### **Comparative studies of Alaskan ice seals**

Colleen Reichmuth and Jillian Sills Update to the Ice Seal Committee – February 5 2021





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### Spotted seals

**Ringed seals** 





Bearded seals



- Research with trained, captive seals
- Non-releasable, rehabilitated seals and one collected bearded seal
- Seal studies at Long Marine Laboratory and Alaska SeaLife Center
- Focus on **Bioacoustics** (since 2010) and **Physiology** (since 2015)
- Captive studies to address research questions that cannot be conducted with wild individuals
- Emphasis on animal welfare and cooperative behavior



Polar Biology (2020) 43:1681–1691 https://doi.org/10.1007/s00300-020-02736-w

**ORIGINAL PAPER** 



### Auditory biology of bearded seals (Erignathus barbatus)

Jillian M. Sills<sup>1</sup> · Colleen Reichmuth<sup>1,2</sup> · Brandon L. Southall<sup>1,3</sup> · Alex Whiting<sup>4</sup> · John Goodwin<sup>4</sup>





## Evaluating temporary threshold shift onset levels for impulsive noise in seals<sup>a)</sup>

Jillian M. Sills,<sup>1,b)</sup> Brandi Ruscher,<sup>2</sup> Ross Nichols,<sup>2</sup> Brandon L. Southall,<sup>3</sup> and Colleen Reichmuth<sup>1</sup> <sup>1</sup>Institute of Marine Sciences, Long Marine Laboratory, University of California Santa Cruz, Santa Cruz, California 95060, USA <sup>2</sup>Department of Ocean Sciences, University of California Santa Cruz, Santa Cruz, California 95064, USA <sup>3</sup>Southall Environmental Associates, Inc., 9099 Soquel Drive, Suite 8, Aptos, California 95003, USA



- Bearded seals have sensitive hearing across a wide range of frequencies in water, similar to related species despite evolutionary differences and different life histories
- Auditory masking data (hearing ability in the presence of noise) can be used to estimate listening space and communication ranges
- We documented transient shifts in hearing (temporary threshold shifts) following exposure to multiple pulses from a seismic air gun. The largest hearing effect was at the frequency with the greatest noise exposure level relative to the seal's auditory ability
- This research adds to similar measurements with spotted and ringed seals. Findings suggest that current regulatory guidelines (NMFS, 2018) are appropriate for Alaskan seals
- We cannot address all noise impacts with our research. Our measurements focus on auditory abilities and the effects of noise.
  Studies of behavioral responses to sound in wild seals are still needed
- Our next planned bioacoustics studies will consider how very lowfrequency noise ( < 100 Hz) is detected by bearded seals, and how lowfrequency seismic noise may interfere with normal hearing



- Alaskan seals are providing important data that will influence the management of seals worldwide
- Sensitive hearing in trained bearded seals will enable upcoming research projects to address the difficult issue of marine mammals and human-generated noise

### **Underwater sound production in spotted seals**



- We also study behavior associated with breeding, including underwater vocalizations produced by mature males during the breeding season
  - Acoustic cues, scent cues
  - Developmental changes in behavior
- Data collection and analysis are now complete

### **Underwater sound production in spotted seals**



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## PHOCAS: Physiology and Health of Cooperating Arctic Seals

- Baseline measures of health
- Energy intake requirements
- Seasonal and developmental patterns of growth and body condition
- Individual patterns of molt
- Measurements of resting metabolism
- Oxygen storage capacity in muscle, blood, and lungs
- Measurements of energetic costs of diving and swimming
- Evaluating limits to diving and foraging
- Describing resting and active heart rate patterns
- Understanding thermal biology and thermoregulatory strategies





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**Research article** 

# Molting strategies of Arctic seals drive annual patterns in metabolism

Nicole M. Thometz<sup>1,2,\*</sup>, Holly Hermann-Sorensen<sup>2</sup>, Brandon Russell<sup>3</sup>, David A. S. Rosen<sup>4</sup> and Colleen Reichmuth<sup>2,3</sup>

- Measured energy budgets of individual spotted, ringed, and bearded seals over four years using open-flow respirometry



- Related changes in resting metabolism to developmental stages, environmental conditions, and molting status (which was related to patterns in energy intake and body condition)
- Metabolic demands were highest in ringed seals and lowest in bearded seals. There were consistent annual patterns in metabolism that were related to the distinct molting strategies of each species
- We provide quantitative data to describe energetic costs and tradeoffs that may be influenced by climate change



#### SHORT COMMUNICATION

# *In vivo* measurement of lung volume in ringed seals: insights from biomedical imaging

Holly Hermann-Sorensen<sup>1</sup>, Nicole M. Thometz<sup>2,3</sup>, Kathleen Woodie<sup>4</sup>, Sophie Dennison-Gibby<sup>5</sup> and Colleen Reichmuth<sup>3,4,\*</sup>



- Seals treated during rehabilitation provide knowledge about species biology
- Whole body view into living ringed seals reveals lung volumes, body density
- Information and ideas about constraints on diving in the smallest seals

### **PHOCAS projects pending completion**

- Define energy intake requirements (calories needed) for ringed, spotted, and bearded seals at seasonal, annual, and developmental scales
- Describe longitudinal changes in body condition; new collaboration with NOAAs polar ecosystem program
- Characterize fine-scale individual patterns of molt and haul-out behavior in each species
- Compare metabolic costs of resting in water versus on ice relative to molting status



### Project contacts -- pinnipedlab.ucsc.edu

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### **Research papers since last update to ISC**

Sills, J. M., Ruscher, B., Nichols, R., Southall, B. L., and Reichmuth, C. 2020. Evaluating temporary threshold shift onset levels for impulsive noise in seals. The Journal of the Acoustical Society of America, 148(5): 2973-2986.

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Thometz, N. M., Hermann-Sorensen, H., Russell, B., Rosen, D. A. S., and Reichmuth, C. 2021. Molting strategies of Arctic seals drive annual patterns in metabolism. Conservation Physiology, 9: 10.1093/conphys/coaa112

Hermann-Sorensen, H., Thometz, N. M., Woodie, K., Dennison-Gibby, S., and Reichmuth, C. 2021 *In vivo* measurement of lung volume in ringed seals: insights from biomedical imaging. Journal of Experimental Biology, 224: jeb235507

### **Research summaries and posters**

Hartwick, M., Reichmuth, C., and Thometz, N.M. 2021. Using physiological measures of captive seals to inform best practices of rapid body condition assessments of wild Arctic seals. Society for Integrative and Comparative Biology Annual Meeting, 3 January-28 February.

Hartwick, M., Reichmuth, C., and Thometz, N. M. 2021. Informing best practices for field body condition assessments of wild Arctic seals. Alaska Marine Science Symposium, Anchorage, Alaska, 26-28 January.

Hermann-Sorensen, H., Thometz, N. M., Rosen, D. A. S., and Reichmuth, C. 2021. Molting status differentially affects resting metabolism of Alaskan seals in air and water. Alaska Marine Science Symposium, Anchorage, Alaska, 26-28 January.

Jones, R., Meranda, M., Thometz, N. M., and Reichmuth, C. 2021. Cardiorespiratory patterns in resting Alaskan seals. Alaska Marine Science Symposium, Anchorage, Alaska, 26-28 January.

Mukhtar, V., Dearolf, J., Thometz, N., Bryan, A., Reichmuth, C. 2020. Fiber-type profile of the longissimus dorsi muscle of the ringed seal. Society for Integrative & Comparative Biology Annual Meeting, Austin, Texas, 3-7 January.

Fletcher, M., Barett, L., Dearolf, J., Thometz, N., Bryan, A., Reichmuth, C. 2020. Fiber-type profile of bearded seal (*Erignathus barbatus*) longissimus dorsi muscle. Society for Integrative & Comparative Biology Annual Meeting, Austin, Texas, 3-7 January.

Nazar, S., Dearolf, J., Thometz, N., Bryan, A., Reichmuth, C. 2020. Fiber-type profile of the locomotor muscle of spotted seals. Society for Integrative & Comparative Biology Annual Meeting, Austin, Texas, 3-7 January.