Stiftung Tierärztliche Hochschule Hannover
University of Veterinary Medicine Hannover, Foundation

Harbour porpoises in the southern North Sea – Analysis of potential influences of *alpha ventus* in the context of general distribution trends

Anita Gilles, Michael Dähne, Verena Peschko, Sven Adler, Katrin Ronnenberg, Sacha Viquerat, Ursula Siebert

Institute for Terrestrial and Aquatic Wildlife Research (ITAW), Werftstr. 6, 25761 Büsum

Gefördert auf Grund eines Beschlusses des Deutschen Bundestages

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

Projektträger

Projektträger Jülich Forschungszentrum Jülich

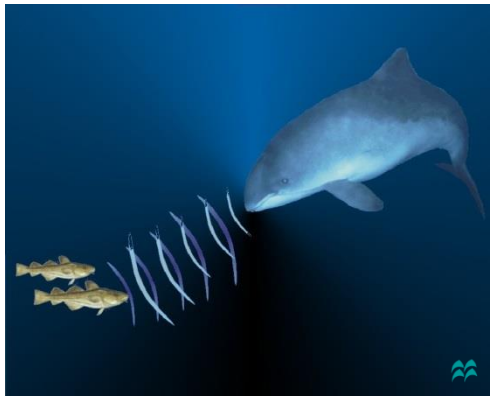
Koordination

BSH Bundesamt für Seeschifffahrt und Hydrographie

RAVE RESEARCH AT ALPHA VENTUS
Eine Forschungsinitiative des Bundesumweltministeriums

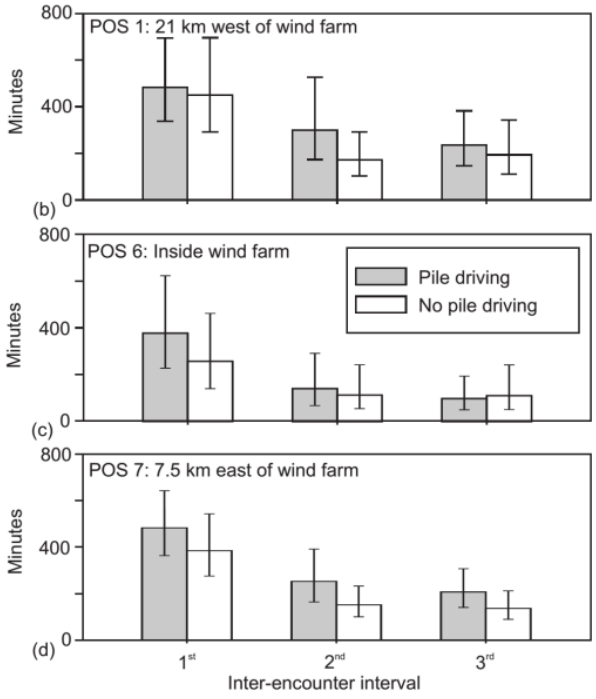
Research questions

- Seasonal and spatial distribution of harbour porpoises?
- Behavioural reaction related to pile-driving?
- How far are porpoises displaced? For how long? Return to pre-disturbance levels?
- Effects of the operation period?
- Possible to evaluate effects incorporating external anthropogenic pressures and environmental factors?



Studies on marine mammals and wind farms (selected)

Horns Rev (DK, North Sea)



Tougaard et al. 2009

Pile-driving zones of responsiveness

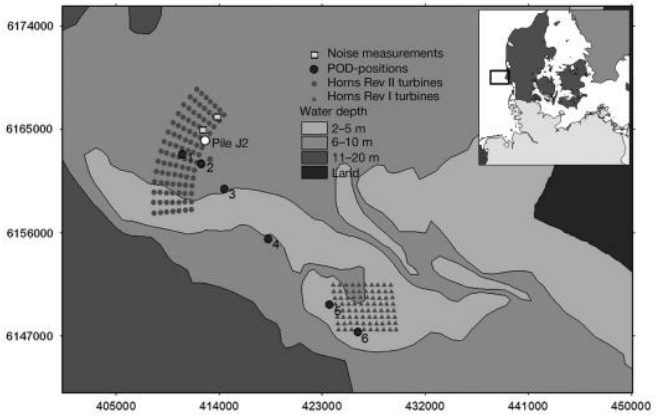
Displacement

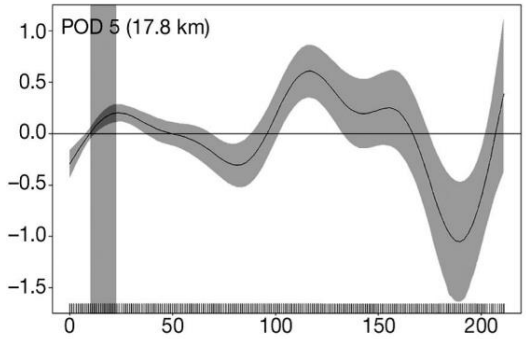
21 km 17.8 km

Duration

5.9 ➔ 7.5 h (2nd WT) 10-72 h

Horns Rev II (DK, North Sea)



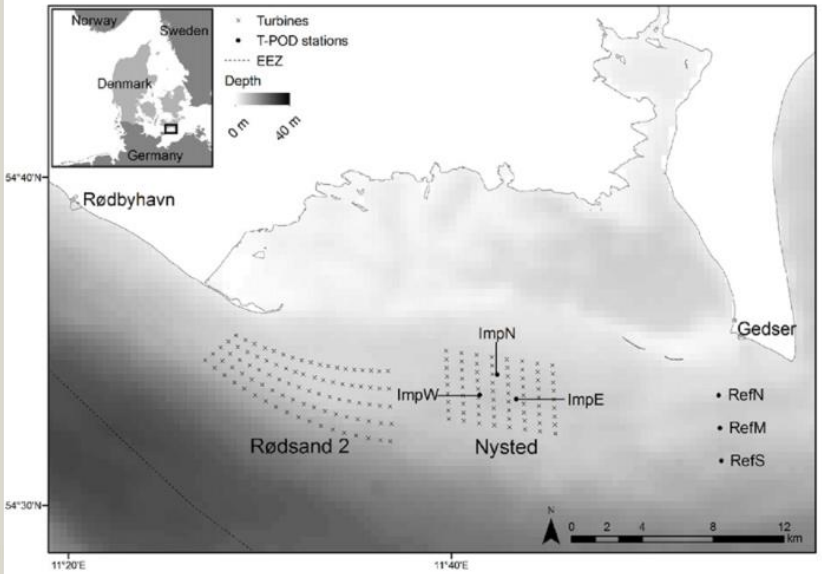


Brandt et al. 2011

Studies on marine mammals and wind farms (selected)

Nysted (DK, Baltic Sea)

Carstensen et al. 2006
Teilmann & Carstensen 2012

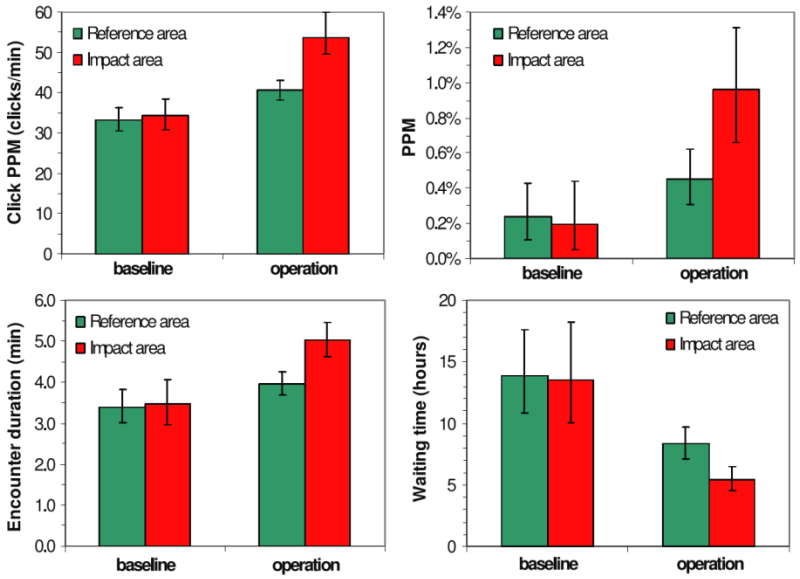


Increase in WT from 6 h to 72 h
Pile-driving effect (WT: 4 h to 41 h)

Construction and Operation Effect:
Long-lasting (years?)
Recovery due to an artificial reef effect?

Egmond aan Zee (NL, North Sea)

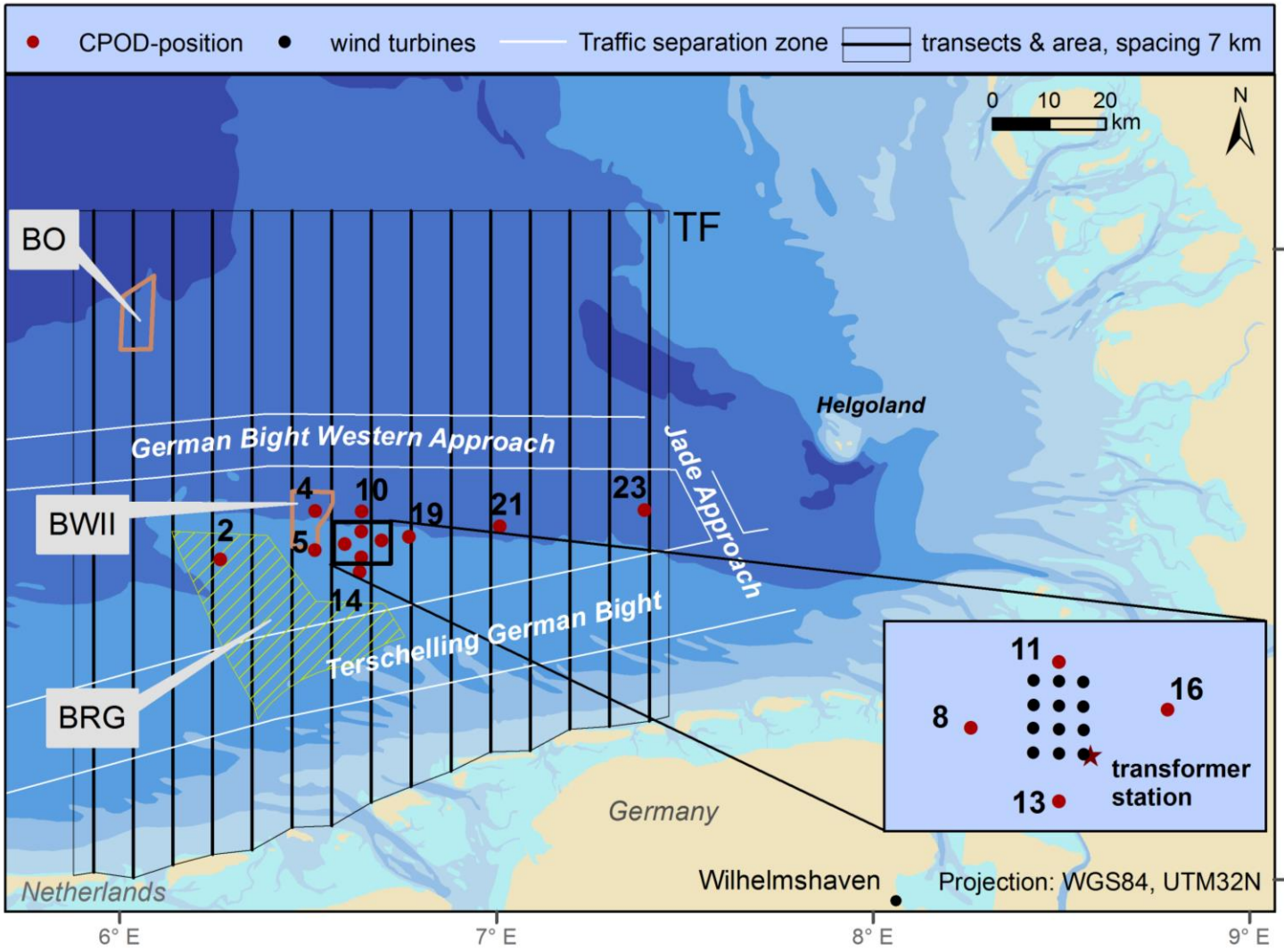
Scheidat et al. 2011



More detections in operation period

Operation Effect:
Artificial reef effect?
Sheltered area?

Study area



Alpha Ventus
09/2008 (Transf.P)
04/2009 - 08/2009

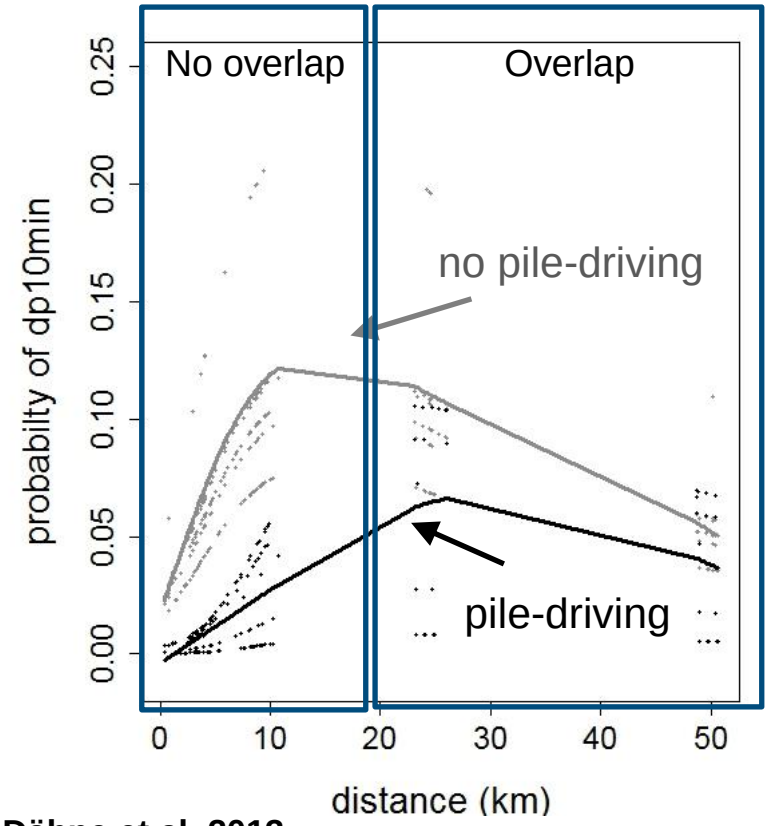
BARD Offshore I
05/2009 (Transf.P)
04/2010 - 03/2013

Borkum West II
09/2011 - 04/2012

Impacts during pile-driving at AV – spatial and temporal displacement

Displacement range

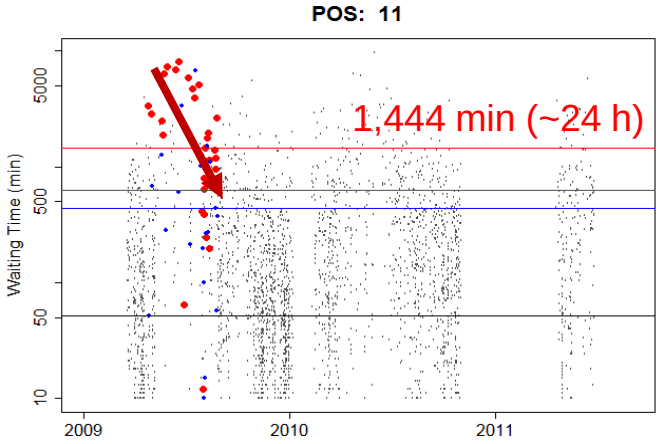
In relation to:
- distance to pile-driving/wind farm
- seasonal variation (month)

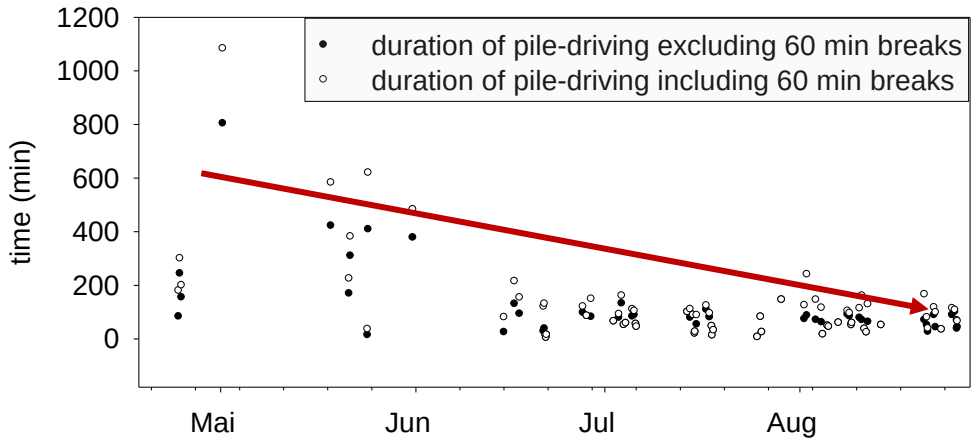


Dähne et al. 2013

Displacement duration

1st WT_{all} 1,008 min (17 h)



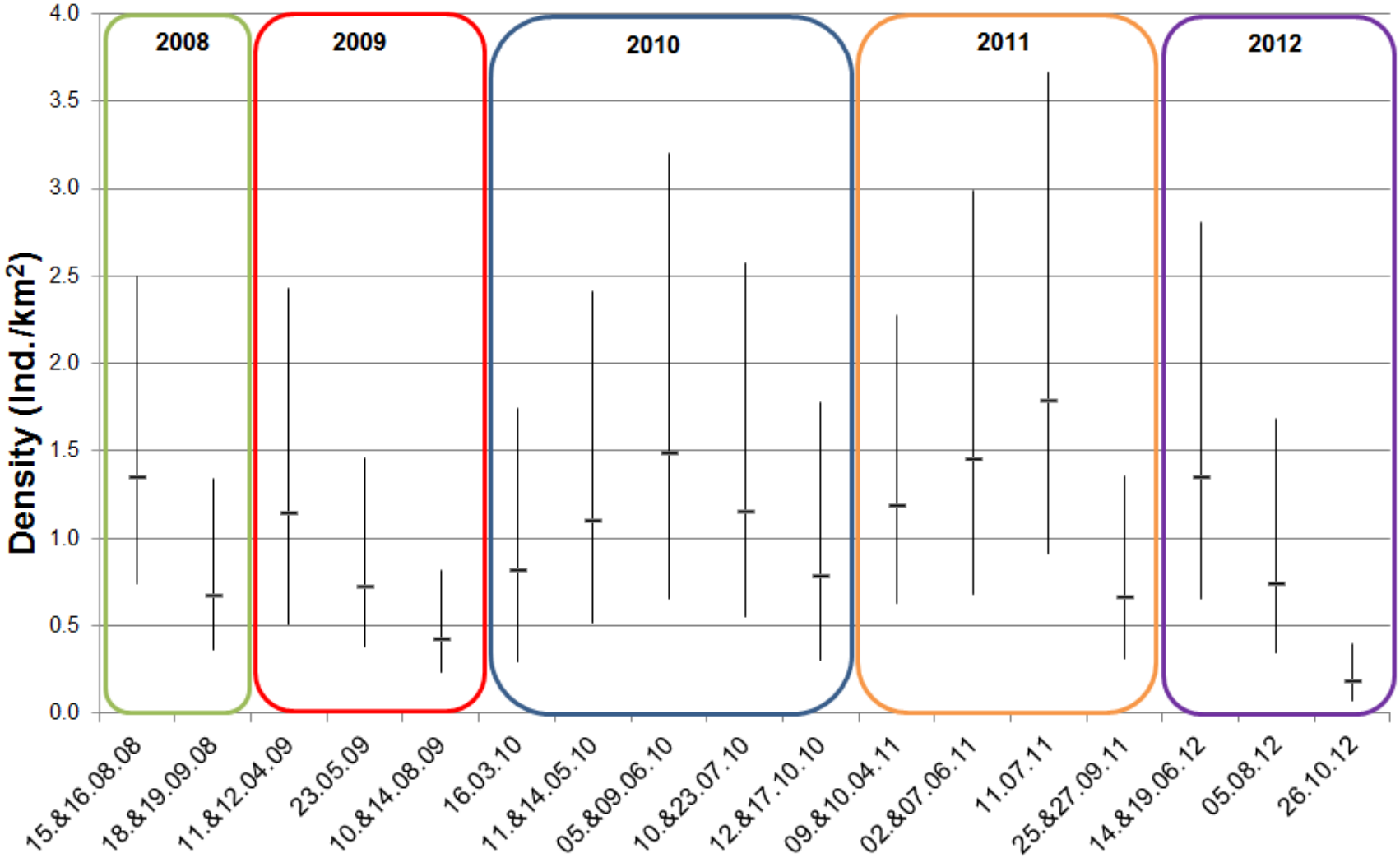


	minimum	maximum	
distance	10	ca. 25	km
SEL*	146-152	139-145	dB re µPa²s

*SEL of a single hammer stroke; most probably an overestimate

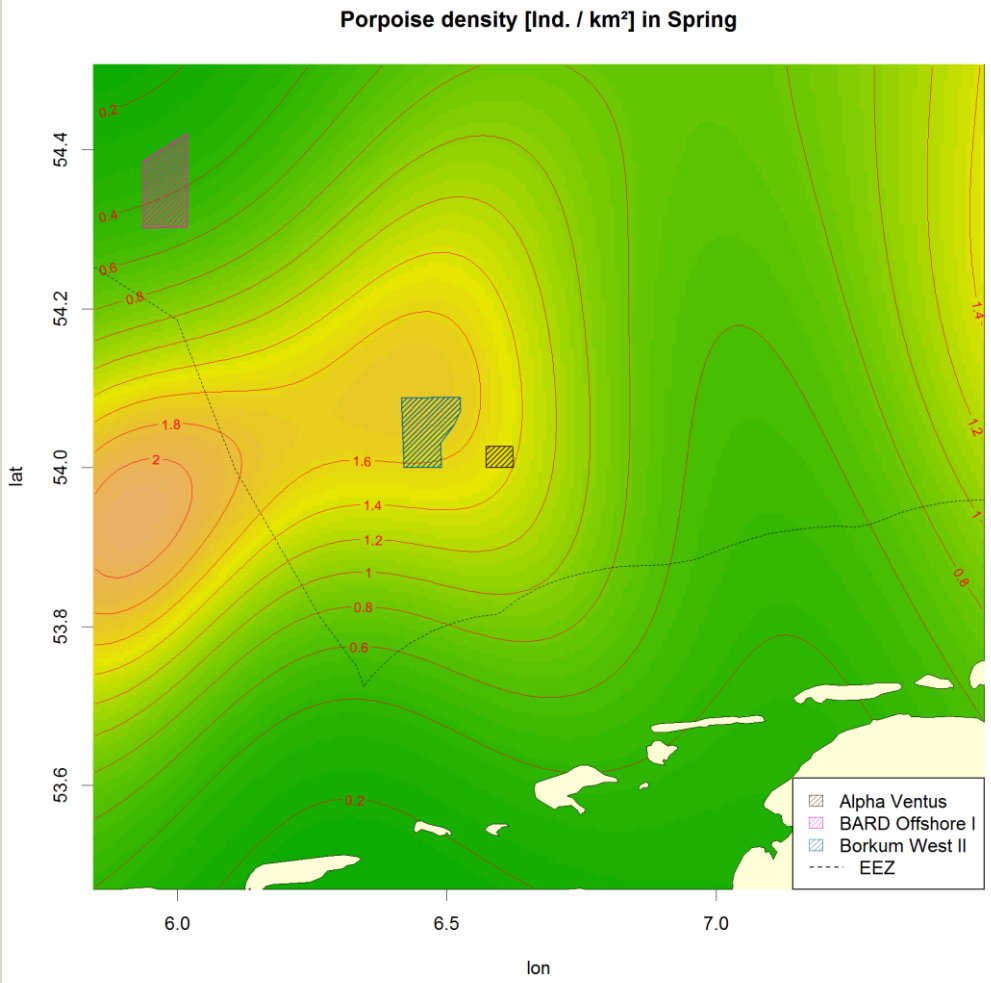
Aerial surveys

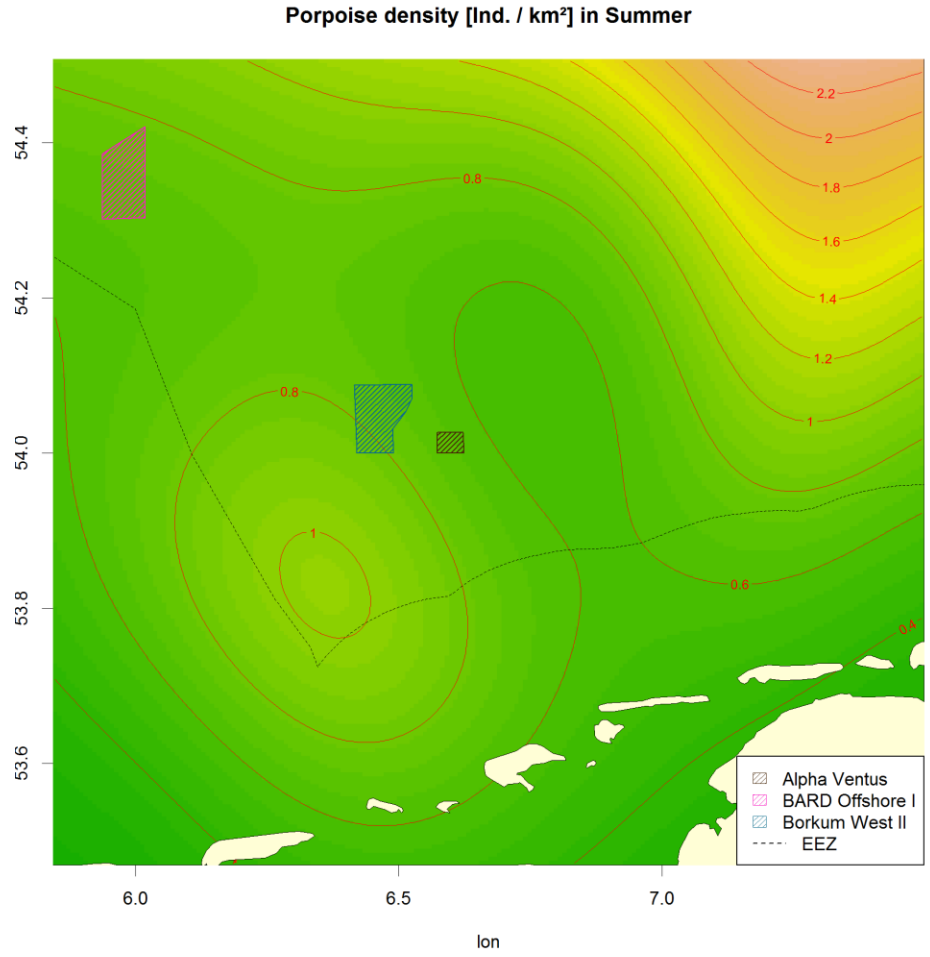
Aug. 2008 to Oct. 2012: 23,300 km effort, 1,999 sightings with 2,393 individuals (107 calves)



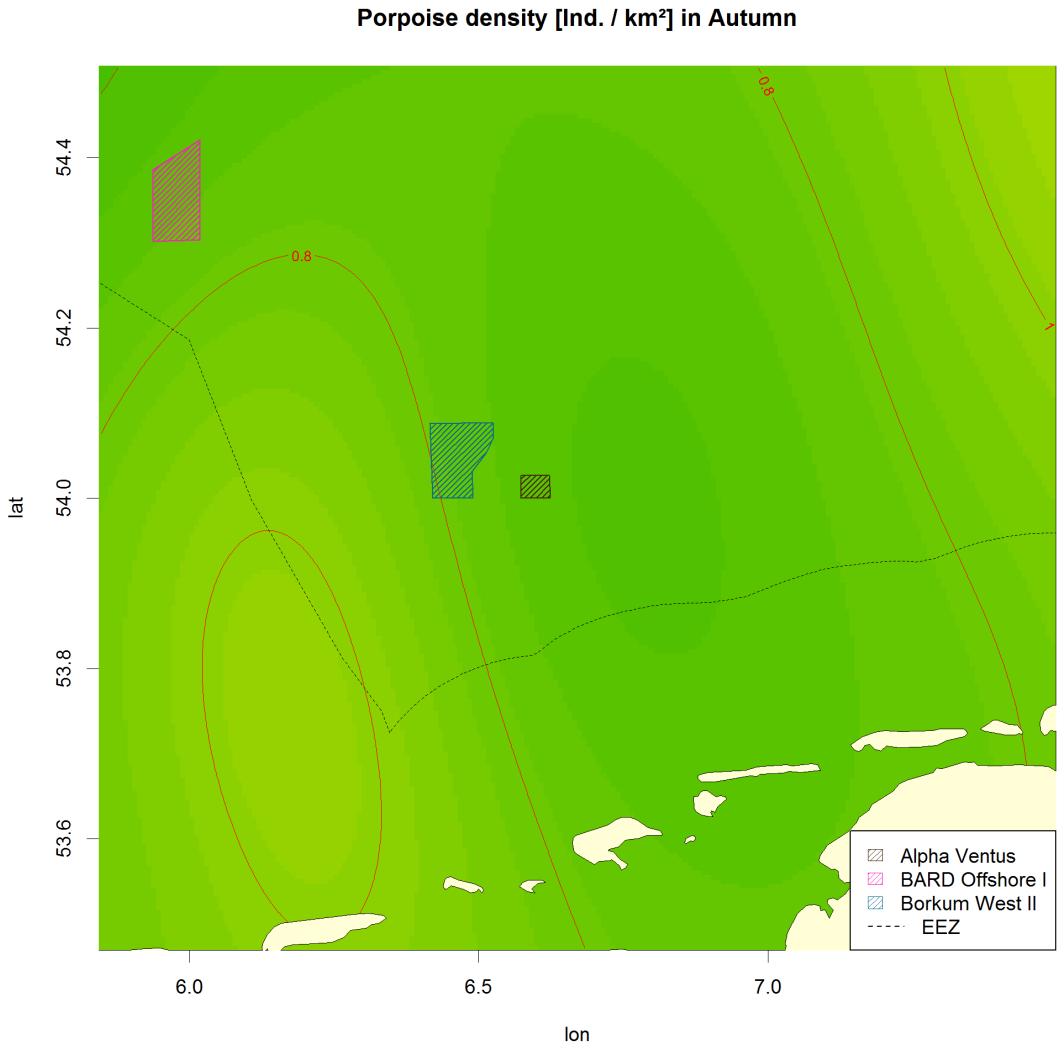
Seasonal distribution

Spatial density model GAMM: lat, lon, dist. to coast, water depth; random „survey ID“





Seasonal distribution



Possible effects of the operation period on marine mammals

Noise effects

- Turbines produce low frequency tonal sounds, however:
  - Sounds are of low energy and are perceivable for seals over larger distances, but not for porpoises
  - Displacement or attraction?
- Increased shipping for maintenance

Artificial reef effect (alteration of habitat)

- Hard substrates will be introduced
- Species composition and biomass may change

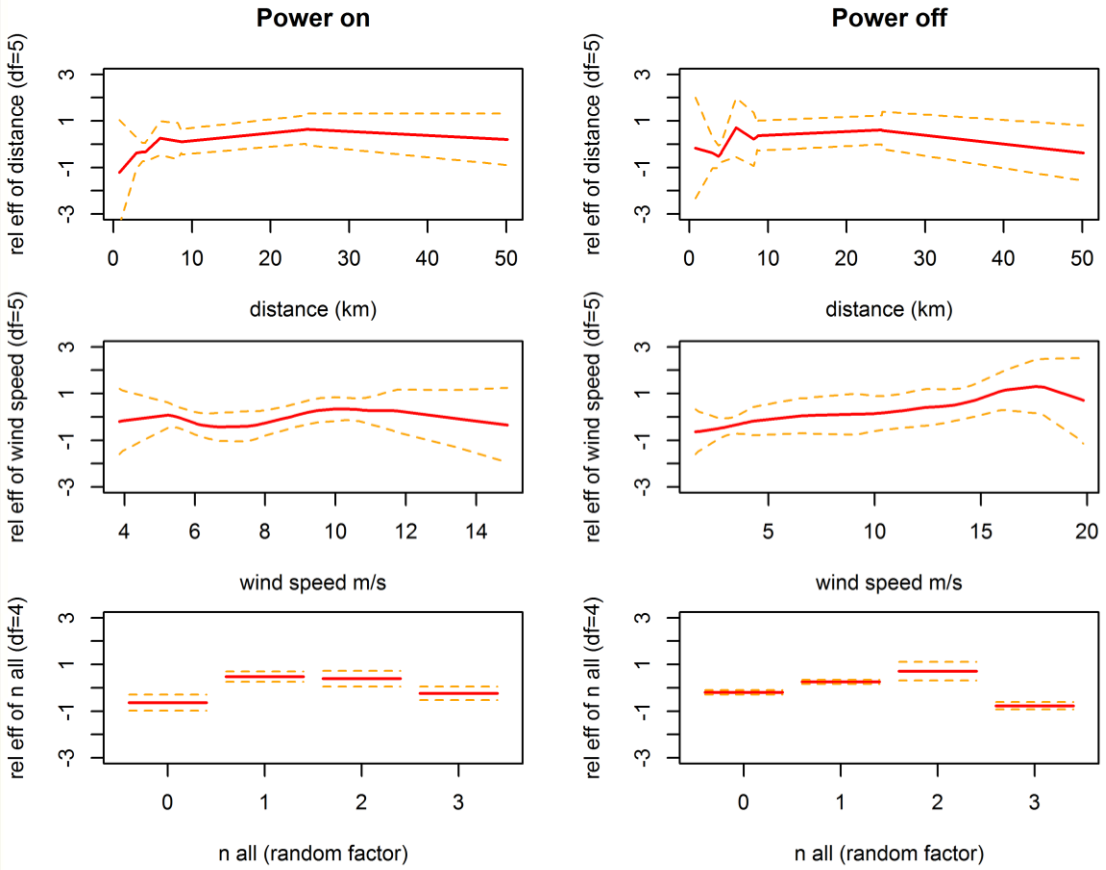
Effect of sheltered area

- No fishing effort/sanctuary areas*

* Risk: increased fishing pressure outside OWF, eventually spill over effect?

Effects of operational noise at *alpha ventus* on harbour porpoises

Approach: GAMLSS



Dph (2011) ~

s(distance to closest turbine)

s(windspeed)

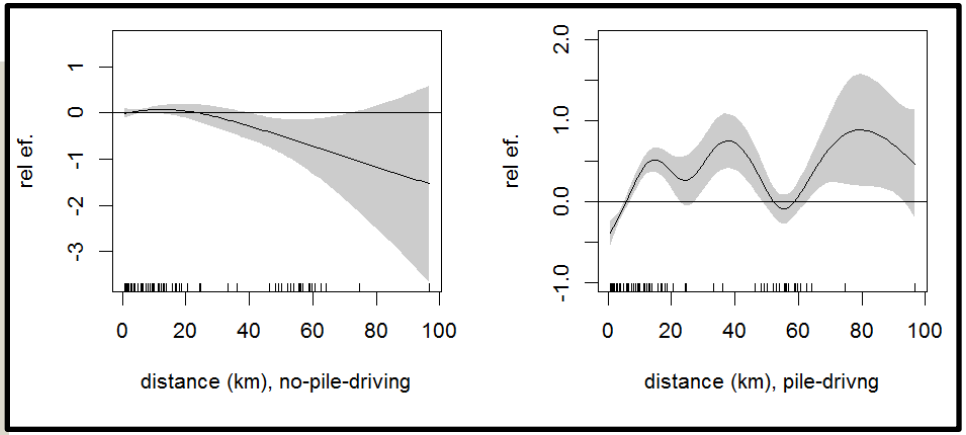
Number of all registered clicks/sound (measure for background noise)

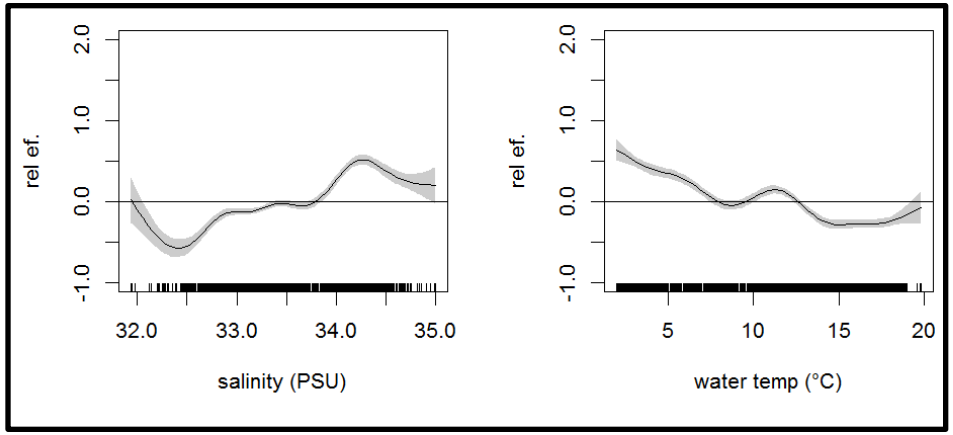
No clear displacement / approach pattern

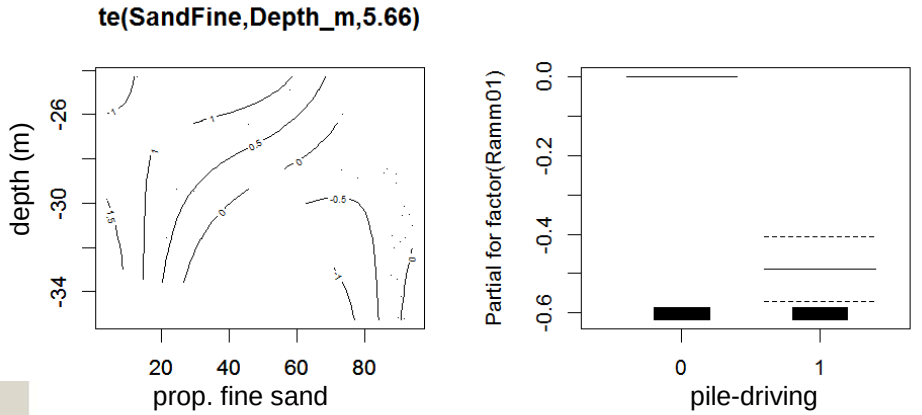
Modelling environmental influence

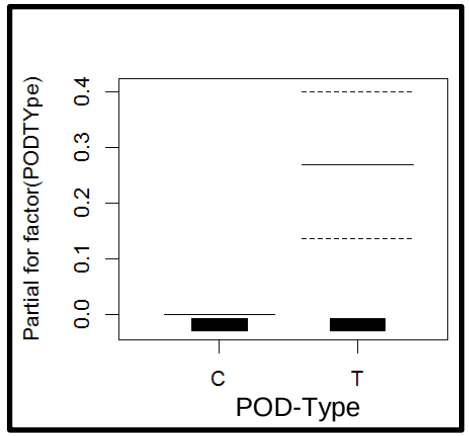
- How to monitor the entire process?
  - Construction / operation / decommissioning
  - Traditional BACI design is obsolete, “undisturbed” ref. areas?
- Approach: Generalized additive model (GAM)
- Response variable: daily statistics (dpm/d)
  - Data 2008-2012 (incl. StUK 3, BioConsult SH)
- explanatory variables: environmental data
  - Chlorophyll, salinity, water temperature, wind speed…
  - Data gaps led to exclusion
    - And pile-driving data (potential bias for operation period)
  - *alpha ventus*, BARD Offshore 1, Trianel Borkum West II

Modelling environmental influence







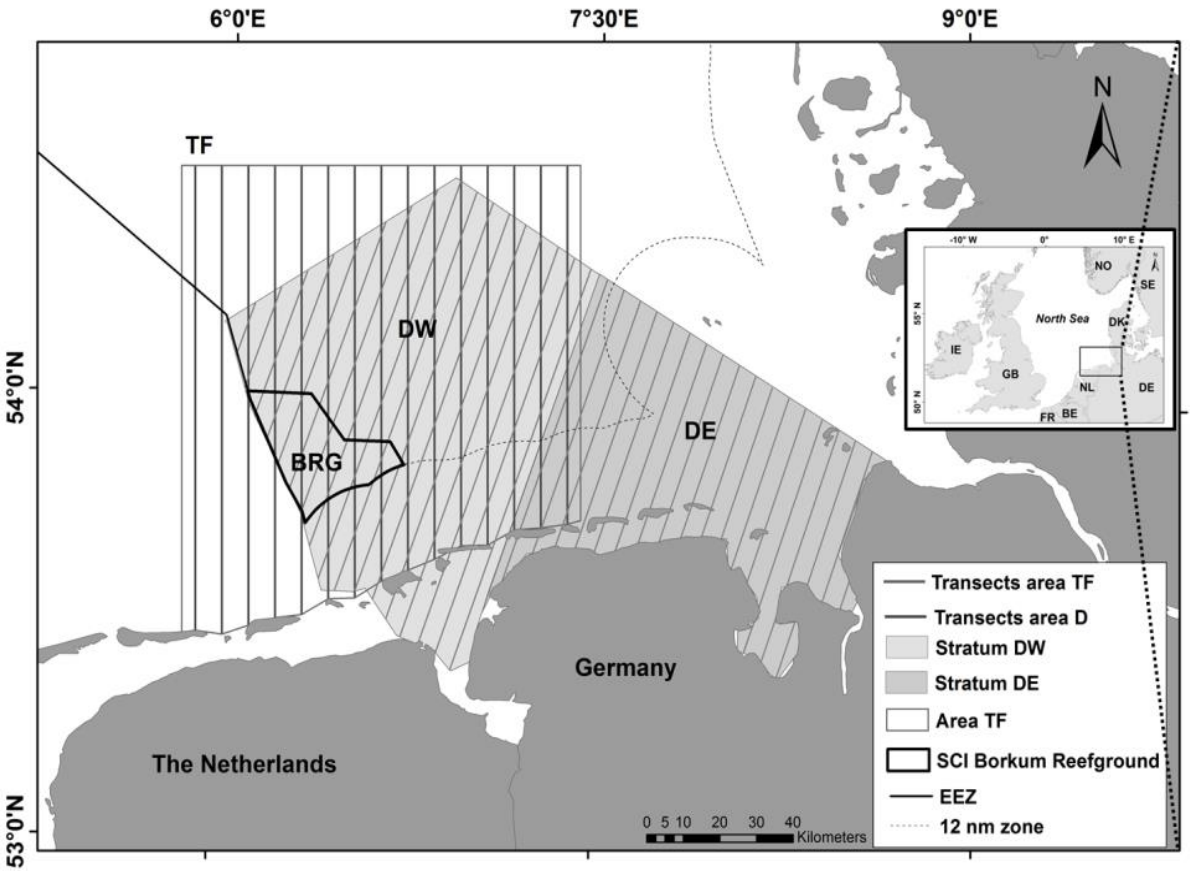


Effect of pile-driving of three construction sites on a daily unit

➔When evaluating ecological factors and the operation period, **effects of adjacent construction work** need to be considered; do not change methodology

Bayesian trend analysis - visual data I

- temporal trend analysis in porpoise occurrence over 11 years (2002-2012)
- check for spatial trend? (west – east)



Peschko et al. ***in prep.***

Bayesian trend analysis - visual data I

- temporal trend analysis in porpoise occurrence over 11 years (2002-2012)
- check for spatial trend? (west – east)

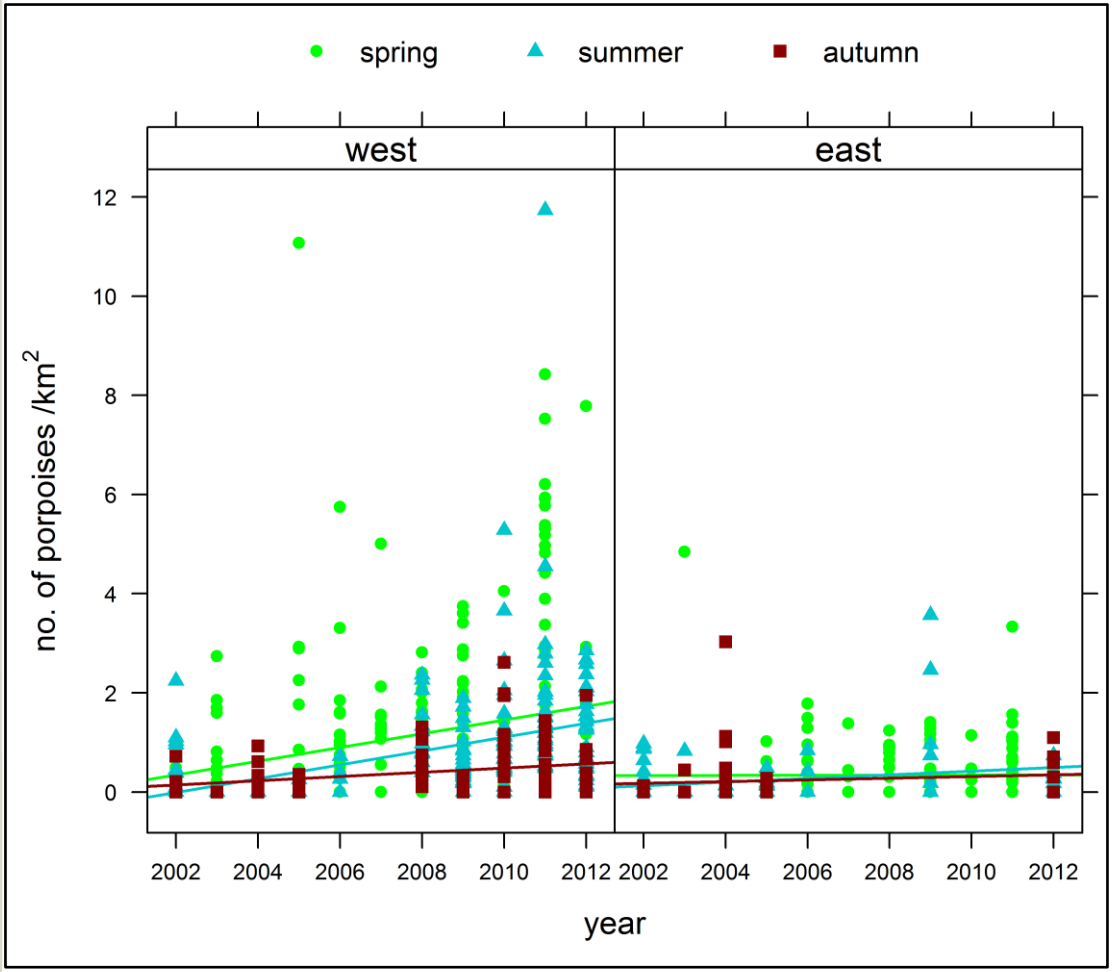
- **Bayesian framework with Monte Carlo Markov Chain (MCMC)**

  - zero-inflated mixed model (ZIP) showed poor mixing indicating no true zero-inflation but overdispersion

  ➔ MCMC generalized linear mixed models (MCMCglmm package, Hadfield 2010)

  ➔ Sampling unit: transect per survey day

Bayesian trend analysis - visual data II



- ✓ Positive trend for the entire study area between 2002 and 2012 (***year*****)
- ✓ ***Longitude*** ****** most pronounced effect with highest porpoise densities in the west
- ✓ Positive trend more pronounced in the west (***longitude:year*****)
- ✓ ***Day of the year***** => highest density in spring, successively decreasing

Peschko et al. ***in prep.***

SCANS July **1994**

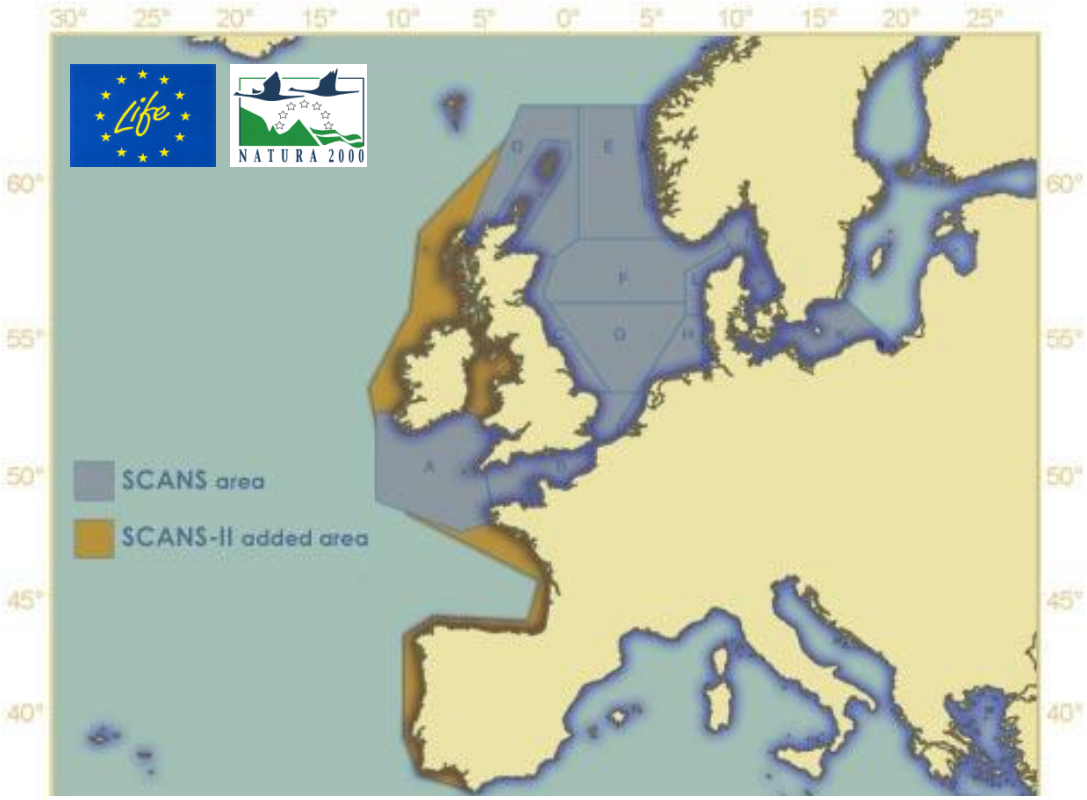
Abundance harbour porpoise: **341,366** (95% KI 260,000 - 449,000)

aerial- and ship surveys

SCANS II July **2005**

Abundance harbour porpoise: **375,358** (95% KI 261,266 - 569,153)

- ✓ no sign. difference overall estimate
- ✓ marked difference in distribution between 1994 and 2005 (north ➔ south)



Hammond et al. 2002, 2013

Summary & Conclusion

- Significant displacement of harbour porpoises during construction
- No clear displacement / approach pattern during operation period
- Effects are complex and should be monitored including all possible stressors to define the direct impact of the wind farm
- Consider construction work at adjacent developments and keep methods constant
- Strong evidence for increasing harbour porpoise abundance in the southern North Sea since 2005
- Set results into perspective with cumulative impacts
- Impact on individual animals in terms of energetic consequences? Population consequence?

Observed threats - Anthropogenic pressures

- Bycatch
- Acoustic & physical disturbance
- Diseases
- Prey depletion
- (Climate change)

References

Brandt, M., Diederichs, A., Betke, K., Nehls, G. (2011) Responses of harbour porpoises to pile-driving at the Horns Rev II offshore wind farm in the Danish North Sea. Marine Ecology Progress Series 421: 205-216

Carstensen, J., Henriksen, O.D., Teilmann, J., Pen, O. (2006) Impacts of offshore wind farm construction on harbour porpoises: acoustic monitoring of echolocation activity using porpoise detectors (TPODs). Marine Ecology Progress Series 321: 295-308

Dähne, M., Gilles, A., Lucke, K., Peschko, V., Adler, S., Krügel, K., Siebert, U. (2013) Effects of pile-driving on harbour porpoises (*Phocoena phocoena*) at the first offshore wind farm in Germany. Environmental Research Letters *8*(2): 025002. doi:10.1088/1748-9326/8/2/025002

Hadfield, J.D. (2010) MCMC methods for Multi-response Generalised Linear Mixed Models: The MCMCglmm R package. Journal of Statistical Software 33: 1-22

Hammond, P.S., Berggren, P., Benke, H., Borchers, D.L., Collet, A., Heide-Jørgensen, M.P., Heimlich, S., Hiby, A.R., Leopold, M.F., Øien, N. (2002) Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology 39: 361-376

Hammond, P.S., Macleod,K., Berggren, P., Borchers, D.L. Burt, L., Canadas, Desportes, G., Donovan, G.P., Gilles, A., Gillespie, D., Gordon, J., Hiby, L., Kuklik, I., Leaper, R., Lehnert, K., Leopold, M., Lovell, P., Øien, Paxton, C.G.M., Ridoux, V., Rogan, E., Samarra, F., Scheidat, M., Sequeira, M., Siebert, U., Skov, H., Swift, R., Tasker, M., Teilmann, J., van Canneyt, O., Vázques, J.A. (2013) Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. Biological Conservation 164: 107-122

Scheidat, M., Tougaard, J., Brasseur, S., Carstensen, J., van Polanen Petel, T., Teilmann, J., Reijnders, P. (2011) Harbour porpoises (*Phocoena phocoena*) and wind farms: a case study in the Dutch North Sea. Environ. Res. Lett. 6: 025102. doi:10.1088/1748-9326/6/2/025102

Teilmann, J., Carstensen, J. (2012) Negative long term effects on harbour porpoises from a large scale offshore wind farm in the Baltic-evidence of slow recovery. Environmental Research Letters *7*(4): 045101. doi:10.1088/1748-9326/7/4/045101

Tougaard, J., Carstensen, J., Teilmann, J., Skov, H., Rasmussen, P. (2009) Pile driving zone of responsiveness extends beyond 20 km for harbor porpoises (*Phocoena phocoena*). Journal Acoustical Society of America 126: 11-14

Acknowledgements

Aerial surveys: Sabine Billerbeck, Helena Herr, Tina Kesselring, Linn Lehnert, Danny Martensen-Staginnus, Sebastian Müller, Carsten Rocholl, Conny Schmidt. Sylt Air and unforgotten Leif

Acoustic Monitoring: Klaus Lucke, Janne Sundermeyer, Anja Brandecker, Kathrin Krügel, Anne Hermann,, crews of the KfK Venus, MV Laura, MV Christopher, MV Karoline, MV Cecilie, MV Blue Capella and the water and shipping authorities

StUK3 data: Bioconsult SH

Bundesamt für Seeschifffahrt und Hydrographie & Projektträger Jülich for coordination and administration

Gefördert durch:
Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
aufgrund eines Beschlusses des Deutschen Bundestages

Projektträger Jülich
Forschungszentrum Jülich

BSH
BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Thank you for your attention!