

Navy Perspective (ONR Basic Research Perspective)



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Background



- Issue: Marine Mammal Strandings
 Examples Greece 1996; Bahamas, 2000;
 Canaries (multiple events); Greece 2014;
 others
- U.S. National Academies of Science 2003 Report
 - Potential effects of acoustic disturbance include ... <u>behavioral changes</u>
- U.S. NAS 2005 Report
 - Link short-term <u>behavior change</u> to population-level change



Level Source Duty cycle



- Regulatory framework
- ONR Marine Mammal & Biology Program
- Initial drivers / achievements
- Evolving drivers / achievements
- Evolving Navy programs
- Future needs

Regulatory Framework



- <u>U.S. National Environmental Policy Act</u> (NEPA)
 - All US federal agencies are <u>required</u> under federal law to evaluate potential adverse environmental effects from their own activities
- <u>U.S. Marine Mammal Protection Act</u> (MMPA)
 - Level A Harassment (take) potential to *injure*
 - <u>Level B</u> Harassment (take) *potential to <u>disturb</u>* (*behavioral effects*)
- <u>EU Marine Strategy 2008</u>:
 - Achieve or maintain Good Environmental Status









Regulatory Approach for MFAS Compliance

- 2008 implementation; ongoing, complex process
- Risk Assessment Modeling (MMPA A/B)

• Navy and NOAA Develop Systematic

- TAP I 2009-2013
- TAP II 2014-2018
- TAP III 2019-2023 (* Modeling begin 2015)
- NMFS Negligible Impacts Determination
 - Level of <u>species or stock</u>
- NMFS Letters of Authorization (LOA)
 - Requirement for *Monitoring & Reporting*
 - <u>Strategic Plan</u> in 2012/13

U.S. Navy Compliance







Goal - Enable Navy to meet its operational training and testing objectives in an environmentally responsible and legal manner

Objectives

- Invest in basic (6.1) and early applied (6.2) research and technology development to discover and understand the effects of sound on marine mammals
- Coordinate within Navy to:
 - ensure that risk assessment needs have best & most relevant information,
 - develop cutting edge capability & tools for Fleet and SYSCOM Compliance Monitoring Program

ONR MMB Research Topics







* Improve monitoring of free-ranging marine mammals using passive acoustics, Infrared, other

* Integrated Ecosystem Research

- Multidisciplinary approach to collect baseline measures of marine mammal behaviors and distributions relative to key environmental features
- <u>Sensor and Tag Development</u>: Development of a broad suite of sensors on a variety of tag form factors, and development of attachment mechanisms

***** Effects of Sound on Marine Mammals

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

* Models & Databases for Decision Making

 Provide tools and publically accessible databases to support Navy environmental compliance & decision making

BRS – Initial Drivers

- E.U. and U.S. relied heavily on risk of injury, but growing interest in behavioral effects (U.S. – Level B takes)
- Initial Studies
 - AUTEC 2007/08 (ONR/N45/Fleets)
 - Stationary, simulated source
 - MFAS ~ 3.5 kHz
 - Investigate onset of behavioral response (permit limitations – 'Death ray')
 - 3S: 2006/08/09 Dutch/Norwegian/U.S.
 - Operational Dutch naval source, mobile
 - LFAS 1-2 kHz, MFAS 6-7 kHz
 - Better understand the risk of stranding, mitigate behavioral mechanism







Key S&T Enabler – Dtag

- WHOI: M. Johnson/P. Tyack Non-invasive, remote-deployed, archival tags to obtain highresolution, multivariate individual data:
 - Depth (pressure sensors)
 - 3D movement (accelerometers, magnetometers)
 - Light (photo sensors)
 - High-sampling rate acoustics (up to 512 kHz), some with multiple hydrophones
 - Lat/Lon position









3S - Achievements



| | Killer | Pilot | Sperm | Herring |
|--------------------------------------|--------|-------|-------|---------|
| 3S-BRS achievements 2006, 2008, 2009 | | 6 | * | |
| | 10 | 24 | 8 | |
| LFAS MFAS Silent | 4 | 6 | 4 | 12+6 |
| LFAS down sweep | 1 | 2 | 2 | |
| Killer whale sounds | 3 | 4 | 3 | 6 |

3S - Achievements





Pls - Len Thomas and Catriona Harris – University of St. Andrews

(Multi-study OCean acoustics Human effects Analysis)

- Support the Navy-funded MFA sonar BRSs by developing and demonstrating analytical approaches for:
 - Combining behavioral / acoustic measures into single metric
 - Producing dose-response functions from individual studies
 - Pooling information across studies and species
 - Sensitivity analyses to inform future experimental.
- MFA sources
 - Bahamas BRS (2007-2008)
 - SOCAL BRS (2010-2015)

The MOCHA project

- 3S and 3S2 (2006-2013)
- Cape Hatteras and Hawaii BRS (2012-2014)





BRS – Evolving Drivers



- E.U. and U.S. interested in the effects of behavioral changes on fitness and population-level effects
- More Studies
 - Bahamas BRS (2007-2008), SOCAL BRS (2010-2015), 3S and
 3S2 (2006-2013), Cape Hatteras and Hawaii BRS (2012-2014)



3S and 3S² Achievements 2006-2013

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Research to Compliance Application







- <u>Evolving Drivers</u> E.U. and U.S. interested in the effects of behavioral changes on fitness and populations
- Biologically significant responses that effect fitness
- Cumulative effects of multiple sources / stressors





Behavioral Response Research Evaluation Workshop (BRREW) - April 2015



- **Goal:** An assessment of the <u>current state</u> of knowledge on the behavioral response of marine mammals to <u>Navy sonar</u>
- **PI Team** L. Thomas, C. Harris (MOCHA)
- Steering Group P. Tyack, P. Kvadsheim, A. Reid, P. Miller, B. Southall
- External Panel Review D. Wartzok, H. Slabberkoorn,
 V. Janik
- Outcomes
 - Workshop Report PIs and External Panel
 - Review Paper PIs, SG, External Panel





Behavioral Response Research Evaluation Workshop (BRREW) - April 2015



Table 2: Recommendations for future research

- Free Range CEE
 - Baseline data all species
 - CEE with real Navy ships/sources and generate dose-response curve
 - Investigate response with distance from source to whale
- Observational
 - Compare population demographics on/off Navy ranges
 - Improve understanding of dose and severity response to understand consequences (fitness and populations; CEE)
- <u>Technology</u>
 - Develop medium-to-long term tags with GPS and acoustics
- <u>Captive Studies</u>
 - explore signal characteristics





Thank you



• Questions

