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Introduction to Population Consequences of Acoustic Disturbance (PCAD) Working Group



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Overview

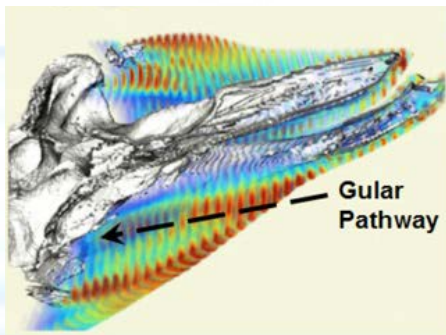
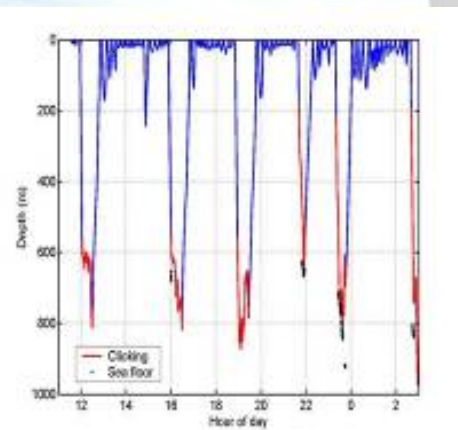
- ONR Program Overview
- Drivers
 - U.S. policies & regulatory framework
 - U.S. National Academies of Science National Research Council (NRC) reports
- Overview of NRC (2005) PCAD model
- ONR Working Group
 - Implications
 - Limitations

ONR Marine Mammals Program

Principal Objective:

- Invest in basic (6.1) and applied (6.2) research and technology development to discover and understand the effects of sound on marine mammals.
- Coordinate with fleet and other Navy programs to help ensure that environmental assessment needs have best, relevant information available

ONR Marine Mammal Program



❖ Integrated Ecosystem Research

- ❖ Multidisciplinary approach using tagging and/or visual/passive acoustic data to collect baseline measures of marine mammal behaviors and distributions relative to key environmental features (biotic & abiotic)
- ❖ Sensor and Tag Development: Development of attachment mechanisms covering short, medium, and long-term time durations; development of broad sensor suites into tags;

❖ Effects of Sound on Marine Mammals

- ❖ Behavioral Response: Define/characterize behavioral response of tagged whales to sound exposure, with a beaked whale focus
- ❖ Hearing: Developing complete model of marine mammal hearing anatomy, temporary and permanent threshold shifts, improved testing via auditory evoked potential
- ❖ Dive Physiology: Investigate potential development of gas-bubble disease or Decompression Sickness (DCS) related to MFA exposure
- ❖ Stress: Characterize and measure the stress response in marine mammals from acoustic disturbance using hormones and other biomarkers
- ❖ Population Level Effects of Disturbance (PCAD): Determine if short term responses of marine mammals result in 'biologically significant' or meaningful effects on individuals and/or their populations

❖ Monitoring & Detection of Marine Mammals

- ❖ Improve monitoring of marine mammals over current methods using passive acoustics
- ❖ Autonomous platforms (ocean gliders, profilers, etc) can provide real-time detection and reporting

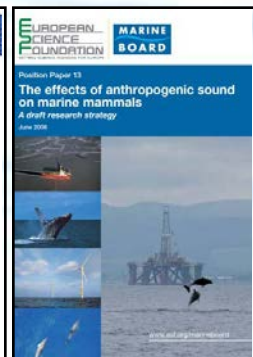
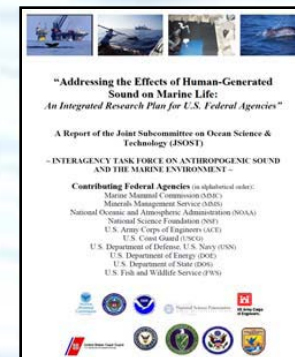
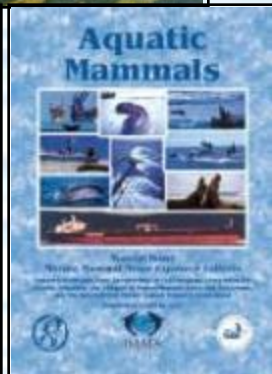
❖ Models & Databases for Decision Making

- ❖ Provide tools to support environmental compliance & decision making
- ❖ ESME – noise risk assessment model that integrates ocean acoustics & environment with animal distribution and behavior

❖ Education & Outreach

Need for an Estimate of Biological Significance

- Numerous scientific and government panels/task forces have identified need to improve our ability to identify and understand biologically significant effects of sound exposure (*e.g.*, NRC 2000, 2003, 2004; Cox *et al.*, 2006; Southall *et al.*, 2007, 2009; Boyd *et al.*, 2008)



Overview U.S. Regulatory Framework

- National Environmental Policy Act (NEPA):
All US federal agencies are required under federal law to evaluate potential adverse environmental effects from their activities
 - Risk assessment modeling / EIS
 - Biological Significance
- Marine Mammal Protection Act (MMPA)
 - Level A Harassment (Take): *potential to injure*
 - Level B Harassment (Take)*: *potential to disturb*



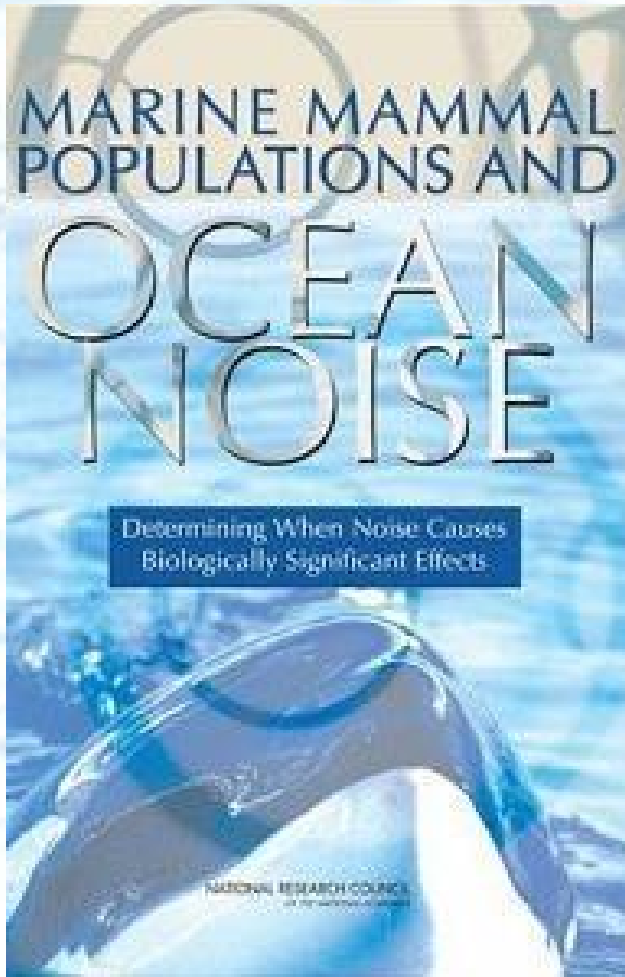
Marine Mammals & Sound

Determining Biological Significance

- It is relatively easy to determine how deaths of individuals will affect their populations
- **Challenge** - currently very limited in our ability to assess if/how a behavioral response ('level B takes') affect a population, i.e. biologically significant (NRC 2005)



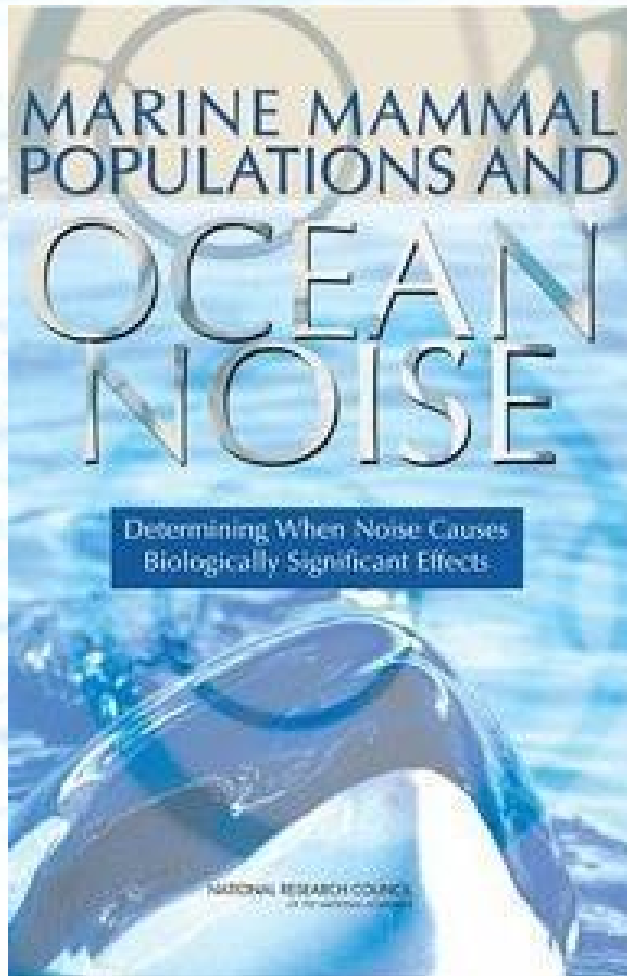
National Resource Council 2005 Report



“The basic goal of this report is to explore the scientific challenge of using short-term observations at the level of individuals to predict effects on populations.”

National Resource Council

2005 Report

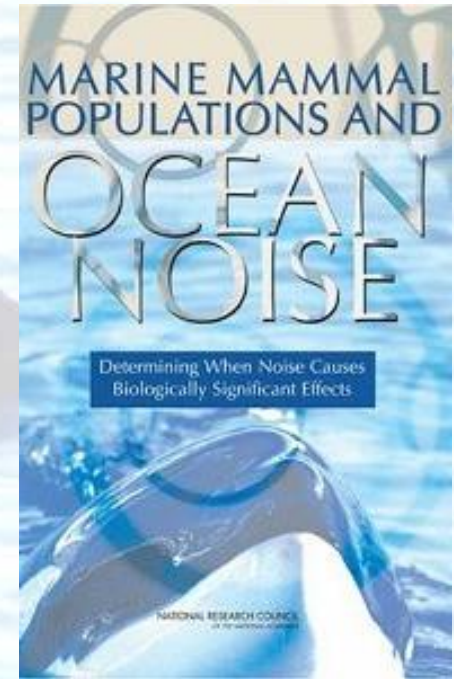


“An action or activity becomes **biologically significant** to an individual animal **when it affects the ability of the animal to grow, survive, and reproduce**. Those are the effects on individuals that can have population-level consequences and affect the viability of the species. However, those effects are separated in time and usually in space from the precipitating event. What can be observed, with difficulty in the case of marine mammals, ...

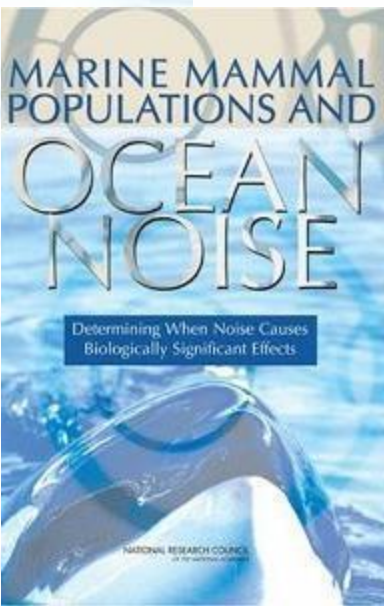
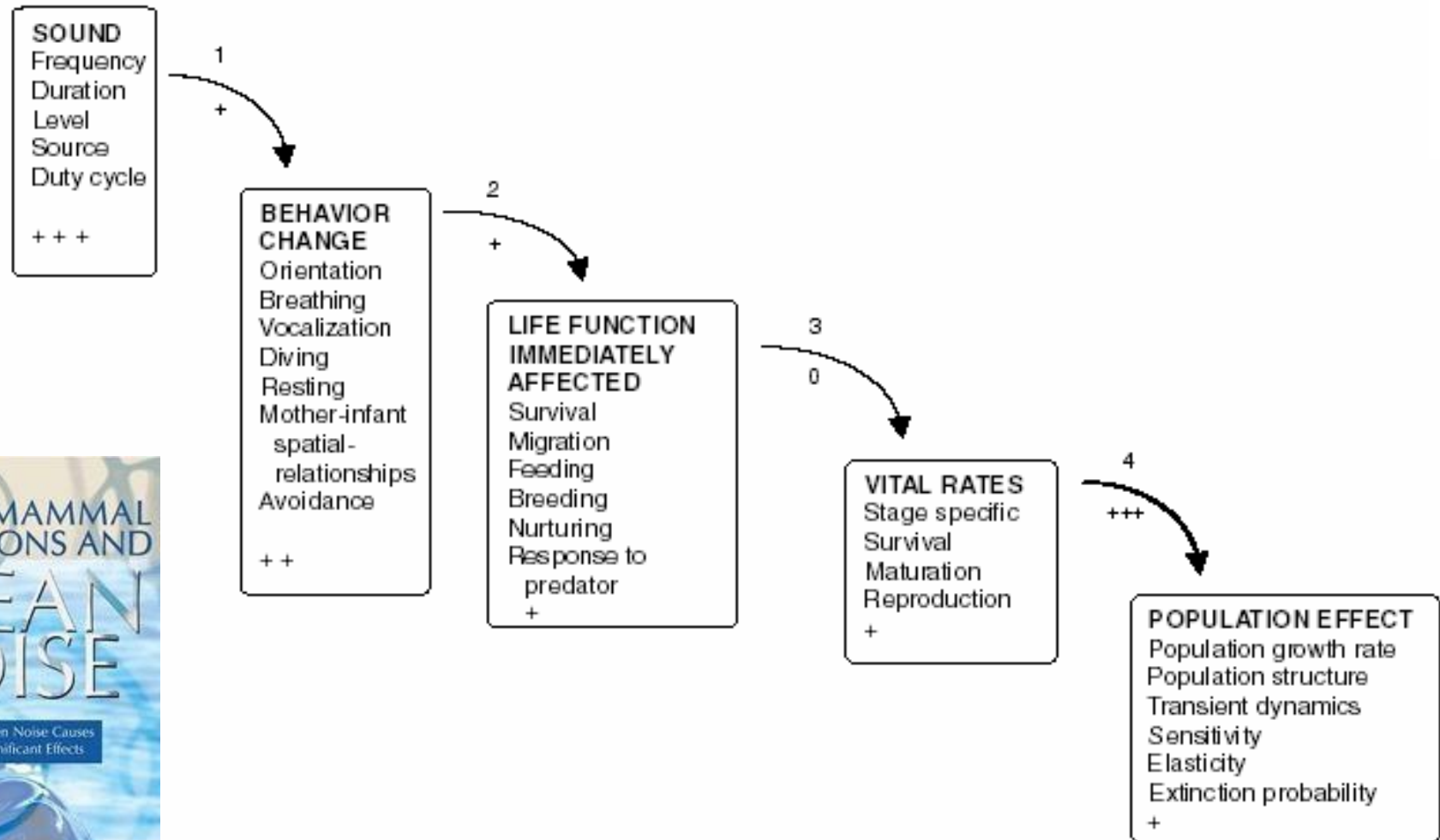
PCAD: a framework for determining the importance of Level B harassment

“It does not make sense to regulate minor changes in behavior having no adverse impact; rather, regulations must focus on significant disruption of behaviors critical to survival and reproduction.” -NRC 2000

“...a conceptual model designed to serve as a roadmap for developing a predictive model that will relate behavioral responses caused by anthropogenic sound to biologically significant, population-level consequences.” -NRC 2005



PCAD model connects observable data through a series of transfer functions



NRC 2005

ONR PCAD Working Group

- Planning meeting Feb 2009
- Initiated Working Group Sep 2009, 2 ½ yr effort
- Oil & Gas Joint Industry Program, MMC
- Scientific Steering Committee
 - John Harwood (U. St. Andrews) - chair
 - Dan Costa (UC Santa Cruz)
 - Peter Tyack (WHOI / U. St. Andrews)
 - Erica Fleishman (UC Davis) – facilitator



ONR PCAD Working Group

- NCEAS-style Working Group
 - Mix of data holders/biologist and modelers
 - Collaborative partnerships (biologist / modelers)
- Approach:
 - Case study approach
 - Identify / use most robust datasets available
 - Generalized disturbance



Working Group Case Studies

- Elephant Seals (N/S)
- Coastal Bottlenose Dolphins
- North Atlantic Right Whale
- Beaked Whale



ONR PCAD Working Group

Objectives

- Translate the NRC PCAD model into a formal mathematical framework
- Develop conceptual approaches and exploratory models for the *transfer functions* of the NRC model
- Consider how these models can be parameterized with *existing or new data*



PCAD Implications

- Little known about if/how ‘takes’ might reduce survival or annual recruitment
- PCAD framework will provide **quantitative** approach to evaluate effects and the relationship between “takes” and possible changes to adult survival and/or annual recruitment
- Alternative, more rigorous and informed approach than is currently used



PCAD Limitations

- We've have only just begun....
- Species-specific models, rather than generalized or transferable
- Requires diverse and robust datasets
- Opportunistic vs specific disturbance of interest
- Others...



PCAD Working Group ...Next Steps

- Phase II Working Group ?
- Expand case studies
- Transferability
- Guidance to monitoring efforts on key metrics that are biologically significant



Thanks to Working Group Participants

(April 2011)

Erica Fleishman, University of California, Davis

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Dan Costa, University of California, Santa Cruz

Mark Hindell, University of Tasmania

Sascha Hooker, University of St Andrews

Scott Kraus, New England Aquarium

Clive McMahon, Charles Darwin University

Dave Moretti, Naval Undersea Warfare Center

Samantha Simmons, Marine Mammal Commission

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Len Thomas, University of St Andrews

