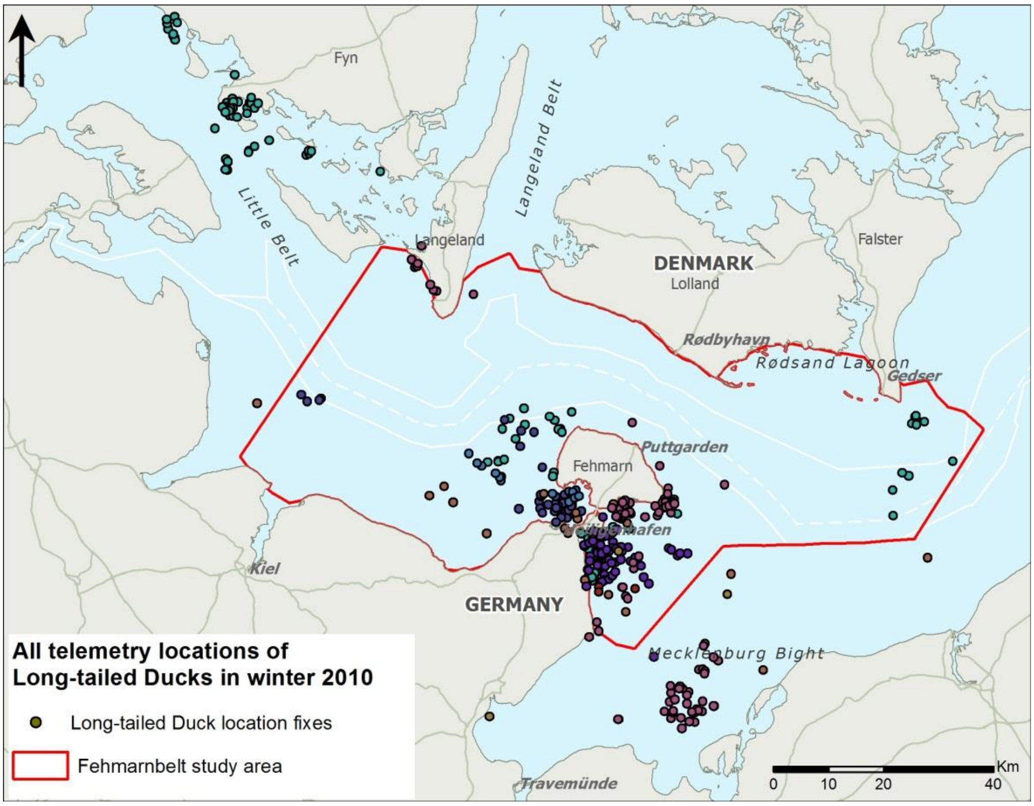
Figure A.4 Spatial correlograms displaying the spatial autocorrelation over 10 lags in the residuals of the first 10 GAMs (out of 100 fitted models) for the Common Eider using telemetry data. The dots indicate the estimated Moran's I value and the bars show two standard deviations from the estimated Moran's I value. One lag equals the defined nearest neighbourhood of 1,500 meters.

Tracking Long-tailed Ducks, Common Scoters and Tufted Ducks in the Fehmarnbelt

Satellite telemetry data of Long-tailed Ducks, Common Scoters and Tufted Ducks yielded relatively few locations in the Fehmarnbelt area due to low number of tagged individuals and also some of them transmitted rather few locations (Table 2.18 in this report, Figure A.5, Figure A.6). After subsampling procedure (described above for the Common Eider) there was insufficient number and spread of locations for fitting habitat suitability models for these species. Therefore, it was not possible to use the same approach as for the Common Eider aiming to verify whether tagged birds of these three species comprised a representative sample of their respective populations.

Nevertheless, although we have no method to test whether tagged individuals behaved naturally and represented typical behaviour of their species, we maintain our assumption that equipping Long-tailed Ducks and Common Scoters with satellite transmitters did not alter their wintering behaviour in a significant way. We base this assumption on the fact that these species live in rather extreme environmental conditions (low ambient temperature, diving to great depths) and need to collect a lot of food daily. Therefore, these birds must be in good health at all times, otherwise sick individuals or birds deviating from optimal behaviour would face inevitable death with short time. Our birds equipped with satellite transmitters, which survived immediate post-surgery period, not only lived through harsh conditions of winter 2010, but also migrated long-distances to the high Artic for breeding, a move that would have been impossible for individuals in suboptimal body state. All Long-tailed Ducks migrated 3,500-4,000 km to their breeding grounds, and tagged Common Scoter female migrated about 3,000 km to the nesting site. Tagged Common Scoter male stayed in the Baltic throughout the summer, however it is not unusual for males of this species to do so, and high mobility of this individual across several staging areas (Figure A.7), that are known being typical Common Scoter habitats (Petersen and Nielsen 2011, Skov et al. 2011), also suggest that the bird was behaving normally.

Tufted Ducks equipped with satellite transmitters, however, experienced high mortality and it cannot be rejected that tracked individuals did not behave naturally. Still, one bird survived the winter and migrated approximately 2,000 km to a breeding site at the White Sea and then returned to the Baltic.



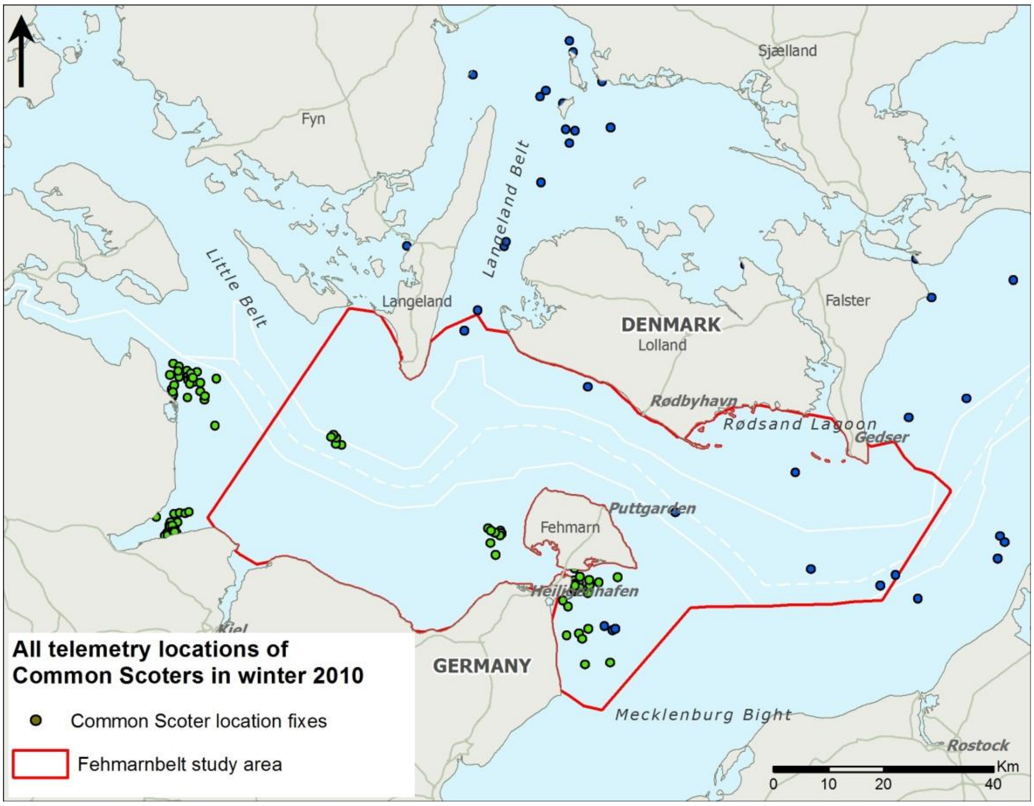


Figure A.5 All filtered locations of Long-tailed Ducks (upper map) and Common Scoters (lower map) recorded by satellite telemetry in the Fehmarnbelt in winter 2010.

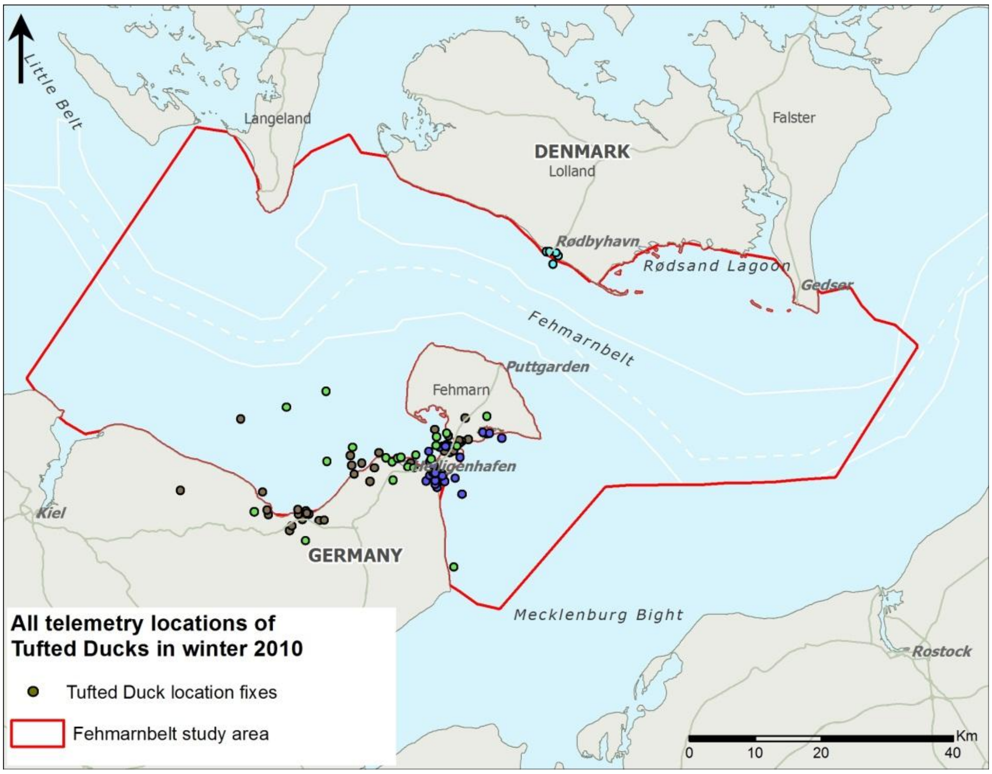


Figure A.6 All filtered locations of Tufted Ducks recorded using satellite telemetry in the Fehmarnbelt in winter 2010.

Figure A.7 All filtered locations of one Common Scoter recorded using satellite telemetry in the Fehmarnbelt in 2010. The bird (male) did not migrate and remained in the Baltic round year.

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