

Physiological and Energetic Measurements of Bearded Seals (*Erignathus barbatus*) During Early Development

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Bearded seals (*Erignathus barbatus*) are threatened by global warming given their adaptation to Arctic conditions and reliance on broken sea ice as haul-out substrate. Predicting the consequences of environmental changes requires knowledge of the physiology and energy demands of individual seals, and how these differ over a seal's lifetime. Unfortunately, examining the physiological ontogeny of bearded seals through repeated sampling of free-ranging individuals is not yet possible due to their inaccessibility and widespread distribution. Furthermore, measurements of energy intake and energy expenditure cannot be obtained from cross-sectional studies of wild seals from different demographic groups. To overcome the limitations of field sampling, two bearded seals were studied in captive care at Long Marine Laboratory in Santa Cruz, California. Data on body condition, growth, energy intake, and metabolism were obtained from a male bearded seal from ages 1-6 years and a 2-year-old female seal to investigate developmental changes in energy budgets. On an absolute basis, average resting metabolic rates (RMR; determined using open-flow respirometry) for the male seal remained constant between ages 2-4 years, averaging 470 ml O₂ min⁻¹ (n=68 measurements). This was similar to the RMR of 450 ml O₂ min⁻¹ (n=10) for the 2-year-old female. Metabolism for the male increased slightly in year 5 (498 ml O₂ min⁻¹, n=18) and was highest in year 6 (552 ml O₂ min⁻¹, n=4). The observed changes in metabolism during development can be related to corresponding changes in body mass, body condition, and energy intake. Developmental trends in absolute metabolism were only partially explained by concurrent changes in body size. When considered on a mass-specific basis, RMR was highest for the male seal at age 2 (4.1 ml O₂ min⁻¹ kg⁻¹), which was similar to that of the smaller 2-year-old female (4.9 ml O₂ min⁻¹ kg⁻¹). Mass-specific RMR for the male declined significantly each year through age 4 and was lowest as this individual reached sexual maturity at 5-6 years old (2.9 ml O₂ min⁻¹ kg⁻¹; n=22). While absolute metabolism increased by only 12% from juvenile (2-4 years) to subadult and young adult stages (5-6 years), absolute food consumption (in calories) increased by 23%. Over the same interval, body mass increased by 44%, including a 7% increase in blubber content. Our understanding of demographic differences in physiological parameters relevant to bioenergetic modeling efforts will be refined as more data become available for this species.