IMPLEMENTATION OF SCIENCE INTO MANAGEMENT TOOLS

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TNO innovation for life

OUTLINE

- Background on Dutch approach managing risk of sonar operation
  - SAKAMATA: Operational tool used by the Royal Netherland Navy (RNLN)
  - How are CEE results currently used by RNLN?

- Challenges with implementing science into management tools
  - What is validity of sonar sound exposure models?
  - How to accumulate and assess consequences of behavioural disturbance?

CURRENT APPROACH BY RNLN

- Assess risk of sonar operation during 2 stages:
  - planning stage: Include environmental risk in planning of tests/exercises when possible to choose between different areas/seasons.
  - on-board: Adapt ramp-up procedure and sonar settings to current environment if needed and when possible.

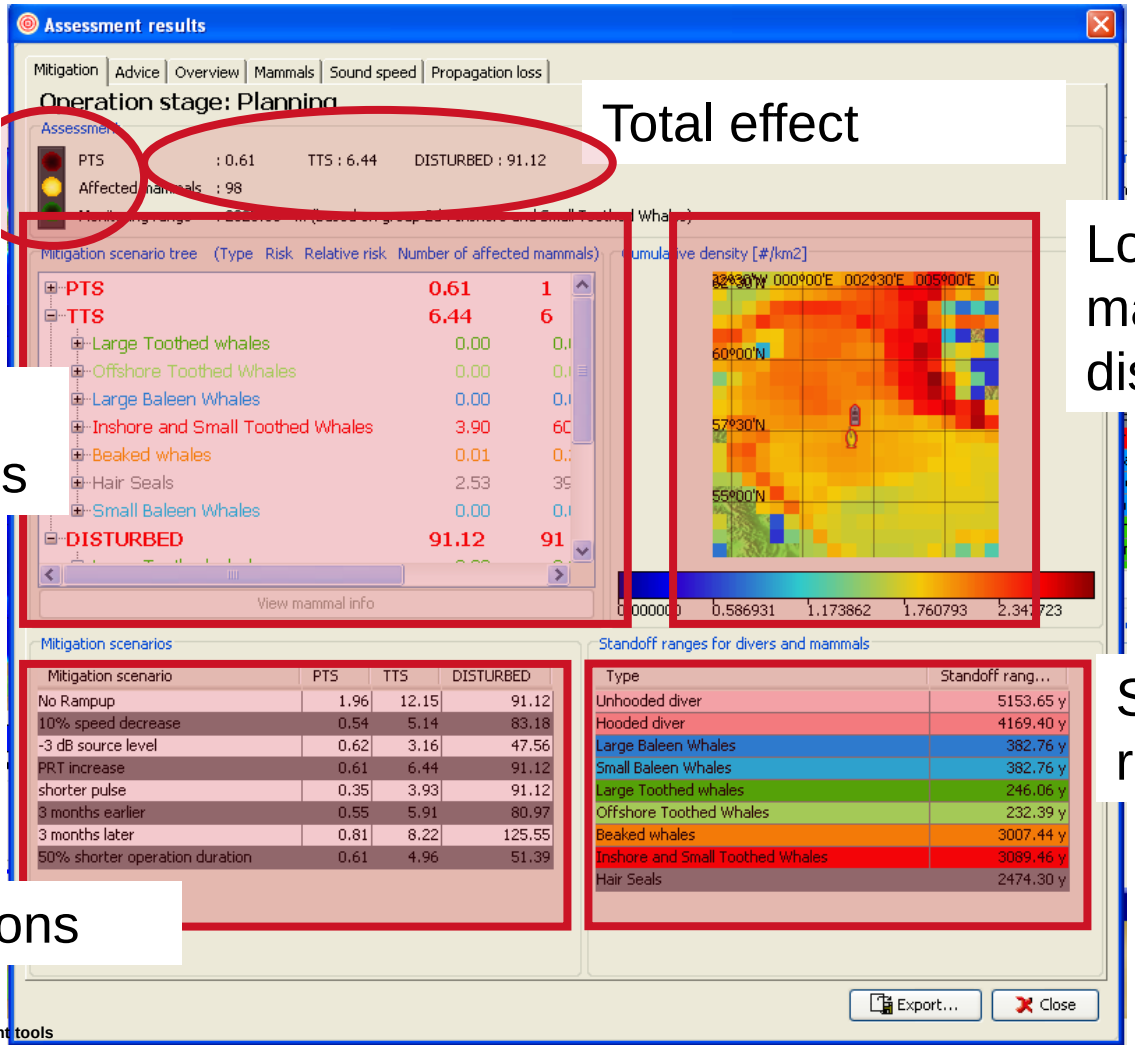
- Used on case-by-case basis
  - does not look yet at cumulative risk of multiple sonar/ multiple days operations

AN EXAMPLE (SAKAMATA – OUTPUT SCREEN)

Traffic light (RNLN Policy)

Breakdown of impact by species

Mitigation options



Total effect

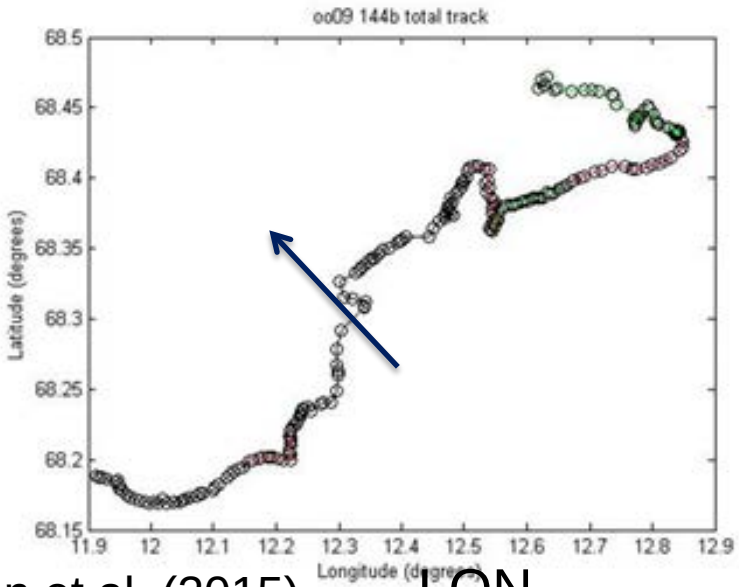
Local marine mammal distribution

Stand-off ranges

EFFECT OF SONAR EXPOSURE ON ANIMAL BEHAVIOUR

EFFECT OF ANIMAL BEHAVIOUR ON SONAR EXPOSURE (RISK OF PTS/TTS)

EFFECT OF ANIMAL RESPONSE ON SEL

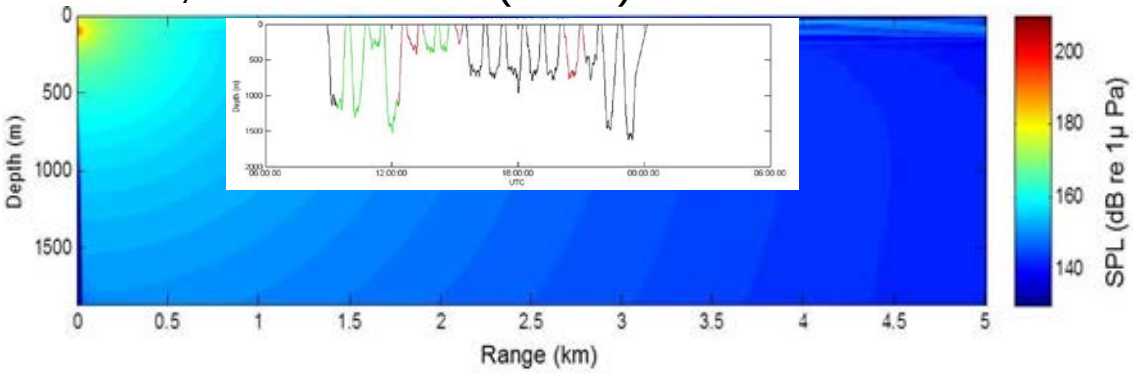


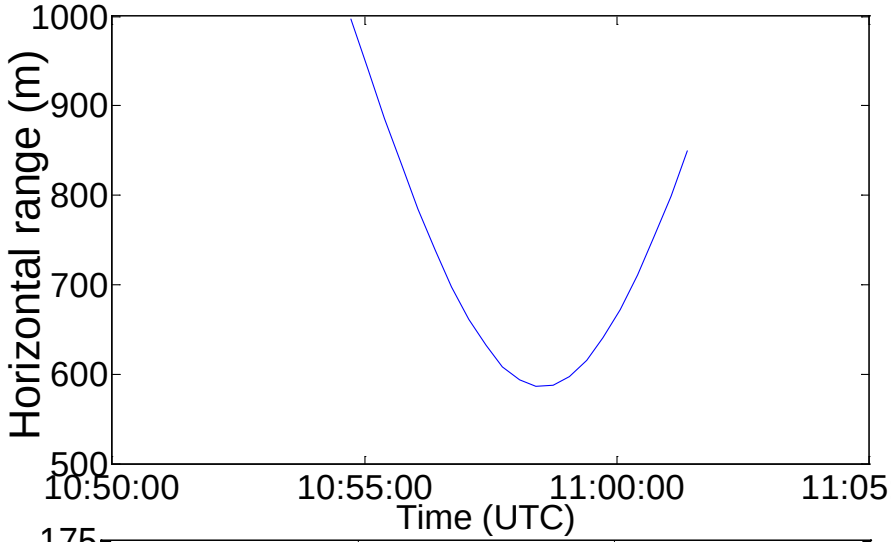
LAT

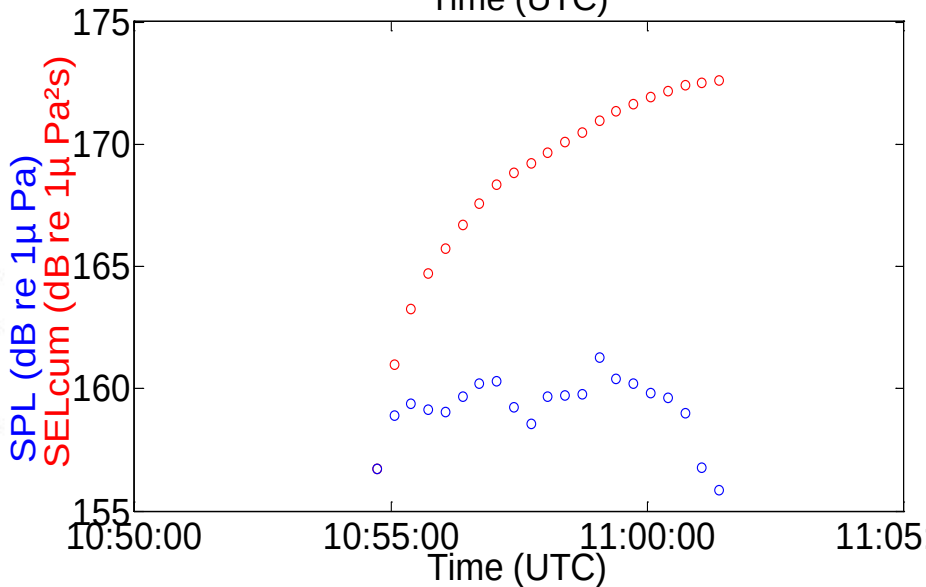
LON

Wensveen et al. (2015)

Dreteler, M.Sc. Thesis (2015)



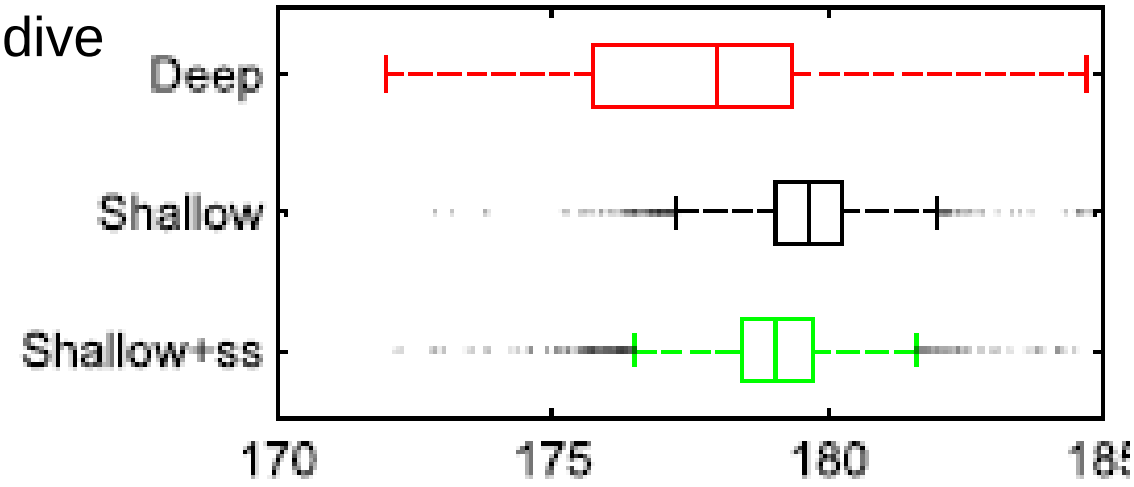




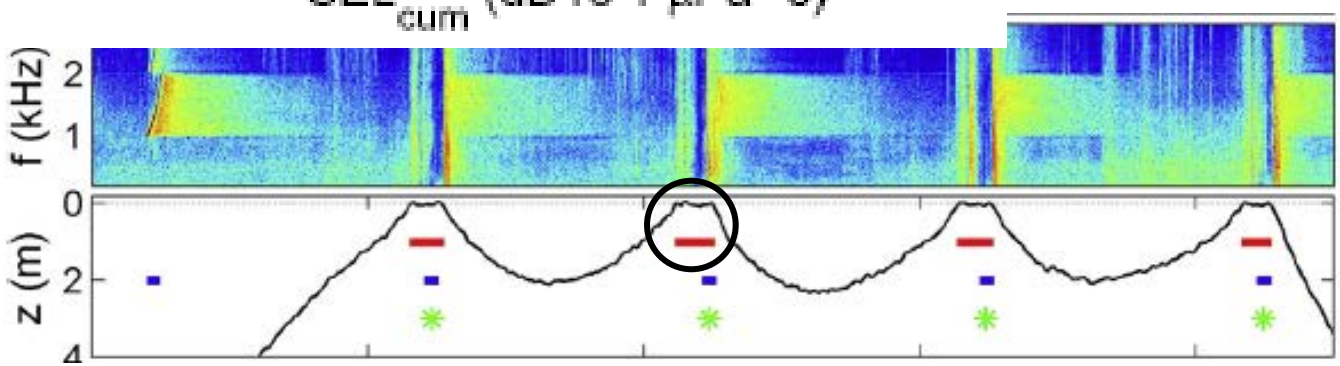
EFFECT OF VERTICAL RESPONSE TO SONAR EXPOSURE

Wensveen et al. (2015)

Deep dive -> shallow dive
Increases SEL



Synchronous surfacing
by pilot whales
with arrival sonar sound
-> vertical avoidance?



EFFECT OF HORIZONTAL RESPONSE TO SONAR EXPOSURE

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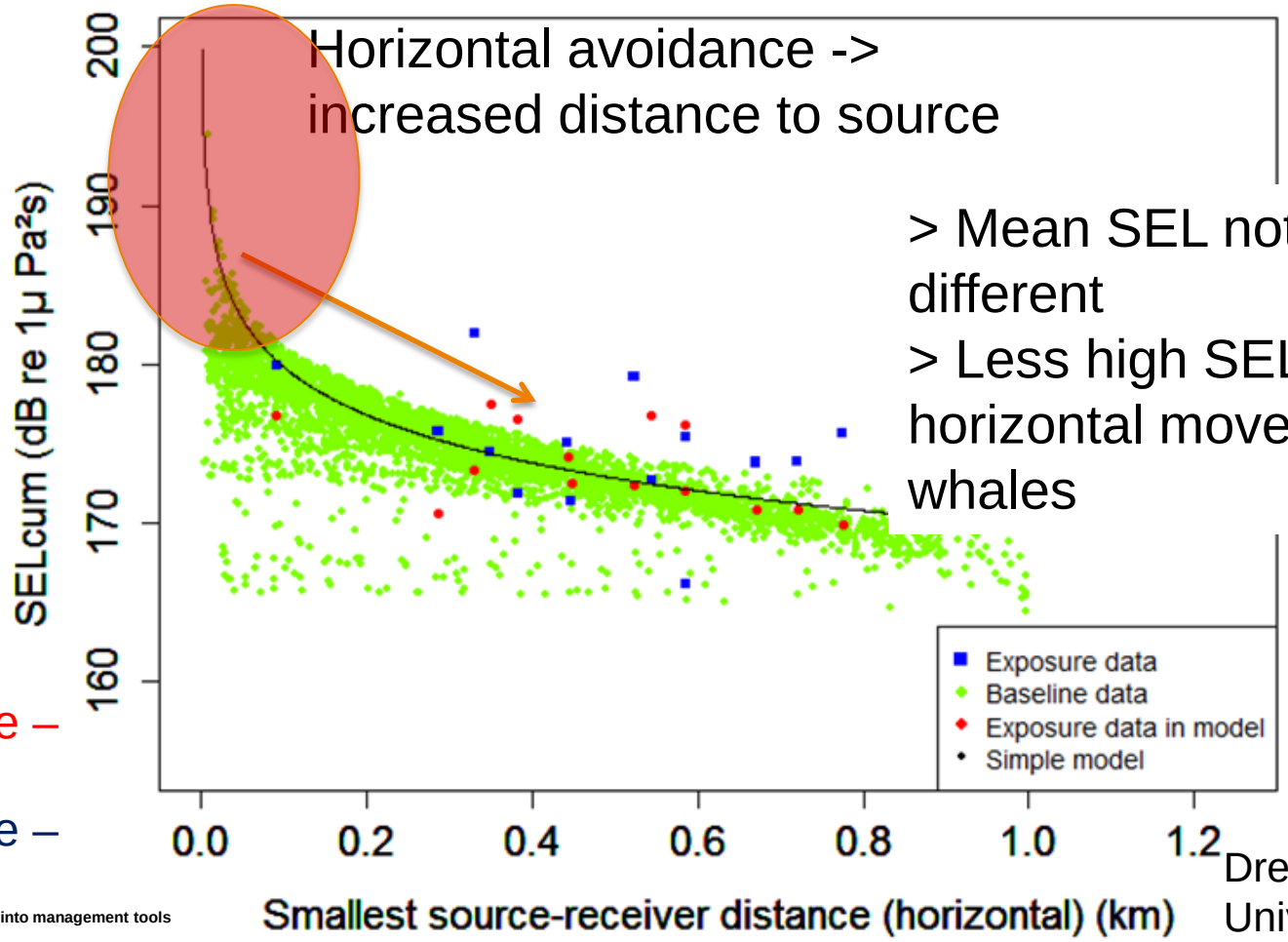


> Mean SEL not significantly different
> Less high SEL outliers due to horizontal movement for killer whales

Undisturbed-modeled

With response – Modeled

With response – DTAG

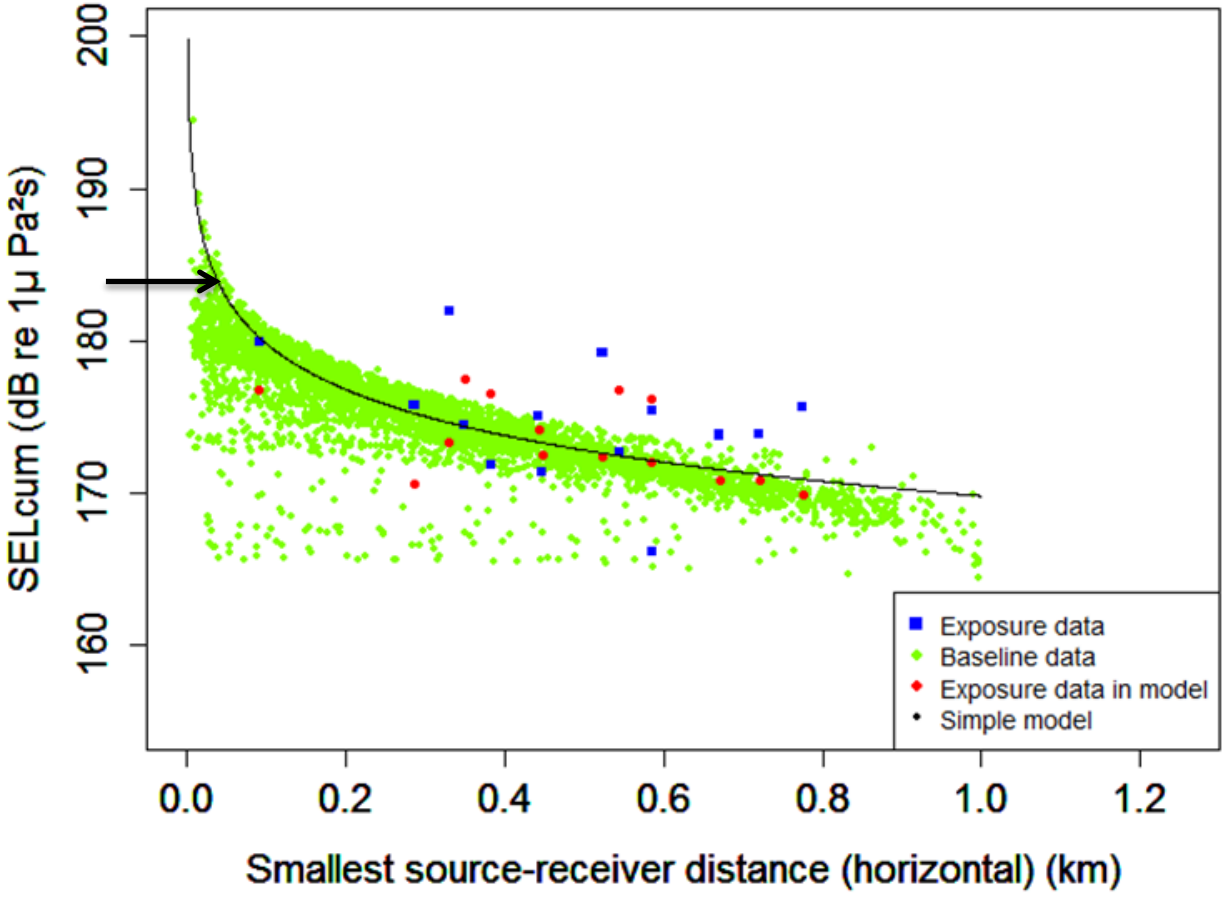
Dreteler, M.Sc. Thesis, University of Leiden (2015)

OUTLOOK – VALIDATING EXPOSURE MODELS

How would animal movement models predict these scenario's? (e.g. SAKAMATA, SAFESIMM, 3BM)

Simple exposure model: (Sivle et al. 2014)
Stationary receiver,
Source moving at constant speed

Dreteler, M.Sc. Thesis, University of Leiden (2015)

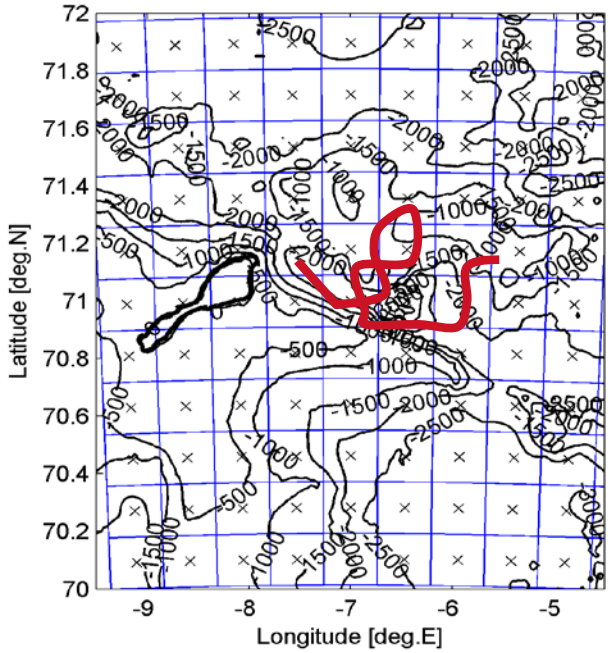


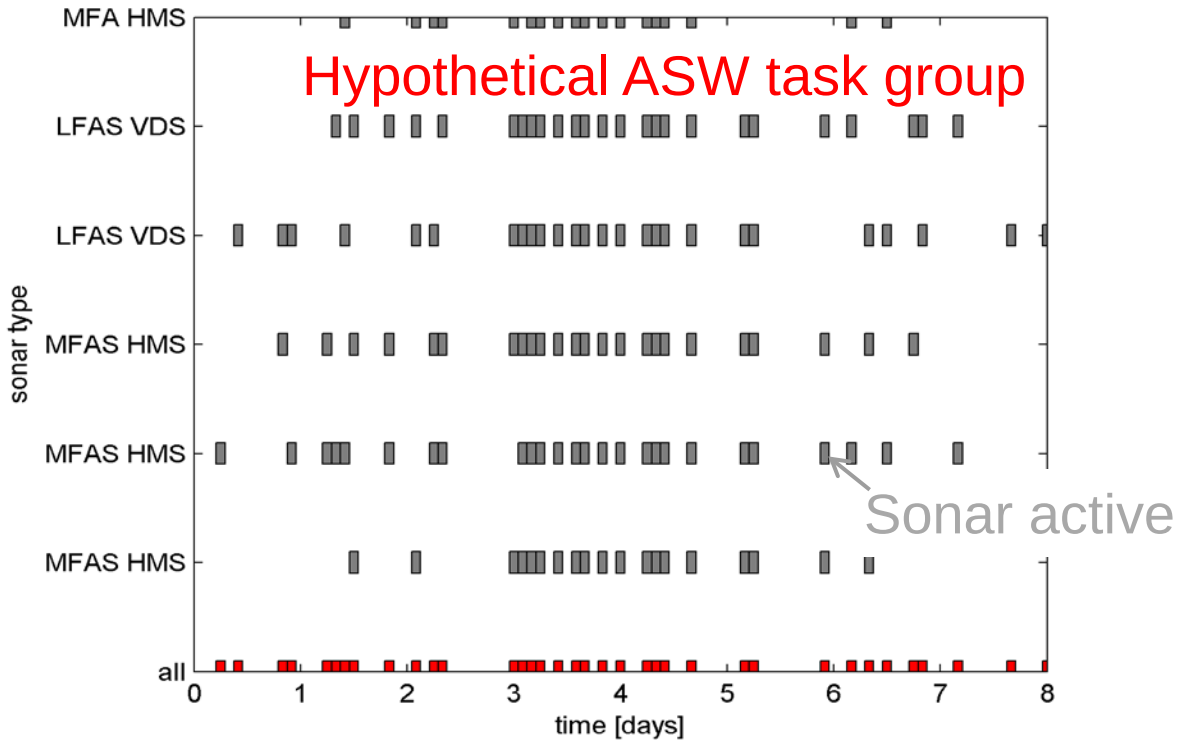
CHALLENGES (2) - DISTURBANCE

- Dose-response relationships SPL-based: but we know context is important.
- Most of the responses are sub-lethal, but significant effects could occur when they accumulate over time.
- Disturbance due to sonar may accumulate with other sound sources
- PCoD models not yet mature
- Unknown what level of behavioural disturbance is ‘acceptable’

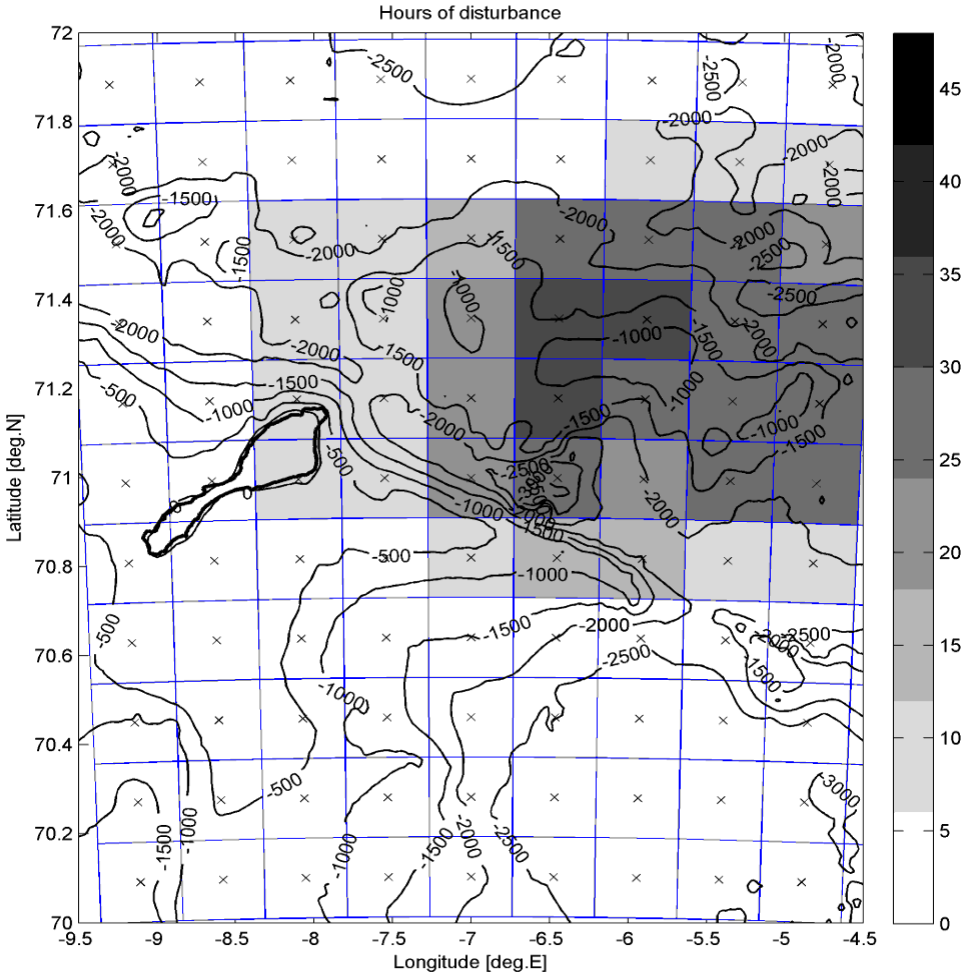
DISTURBANCE MAPS – HOW MUCH AND WHERE?

- Disturbance map : geographical representation of the duration of the disturbance





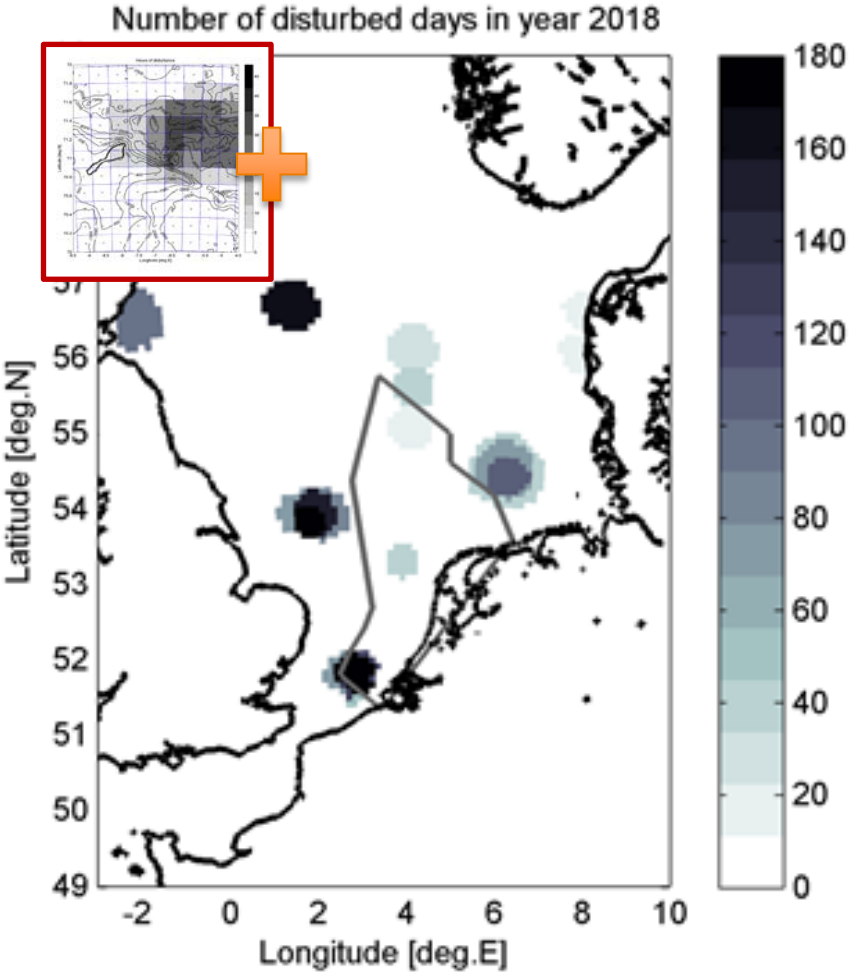
DISTURBANCE MAP OF A SIMULATED SONAR EXERCISE



- Hours of disturbance (SPL > 140 dB re 1µPa^2)
- Per area -> not per animal!
- Indicator of ‘habitat loss’
  - Compare to important areas (e.g. feeding, breeding areas)

ACCUMULATION OF DISTURBANCE DUE TO MULTIPLE SOUND SOURCES

- Accumulation of disturbance due to pile driving and seismic surveys in North Sea
  - Study by NL working group underwater noise (Heinis & de Jong, 2015)
- Include footprint of sonar to assess Good Environmental Status (GES) under MSFD?

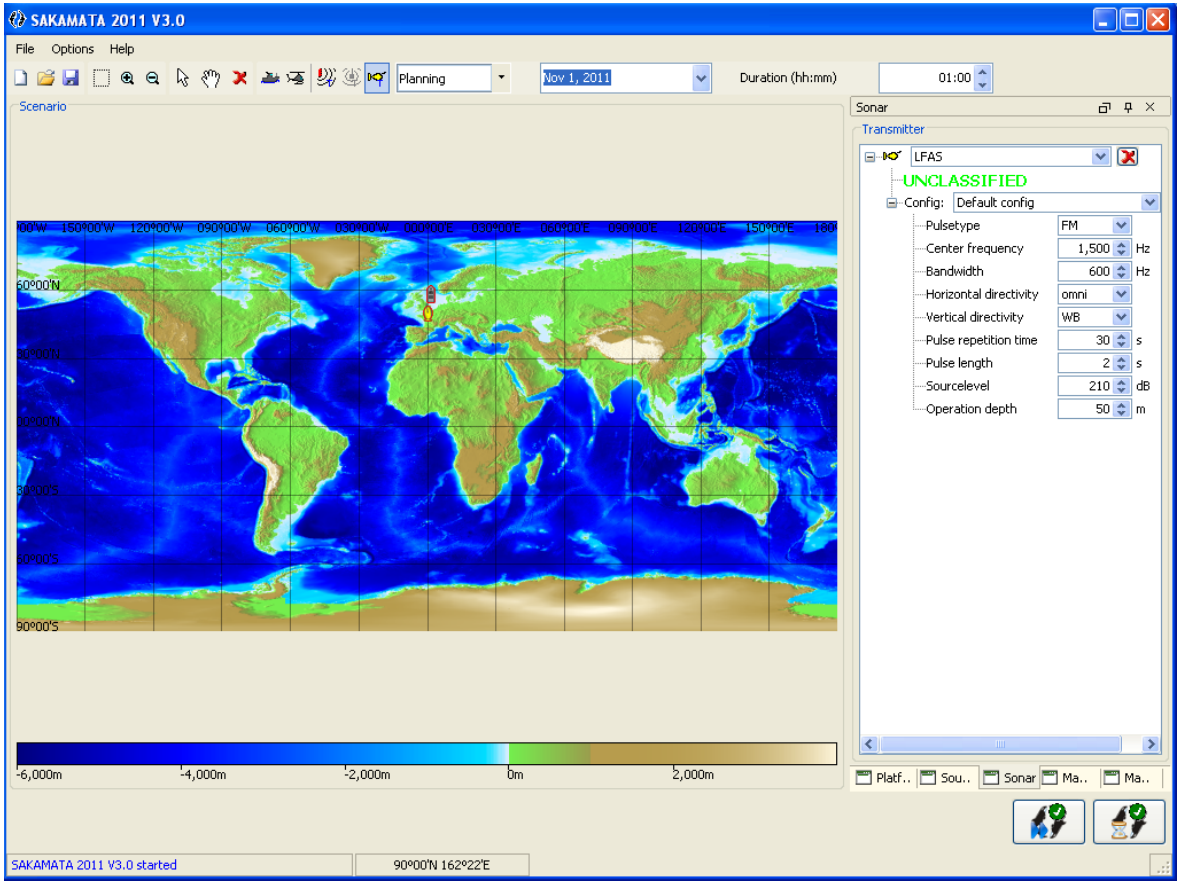


CONCLUSION

- Observations from BRS/CEE studies used to improve realism of exposure models
- Difficult to manage risk of behavioural disturbance
  - Unknown what level of disturbance is ‘acceptable’
- Use dose-response relationships to produce ‘disturbance maps’ to include duration, as well as area (/context?).
- Disturbance managed in future at regional level in EU (MSFD)?

QUESTIONS?

IMPLEMENTATION IN RISK ASSESSMENTS: AN EXAMPLE (SAKAMATA – INPUT SCREEN)



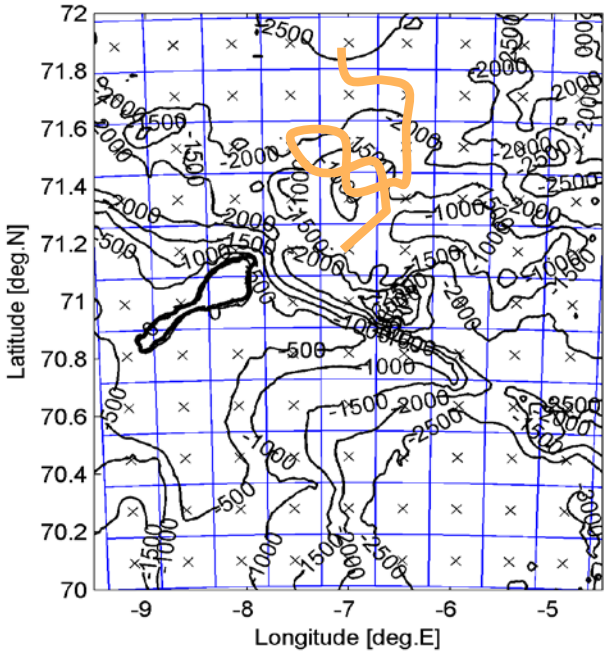
HOW ARE CEE/BRS RESULTS USED IN SAKAMATA?

- Include observed responses and dose-response relationships in exposure models to estimate risk of TTS/PTS.
  - Swim speeds, horizontal/vertical response.

- Dose-response relationships (in SPL) used for
  - Estimating number of disturbed animals.
  - Dose-response relationships for species groups based on US Navy risk functions, with exception for some species (killer whales and beaked whales)

DISTURBANCE MAPS – A THOUGHT EXPERIMENT

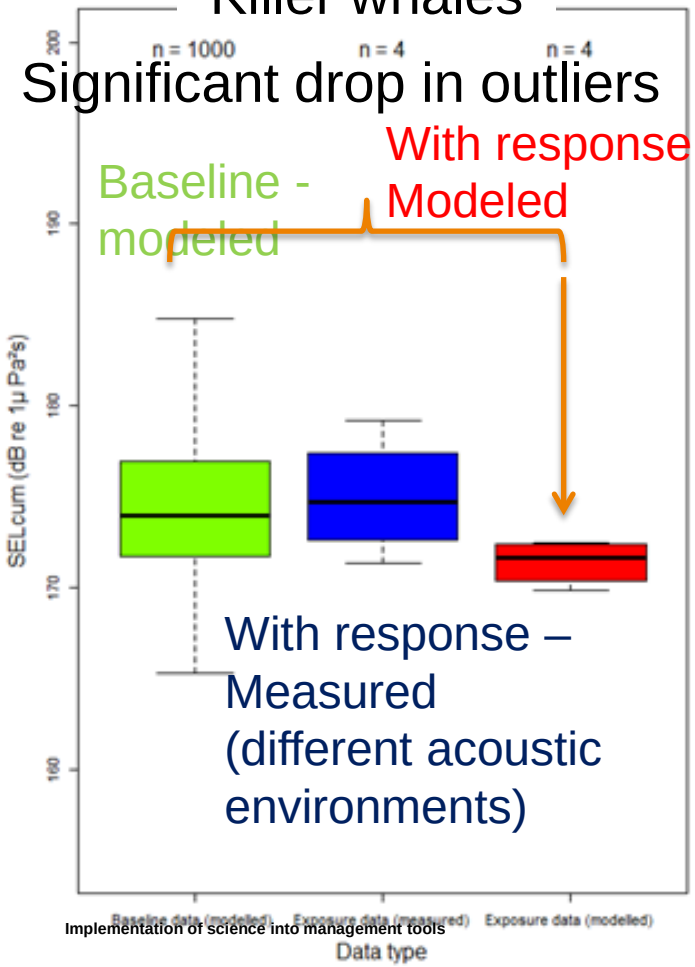
- Hypothetical 8 day exercise, involving up to 6 sonar systems
- Percent time sonar active of 0.1 – 0.5 (assumed 0.25)
- Remains inside operation area (few square degrees, ~ 200x200 km^2)



EFFECT OF HORIZONTAL RESPONSE TO SONAR EXPOSURE

Killer whales

Significant drop in outliers



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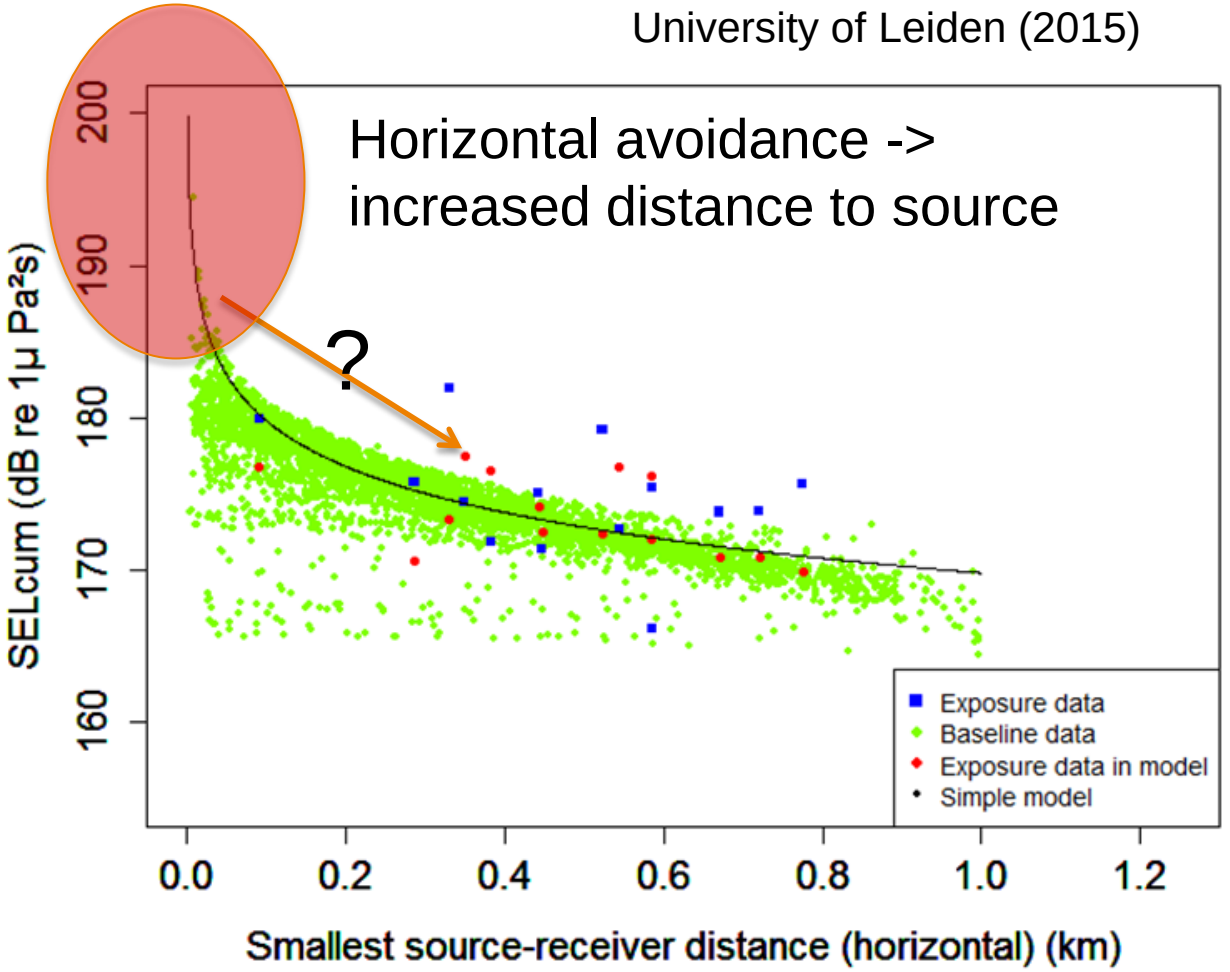

CHALLENGES (1) – HEARING EFFECTS

- Sound exposure models include animal swim behaviour to estimate risk of hearing effects (TTS/PTS)
- What is effect of animal response to sonar on sound exposure?
- How do sound exposure model predictions compare to observed sonar exposures -> How valid are sound exposure models?