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For polar bears the cost of living is rising

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A warming Arctic is causing reductions in sea ice thickness and increasing its drift speed. Compositional and dynamic changes in sea ice could have impacts on the ability of ice-dependent vertebrates to acquire and amass energy needed for maintenance, growth, and reproduction. Knowledge of how ice-dependent Arctic wildlife responds to climate change is critical for narrowing the uncertainty in projections of population trends and to inform conservation actions directed at mitigating the impact on those organisms.

Polar bears depend on sea ice to access their primary prey, ringed and bearded seals. Sea ice declines are expected to continue in lockstep with increasing greenhouse gas emissions through the 21st century. Reductions in access to preferred sea ice habitats, especially during late spring and early summer when polar bears must recoup the mass loss from the previous winter, have and will continue to reduce prey availability with negative impacts on bears in many parts of their range.

Sea ice over most of the range of polar bears is in constant motion, implying that bears in many locations live on a "treadmill" of ice, requiring energy expenditure even to remain in one place. As ice has become thinner and less expansive, rates and patterns of sea ice drift have changed with unknown effects on polar bears. In many places, sea ice is drifting faster now than it was 20 years ago, and we hypothesized polar bears in those regions may now spend more time traveling and require more energy to continue occupying their traditional ranges. To elucidate this previously unexplained mechanism of faster ice drift and its impact on polar bears, we estimated the change in bear movements and the resulting increase in energy costs.

We used over 77,000 bear locations and matching ice drift values to quantify the influence of ice drift on polar bear movements between two periods with different sea ice drift dynamics, 1987-1998 and 1999-2013 and in two regions of contrasting physical and biological oceanography, the Beaufort and the Chukchi seas. From our estimates of change in movement rates between periods and regions, we modeled the energetic consequences for a 190 kg adult female polar bear, when she traveled alone and when she was accompanied by young.

We found that westward and northward drift of the sea ice used by polar bears in both regions increased 30% and 37% between 1987-1998 and 1999-2013 in the Beaufort Sea and Chukchi seas, respectively. In response, polar bears during the recent period increased their eastward movements, while their movements north in the spring (i.e., ice breakup) and south in fall (i.e., freeze-up) were frequently aided by ice drift. To cope with faster eastward ice drift polar bears needed to either increase their time spent active by 7.6 – 9.6%, or their travel speed by 8.5 – 8.9%. This increased their annual energy expenditure by 1.8 – 3.6% (depending on region and reproductive status), a cost which required they capture an additional 1 – 3 seals per year.

Although this may appear to be a modest added

cost, there are several reasons why our estimated change in energy expenditure is likely conservative. Polar bears that shed their collars gave us one very important clue to this underestimate! Transmissions from collars laying on the ice told us the ice was drifting significantly faster than satellite observations suggested. Keeping up with a faster moving treadmill, of course, would require more energy. Also, we were limited to metabolic data for a small (i.e., 190 kg) female polar bear walking on a mechanical treadmill. Most collared bears in our study were >200 kg and larger animals need more energy to move their larger bodies-just like a big dog requires more dogfood than a smaller one. Additionally, research on other predators suggests the relationship between walking speed and energy costs may be much steeper than that previously reported for polar bears. Finally, our models did not account for the impact of walking on an increasingly deformed and fractured sea ice surface, or for the greater occurrence of long-distance swimming observed in recent years.

Our study is the first to show that altered and faster sea ice drift is another negative impact of global warming on polar bears. Altered movements, in response to changes in sea ice drift, appear to have a negative effect on polar bear energy balance in the Chukchi and Beaufort seas, exacerbating the physiological stress due to reduced foraging opportunity.