

Revised expert elicitation inputs to the interim PCoD model

Cormac Booth, Floor Heinis, Rachael Sinclair & John Harwood + many more...

Marine Scotland Marine Mammal Symposium 6th – 7th March 2019

iPCoD built to assess the potential effects of offshore renewable energy construction on marine mammals

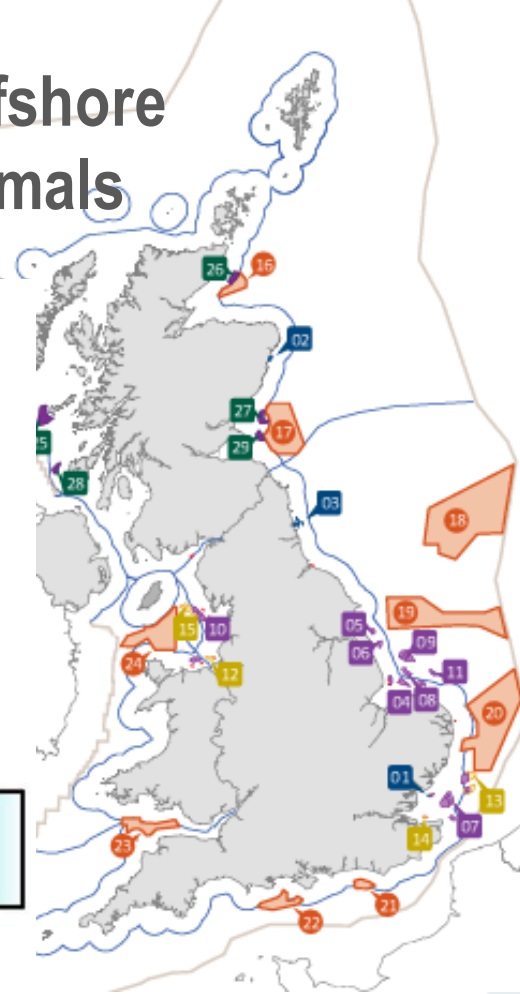
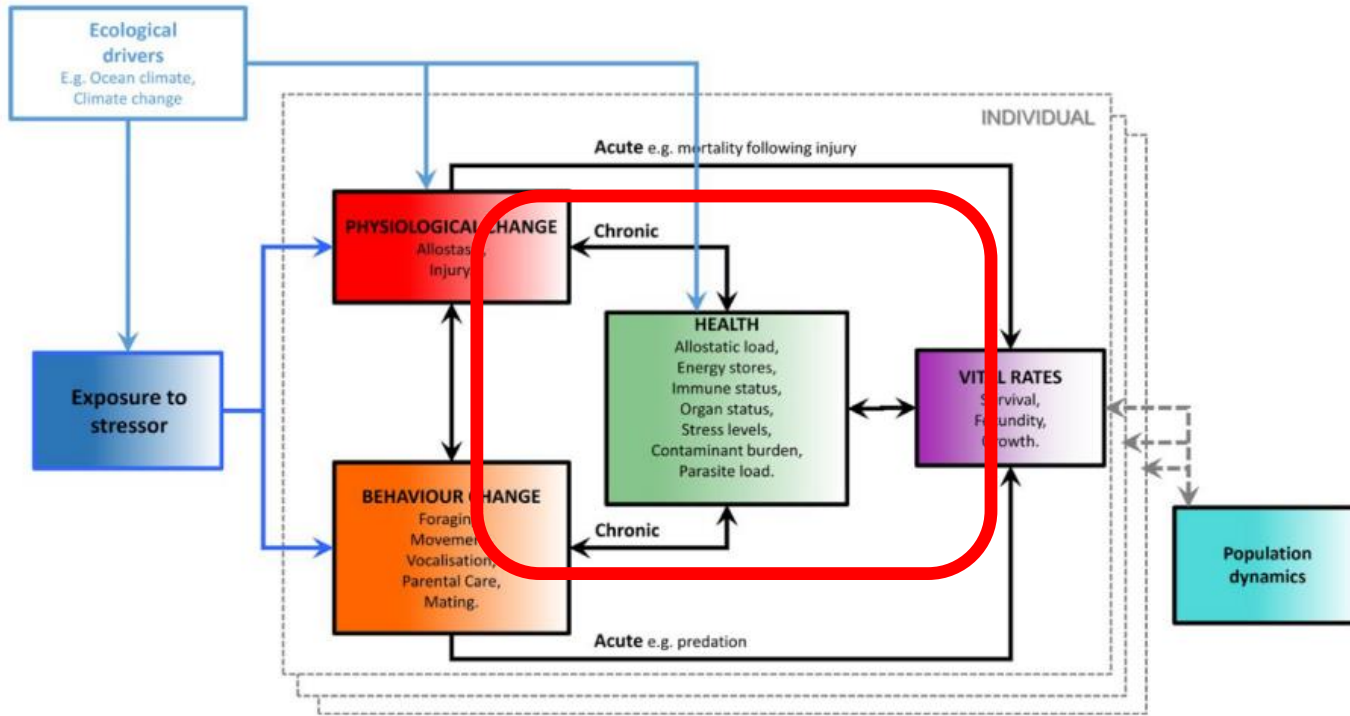


FIGURE 1 The Population Consequences of Disturbance (PCoD) conceptual framework, modified from National Academies (2017). The boxes within the dashed gray boundary line represent the effects of exposure to a stressor and a range of ecological drivers on the

Pirotta et al 2018



Project Objective

- Focused on updating transfer functions
 - The effect of permanent threshold shift (PTS) on individual survival and fertility rates (*'vital rates'*)
 - Porpoise, harbour & grey seal, bnd – not minke whale
 - The effect of disturbance on vital rates
 - Porpoise, harbour and grey seal
- Resulting in an updated iPCoD model – available online today.

Updating iPCoD – EE workshops

- Convened an expert workshop of hearing/taxa specialists with a range of backgrounds in 2 workshops

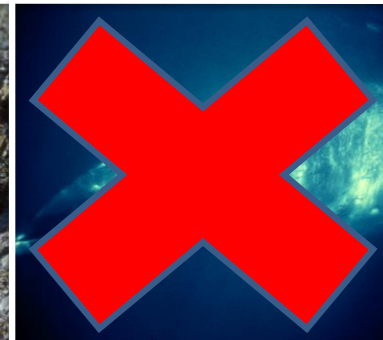
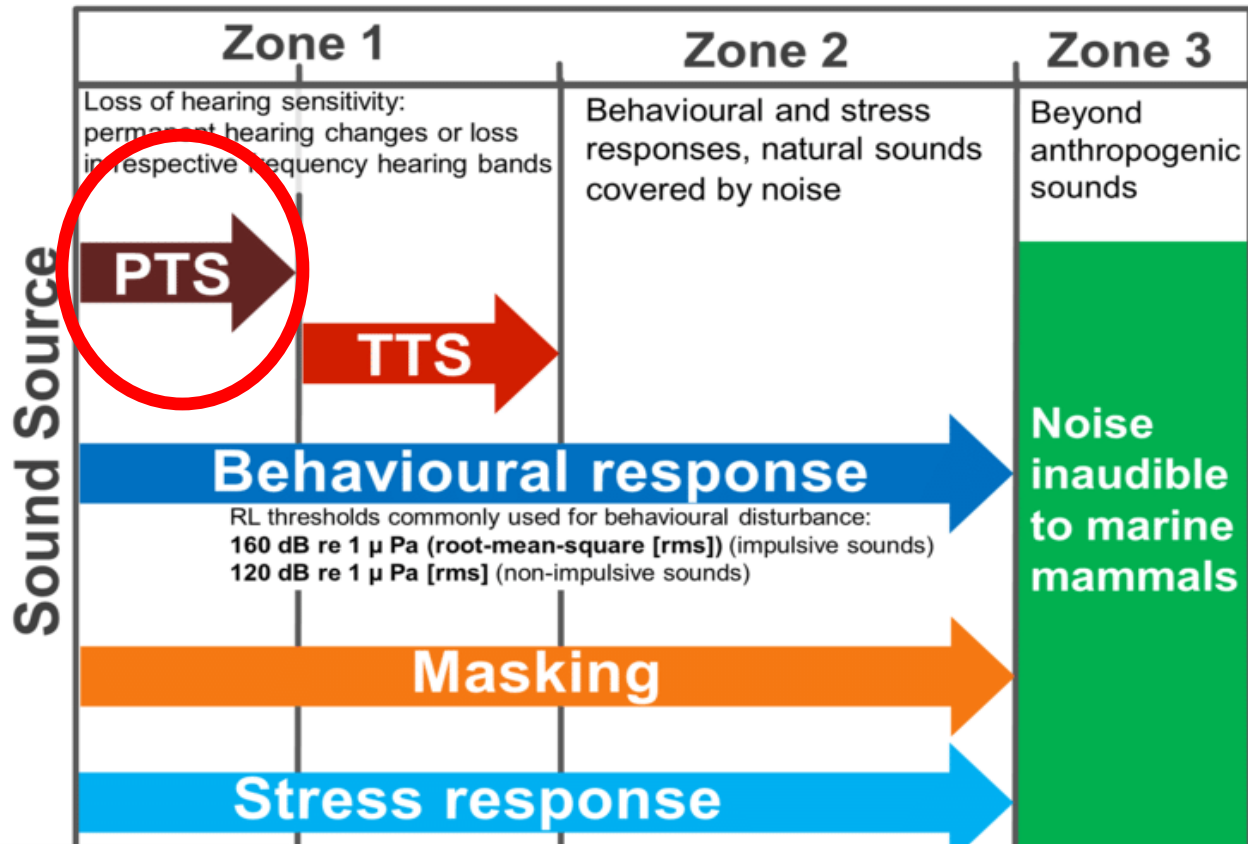
Effects of PTS on vital rates

Name	Role
Darlene Ketten	Invited expert
Jakob Tougaard	Invited expert
Dorian Houser	Invited expert
Ron Kastelein	Invited expert
Klaus Lucke	Invited expert
Peter Tyack	Invited expert
Paul Thompson	Invited expert
Cormac Booth	PI and Facilitator
Floor Heinis	Recorder
Vincent Janik	Observer*
Gordon Hastie	Observer*
Francesca Marubini	Observer

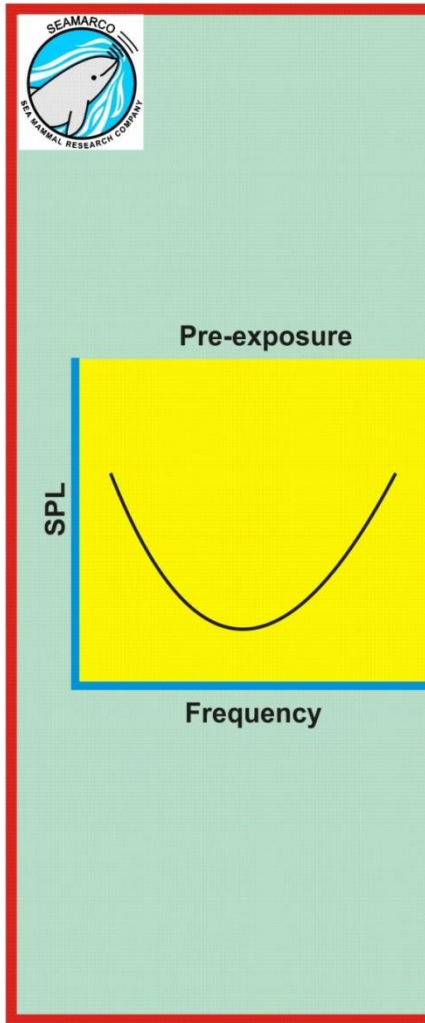
Effects of disturbance on vital rates

Name	Role
Christina Lockyer	Invited expert
Fredrik Christiansen	Invited expert
Ailsa Hall	Invited expert
Carol Sparling	Invited expert
Sophie Smout	Invited expert
Garry Stenson	Invited expert
Jacob Nabe-Nielsen	Invited expert
Cormac Booth	PI and Facilitator*
Floor Heinis	Recorder*
John Harwood	Observer*
Alex Brown	Observer

Effects of PTS



What is PTS?

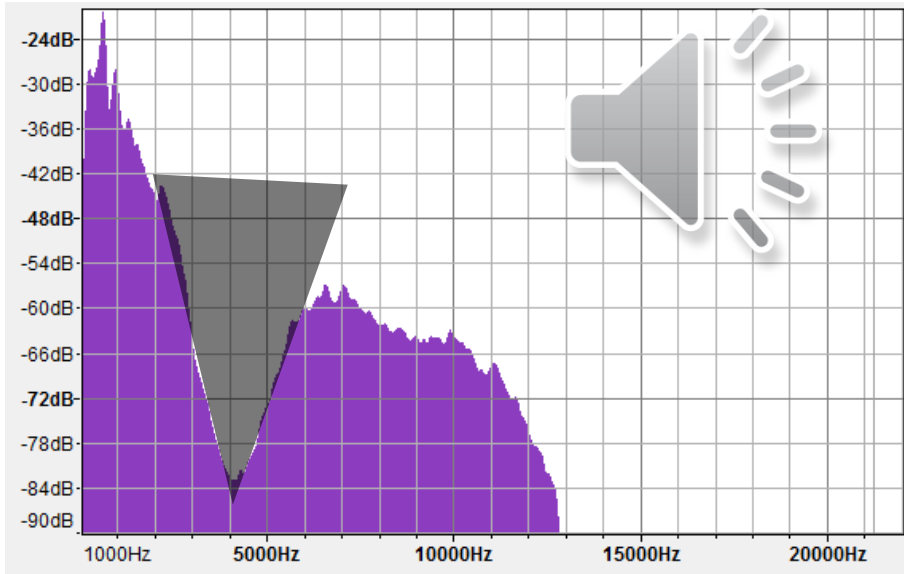


Hearing Quiz

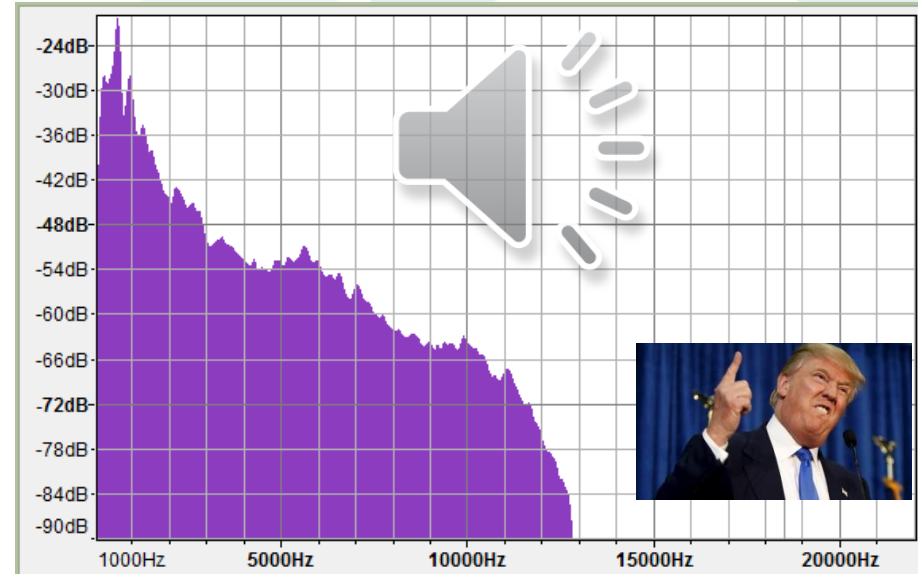
- What is this sound?



**'Moderate' ~38 dB PTS for humans
4 kHz wide notch at 4 kHz**



Raw audio



Region of best hearing in human beings

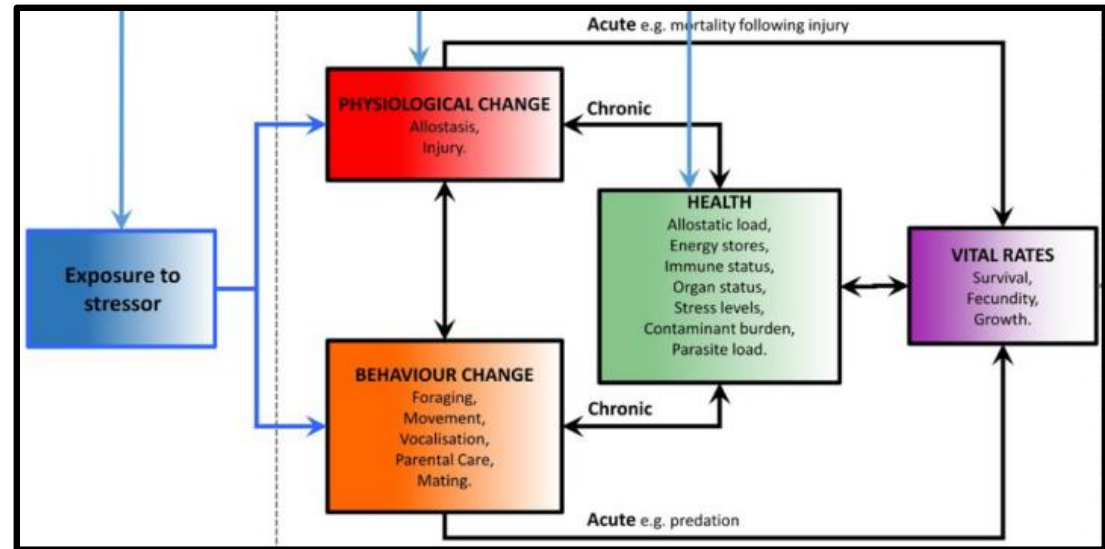


EE scope - PTS

- **What noise stimuli are we considering**
 - *Low frequency, broadband pulsed noise*
- **At what frequencies does PTS manifest following exposure to pile-driving noise?**
 - TTS was typically observed 1.5 octaves higher than the centre frequency of the exposure sound for seals and porpoise
 - » *i.e. PTS will likely occur somewhere between 2-10 kHz*
- **What magnitude of PTS should be considered?**
 - Experts agreed it was unlikely that **seals or bottlenose dolphin** would experience more than **6 dB of PTS** in the **2-10 kHz frequency band** following exposure to LFBP due to low growth rates (under low duty cycle conditions).
 - Experts agreed TTS growth rates higher in **porpoises**, so we elicited for **6 dB PTS and 18 dB PTS (in the 2-10 kHz band)** – higher magnitude of PTS was considered very unlikely to be experienced (given source level and frequency content)



How does hearing/disturbance affect the vital rates?



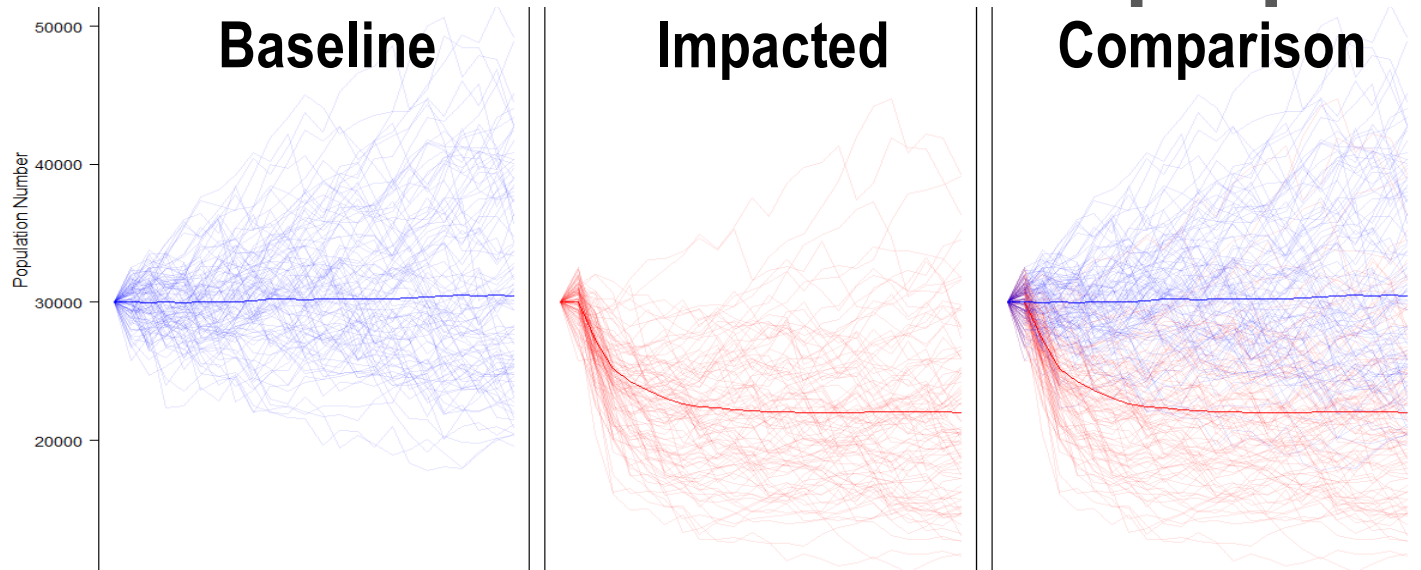
- Discussed with experts what the mechanisms were:
 - Finding conspecifics/mates
 - Finding food
 - Avoiding danger

Comparison of iPCoD versions

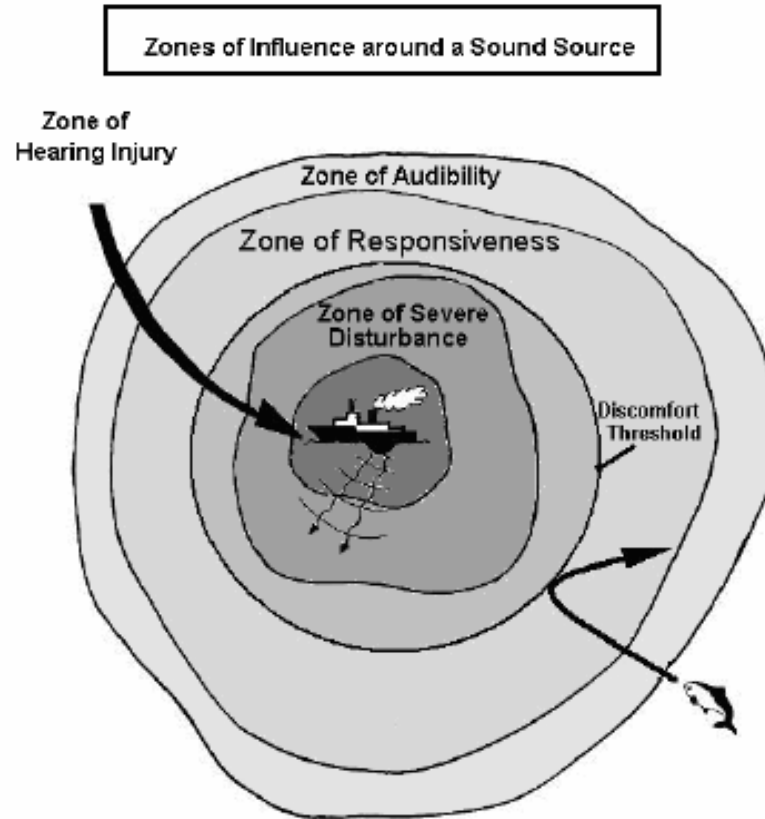
- Ran duplicate scenarios with 'old' (2013) and 'new' (2018) to understand the effects of updated EE.
 - Scenarios were identical – only the iPCoD model version was changed between them.

Updated iPCoD – PTS – harbour porpoises

2013 EE



The effects of disturbance



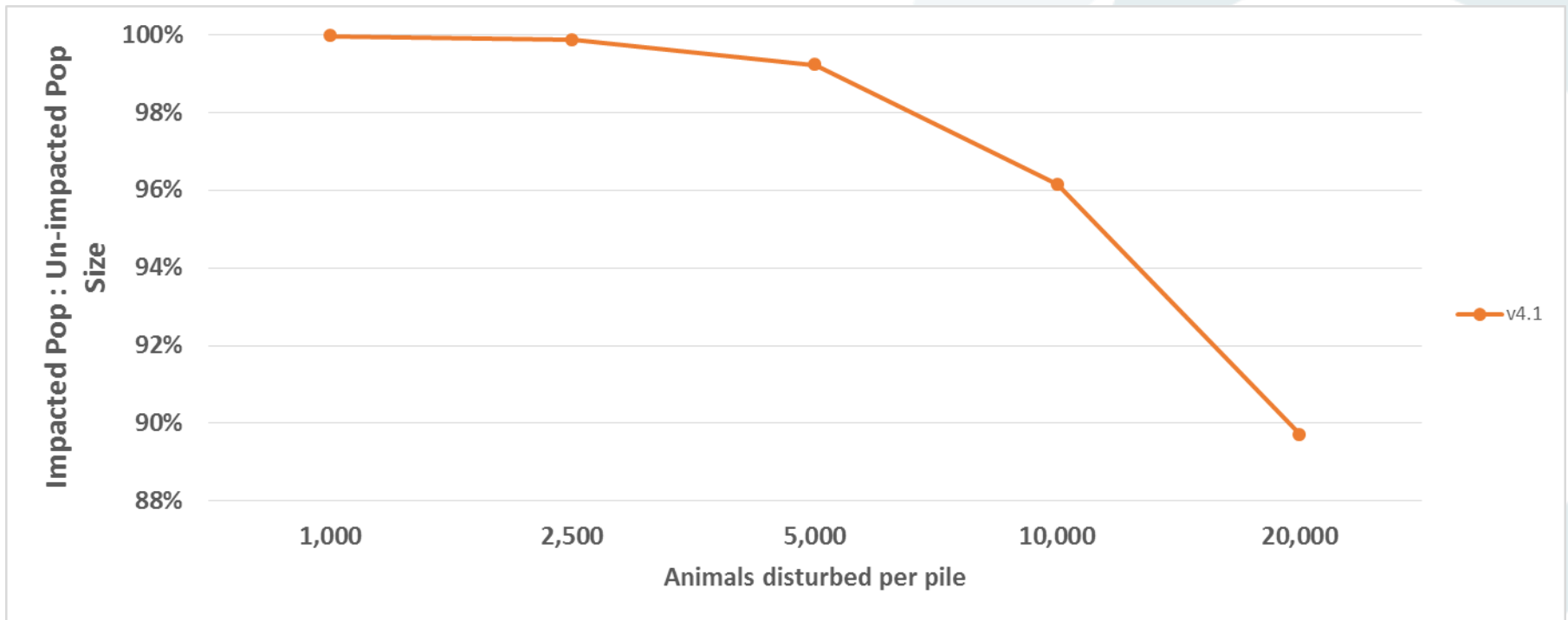
Verboom 2005



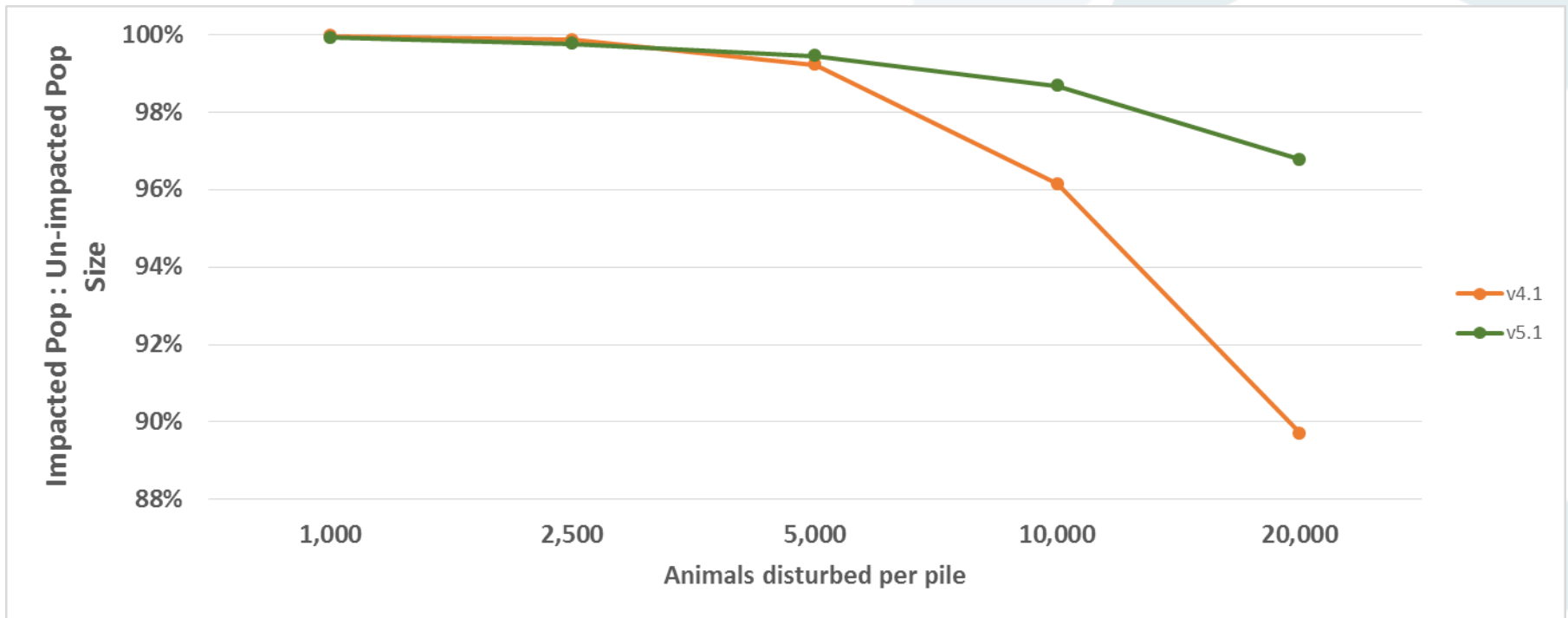
Scope of EE – Disturbance

- Harbour porpoise
 - Length of disturbance agreed in the EE as for 6hrs
 - likely compensation, not foraging for 24 hrs is a severe/extreme response.
 - EE supported by DEB model for HP – Hin et al (in review)
- Seals
 - Length of disturbance was hard to explicitly define, but experts agreed it was much less than 24 hours in seals
 - No DEB model available.
- Not eliciting for BND or MW.

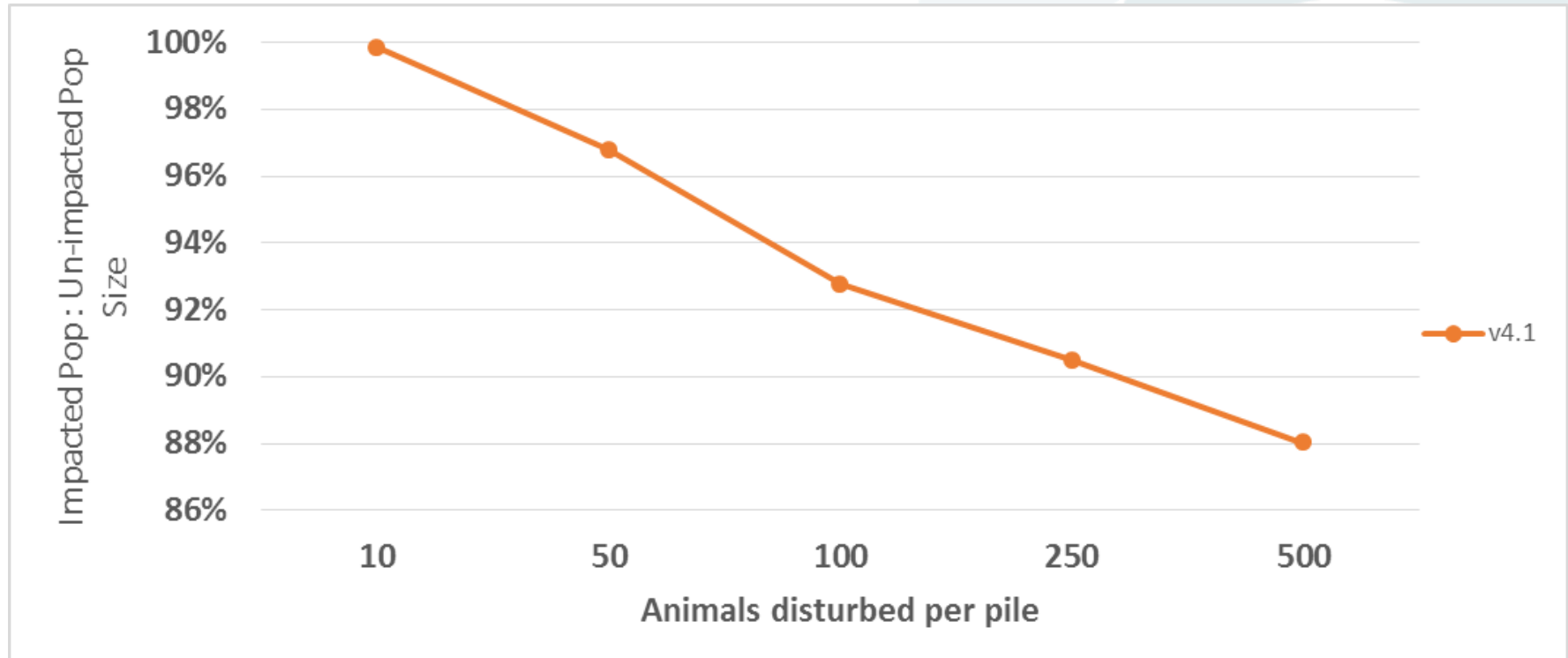
Comparison of EE - porpoises



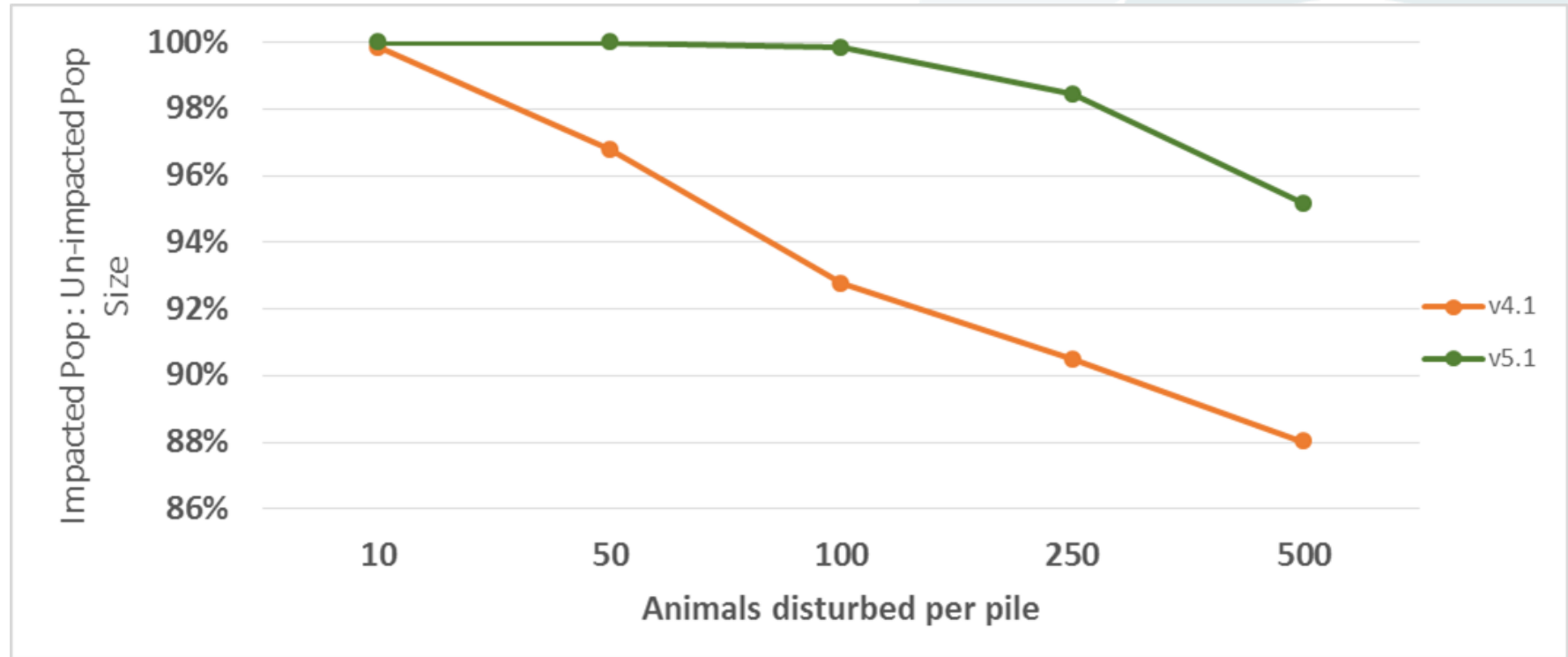
Comparison of EE - porpoises



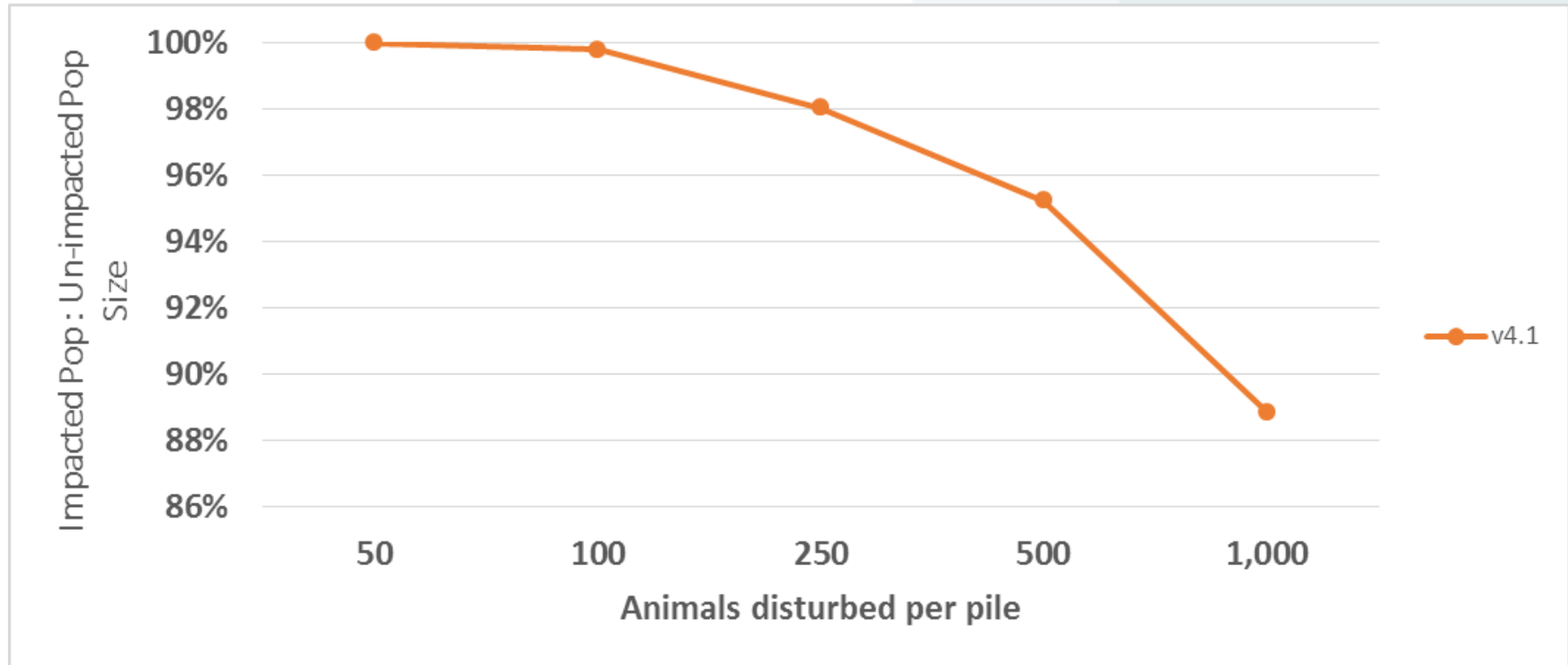
Comparison of EE – harbour seal



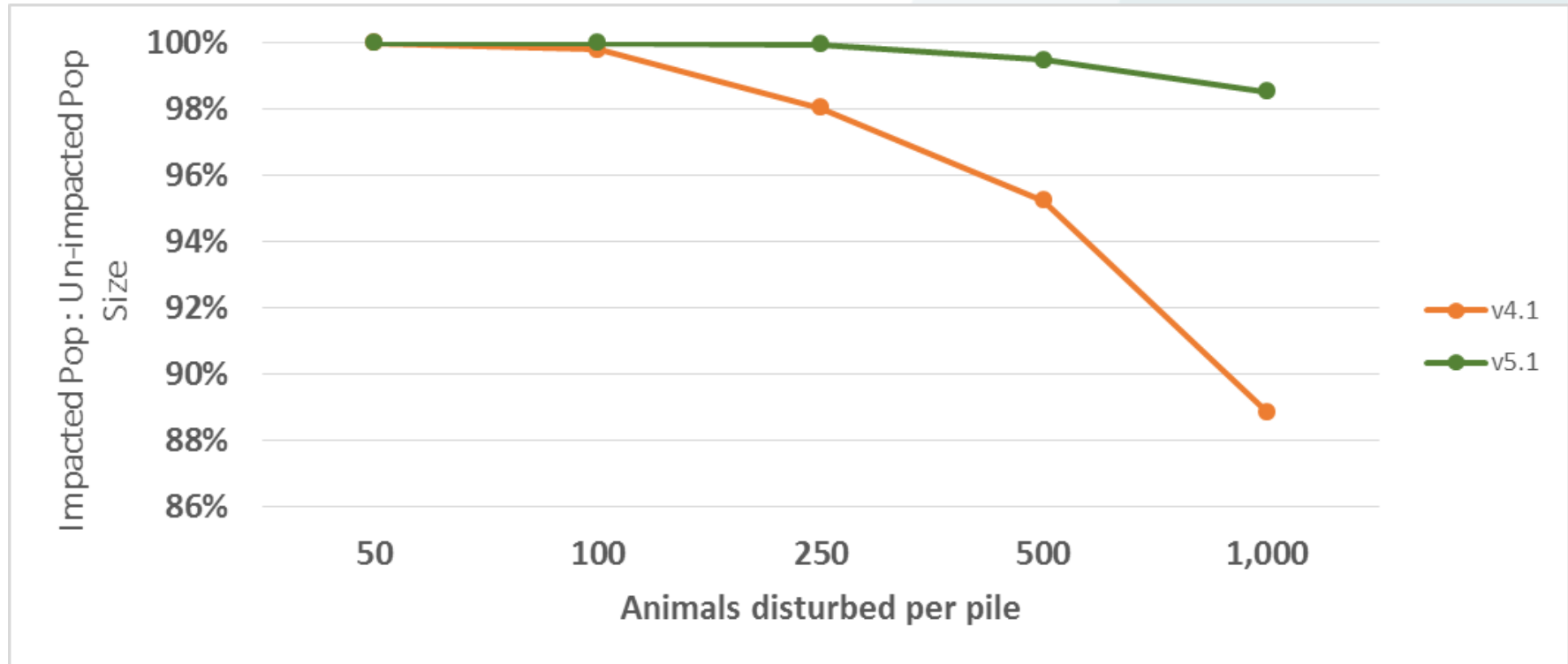
Results of new EE – harbour seal



Results of new EE – grey seal



Results of new EE – grey seal



Conclusions

- Updating the EE functions in iPCoD has resulted in significant changes in forecasts of population impact
- Experts agreed that the effects of PTS from pile-driving were generally very low
 - But source level, frequency content, species hearing and ambient noise are factors to be considered
- Effects of disturbance were lower than in from 2013
 - Species more tolerant to disturbance – especially seal species, due to life history (+ energy stores)

Acknowledgments

- All the experts, observers in the elicitations
- Marine Scotland + UK regs/SNCBs for initial development and continued support since 2013
- Department for Business, Energy & Industrial Strategy and Gemini Offshore Windpark for support.

**Thank
you!**

