Balancing the Budget: Seasonal Energy Demands of Ice-Dependent Arctic Seals

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Alaskan seals use sea ice as a substrate for various critical functions including rest, pupping, and molting. These activities may become disrupted or more costly in the absence of sea ice. For example, during the annual molt seals shed several layers of epidermis and fur, and regenerate a new coat. Thermoregulatory costs associated with molt are predicted to increase if appropriate haul-out substrate is unavailable. Similarly, energetic costs will increase if haul out platforms and foraging areas are spatially separated. Measures of energy intake and metabolism can be used to evaluate the potential impact of environmental change on energy budgets. Working with eight trained seals representing three species [bearded (*Erignathus barbatus*), ringed (*Pusa hispida*), and spotted (*Phoca largha*) seals], we documented longitudinal changes in daily gross energy intake (GEI) and body mass, and monitored fine-scale changes in resting metabolic rate (RMR). Further, we examined the relative importance of air and water temperature, age, body mass, and physiological state on changes in GEI and RMR. We found clear seasonal patterns in GEI, defined by alternating periods of hyperphagia and hypophagia. In spotted and ringed seals these cycles became more pronounced with age but did not necessarily lead to commensurate changes in body mass. Increasing food intake over the molting interval was associated with simultaneous decreases in body mass, indicating a period of high energy expenditure. The severity of this pattern was related to molt duration. Weekly measures of metabolism revealed seasonal changes in RMR that corresponded to the distinct molting strategies of each species. For species that molt over a relatively short interval (spotted: 36±4.6 days, ringed: 29±2.5 days), RMR increased sharply (range: 26-47%) across the molt. In contrast, molting over a longer interval (bearded: 107±14.8 days) appeared to limit energetic costs as indicated by a more stable annual RMR. Our findings reveal dynamic relationships between GEI, RMR, and body mass, and highlight a previously unknown relationship between molting strategy and seasonal energy budgets. Ultimately, this work contributes quantitative data that can be used in predictive models to assess the consequences of sea ice loss on ice-dependent seals.