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METABOLIC COSTS OF SUBMERGED ACTIVITY IN THREE SPECIES OF ARCTIC SEALS

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Arctic seals live in dynamic environments characterized by seasonally changing sea ice and extremely cold temperatures. Spotted (*Phoca largha*), ringed (*Pusa hispida*), and bearded seals (*Erignathus barbatus*) are physiologically adapted to an amphibious lifestyle, relying primarily on sea ice as haul-out substrate but spending more than half their time submerged. Projected habitat changes emphasize the importance of in-water activities when considering the energy budgets of free-ranging seals, but estimates of activity-specific costs are not available for these species. We used open-flow respirometry to compare resting metabolic rates (RMR) with the energetic costs of submerged behaviors in five adult seals at the Alaska SeaLife Center in Seward, AK and Long Marine Laboratory, in Santa Cruz, CA. Individuals were trained to complete a stationary breath hold under water or a continuous submerged swim before surfacing beneath a metabolic dome to measure rate of oxygen consumption. Metabolic rates decreased 11- 24% relative to RMR for the spotted and ringed seals while voluntarily diving for 3, 5, or 7 min, and did not change with increasing duration. The bearded seal did not show evidence of a similar dive response. All individuals exhibited notably increased costs to support exercise while swimming for 2-3 min. These elevations were 243% and 114% above resting costs for spotted and ringed seals, and only 60% for the bearded seal. These results from relaxed, cooperating individuals highlight the unique physiological responses of the bearded seal, and help to explain how seals resolve conflicting pressures of metabolic suppression during diving and elevated oxygen requirements of exercise. The costs of submerged activity can now be considered in quantitative models of ice seal energy budgets to inform how species differences will influence tolerance of individuals and populations to the rapidly changing Arctic.