Variation in the Annual Cost of Living of an Endangered Population of Bighorn Sheep

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ABSTRACT: Energy is fundamental to survival, growth, and reproduction with effects that scale up to influence larger-scale processes including movements, habitat selection, and population productivity. Estimates of the amount of energy wild animals need to make a living rarely have been quantified or related to larger-scale processes. Our objective was to develop a tool to calculate energy budgets of bighorn sheep based on body mass, reproductive status, and movement data. We used empirical data from 37 Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*) that were captured during 2009–2014 and fitted with GPS collars, weighed, and assessed for reproductive status. Resting metabolic rates (reported in the literature) were the foundation of energy budgets; we added costs for eating, walking, and sinking in snow. Empirical data for reproduction and replenishment of body fat for bighorn sheep were not available in the literature, so we estimated these costs based on data for related species while correcting for allometric scaling relationships. Annual energy requirements varied with sex, reproductive status, and migratory tactic. Our model provides the basis for quantifying energetic implications of migration tactic for sheep and estimates of energy intake needed for optimal reproductive output. Coupling our model with estimates of food supplies may provide insights into energetic motivations of habitat selection and aid in establishing estimates of nutritional carrying capacity. Our energy model can be adapted to any population of free-ranging sheep if annual body mass (and fat) dynamics, reproductive status, and movement rates are known.

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KEYWORDS Sierra Nevada bighorn sheep; *Ovis canadensis sierrae*; energy budget; metabolic rates; energy model.