Stationary diving metabolic costs in Alaskan ice seals

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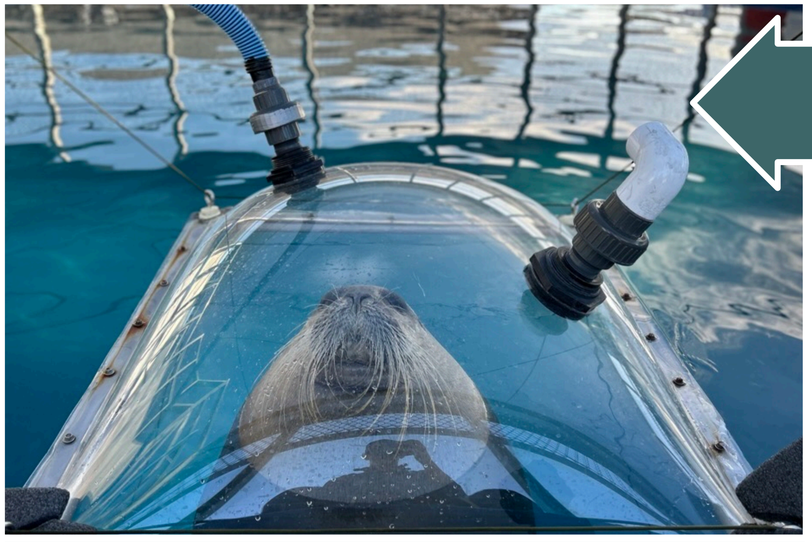
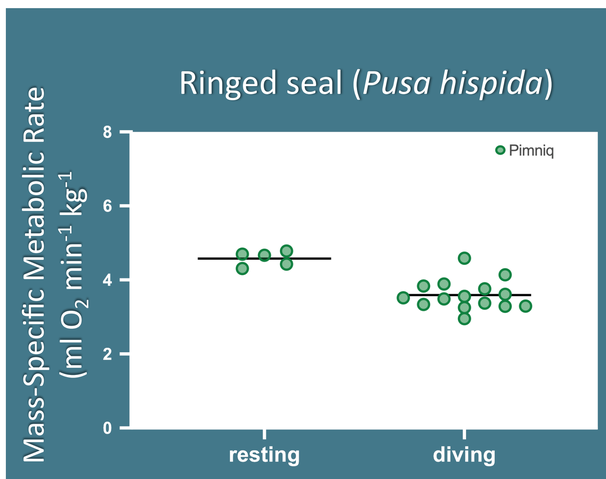
ALASKA MARINE SCIENCE SYMPOSIUM



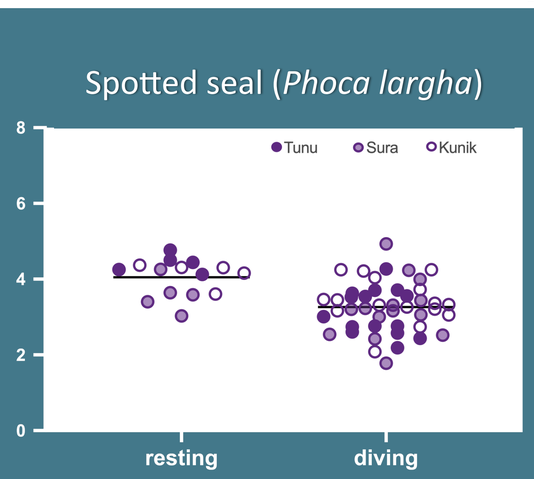
RESTING : Seals were trained to rest calmly at the water's surface under an acrylic metabolic dome for 8 - 16 min while rate of oxygen consumption ($\dot{V}O_2$) was measured.

DIVING : Seals were trained to complete a submerged, stationary dive at the bottom of their pool before surfacing in the metabolic dome where recovery $\dot{V}O_2$ was measured. Dive durations were 3, 5, or 7 min.

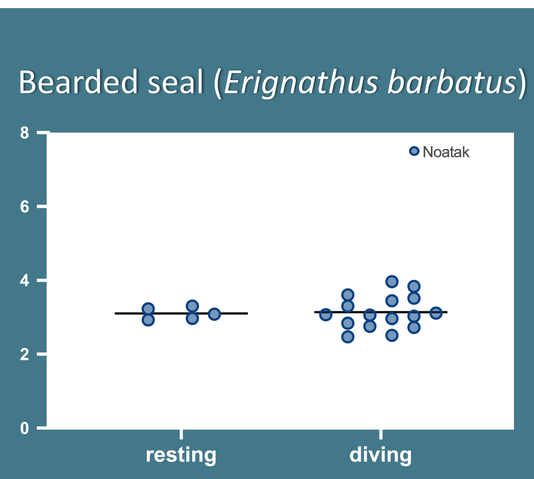
OBJECTIVE : The unique physiology of Alaskan ice seals is largely unknown. To obtain information about the energetic costs of routine activity for spotted, ringed, and bearded seals, we used open-flow respirometry to measure metabolic rates during stationary diving. We also collected resting metabolic rates from the same individuals for comparison. Five adult seals were specially trained to participate in this cooperative research. Given presumed adaptations for extended submersion, we predicted the seals would exhibit reduced energetic costs during diving relative to those measured during rest.



Diving metabolic rates for the ringed seal (n=1) were 22% lower than resting metabolic rates.



Diving metabolic rates for spotted seals (n=3) were 12, 17, and 29% lower than resting metabolic rates.



Diving metabolic rates for the bearded seal (n=1) were the same as resting metabolic rates.

CONCLUSIONS : Metabolic costs incurred by each seal were similar irrespective of dive durations between 3 and 7 min (one-way ANOVA, $p>0.05$) suggesting these seals were diving within aerobic limits. Therefore, dive trials (n=5 per duration) were pooled by individual for comparison to resting values. The ringed seal showed marked reduction in metabolic cost during diving ($t=5.162$, $p<0.0001$). The three spotted seals exhibited reductions of 12-29% metabolic rate during diving, but the difference was significant for only one individual (*Tunu*, $t=4.581$, $p<.0001$) given the sample size. Surprisingly, the bearded seal showed no discernable difference in diving and resting metabolic rates ($t=1.553$, $p=0.1597$). The decrease in metabolic rates documented for ringed and spotted seals can be attributed to the mammalian dive response, while the bearded seal did not show evidence of this response. To further quantify the energetic cost of routine activities, trials to directly measure $\dot{V}O_2$ during submerged swimming are in progress with these individuals. These bioenergetic data can be used to better understand the physiological implications of modifying routine activity in response to environmental change.

Data were collected using positive behavioral conditioning methods and without harm to animals. This project was funded by NOAA's Alaska Pinniped Program with ancillary support from the SeaWorld Busch Gardens Conservation Fund. Research activities were authorized by NMFS permits 18902 and 23554, with approval from the Ice Seal Committee and oversight from the Institutional Animal Care and Use Committee at UC Santa Cruz. We thank the dedicated research and husbandry teams at Long Marine Laboratory and the Alaska SeaLife Center, especially Shelby Burman, Juliana Kim, Jamie Mullins, and Madilyn Pardini. We thank John and Pearl Goodwin and Alex Whiting from the Native Village of Kotzebue for their help with the PHOCAS research program, and Drs. Carrie Goertz and David Casper for expert veterinary care.