

Marine Mammals and Stress Workshop

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LONG-TERM GOALS

The purpose of the workshop held in conjunction with the 19th Biennial Conference on the Biology of Marine Mammals was to: 1) assemble a cross-section of researchers in the field of stress physiology and behavioral research, 2) evaluate state-of-the-art or developing technologies for measuring indicators of stress, and 3) identify scientific or regional topics for future stress-related research involving marine mammals, including cumulative effects and conservation impacts of stressors.

OBJECTIVES

The 2009 workshop hosted by ONR in Arlington, VA covered two main areas, technological needs for conducting stress-related research on marine mammals and priority stress-related research topics. The recognized technological needs recommendations varied from the development of genomic libraries, to innovative improvements in sample collection (eg sensors, attachments, robotics), and increased partnering with existing endocrine laboratories. The recommendations for stress-related research ranged from understanding natural variations in hormones and/or biomarkers to the effects caused by sample collection, to the cumulative effects of multiple stressors, and identifying populations or acoustic exposure events where stress responses could be quantified. Both technological advancements in stress measures and needed stress-related research are of keen interest to the marine mammal community as stress-related factors must be considered in surveys, experimental designs, data interpretations, regulatory decisions, and conservation efforts. Thus, the 2011 workshop was designed to be of interest to a broad cross-section of the SMM conference participants. The SMM Biennial Conference was a desirable venue to host our workshop as it is a gathering place for marine mammal scientists with diverse specialties and interests.

APPROACH

This full day workshop, held in conjunction with the 19th Biennial Conference on the Biology of Marine Mammals (Nov 2011) had oral presentations in the morning that focused on the ideology of stress research, state-of-the-art techniques for monitoring indicators of stress. There was also a session on human disturbance, policy and marine mammal research. The afternoon session highlighted scientific research topics that covered current ideas on conservation, health and reproductive impacts

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of stress physiology in wildlife systems. The format of the workshop included two overview talks along with seven traditional research presentations and six rapid delivery presentations.

WORK COMPLETED AND RESULTS

The workshop agenda is attached as Appendix A. The workshop was extremely well received by all participants. All of the speakers, except one, agreed to make their powerpoint presentations available to the participants. A website (<https://drive.google.com/a/alaska.edu/?tab=mo#home>) with the presentations was set up for all of the participants to be able to review the powerpoint presentations.

IMPACT/APPLICATIONS

The organizing committee agreed that a suitable product from the workshop would be a peer-reviewed synopsis of stress research in marine mammals. The outline of the manuscript is attached as Appendix B. The draft of the full manuscript is anticipated in fall 2012.

RELATED PROJECTS

None

REFERENCES

Presentations at workshop:

Atkinson, S. University of Alaska Fairbanks, School of Fisheries and Ocean Sciences. "History and ideology of stress research".

Crocker, D. Sonoma State University. "Techniques, context and interpretation of stress measurements".

Wright, A.J. Aarhus University, Department of Bioscience, Denmark. "Human disturbance, stress and marine mammals".

Bloodworth, B. NOAA Fisheries Service. "Consideration of stress during consultation under the Endangered Species Act for directed marine mammal research".

Wilson, S., Oriel, E. Tara Seal Research. "Recognising and defining stress in harbour seal pups".

Houser, D., Champagne, C., Yeates, L., Crocker, D., Fair, P. National Marine Mammal Foundation, Sonoma State University, NOAA Fisheries. "Estimating the impact of specific stressors requires comparisons to minimal stress conditions".

Mashburn, K., Atkinson, S. University of Alaska Fairbanks, School of Fisheries and Ocean Sciences. "Stress from a different perspective: What's good is good and what's good can confound results".

Rea, L., Banks, A., Castellini, M., Fadely, B., Burkanov, V. Alaska Department of Fish and Game, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, National Marine Mammal Laboratory. "Plasma haptoglobin concentrations vary by region of capture in free-ranging Steller sea lion pups".

Bechshoft, T., Sonne, C., Meyer, J.S., Novak, M.A., Henchey, E., Riget, F.F., Eulaers, I., Jaspers, V., Covaci, A., Letcher, R.J., Dietz, R. Aarhus University, Denmark. "Cortisol in polar bear hair; results and applications".

- Champagne, C., Houser, D., Costa, D., Crocker, D. University of California Santa Cruz, Department of Ecology and Evolutionary Biology, National Marine Mammal Foundation, Sonoma State University. “The effects of handling and anesthetic agents on the stress response and carbohydrate metabolism in northern elephant seals”.
- Apprill, A. Woods Hole Oceanographic Institution, Department of Marine Chemistry and Geochemistry. “Using microorganisms as sensors for detecting stress and health-related alterations in marine mammals”.
- Godard-Codding, C. Texas Tech University, The Institute of Environmental and Human Health. “Organotypic cultures of skin biopsies and their potential for cetacean stress assessment”.
- Trumble, S., Usenko, S. Baylor University. “A lifetime of stress: Anthropogenic and physiological data reconstructed from whale ear plugs”.
- Rosen, D. University of British Columbia, Marine Mammal Energetics and Nutritional Laboratory. “Stress in Otariids What causes it? How do you measure it? What does it do?”.
- Black, S. University of Calgary, Faculty of Veterinary Medicine. “Acute and chronic stress in narwhal in the Canadian high Arctic”.

PUBLICATIONS

- Atkinson, S., Crocker, D., Houser, D., Mashburn, K. 2013. Stress physiology and marine mammals: How well do they fit the terrestrial model?. *Comp. Biochem. Physiol.* In Prep.

APPENDIX A.

Marine Mammals and Stress Workshop
November 26, 2011
Tampa Convention Center, 333 Franklin Street RM 12
Agenda

- | | |
|-------------------|--|
| 8:30am – 8:45am | Registration |
| 8:45am – 9:00am - | Introduction to workshop |
| 9:00am – 10:00am | Overview talk on the history and ideology of stress research –Shannon Atkinson, Professor, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks (45 min talk – 15 min question/discussion). |
| 10:00am – 10:20am | Break |
| 10:20am – 11:20am | Overview talk on recent techniques used in stress research – Dan Crocker, Professor, Sonoma State University (45 min talk – 15 min question/discussion). 11:20am – 12:20pm Human Disturbance, Policy and Marine Mammal Research |
| | <ol style="list-style-type: none">1. Wright, Andrew – “Human disturbance, stress and marine mammals2. Bloodworth, Brian - “Consideration of stress during consultation under the Endangered Species Act for directed marine mammal research3. Wilson, Susan - “Defining and measuring stress in harbour seals <i>Phoca vitulina</i> in rehabilitation and captivity” |
| 12:20pm – 1:30pm | Lunch Break – Participants go out for lunch |
| 1:30pm – 2:10pm | Designing Research on Specific Stressors |
| | <ol style="list-style-type: none">4. Houser, Dorian - “Estimating the impact of specific stressors requires comparisons to minimal stress conditions”.5. Mashburn, Kendall - “Stress from a different perspective: What’s good is good and what’s good can confound results”. |
| 2:10pm – 3:10pm | Applied Stress Research |
| | <ol style="list-style-type: none">6. Rea, Lorrie - “Plasma haptoglobin concentrations vary by region of capture in free-ranging Steller sea lion pups.”7. Bechshøft, Thea - “Cortisol in polar bear hair; results and applications” |
| 2:50pm –3:15pm | Break |
| 3:15pm – 4:00pm | Rapid Delivery Projects (5x5 min) + Questions and Discussions |
| | <ol style="list-style-type: none">1. Champagne, Cory - “Effects of handling and anesthetic agents on the stress response and carbohydrate metabolism in northern elephant seals.”2. Apprill, Amy - “Using microorganisms as sensors for detecting stress and health-related alterations in marine mammals.”3. Godard-Codding - “Organotypic cultures of skin biopsies and their potential for cetacean stress assessment”4. Trumble, Stephen - “Anthropogenic and Physiological Data Reconstructed from Whale Earwax Plugs” |

5. Rosen, David – “Diet-induced stress in Steller sea lions: validation of field measurements and potential links to life history”.
6. Black, Sandie - -“Acute and chronic stress in Narwhal in the Canadian high Arctic”.

4:00pm – 5:00pm Group discussions on recommendations for research topics

APPENDIX B

Title: Stress Physiology and Marine Mammals: How well do they fit the terrestrial model?

Atkinson, Shannon¹, Crocker, Daniel², Houser, Dorian³, Mashburn, Kendall¹

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Possible Journals:

Hormones and Behavior

Comparative Biochemistry and Physiology

Trends in Ecology and Evolution

Outline for Stress Paper

I. Introduction.

Major Points:

- 1) Brief history of stress studies
- 2) Stress is vital to survival for any organism. Define acute vs. chronic here. [SA](#)
- 3) Compare/contrast marine vs. terrestrial [SA/DC](#)
- 4) Marine mammals exist in a completely different physical environment than terrestrial mammals [DC](#)
- 5) Marine mammals have a lipid-based metabolism. Limited carbohydrate intake. Marine mammals do not have ready access to fresh water sources [DC](#)
- 6) Marine mammal structures/tissues serve multiple purposes (ie. dorsal fin if present, blubber, etc). Must maintain very balanced utilization of resources and structures. [DC](#)
- 7) Should we expect differences between terrestrial and marine mammal responses to stress? [SA](#)

II. Definition of terms [SA](#) (Already done)

- 1) Stress – from ONR Workshop and Selye 1950/Brett 1958
- 2) Stressor – from ONR Workshop
- 3) Stress response - from ONR Workshop
- 4) Homeostasis -
- 5) Allostasis, Allostatic state – Modified from McEwen and Wingfield 2003
- 6) G) Types of stress
- 7) Acute/chronic (briefly – referring to introduction?)
- 8) Allostatic overload – McEwen and Wingfield 2003 or Romero

III. What are stressors? Specific to marine mammals – but start paragraphs with terrestrial equivalent where applicable. [SA/KM](#)

- 1) Natural
 - a. Marine environment – subject to el nino, la nina change
 - b. Food – diving/foraging behaviors – oceanic regime shift
 - c. Weather and temperature – climate change
 - d. Predators
 - e. Social stressors
 - f. Reproductive strategies
 - g. Natural pathogens
- 2) Anthropogenic
- 3) Resource competition – food
 - a. interspecific interactions
 - b. leading to fisheries interactions ie. Humpbacks/hatcheries, by-catch
- 4) Resource competition – space
 - a. reduced space (due to human population growth, boat traffic, offshore exploration/drilling?) leads to increase in competition for haul-out, rookery, hunting grounds territories spaces. Interspecies – intraspecies.
 - b. more advanced technology in gear coupled with the desire to visit remote locations allows humans to go to previously unavailable territories and can increase human disturbances.

- 5) Noise
- 6) Wildlife viewing/disturbance
- 7) Pollution. Has the potential to be the most devastating to marine mammals. Effects commonly not visible (with the exception of entanglement, plastic rings around necks etc)

Points:

- a. Trash increase as human coastal populations increase. Trash as a result of natural disasters (Japan). Arctic coasts susceptible due to ocean currents.
- b. Polluted streams and rivers emptying to areas previously used for hunting grounds. Fertilizers, etc
- c. POPs, metals, toxins
- d. Petroleum-based pollution potential increase with increased offshore drilling.

IV. Measuring stress in marine mammals. Problems and means to overcome them

- 1) Routinely used markers of stress -**DC**
- 2) Other markers of stress - **DC**
- 3) Logistical and methodological difficulties - **DH**
- 4) Interpretation of data – difficulties - **DH**
- 5) Chronic or acute – captive vs free-ranging - **KM**
- 6) Making the distinction: is a 5 minute stressor chronic or acute? What if it's a daily 5 minute stressor? Is there a difference between captive, temporarily housed/captive free-ranger and free-ranging.
- 7) Factoring in allostatic loads depending on life stage, reproductive state, season.
- 8) Understanding time course of a stress response is critical to interpreting the potential impacts of a stressor. ie. Fecal samples represent a pooled sample of what occurred 2-3 days ago – must know conditions at that time prior to making assumptions.
- 9) Use of similar captive animals for model of free-ranging animals – results should be interpreted with caution.

V. Actions

- 1) Nervous system - **DC**
- 2) Neuroendocrine system – **DC**
- 3) Binding Proteins and Receptors - **DC**
- 4) Circulatory System - **SA**
- 5) Immune system – **DC/SA**
- 6) Metabolism and Excretion - **DC**
- 7) Reproduction – **SA/KM**

VI. Predisposition to adverse responses to stressors and response strategies to stressors – **SA/KM**

- 1) Review Reactive Scope Model of Romero et al. 2009
- 2) Natural factors: Life stage/Reproductive state/weather/season/disease - briefly
- 3) Anthropogenic factors: chronic disturbance/pollutants/overfishing – briefly
- 4) Response to stressors can become a stressor – artificially created allostatic load – ie distance to swim for food with shrinking ice pack

VII. Conclusions.