

The DEPONS project – Disturbance Effects on the Harbour Porpoise Population in the North Sea

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Introduction | Fine-scale movement | Dispersal | Energetics | Response to noise | Results and perspectives

Modelling cumulative effects of human pressures

- Harbour porpoise (*Phocoena phocoena*) populations are influenced multiple types of anthropogenic disturbances, bycatch etc.
- Objective of DEPONS: develop data-driven model for assessing population effects of wind-farm construction.

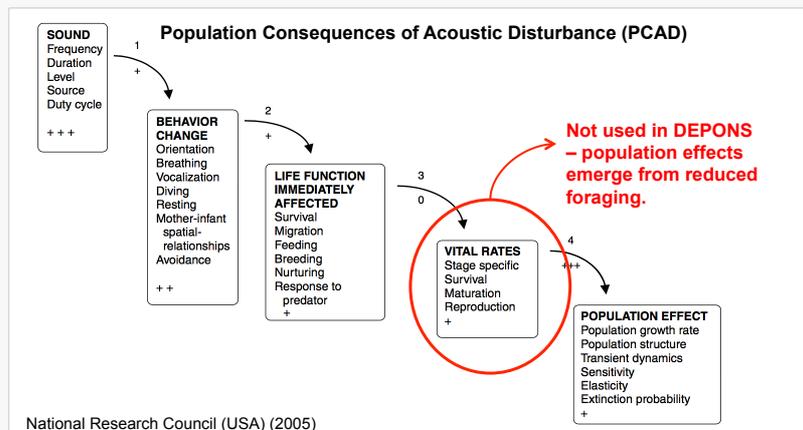


Structure of the DEPONS model

- The DEPONS model is agent-based: simulates movements, birth and death of individual animals.
- The population carrying capacity emerges from competition for a dynamic food resource.
- Noise causes animals to forage less efficiently.
- Data on movement, reactions to noise and food distribution were collected as part of the DEPONS project.

Structure of the DEPONS model

- Mechanisms in DEPONS resemble those in PCAD, but model structure is different.



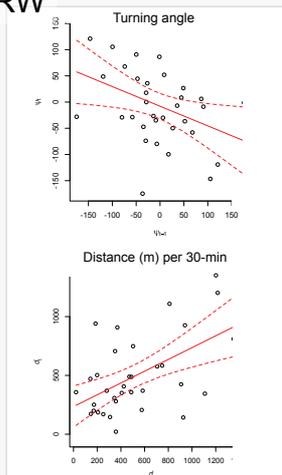
Collection of movement data

- Natural movements were recorded using satellite tags, FastLoc GPS tags and dead reckoning.
- Porpoises were entrapped in pound nets along the coasts of Denmark and caught actively by Rømø in the Wadden Sea.

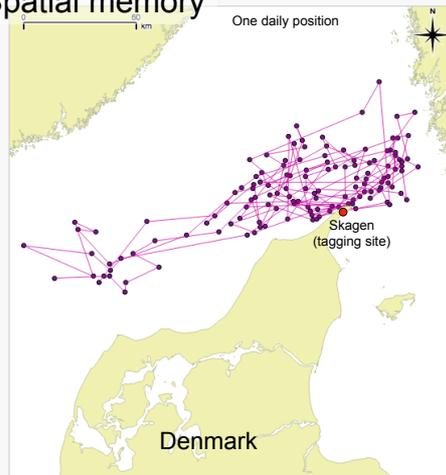


Observed fine-scale movements

CRW

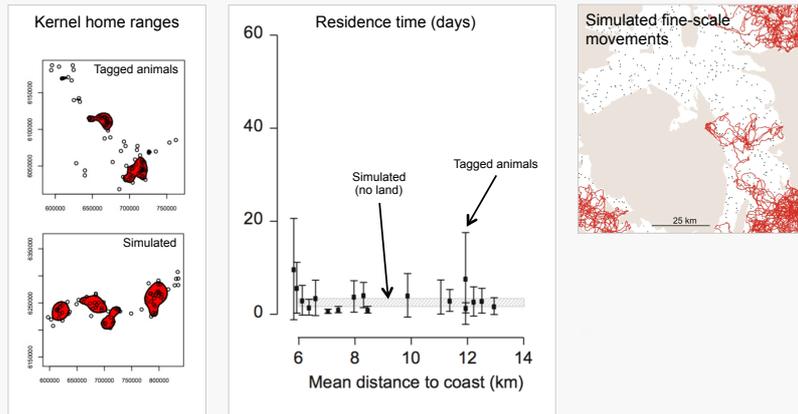


Spatial memory



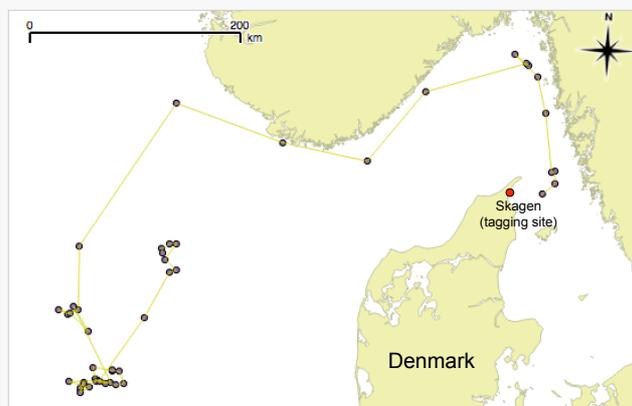
Modelling fine-scale movements

- Satiation memory and spatial memory decay calibrated to obtain realistic fine-scale movements.



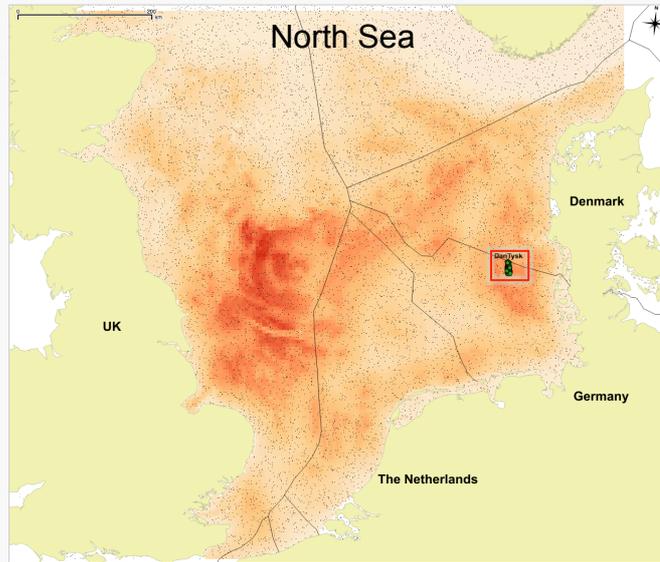
Modelling large-scale movements

- Dispersal: move towards the most profitable area ever visited. Random turns after each dispersal step.
- Calibrated to yield realistic home range sizes.



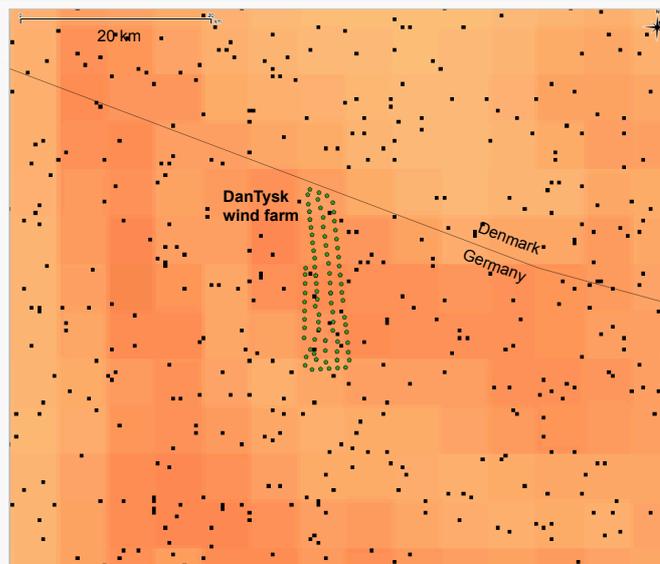
Modelling food distribution

- Food availability based on porpoise survey data.



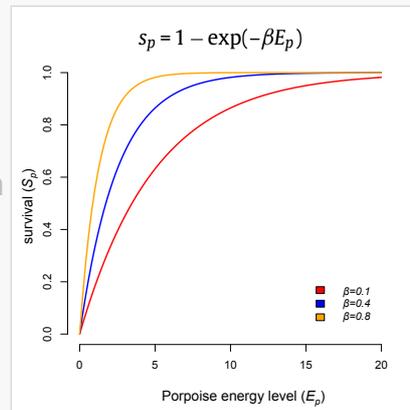
Modelling food distribution

- Food in patches.
- Food recovers after being depleted by a porpoise.



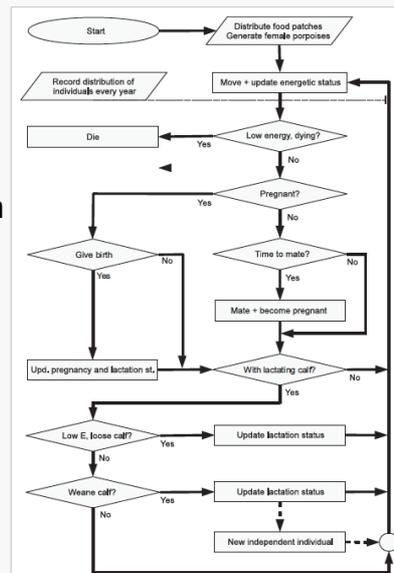
Modelling energetics and life history

- Porpoises use energy when moving; decreased survival.
- Porpoises obtain energy from patches they encounter.
- Life history traits (birth, lactation etc.) included.



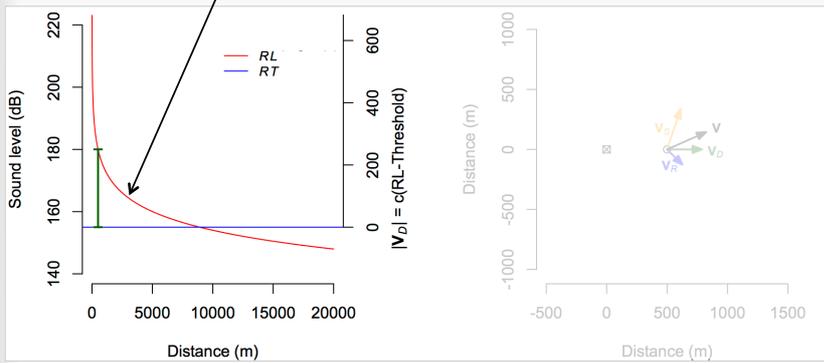
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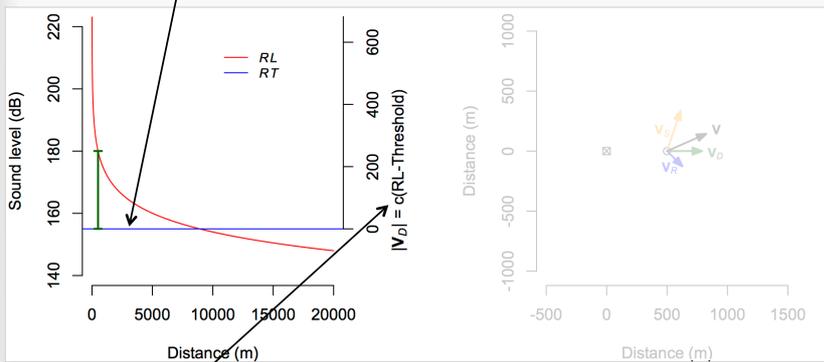
Modelling behavioural response to noise

Sound level, assuming spherical spreading



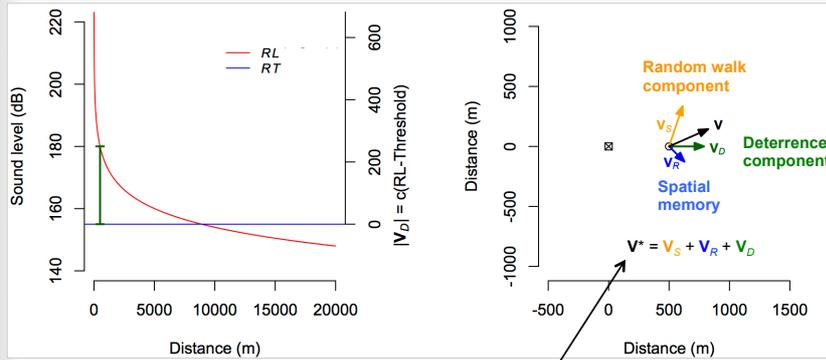
Modelling behavioural response to noise

RT = Threshold for when porpoises start responding to noise.



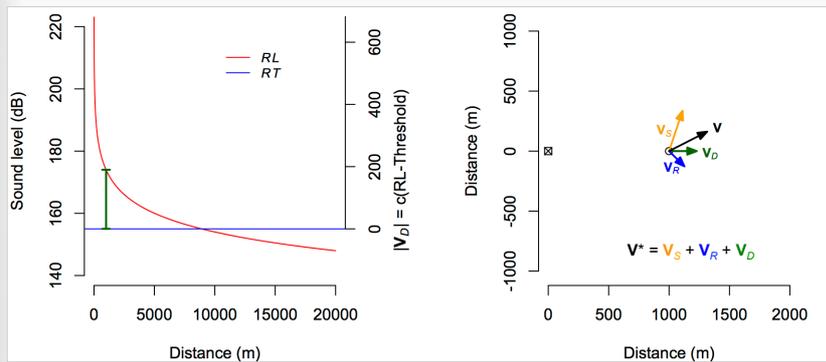
c = Deterrence coefficient, determines strength of deterrence

Modelling behavioural response to noise

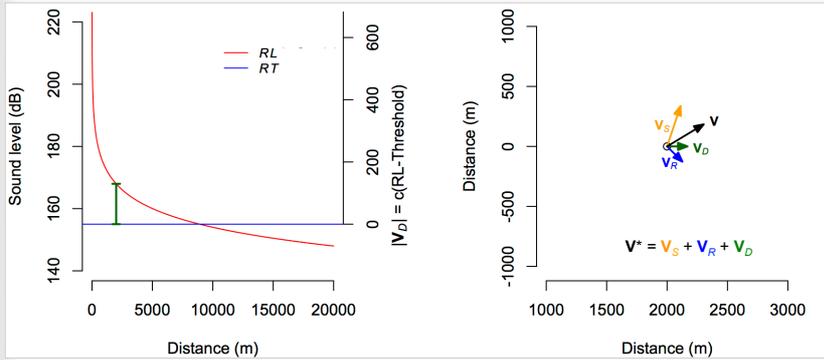


V^* = move for animals that are exposed to noise

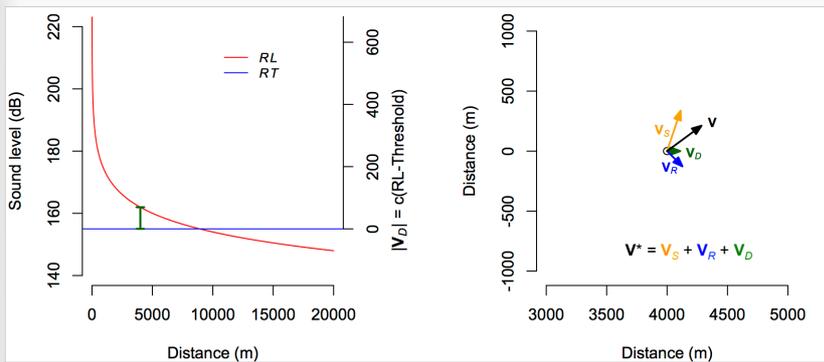
Modelling behavioural response to noise



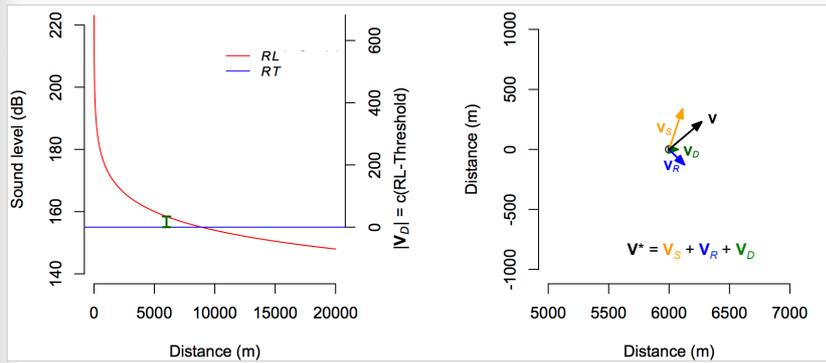
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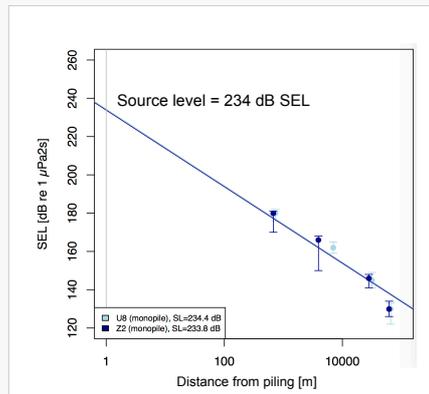
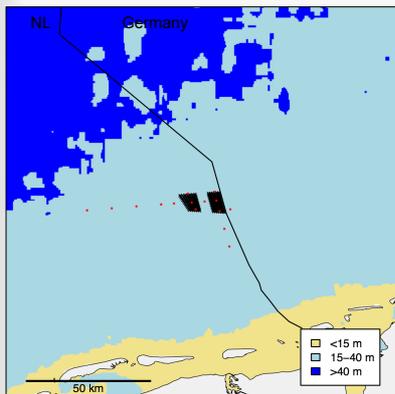


Modelling behavioural response to noise

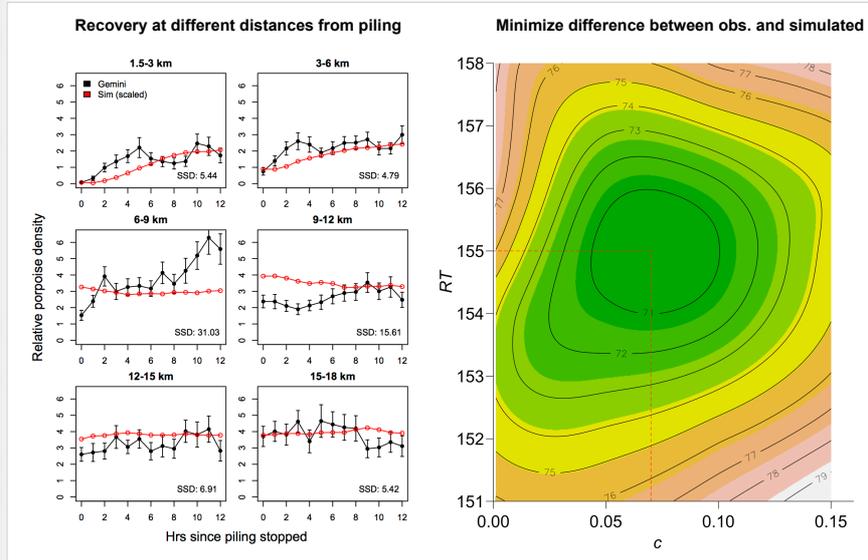


Calibrating response to noise

- Data on porpoise densities collected during construction of the Gemini wind farm.

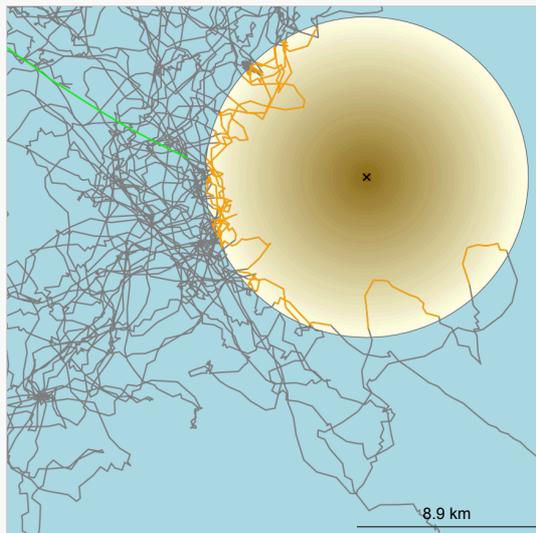


Calibrating response to noise



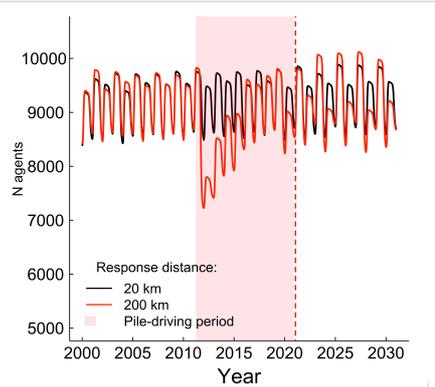
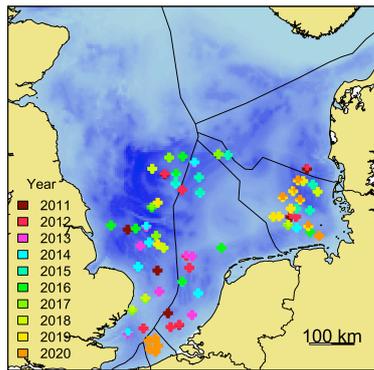
Movement by pile-driving

- Simulated response to continuous pile driving.



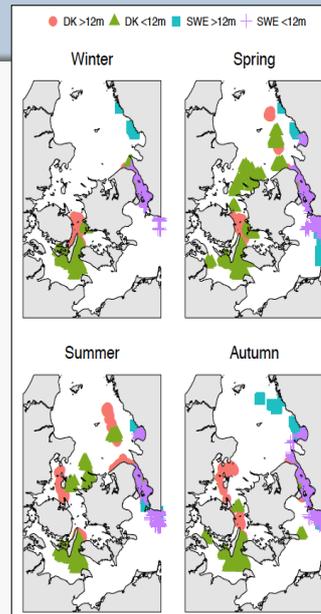
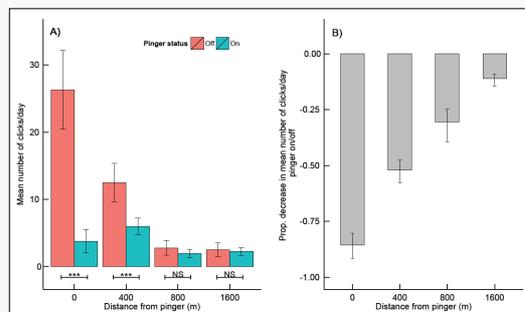
Importance of spatial distribution of noise

- Scenario based on EU 2020 target: 3900 turbines (23 GW); randomly distributed at 15–40m depth.



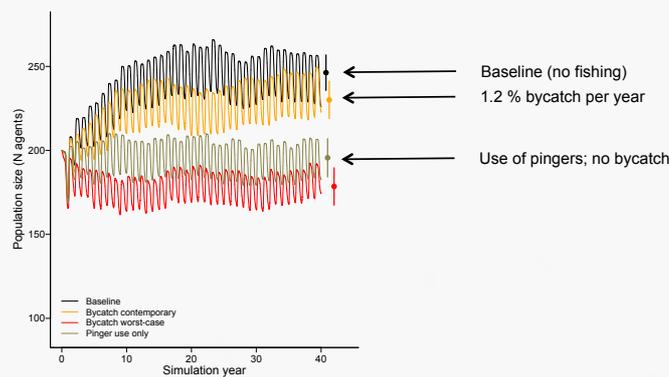
Impacts of bycatch and pingers

- Spatially explicit simulation of gillnet fisheries in inner Danish waters.
- Use of pingers to prevent bycatch in gillnets.



Impacts of bycatch and pingers

- Negative population impacts of mitigating bycatch with pingers exceed those of bycatch.
- Combination of closed areas and pingers worked.



Conclusions and perspectives

- The DEPONS model is data driven; animal movements and response to noise are as observed in nature. Population effects emerge from the same principles as in nature.
- The model is spatially explicit; effects of disturbances vary among areas and depend on disturbance history etc.
- The model is free, open source, easy to use and can be extended to assess cumulative impacts of various kinds of anthropogenic disturbances, bycatch etc.

References

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