Marine Mammal & Biology Program

NAS / BOEM 'First In Class' Workshop




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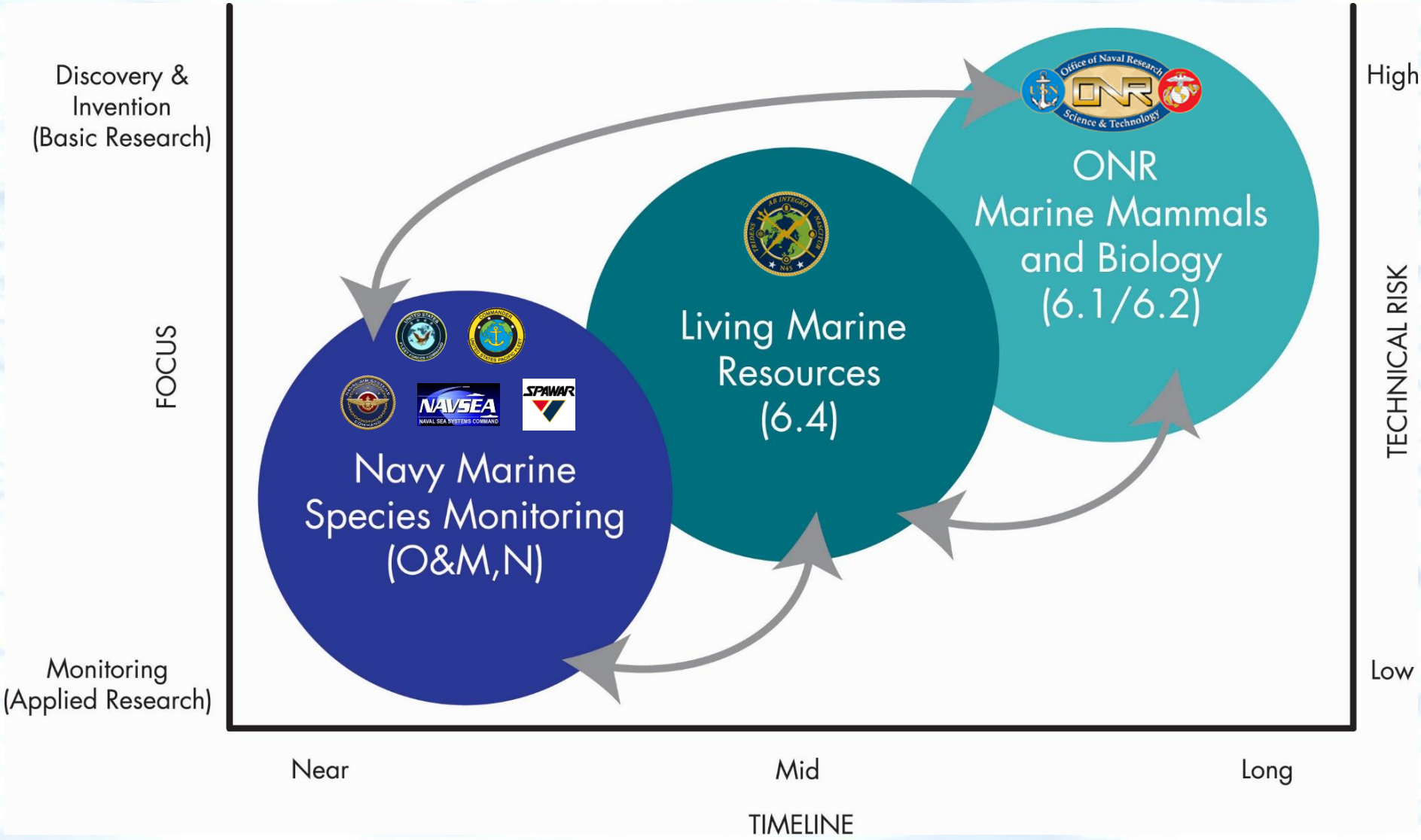
U.S. Navy Marine Resource Investments

From Research to Application



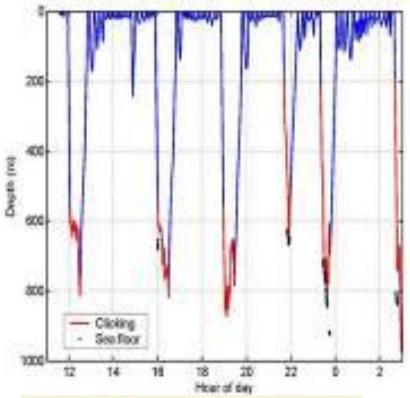
Marine Mammal & Biology Program

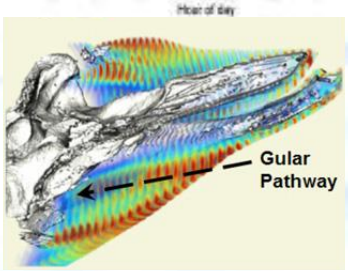
Goal - Enable Navy to meet its operational training and testing objectives in a legal and environmentally responsible manner

Objectives

- 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 within Navy to:
  - Provide the best and most relevant information for risk assessments (i.e. EISs)
  - Develop cutting edge capability & tools for Fleet and SYSCOM Marine Species Monitoring (MSM) Program

Marine Mammal & Biology Program





❖Monitoring & Detection of Marine Mammals

- ❖ Improve monitoring of marine mammals over current methods

❖Integrated Ecosystem Research

- ❖ Multidisciplinary approach to collect baseline measures of marine mammal behaviors and distributions relative to key environmental features
- ❖ Sensor and Tag Development: Development of attachment mechanisms; 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
- ❖ Hearing: Developing complete model of marine mammal hearing anatomy, temporary and permanent threshold shifts, improved testing via AEP
- ❖ 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

❖Models & Databases for Decision Making

- ❖ Develop tools to support environmental compliance & decision making

Outline

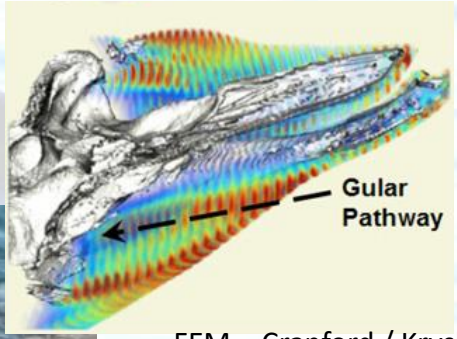
1. Identifying Science Needs
2. Identifying Who Conducts the Science
3. Program Outputs
4. Program Impacts
5. Program Improvement




Identifying Science Needs

- Define program scope
- Engage partnerships
- Stay current on state of science
- Targeted expert workshops

DMON in SeaGlider - Bogue / Luby



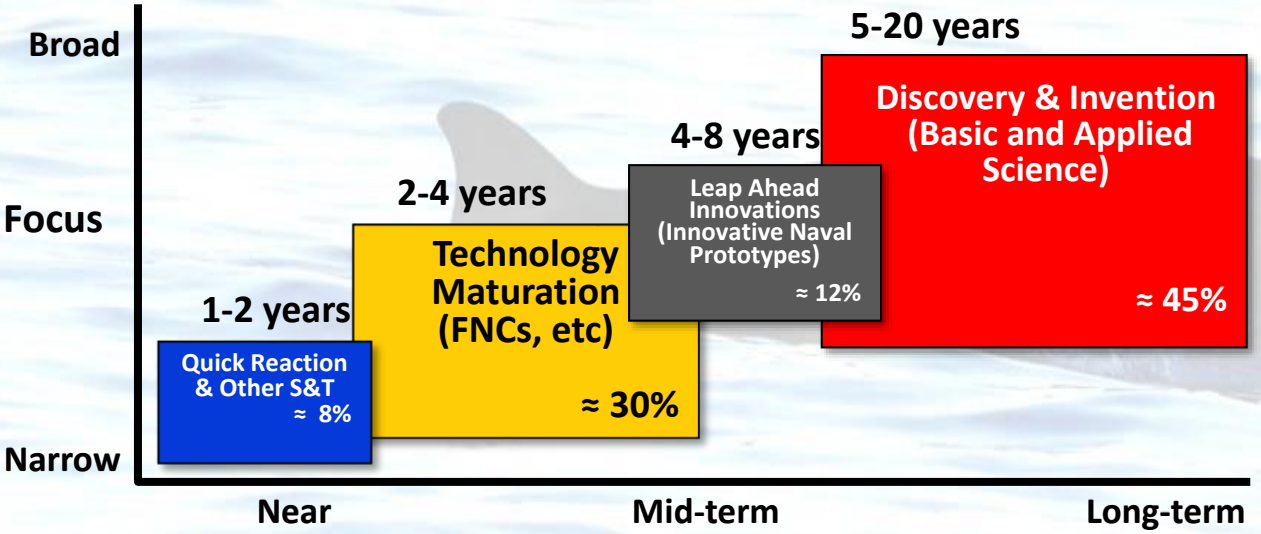
FEM – Cranford / Krysl

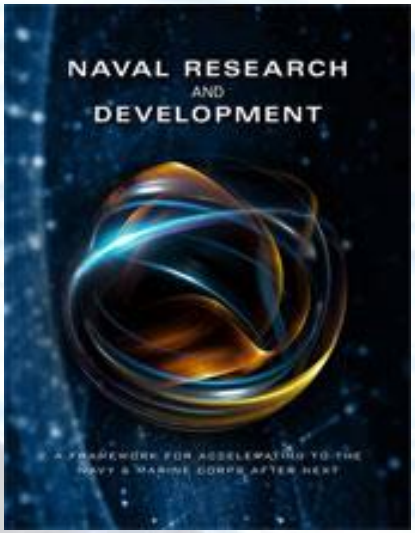
SMRU – FastLoc GPS

UAV – Ferguson / Angliss

The Office of Naval Research

The S&T Provider for the Navy *and* Marine Corps





Naval R&D Framework

Solid State Lights for Submarines

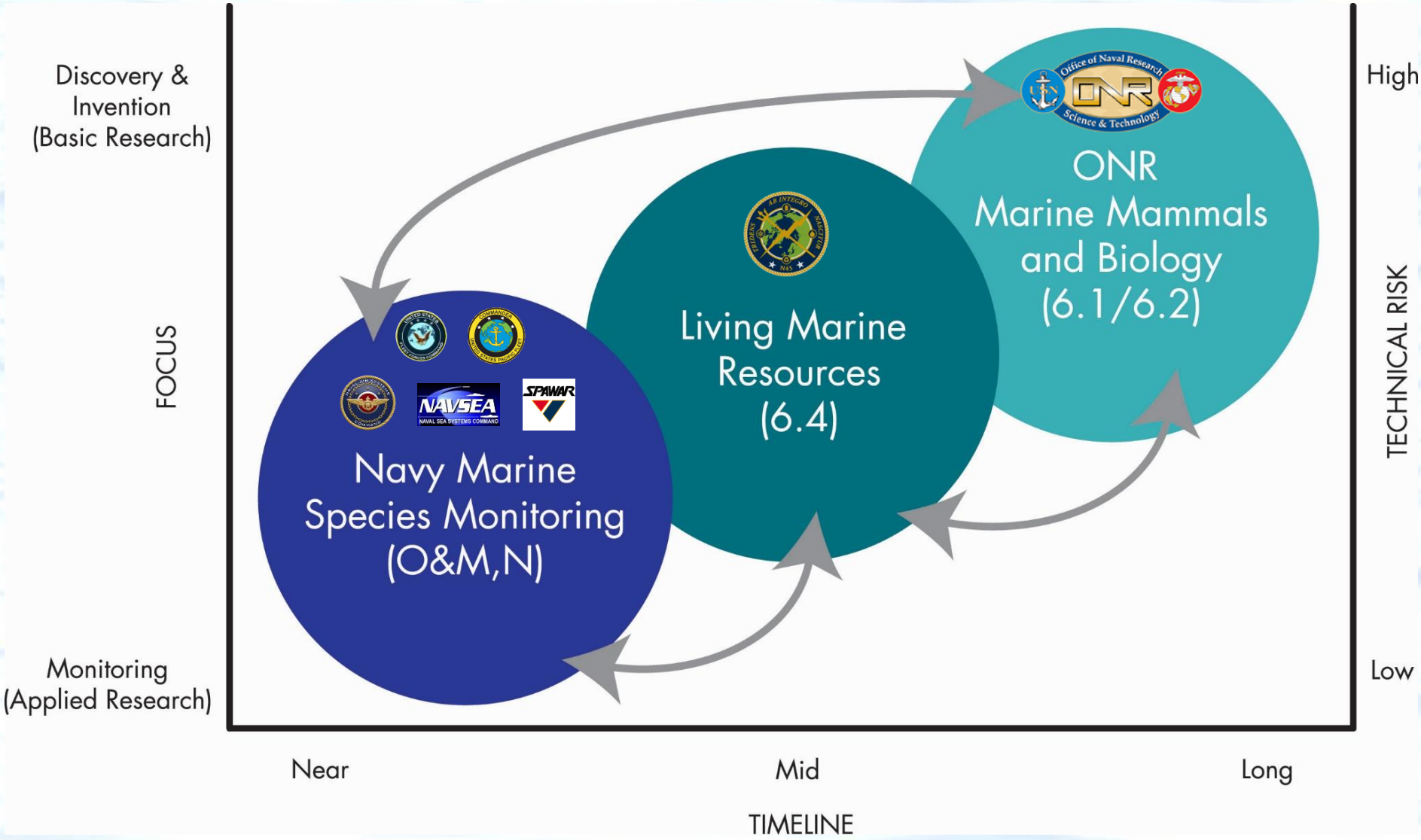
Advanced Materials

Large Displacement UUV

Discovery & Invention

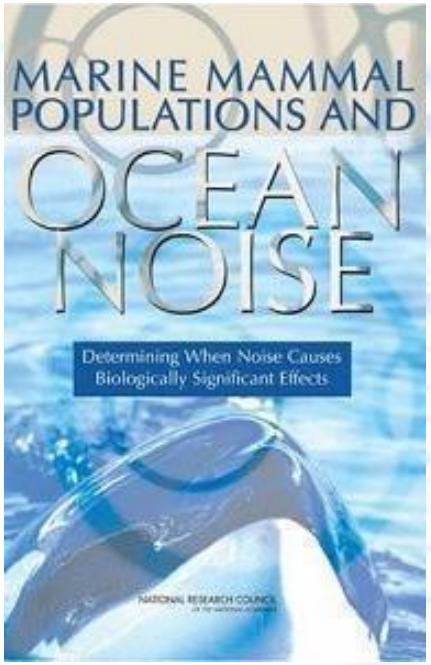
Identifying Science Needs

Define the Scope



Identifying Science Needs

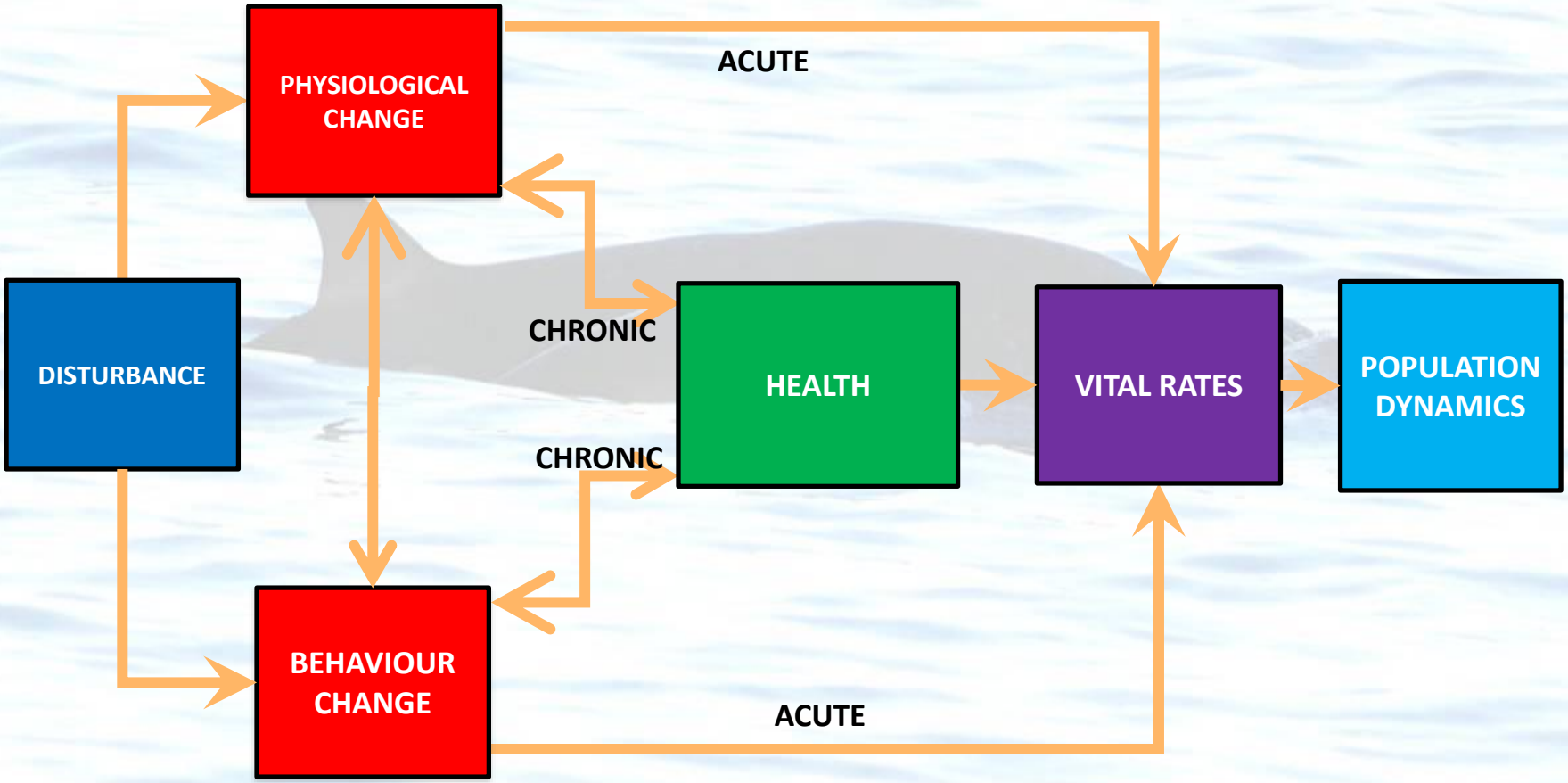
Define the Scope



NAS 2005

Identifying Science Needs

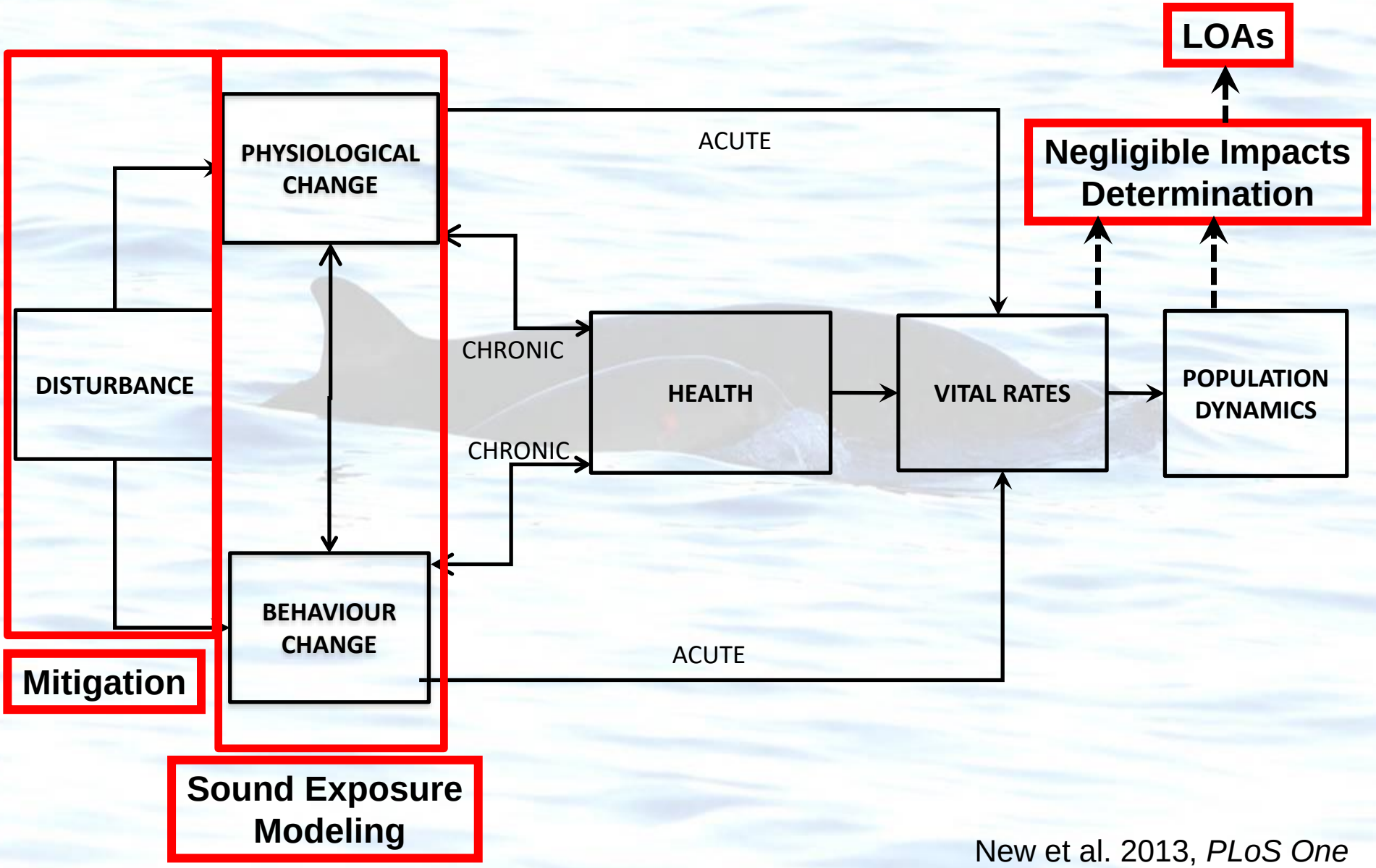
Define the Scope



New et al. 2013, *PLoS One*

Identifying Science Needs

Define the Scope



New et al. 2013, *PLoS One*

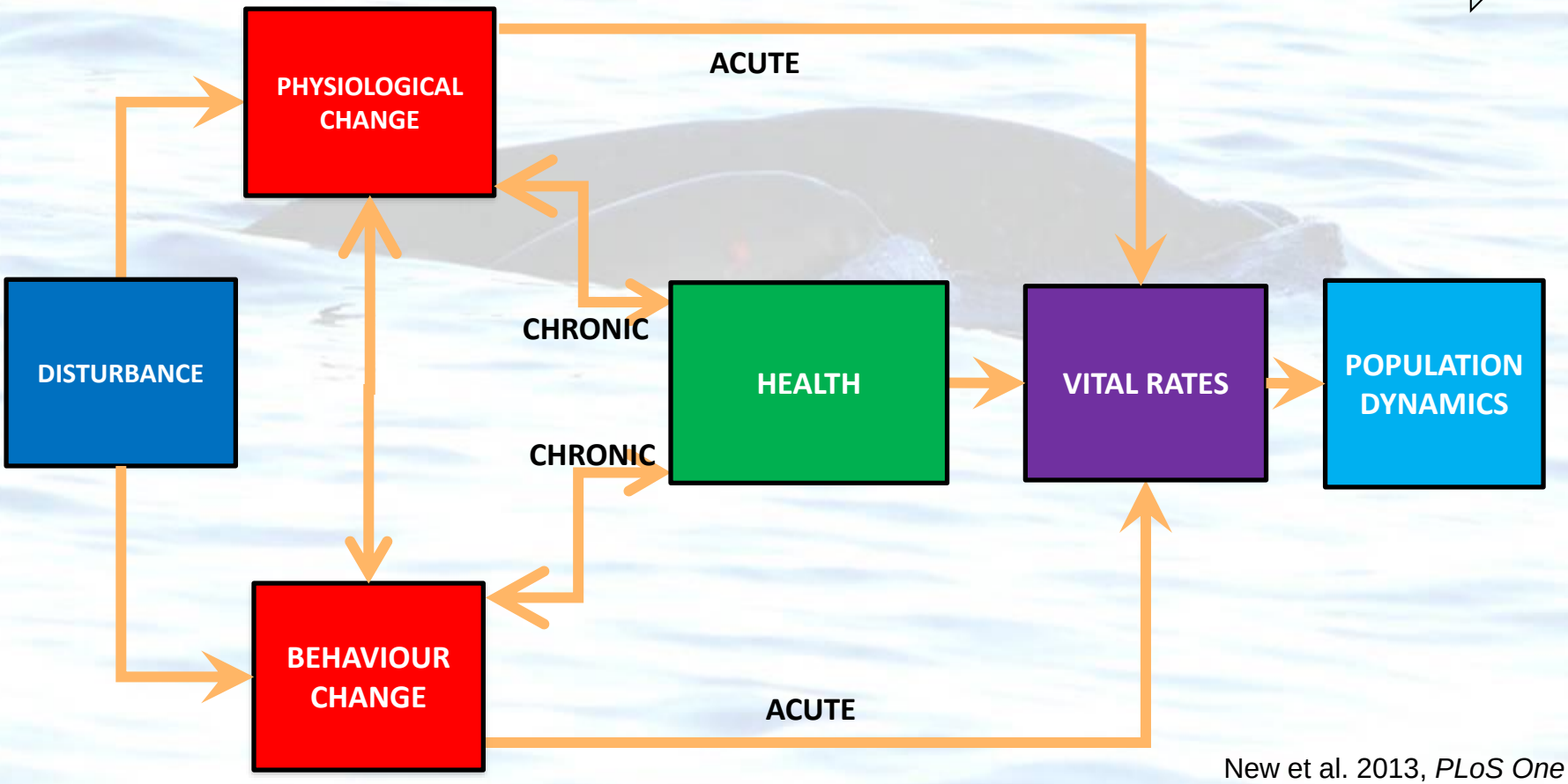
Identifying Science Needs

Define the Scope

Monitoring & Detection

Integrated Ecosystems Research

Effects of Sound on MM

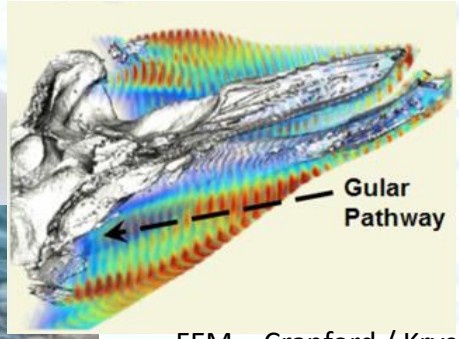


New et al. 2013, *PLoS One*

Identifying Science Needs

- Define program scope
- Engage partnerships
- Targeted expert workshops
- Stay current

DMON in SeaGlider - Bogue / Luby



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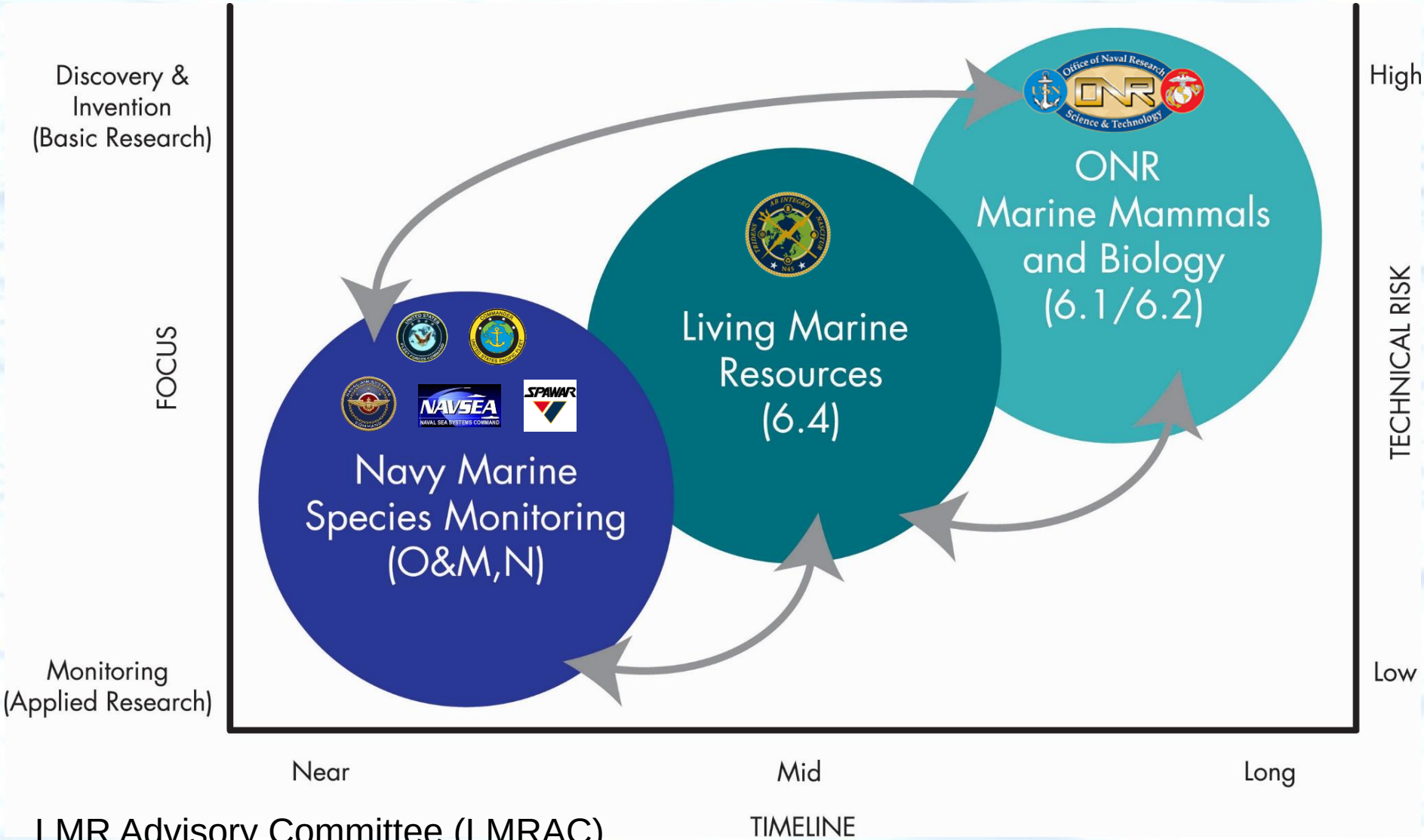
SMRU – FastLoc GPS

UAV – Ferguson / Angliss

Identifying Science Needs

Partnerships



Identifying Science Needs

DOD Partnerships

Navy/DoD/NATO Collaborative Efforts

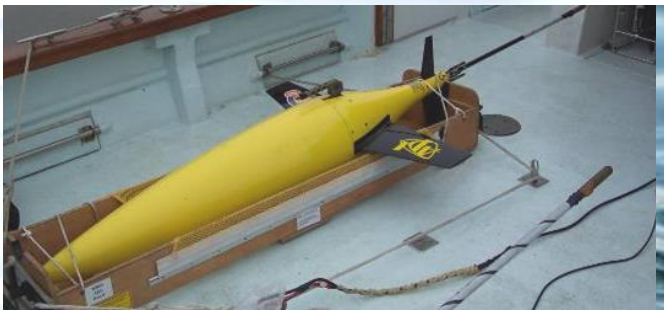
- Strategic Environmental R&D Program (SERDP), Environmental Security Technology Certification Program (ESTCP), *Resource Conservation and Resiliency* - Program Area
  - Multi-stressors / Cumulative Effects
  - Cetacean Ecology RFP (Benoit-Bird, Claridge, Miller)
  - Acoustic tag development (Tyack, WHOI)
- NATO Undersea Research Center (NURC)
  - Longstanding cooperative efforts and surveys;
  - BRS Mediterranean
- NAVSEA
  - Automated Pathways for eDNA Monitoring
  - PEO IWS5 – AUTEC Behavioral Response Study
- DARPA - Microbiome surveillance; Tracking maritime vessels
- US Army Engineer Research & Development Center (ERDC), Environmental Laboratory, Genetics Reconnaissance

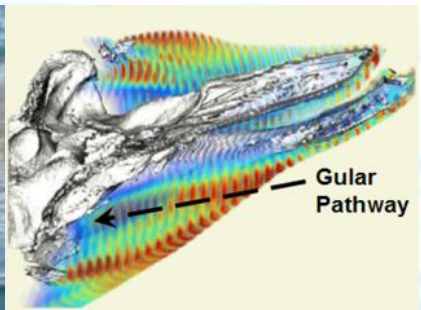
Identifying Science Needs

Interagency Partnerships

White House Office of Science and Technology Policy (OSTP), Subcommittee on Ocean Science and Technology (SOST)

- IWG Integrated Ocean Observing Committee (IOOC)
  - ATN – Animal Telemetry Network Task Team
  - BIO-TT / BIO-ICE – Biological Observing Task Team
- IWG Ocean Sound & Marine Life
  - Large Whale Hearing
  - Noise Reference Stations
  - PAM Archiving
- IWG Committee on Biodiversity
  - MBON – Marine Biodiversity Observing Network





Identifying Science Needs

Interagency Partnerships

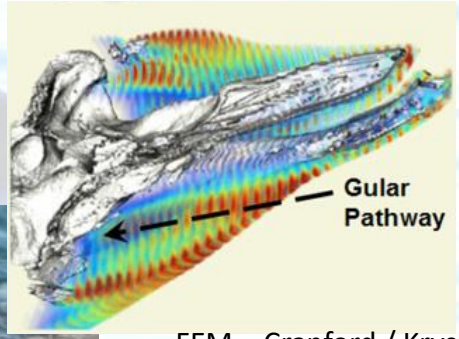
- NOAA
  - 2019 SOST ONML-IWG Development of Mysticete audiogram
  - 2015 NAS
  - 2011 DCL – Clark DCL Development
  - 2010 Tag Attachments – Calambokidis (Type I tags)
  - DECAF - Density estimation using acoustic sensors (U St. Andrews)
- NSF
  - 2011 DCL – Clark WaveGlider; Halpin – OBIS-SEAMAP
  - 2010 Tag Attachments – Moore (Type III tags)
  - 2004/2007 Acoustic tag developments, habitat studies, databases, educational materials
- BOEM
  - 2019 SOST ONML-IWG Development of Mysticete audiogram
  - 2011 DCL – Roch Metadata Management
  - 2010 Tag Attachments - Calambokidis (Type I tags)
- MMC
  - 2021 Bioenergetics Workshop
  - 2019 Development of Mysticete audiograms
- Industry (Exxon-Mobil, JIP)
  - 2009-2015 PCAD Working Group (Costa/Eseal case study)
  - 2011 Clark DCL Development
  - 2010 Tag Attachments - Calambokidis (Type I tags)
  - Passive acoustic detection of mammals in Arctic

NOPP - The field team attaches a tag to the pelage of a sedated male elephant seal

Identifying Science Needs

- Define program scope
- Engage partnerships
  - Navy partners (6.4 LMR Program, FLT/ SYSCOM MSM Program)
  - Federal agencies
  - International
- Targeted expert workshops
- Stay current

DMON in SeaGlider - Bogue / Luby



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SMRU – FastLoc GPS

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Identifying Science Needs

Expert Input

- Workshops, Workshops, Workshops

  Identify State-of-the-Science, Gaps, Research Needs

J. CETACEAN RES. MANAGE. 20: 27–66, 2019

Best practice guidelines for cetacean tagging

RUSSEL D. ANDREWS[1], ROBIN W. BAIRD[2], JOHN CALAMBOKIDIS[2], CAROLINE E.C. GOERTZ[3], FRANCES M.D. GULLAND[4], MADS PETER HEIDE-JØRGENSEN[5], SASCHA K. HOOKER[6], MARK JOHNSON[6], BRUCE MATE[7], YOKO MITANI[8], DOUGLAS P. NOWACEK[9], KYLIE OWEN[10], LORI T. QUAKENBUSH[11], STEPHEN RAVERTY[12], JOOKE ROBBINS[13], GREGORY S. SCHORR[1], OLGA V. SHPAK[14], FORREST I. TOWNSEND, JR.[15], MARCELA UHART[4,16], RANDALL S. WELLS[17] AND ALEXANDRE N. ZERBINI[1,2,18]

Contact e-mail: russ@marecotel.org

ABSTRACT

Animal-borne electronic instruments (tags) are valuable tools for collecting information on cetacean physiology, behaviour and ecology, and for enhancing conservation and management policies for cetacean populations. Tags allow researchers to track the movement patterns, habitat use and

REPORT ON THE CURRENT STATUS AND FUTURE OF BEHAVIORAL RESPONSE RESEARCH

REPORT ON THE CURRENT STATUS AND FUTURE DIRECTIONS OF MARINE MAMMAL DIVING PHYSIOLOGY:

CONSIDERATIONS FOR THE EFFECT OF MILITARY SONAR ON DEEP-DIVING CETACEANS

University of California – Santa Cruz, September 11-13, 2017

Received: 22 September 2016 | Accepted: 13 June 2017

DOI: 10.1111/1365-2664.12955

REVIEW

Journal of Applied Ecology

Marine mammals and sonar: dose-response studies, the risk-disturbance hypothesis and the role of exposure context

Catriona M. Harris[1] | Len Thomas[1] | Erin A. Falcone[2] | John Hildebrand[3] | Dorian Houser[4] | Petter H. Kvadsheim[5] | Frans-Peter A. Lam[6] | Patrick J. O. Miller[7] | David J. Moretti[8] | Andrew J. Read[9] | Hans Slabbekoorn[10] | Brandon L. Southall[11] | Peter L. Tyack[7] | Douglas Wartzok[12] | Vincent M. Janik[7]

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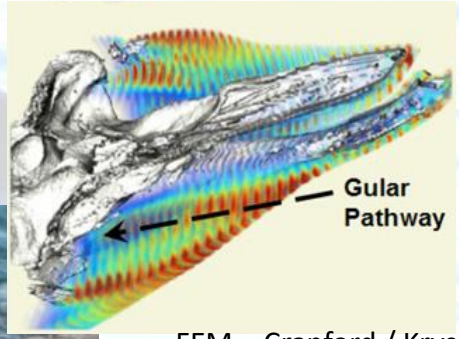
Abstract

1. Marine mammals may be negatively affected by anthropogenic noise. Behavioural response studies (BRS) aim to establish a relationship between noise exposure conditions (dose) from a potential stressor and associated behavioural responses of animals. A recent series of BRS have focused on the effects of naval sonar sounds on cetaceans. Here, we review the current state of understanding of naval sonar impact on marine mammals and highlight knowledge gaps and future research priorities.
2. Many marine mammal species exhibit responses to naval sonar sounds. However, responses vary between and within individuals and populations, highlighting the importance of exposure context in modulating dose–response relationships.
3. There is increasing support from both terrestrial and marine systems for the risk-

Identifying Science Needs

- Define program scope
- Engage partnerships
  - Navy partners (6.4 LMR Program, FLT/ SYSCOM MSM Program)
  - Federal agencies
  - International
- Targeted expert workshops
- Stay current
  - Conferences, Symposiums, Workshops

DMON in SeaGlider - Bogue / Luby



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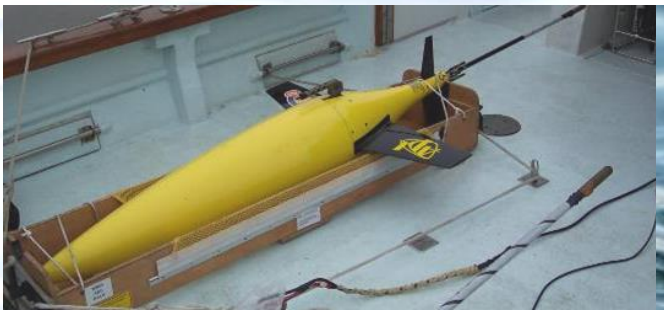
Outline

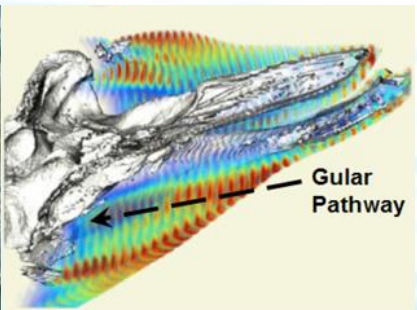
1. Identifying Science Needs
2. Identifying Who Conducts the Science
3. Program Outputs
4. Program Impacts
5. Program Improvement




Identifying the Who

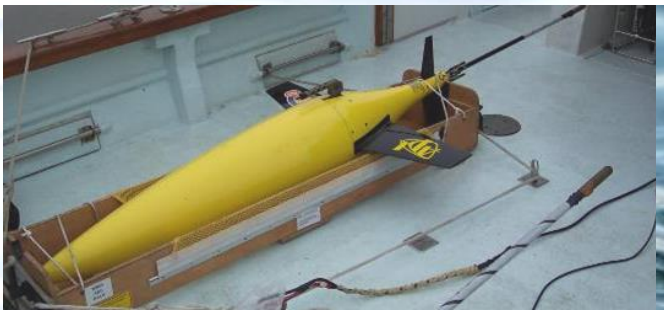
- People, People, People
  - Supporting people and community
  - Diversity & Inclusion (HBCU-MSI)
  - Workforce Development
  - Stay current - Conferences, Symposiums, Workshops
- Proposal Selection…Making Decisions

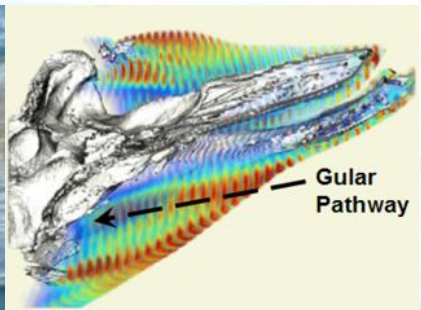




Identifying the Who

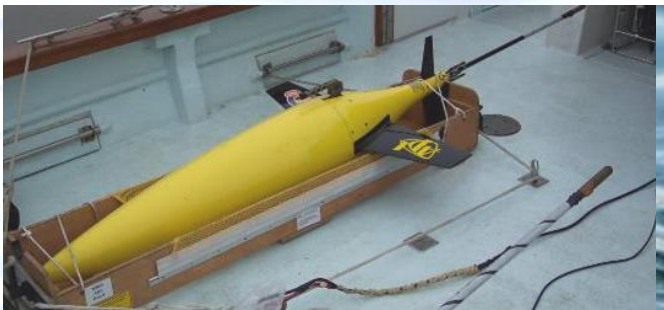
- People, People, People
  - Supporting people and community, not just research
    - Awareness of career & personal needs (i.e. Tenure & promotion, maternity/family leave)
    - Supporting women in science
    - Young PIs – YIPs, PECASE, VBFF awards
    - Keep PI's engaged on topic
  - Diversity & Inclusion (HBCU-MSI)
  - Workforce Development
  - Stay current - Conferences, Symposiums, Workshops
- Proposal Selection…Making Decisions

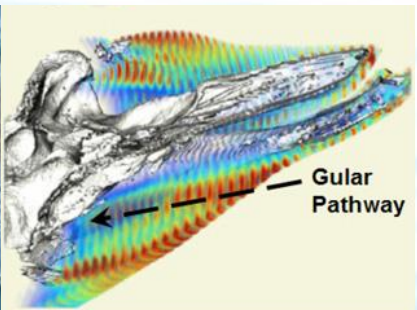




Identifying the Who

- People, People, People
  - Supporting people and community, not just research
  - Diversity & Inclusion (HBCU-MSI)
    - Paid academic year internships (early Undergrads)
    - Paid summer internships
    - Virtual programming (i.e. career development, soft skills, build cohort)
    - Targeted Conference Programs / Workshops (i.e. Aquatic Noise, SMM)
  - Workforce Development
  - Stay current - Conferences, Symposiums, Workshops
- Proposal Selection…Making Decisions

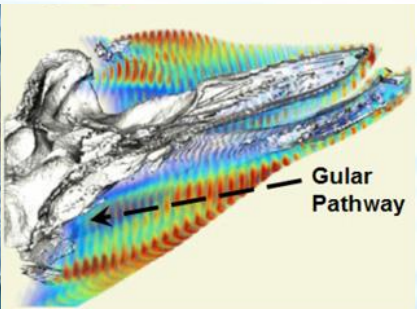




Identifying the Who

- People, People, People
  - Supporting people and community, not just research
  - Diversity & Inclusion (HBCU-MSI)
  - Workforce Development
    - Graduate student support (i.e. NDSEG)
    - Course support (i.e. SeaBass, Marine BioAcoustics)
  - Stay current - Conferences, Symposiums, Workshops
- Proposal Selection…Making Decisions





Identifying the Who

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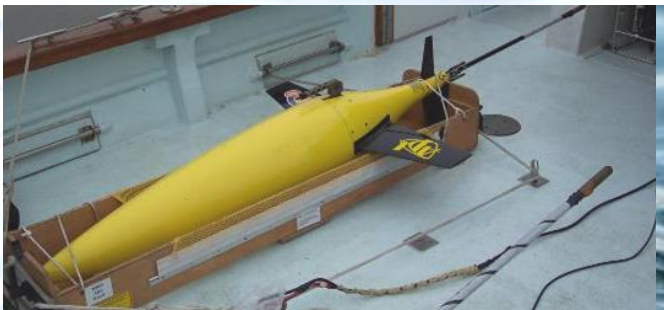
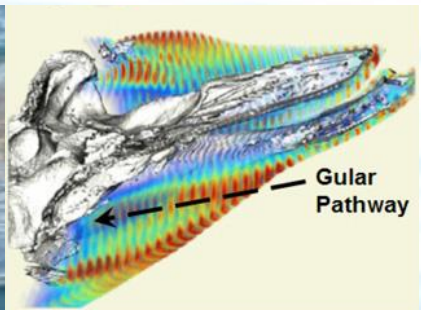
  - Supporting people and community, not just research
  - Diversity & Inclusion (HBCU-MSI)
  - Workforce Development
  - Stay current - Conferences, Symposiums, Workshops
    - Identifying up & coming researchers, Postdocs, and students
- Proposal Selection…Making Decisions





Identifying the Who

Proposal Selection…Making Decisions

ONR Global

FFRDCs

UARCs/Academia

Industry

NRL/Warfare Centers

- 70 Countries
- 50 States
- 1,078 Companies
  - **Contracts**
- 1,035 Universities & Nonprofit Entities
  - 3,340 principal investigators
  - 3,000 grad students
  - **Grants** – Basic/Early Applied Research

Identifying the Who

Proposal Selection…Making Decisions

ONR Funding Opportunities

- **322 Core Programs** (i.e. MMB)
- **MURI** – Multi-University Research Initiative
  - Topic-based driven by Program Managers
- **DURIP** – Defense University Research Instrumentation Program
- **YIP** - Young Investigator Program (tenure-faculty position win last 5 yrs)
- **PEACSE** – Presidential Early Career Award for Scientist and Engineers
- **DRI** - Departmental Research Initiatives
- **BRC** – Basic Research Challenge

Identifying the Who

Proposal Selection…Making Decisions

- Solicitations – Open / targeted BAAs; NOPP or other
  - Posting on List Serves (i.e. MARMAM)
  - Predictable w/ consistent annual cycle
- Pre-Proposal / Proposal Cycle
  - Pre-proposals in Summer (mid-July)
  - Full proposals in Q1 each Fiscal Year
- Proposal Review
  - ***PO for MMB pre- / full proposals***
  - PO's in Code 32 for DURIP, YIP, PECASE
  - Panels for SBIR/STTR, NOPP and other interagency BAA/RFPs

Identifying the Who

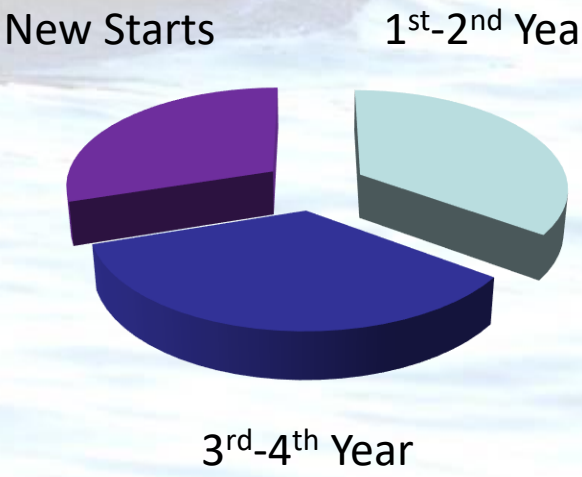
Proposal Selection…Making Decisions

- Picking from the best of the best
  - Track record for grants, publications, etc.
- Seeking best fit for MMB program
  - People
  - Rotating priority topics
  - Balancing portfolio across topic
  - Flexibility to leverage opportunities

Identifying the Who

Proposal Selection…Making Decisions

- Flexibility / Mix it Up
  - Mix of high-risk to incremental developments, improvements
  - Mix of pilots (1yr) to longer-term projects (3-5yrs)
  - 1/3, 1/3, 1/3
- Tailored approach
  - Working Groups: PCOD, Cetacean Tag Attachments, Stress, Classification
  - Cross-disciplinary pairings: modelers, engineers/companies, oceanographers with biologists



Outline

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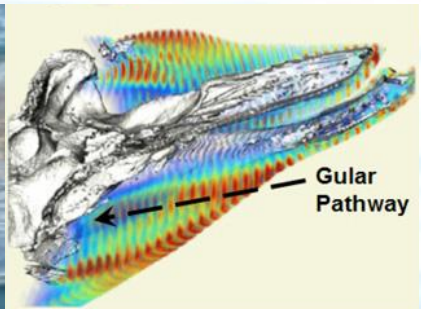
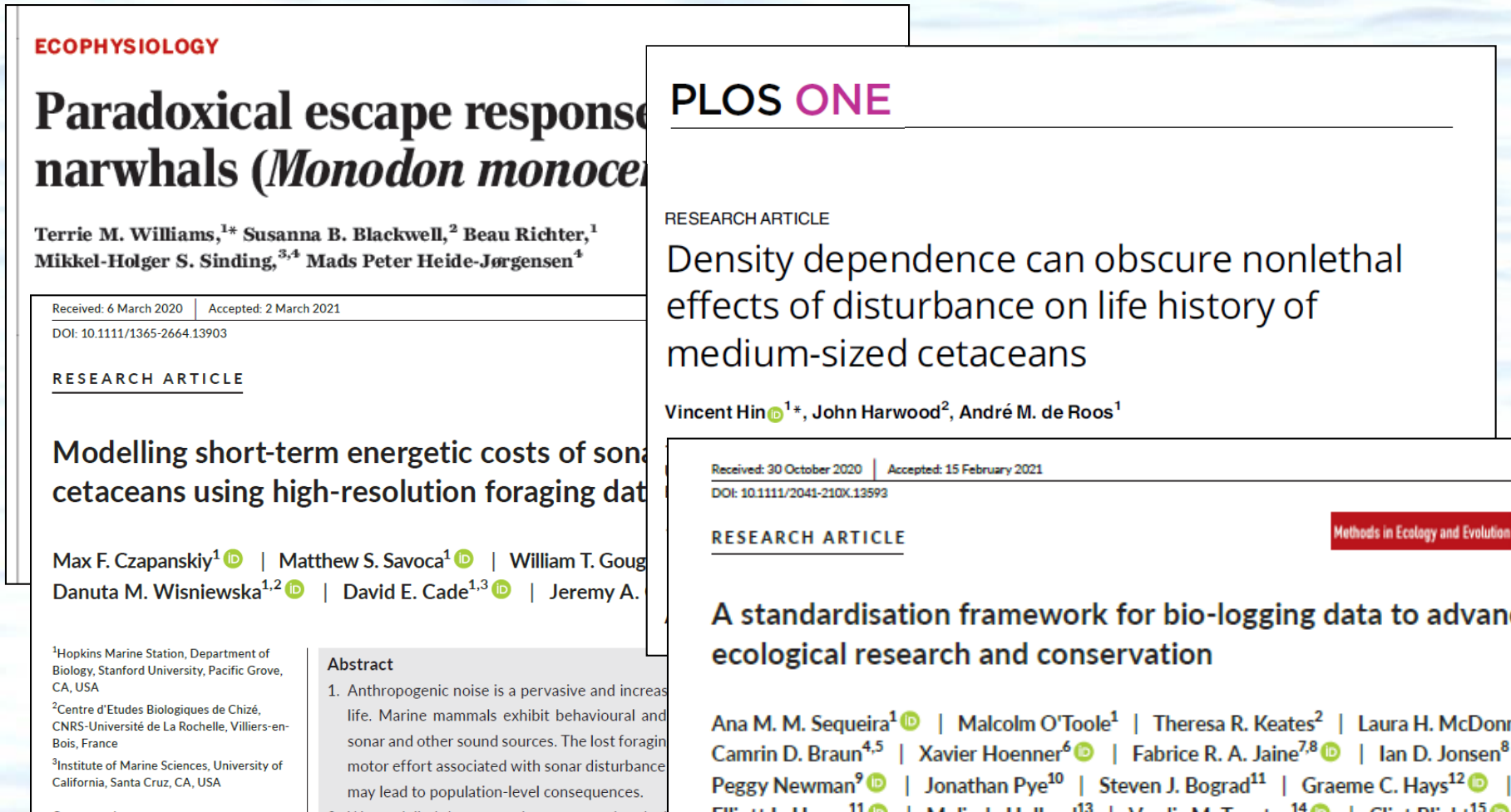
Program Outputs

- Outputs
  - ONR Annual Report is a Requirement
  - Peer review publications are Desirable
  - Observational data
  - Students / Postdocs
- Review & Evaluation of Projects in Progress



Program Outputs

- Relevance to MMB program objectives
- Impact Scores, Citations (MM field, MMB, Navy EIS)



ECOPHYSIOLOGY

**Paradoxical escape response narwhals (*Monodon monoce*

Terrie M. Williams,[1]* Susanna B. Blackwell,[2] Beau Richter,[1] Mikkel-Holger S. Sinding,[3,4] Mads Peter Heide-Jørgensen[4]

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DOI: 10.1111/1365-2664.13903

RESEARCH ARTICLE

Modelling short-term energetic costs of sona cetaceans using high-resolution foraging dat

Max F. Czapanskiy[1] | Matthew S. Savoca[1] | William T. Goug
Danuta M. Wisniewska[1,2] | David E. Cade[1,3] | Jeremy A.

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[3]Institute of Marine Sciences, University of California, Santa Cruz, CA, USA

Abstract

1. Anthropogenic noise is a pervasive and increas
life. Marine mammals exhibit behavioural and
sonar and other sound sources. The lost foragin
motor effort associated with sonar disturbance
may lead to population-level consequences.

PLOS ONE

RESEARCH ARTICLE

Density dependence can obscure nonlethal effects of disturbance on life history of medium-sized cetaceans

Vincent Hin[1]*, John Harwood[2], André M. de Roos[1]

Received: 30 October 2020 | Accepted: 15 February 2021

DOI: 10.1111/2041-210X.13593

RESEARCH ARTICLE

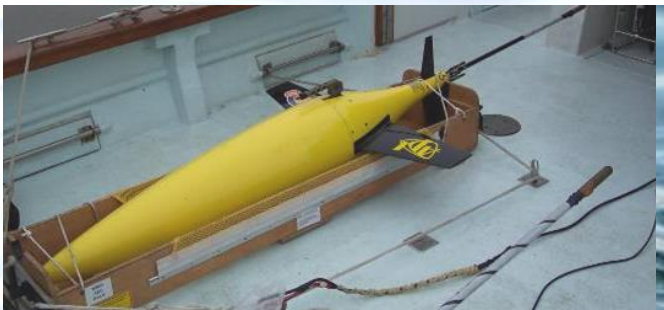
Methods in Ecology and Evolution

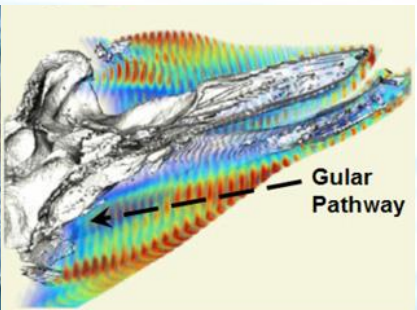
A standardisation framework for bio-logging data to advance ecological research and conservation

Ana M. M. Sequeira[1] | Malcolm O'Toole[1] | Theresa R. Keates[2] | Laura H. McDonnell[3] | Camrin D. Braun[4,5] | Xavier Hoenner[6] | Fabrice R. A. Jaine[7,8] | Ian D. Jonsen[8] | Peggy Newman[9] | Jonathan Pye[10] | Steven J. Bograd[11] | Graeme C. Hays[12] |

Program Outputs

- Outputs
  - ONR Annual Report is a Requirement
  - Peer review publications are Desirable
  - Observational data – tagging, acoustics
  - Students / Postdocs
- Review & Evaluation of Projects in Progress





U.S. Animal Telemetry Network (ATN)

Vision

Goal - Meeting our nation's needs for biological and environmental monitoring

Objective - Provide unity, stability and continuity to the U.S. National Marine Animal Telemetry Network, by supplying *integrated data* on aquatic ecosystems from species to environment and *complementing* existing observing assets.

Critical Benefits

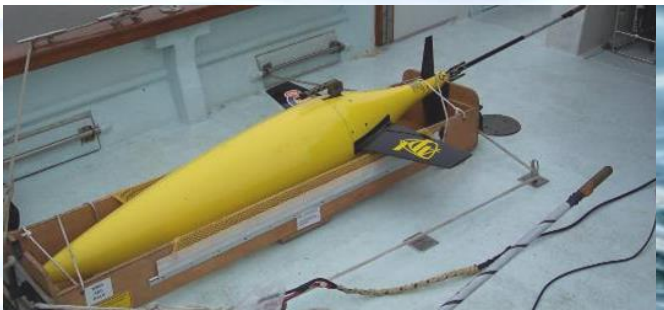
- Provide scientific basis for marine fisheries and protected-endangered species management critical for risk assessments and evaluate effects of disturbance
- ID essential & critical habitat for improved fisheries & listed species stock assessments
- Improve ocean observation & forecasting modeling
- Provide real-time monitoring

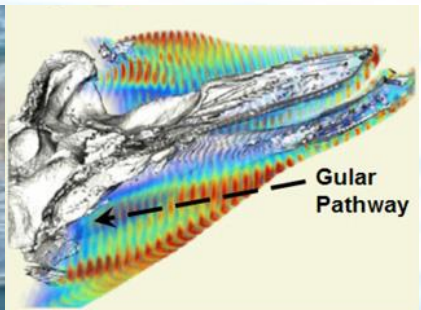
Approach

- Build Alliances and Collaborations
- **Provide Telemetry Data Management and Delivery via a Community-Based Data Assembly Center**
- Advance Capability to Assimilate Marine Animal Borne Sensor Data in R/T into the Coastal & Ocean Modeling Community
- Support Sustained Baseline Animal Telemetry Observations

Program Outcomes

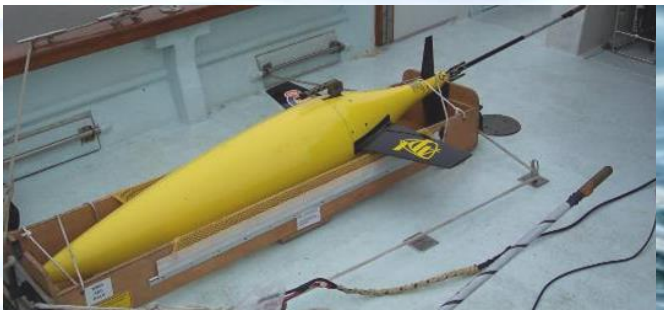
- Outcomes
  - ONR Annual Report is a Requirement
  - Peer review publications are Desirable
  - Observational data – tagging, acoustics
  - Students / Postdocs
    - » Undergrad, Graduate, Postdocs - Women, Minority
- Review & Evaluation of Projects in Progress

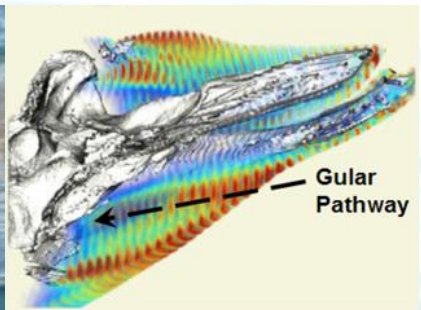




Program Outcomes

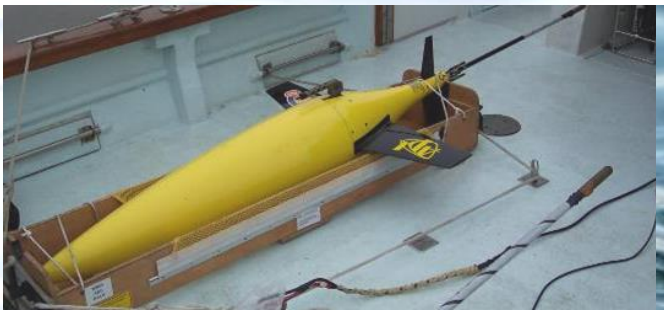
- Outcomes
  - ONR Annual Report is a Requirement
  - Peer review publications are Desirable
  - Observational data
  - Students / Postdocs
- Review & Evaluation of Projects in Progress
  - ONR MMB Program Reviews and presentations
  - ONR MMB Topic Reviews and presentations
  - Conference sessions / Workshop presentations

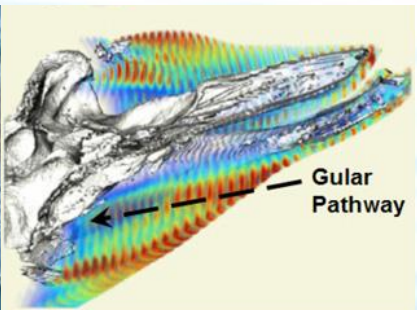




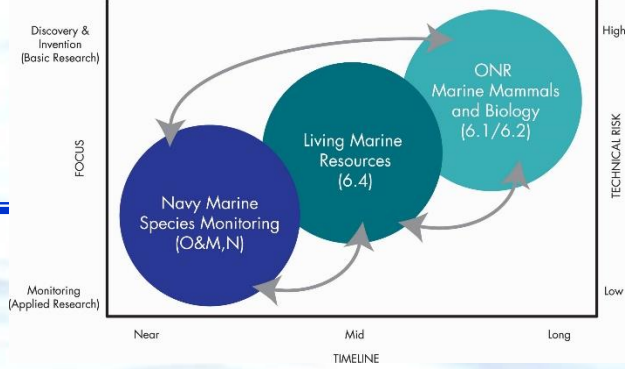
Program Impacts

- Transitions
  - Scientific Literature
  - Foundational Information (i.e. EISs)
  - Small businesses
  - LMR / FLT MSM Programs





Program Impacts



- Transitions - LMR 6.4 Program
  - 2019: Topic N-0203-19 (Tag Attachments) , N-0204-19 (PAM Density), N-0206-19 (Sparse Arrays Density Est), N-0207-19 (PCOD Appl)
  - 2017: Dtag Demval; Analytical support for BRS Noise Criteria
  - 2016: BRS (3S and others) Range/RL, CAS; Syracuse/Duke-Extended duration tagging attachments; SPAWAR-BREVE
  - 2015: Tethys (NOPP w/ BOEM); UM/WHOI Dtag; NUWC-BW Risk Function HA
  - 2013/14: PAM on Autonomous Platforms – WHOI DMON (Slocum, Profiler, WaveGlider); OASIS IRAP, HF Array (UAV, glider); OSU QuePhone (Glider, Profiler); BioWaves-Automated Whistle/Click Detector
  - 2013: TTS / PTS topic; SOCAL BRS, M3R
- Transition - FLT/SYSCOM MSM Program
  - 2020/21: Wildlife Computers SMRT tag
  - 2015, 2019: UW-APL AMAR-XL on SeaGlider (Available via Kongsberg)

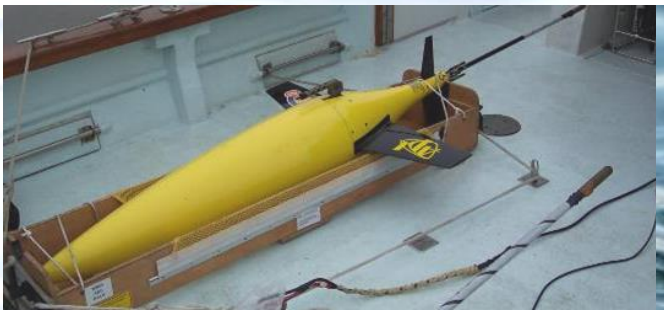
Outline

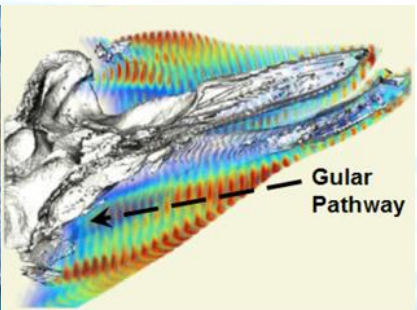
1. Identifying Science Needs
2. Identifying Who Conducts the Science
3. Program Outputs
4. Program Impacts
5. Program Improvement




Program Improvement

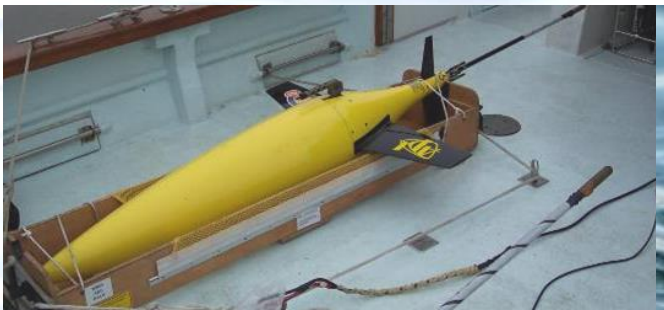
- Scientific Peer-Review
- Partnership Feedback

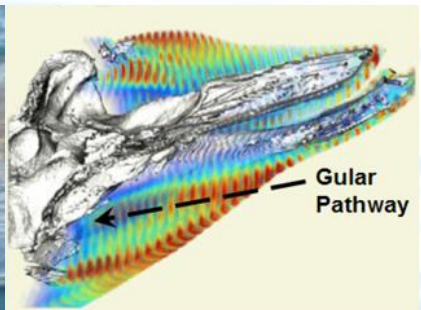




Program Improvement

- Scientific Peer-Review
  - External Program (6.1) / In-Progress (6.2) Reviews - 2 years
  - External Topic Reviews (i.e. PCOD, Stress Response)
  - Workshops with External review (i.e. Hearing, BRS, Dive Physiology)
- Partnership Feedback





Program Improvement - ONR D&I Peer Review

Assess 6.1 Basic Research current portfolio strengths/ weaknesses in terms of Scientific Merit & Accomplishments, Innovations & Potential Impact, and Principal Investigator

- ONR Instruction 3966.1 Peer Review issued 2010; Updated 2013
- Every ONR basic research program will be peer-reviewed during the 2nd to 3rd year from its inception.
  - ONR Program Officers will convene external Peer Review Panel comprised of recognized scientific/technical experts
  - Principal Investigators will present their work
  - Review Projects /Program: Scientific Merit & Accomplishment, Innovations & Potential Impact, Principal Investigator
  - Director of Research, Department Head, and Program Officer will review Panel comments and adjust program as needed

ONR D&I Peer Review

Project Review (Score 1-Poor to 5 – Outstanding)

- Scientific Merit & Accomplishment
  - Does the project address an important problem or a critical barrier to progress in the field?
  - What is the significance of the accomplishments achieved to date?
  - Number of published papers / journal articles?
- Innovations & Potential Impact
  - What are the unique aspects of the research of the project?
  - In what way has the research lead to new knowledge, tools, or open new solution pathways?
- Principal Investigator (PI)
  - Is the level of difficulty appropriate and does the PI/team understand the science and technology challenges?
  - If the project is collaborative or multi-PD/PI, are the investigators each making unique and valuable contributions?

Program Improvement

- Scientific Peer-Review
  - External Program (6.1) / In-Progress (6.2) Reviews - 2 years
  - Topic Reviews with External review (i.e. BRS, PCOD, Stress Response)
  - Workshops with External review (i.e. Hearing, Dive Physiology)
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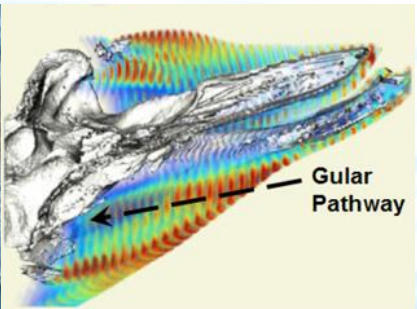

Program Improvement – Topic Reviews

PROCEEDINGS OF THE ROYAL SOCIETY B

FirstCite e-publishing

Proc. R. Soc. B
doi:10.1098/rspb.2011.2088
Published online

Review

Deadly diving? Physiological and behavioural management of decomp stress in diving mammals

S. K. Hooker[1,*], A. Fahlman[2], M. J. Moore[3], N. Aguila

J Comp Physiol B
DOI 10.1007/s00360-015-0901-0

REVIEW

Stress physiology in marine mammals: how wel terrestrial model?

Shannon Atkinson[1] · Daniel Crocker[2] · Dorian Houser[3] · Kendall Mashburn

Received: 19 February 2014 / Revised: 23 March 2015 / Accepted: 9 April 2015

Abstract Stressors are commonly accepted as the causal factors, either internal or external, that evoke physiological responses to mediate the impact of the stressor. The majority of research on the physiological stress response, and costs incurred to an animal, has focused on terrestrial species. This review presents current knowledge on the physiology of the stress response in a lesser studied group of mammals, the marine mammals. Marine mammals are an artificial or pseudo grouping from a taxonomical perspective, as this group represents several distinct and diverse orders of mammals. However, they all are fully or semi-aquatic animals and have experienced selective pressures that have shaped their physiology in a manner that differs

review covers t
marine mammals
from research c
respect to medi
ized terrestrial models. Challenges in conducting research on stress physiology in marine mammals are discussed and ways to overcome these challenges in the future are suggested.

Keywords Stress response · Stress physiology · Stressor · Hypothalamo-pituitary adrenal axis (HPA axis) · Cortisol · Corticosterone

Received: 22 September 2016 | Accepted: 13 June 2017
DOI: 10.1111/1365-2664.12955

REVIEW

Journal of Applied Ecology

Marine mammals and sonar: dose-response studies, the risk-disturbance hypothesis and the role of exposure context

Catriona M. Harris[1] | Len Thomas[1] | Erin A. Falcone[2] | John Hildebrand[3] | Dorian Houser[4] | Petter H. Kvadsheim[5] | Frans-Peter A. Lam[6] | Patrick J. O. Miller[7] | David J. Moretti[8] | Andrew J. Read[9] | Hans Slabbekoorn[10] | Brandon L. Southall[11] | Peter L. Tyack[7] | Douglas Wartzok[12] | Vincent M. Janik[7]

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[2]Marine Ecology and Telemetry Research, Seabeck, WA, USA
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[4]National Marine Mammal Foundation, San Diego, CA, USA
[5]Norwegian Defence Research Establishment (FFI), Maritime Systems, Horten, Norway
[6]Acoustics & Sonar Research Group, Netherlands Organization for Applied Scientific Research (TNO), The Hague, The Netherlands

Abstract

1. Marine mammals may be negatively affected by anthropogenic noise. Behavioural response studies (BRS) aim to establish a relationship between noise exposure conditions (dose) from a potential stressor and associated behavioural responses of animals. A recent series of BRS have focused on the effects of naval sonar sounds on cetaceans. Here, we review the current state of understanding of naval sonar impact on marine mammals and highlight knowledge gaps and future research priorities.
2. Many marine mammal species exhibit responses to naval sonar sounds. However, responses vary between and within individuals and populations, highlighting the importance of exposure context in modulating dose–response relationships.
3. There is increasing support from both terrestrial and marine systems for the risk

Program Improvement

- Scientific Review
  - External Program (6.1) / In-Progress (6.2) Reviews - 2 years
  - External Topic Reviews (i.e. PCOD, Stress Response)
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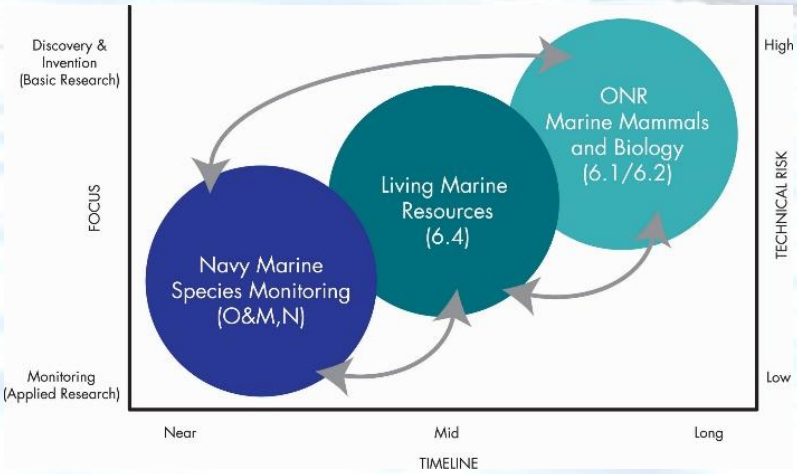

Questions?

ONR MMB Program

http://www.onr.navy.mil/en/Science-Technology/Departments/Code-32/All-Programs/Atmosphere-Research-322/Marine-Mammals-Biology.aspx