Stationary diving metabolic costs in Alaskan ice seals

Madeline Meranda[1], Brandi Ruscher[1], Nicole Thometz[2], David Rosen[4], Colleen Reichmuth[1,3]

[1] University of California, Santa Cruz

[2] University of San Francisco

[3] Alaska SeaLife Center

[4] University of British Columbia

Alaskan ice seals are experiencing rapidly warming environmental conditions, with expected consequences at individual, species, and ecosystem levels. There is a growing need to predict how these marine mammals will respond to sea ice loss and other changes to essential habitats. The physiology of ice-associated seals is understudied, but physiological data can inform and improve bioenergetic and population models. For example, estimates of metabolism can be used to quantify the energy costs associated with modifying routine behavior in response to environmental change. This approach requires information about the metabolic costs of routine activities that will be altered by changing conditions. The PHOCAS research program employs a unique resource of non-releasable Alaskan ice seals studied in human care to provide these types of data. Here, we used open-flow respirometry to measure metabolic rates during rest and stationary diving in individual seals. Three spotted seals and one ringed seal at the Alaska SeaLife Center (Seward, AK) and one bearded seal at Long Marine Laboratory (Santa Cruz, CA) participated in voluntary data collection. For resting measurements, seals were conditioned to position calmly at the water's surface under a custom-built metabolic dome while oxygen consumption ($\dot{V}O_2$) was measured. During diving trials, seals rested at the bottom of saltwater pools on a single breath hold for 3, 5, or 7 min and then surfaced under a metabolic dome while recovery $\dot{V}O_2$ was measured.

We found similar costs of diving for individual seals across the treatments of varying duration and compared these measurements to resting values. The ringed seal had a metabolic rate associated with diving that was 22% lower than that measured while at rest. The spotted seals displayed diving metabolic rates that were 12 to 29% lower than those measured while at rest. This indicates a cost savings during stationary diving up to 7 min for these species which can be attributed to the dive response. The bearded seal showed metabolic rates during diving that were the same as those measured at rest. Submerged swimming trials are now being conducted with the same individuals to assess the increased costs associated with this activity. These emerging species- and behavior-specific physiological data will improve understanding and estimates of changing energy budgets for Alaskan ice seals.