

A decision framework to identify populations that are vulnerable to population-level effects of disturbance ...and other short stories

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State of the Science Workshop on Wildlife and Offshore Wind Energy 2020: Cumulative Impacts
November 2020

Intro – SMRU Consulting

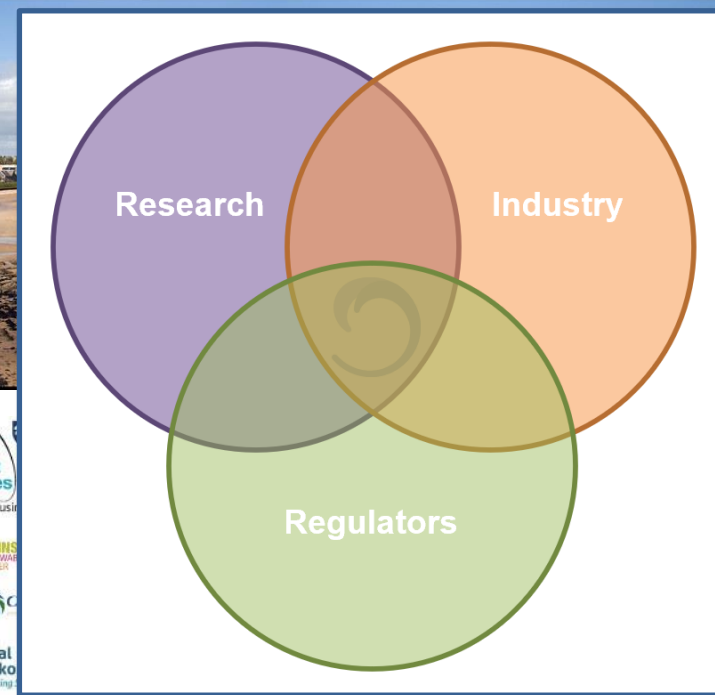
- Established in 2006
- Work exclusively on applied science
- Worked a lot on offshore wind projects
 - Over 21 OWF projects since 2015
- Bridge (potential) gaps between academia, industry and government / regulators



Sea Mammal
Research
Unit



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Impacts of offshore wind farm construction

- For marine mammals

- Primarily concerned with noise impacts

- Geophysical surveys (seabed assessments)
 - UXO clearance (perhaps Europe-specific)
 - Pile-driving (turbine foundation installation)

- Concerns

- Auditory injury
 - Disturbance

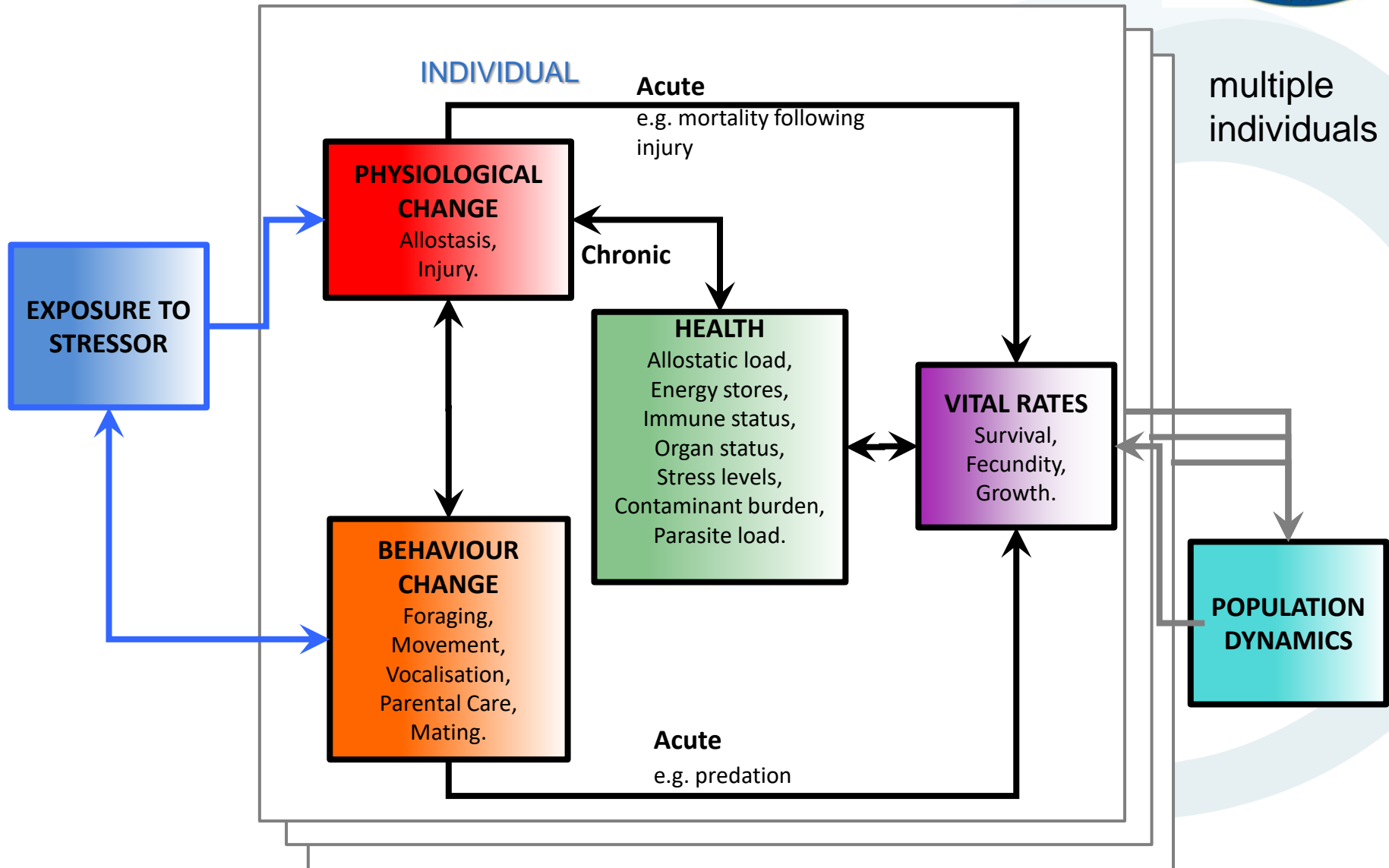
- Typically considered in terms of increased **energy expenditure** and lost feeding opportunities (ie **reduced energy intake**)

- » But other pathways should be considered

- (PCoMS – Tyack - Friday)



Introduction - PCoD



Population Consequences of Disturbance

- There are not enough data to build full PCoD models for most populations of the case study species,
 - or for **any** population of most other marine mammal species.
- What can we do to provide advice to regulators about the potential effects of disturbance for these populations?



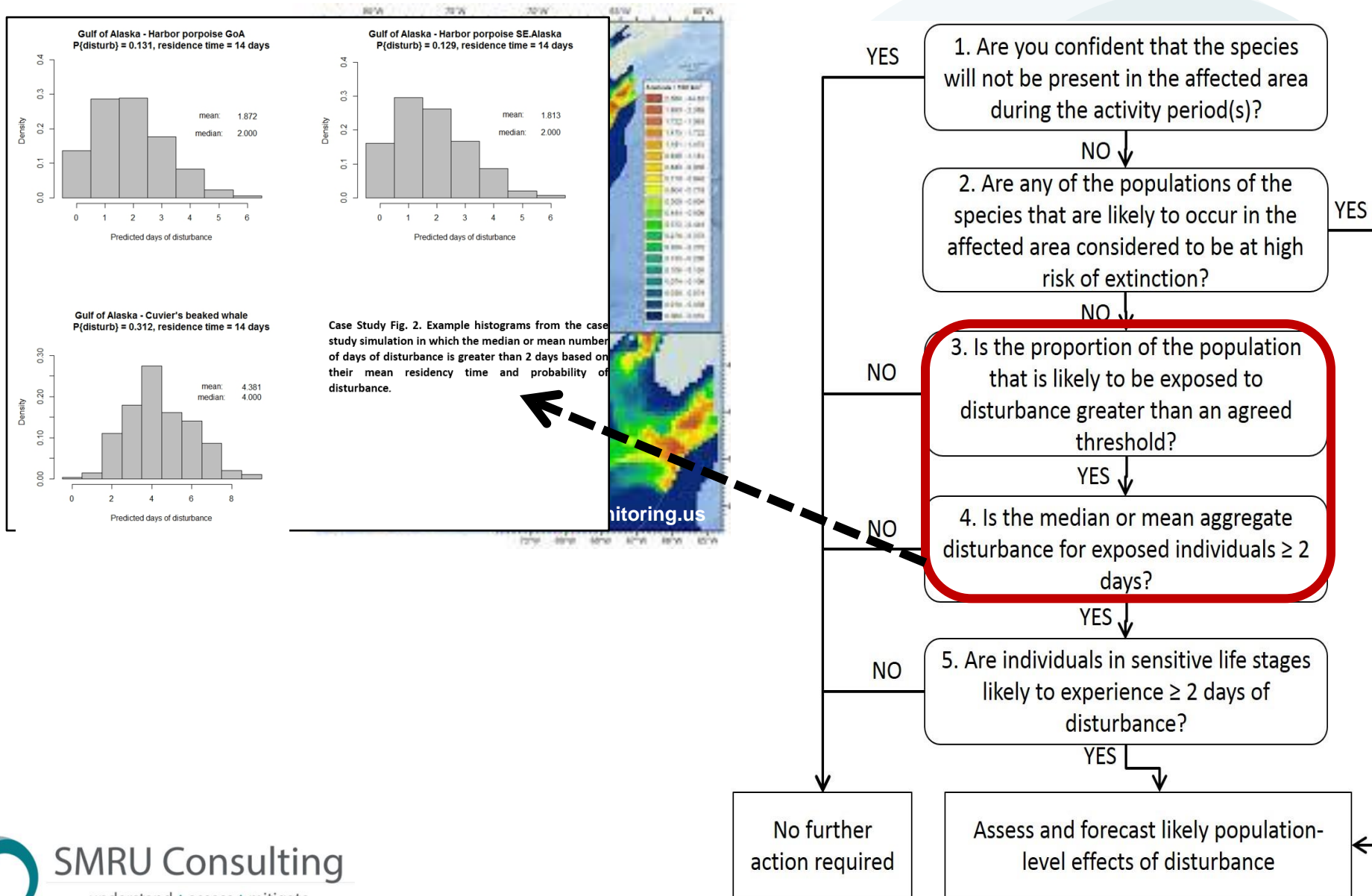
PCoD decision framework

- Develop a decision framework that can be used to prioritize the development of PCoD models for different marine mammal populations exposed to the same source of disturbance.
- Provide guidance on the most appropriate form of PCoD model for these populations, based on likely data availability and model sensitivity.
- **Aim:** to develop a set of rules that can be used to identify
 - when PCoD models are most likely be useful, and
 - which models are most appropriate for a particular situation.

Decision framework – Wilson et al 2020

- The resulting framework includes a **series of questions which form a decision tree**, as well as a description of the input required at each step.
- There are three main components to the decision tree:
 - Estimating the spatio-temporal overlap between species and activities being assessed
 - Estimating the risk of multiple exposure
 - Assessing which type of PCoD model to apply to the populations which are identified as being of high priority.

Decision framework – Wilson et al 2020

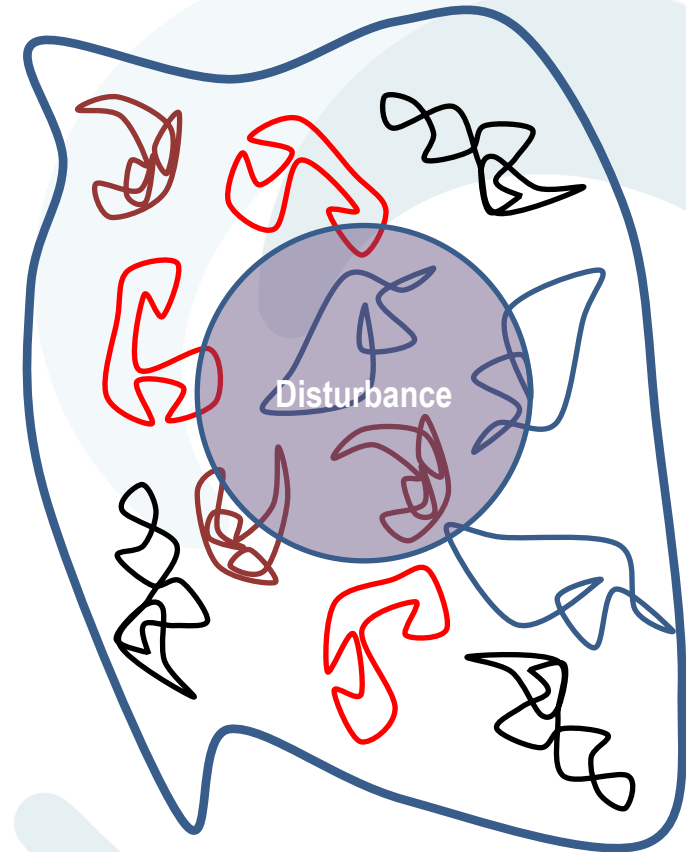


Disturbance and Different Individual Home Range



Nomadic

Many different
individuals disturbed
relatively infrequently



Resident

Fewer individuals disturbed
more frequently

Costa et al. 2018

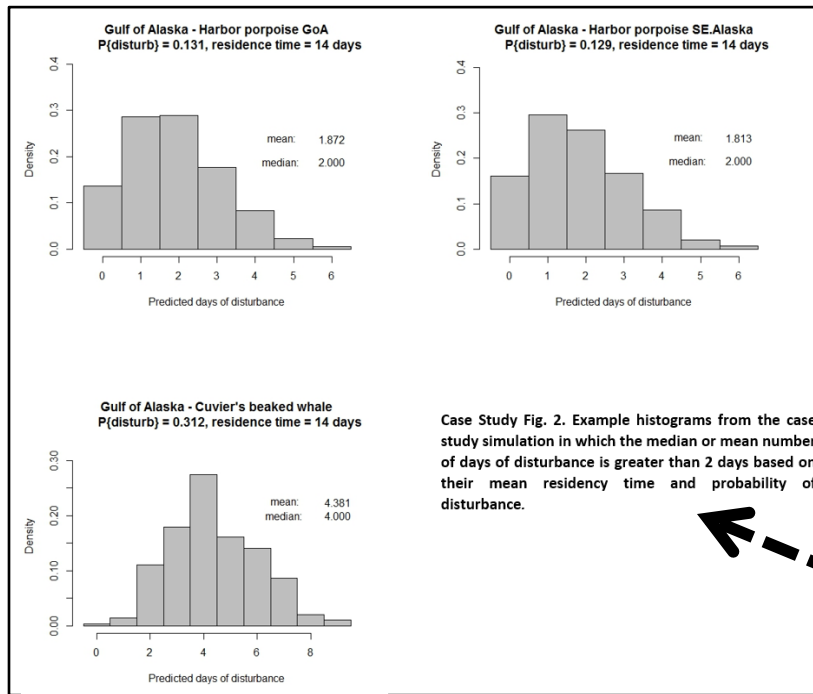


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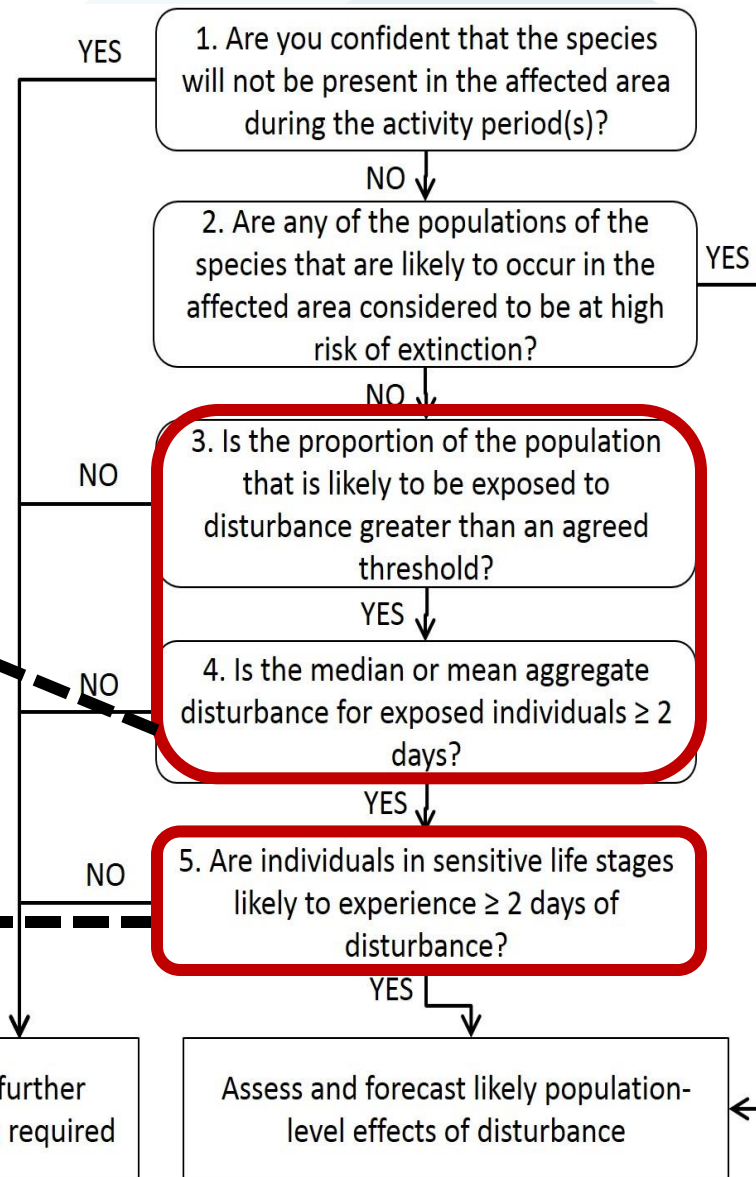
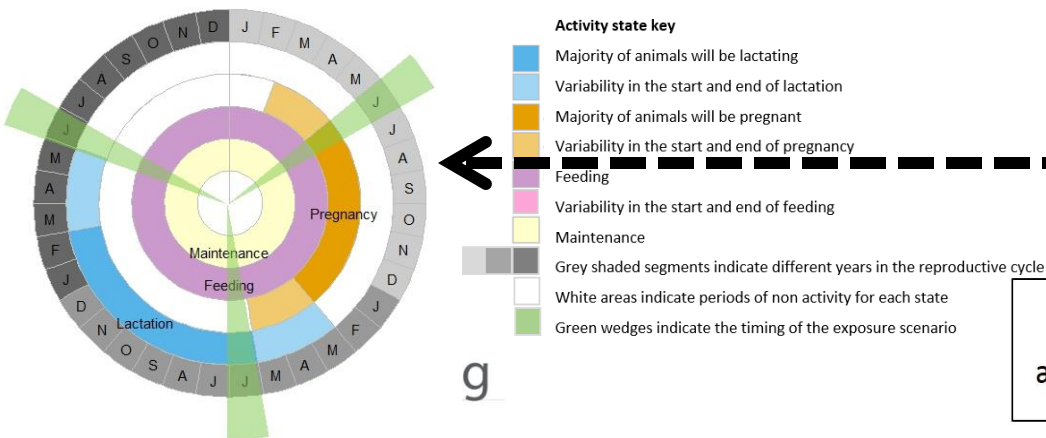
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Decision framework – Wilson et al 2020



Cuvier's beaked whale



Prioritization of effort

- Paper provides an overview of the framework, the supplementary materials include a full worked example
 - PACOM exercise in Gulf of Alaska (discrete two week exercise each year).
- Started with 41 stocks (22 species)
 - Filtered through to 3(+7) priority stocks
- Paper published with annotated R code for each element

Wilson, L. J., Harwood, J., Booth, C. G., Joy, R., & Harris, C. M. (2020). A decision framework to identify populations that are most vulnerable to the population level effects of disturbance. *Conservation Science and Practice*, 2(2), e149.

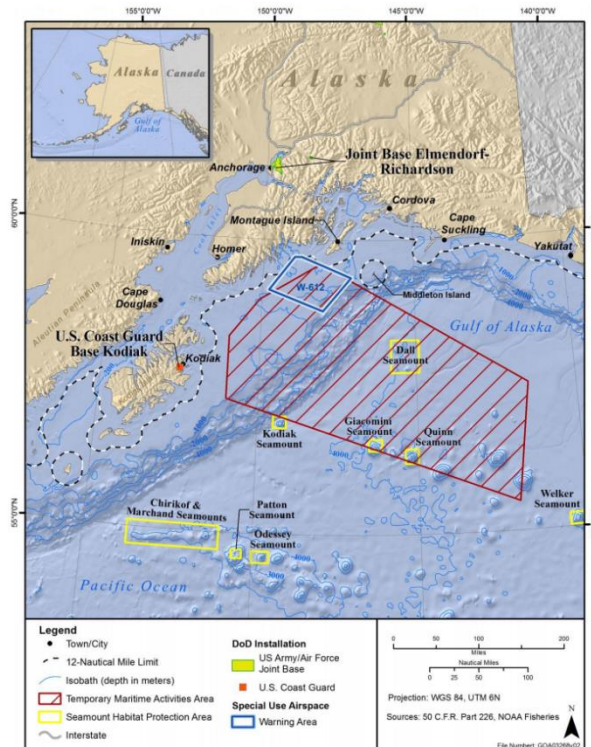
A decision framework to identify populations that are most vulnerable to the population level effects of disturbance

Lindsay J. Wilson, John Harwood, Cormac G. Booth, Ruth Joy, Catriona M. Harris

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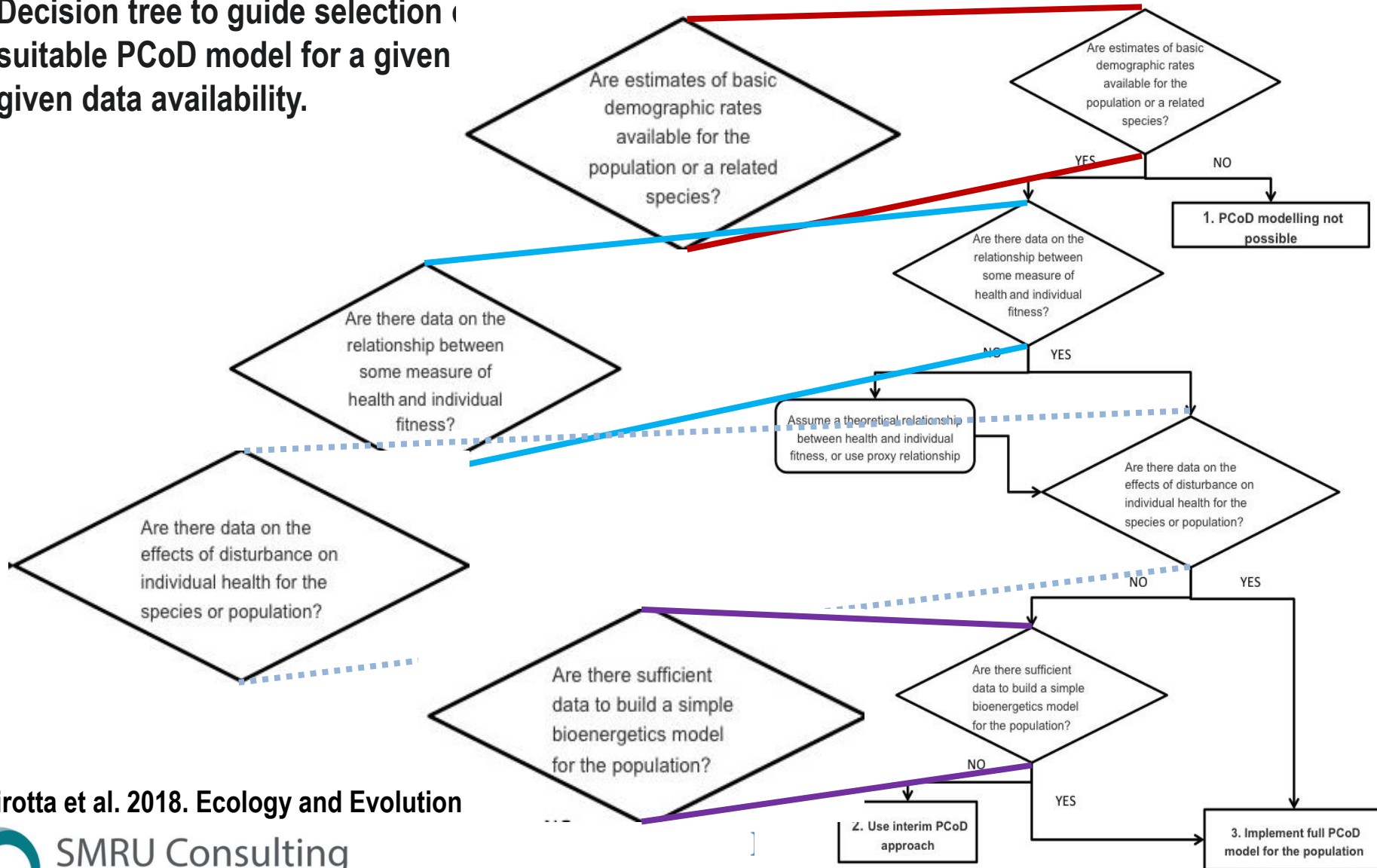


Decision Framework – Summary

- Species at high risk of population-level effects can be identified using information on:
 - the number of individuals that are likely to be disturbed by the activity,
 - total population size,
 - the probability of repeated disturbance,
 - the species' reproductive strategy,
 - and the life stages (e.g., feeding, pregnant, and lactating) of the individuals most likely to be exposed.
- This hierarchical approach provides those responsible for conducting impact assessments with a:
 - time-efficient,
 - cost-effective
 - reproducible
 - workflow that allows them to prioritize their efforts and assign funds to those species with the most pressing conservation needs.

Data needs? What kind of model?

Decision tree to guide selection of suitable PCoD model for a given data availability.



Pirotta et al. 2018. Ecology and Evolution

From concept to application – part I

- Everything up until this point has been largely qualitative
- **Check out talks:**
 - Brandon Southall - cumulative noise impacts to marine mammals from offshore wind development and operations (Session 6 - next)
 - semi-quantitative tool (for managers/proponents)
 - Peter Tyack - Approaches to understanding cumulative effects of stressors on marine mammals (Friday 10:35 Session 8)
 - PCoMS

From concept to application - II

- **Critical to have a robust tool to aid assessments**
 - And management decisions
 - Reduce uncertainty and risk in decision making
- **Need to find balance in the trade-off between hyper-realism and a practical, useful tool.**
 - Ease of use
 - Run times for simulation
 - Understandable outputs

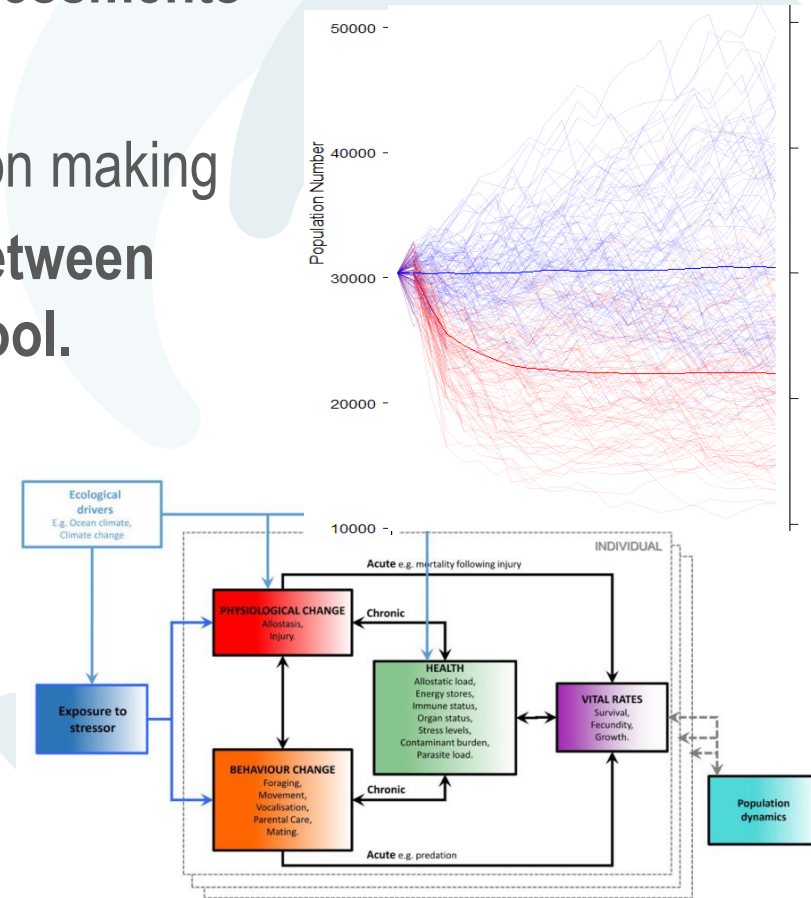


FIGURE 1 The Population Consequences of Disturbance (PCoD) conceptual framework, modified from National Academies (2017). The boxes within the dashed gray boundary line represent the effects of exposure to a stressor and a range of ecological drivers on the vital rates of an individual animal. The effects are then integrated across all individuals in the population to project their effects on the population's dynamics

Case study: the 'interim PCoD model'

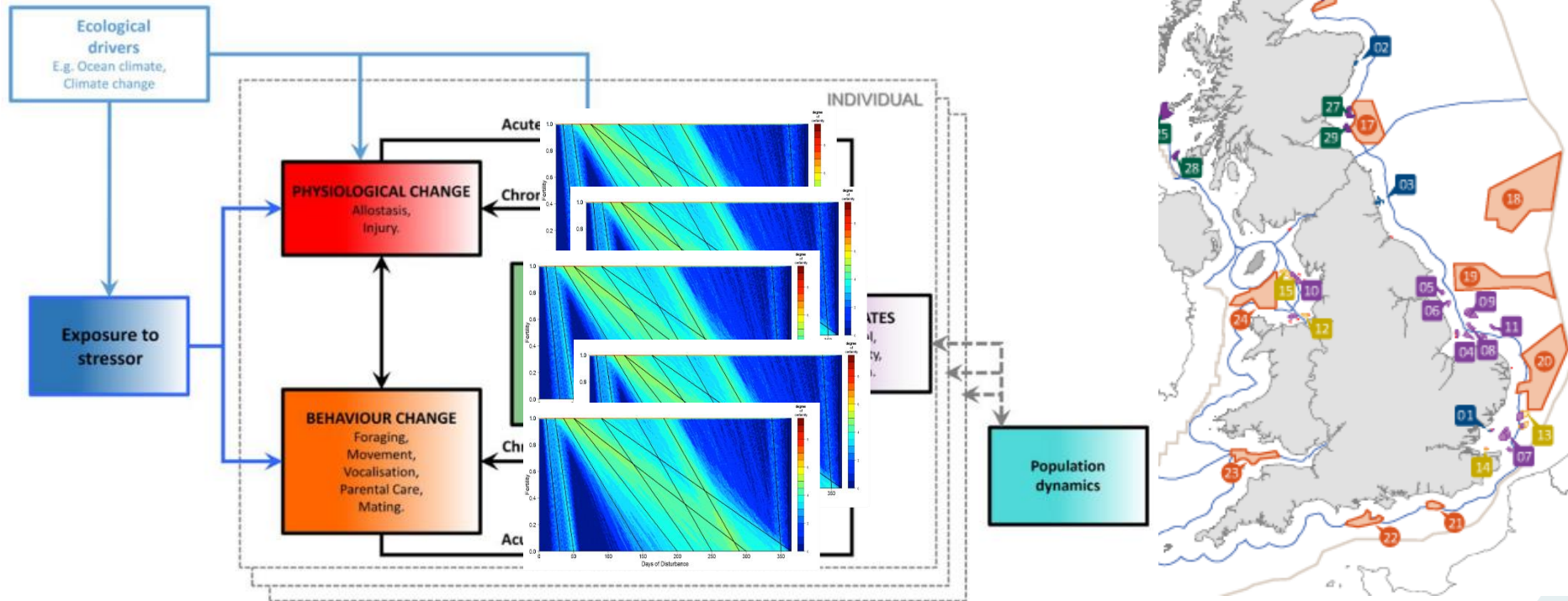


FIGURE 1 The Population Consequences of Disturbance (PCoD) conceptual framework, modified from National Academies (2017). Pirotta et al 2018



Sensitivities / Issues of iPCoD

- **Population size & impact thresholds**
 - # of animals affected by an activity
- **Extent and duration of disturbance**
- **Transfer functions** (disturbance->vital rates)
- **Exposure histories**
 - Realistic movement is really important

Expert Elicitation or Energetics?

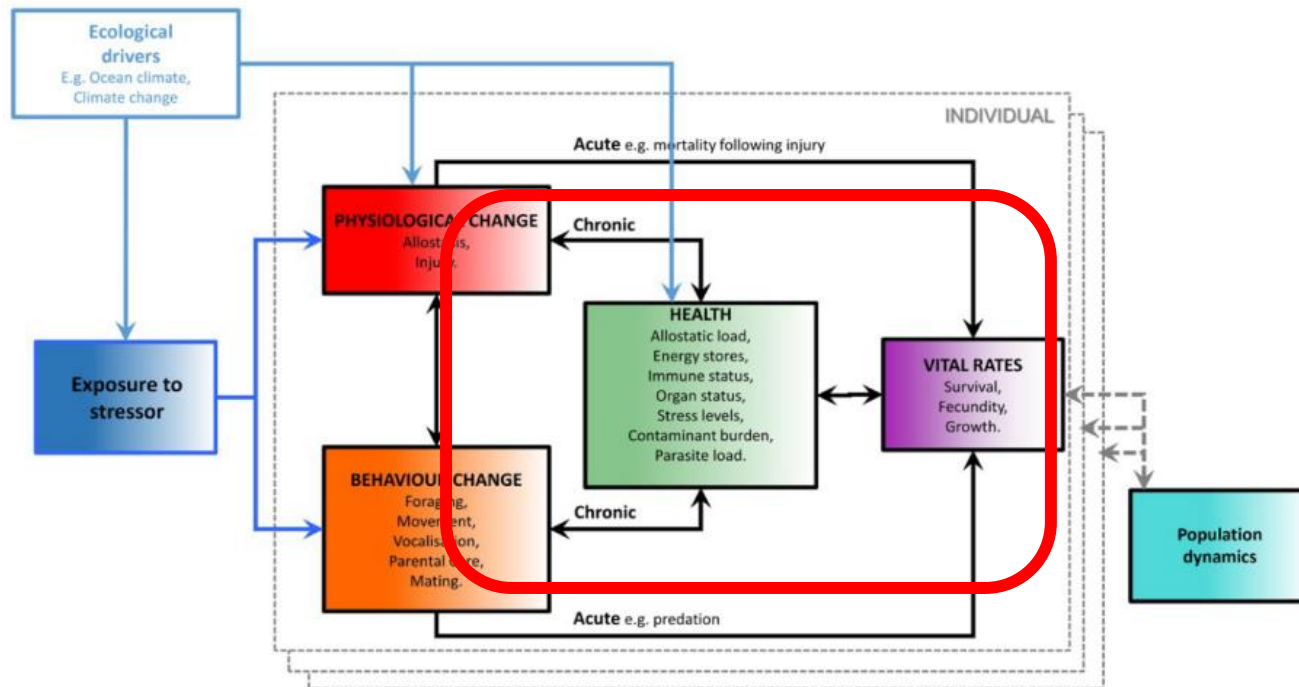
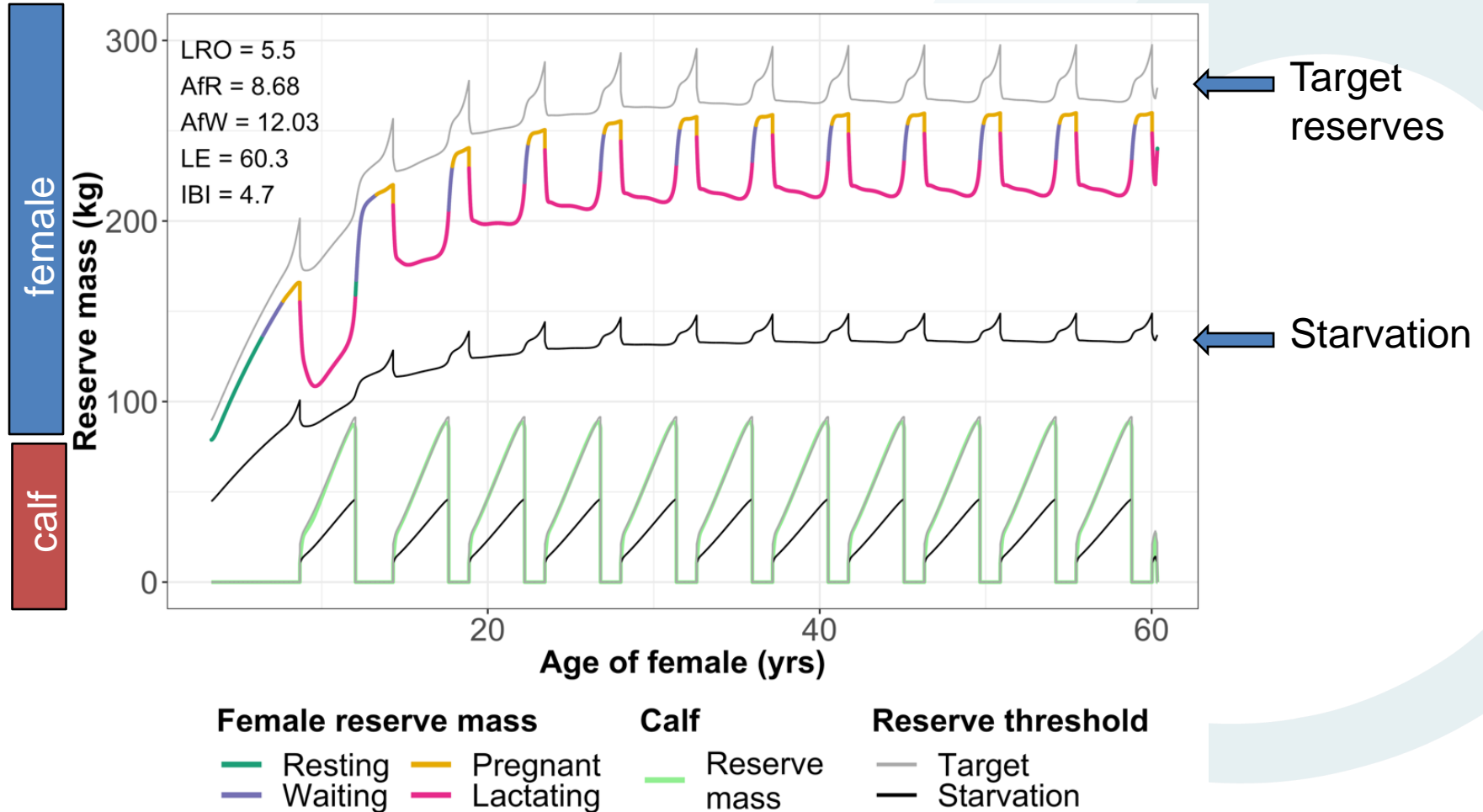


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- iPCoD expert elicitations updated in 2018
 - Consequences of hearing damage & disturbance

Hin et al 2019 – DEB model

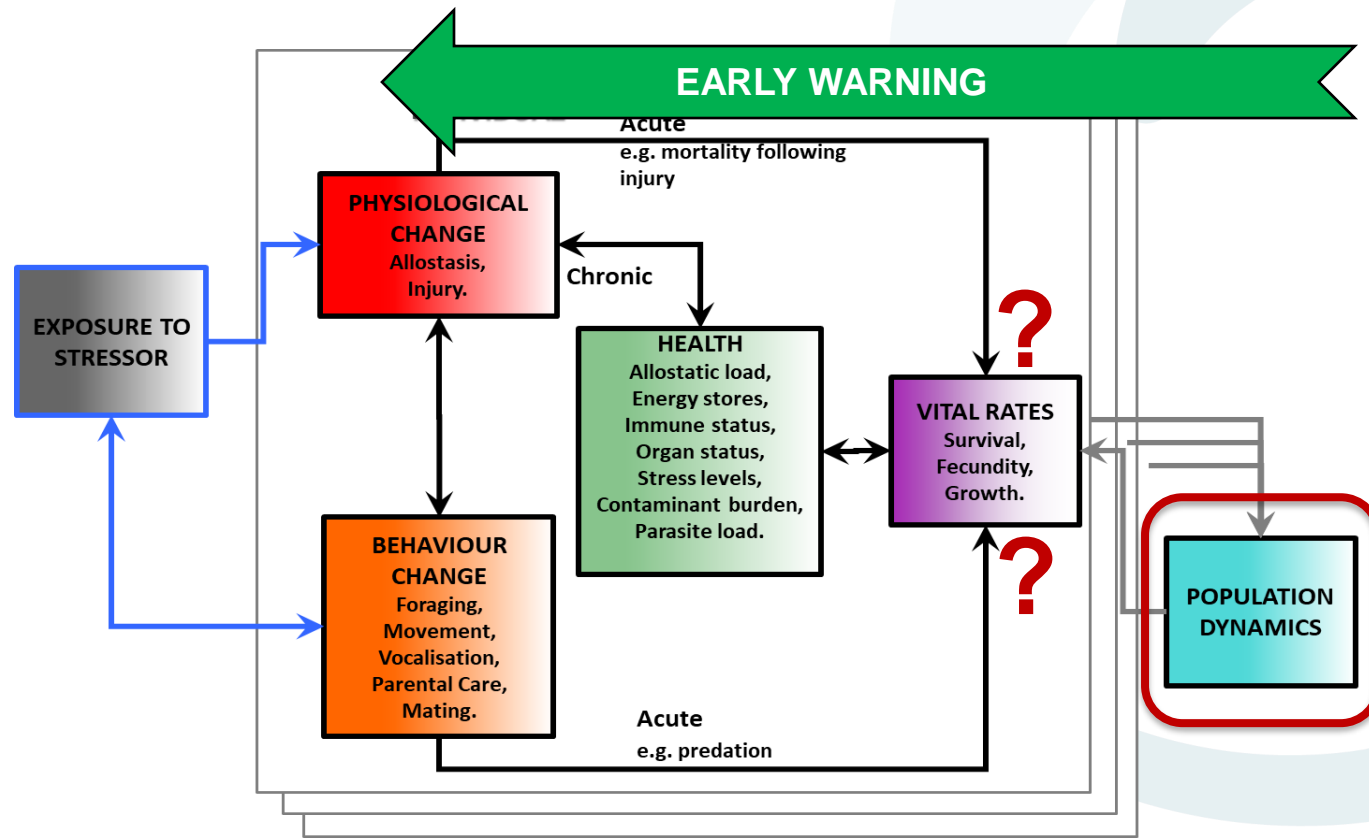


Energetic modelling

- Really useful tool for identifying sensitive stages and understanding how repeated disturbance could affect vital rates
- Highlight the importance of understanding prey environment
 - **The effect of disturbance is heavily dependent on the quality of the environment**
 - Important to monitor this, in order to truly understand the potential for impact
 - Hin et al 2019 (pilot whales); Pirotta et al 2020 (blue whales)

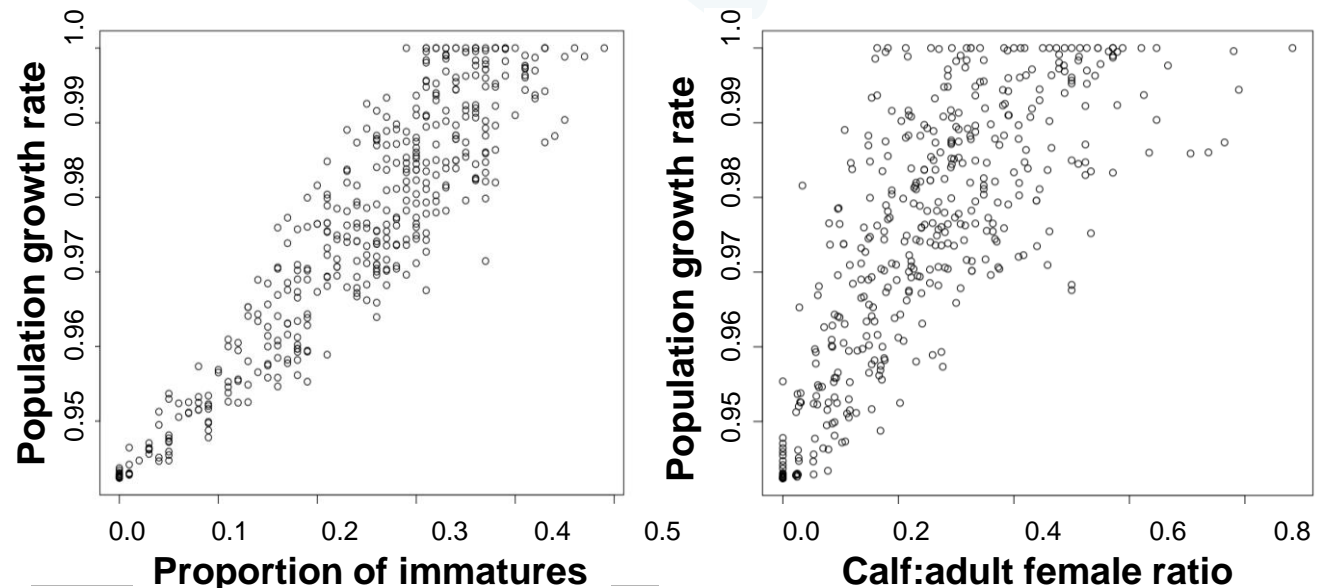
Getting ahead of the (potential) problem

- How to monitor best for population changes?
 - Abundance / counts for MM tend to imprecise and slow to manifest

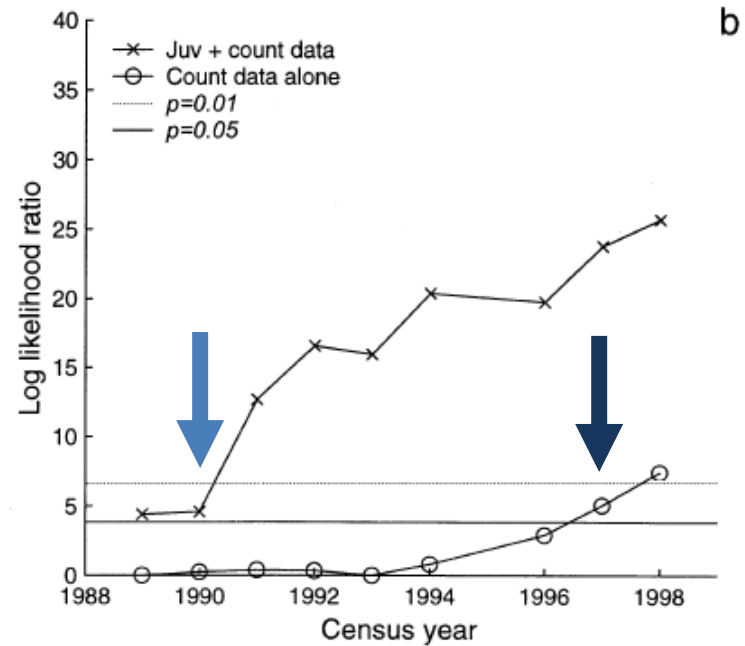
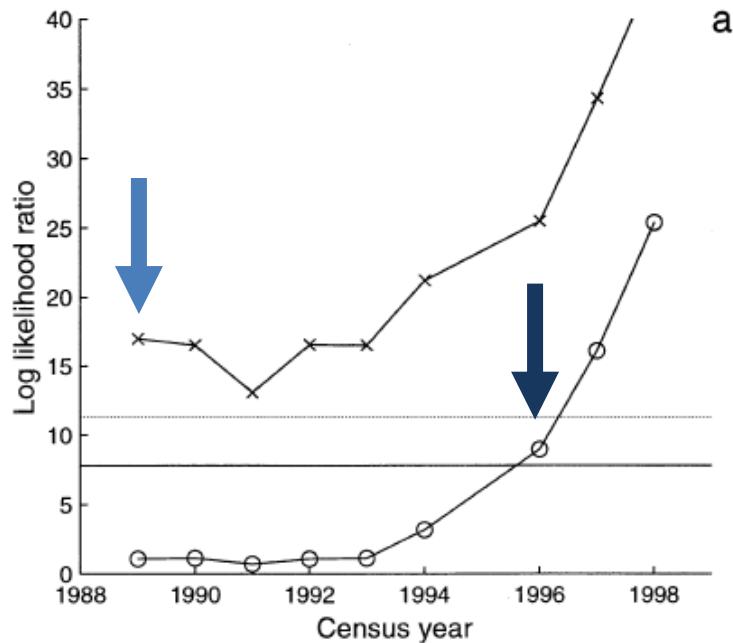


Early warning signs

- Identifying early warning signs of population change
 - Demographic characteristics are strongly correlated with population growth rate
 - Changes in these characteristics can provide an early warning of future changes in abundance.
 - Probability of failing to detect a large change may be high if only one characteristic is monitored



Early monitoring in practice



- Combination of proportion of the population that is juvenile ('juvenile fraction') along with count information improved detection of significant population change.
 - Detected demographic change 7 years earlier than based on count alone
 - Holmes & York, 2003 (Stellar sea lions)

Key knowledge gaps for US offshore wind

- **Population information**
 - Demographic rates (and different ways to monitor for early change)
- **Movement information**
 - To inform residency – exposure histories
- **Understanding extent and duration of disturbance**
 - Species/Taxa-specific
- **Habitat information**
 - Quality of the environment
 - Prey / energetics information

Thank you! – cgb@smruconsulting.com

- Acknowledgements

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