Fasting affects foraging ability in Steller sea lions

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A Steller sea lions (*Eumetopias jubatus*) foraging ability has been shown to decrease after a period of fasting, especially in the winter. This is due to a decrease in the amount of oxygen available for diving after fast, with a subsequent decrease diving time. This might be due to an increase in heat loss when diving after fast as a consequence of substantial loss in insulative fat store.

The population of Steller sea lions have decline with 80 % during the last 30 years (Pitcher et al. 2007). One of the leading hypotheses trying to explain this dramatic decline is the nutritional stress hypothesis. The theory focuses on the decline of prey stocks and alteration in prey availability, quality and diversity (Calkins 1998).

With diminishing prey stocks Steller sea lions could potentially face period of fasting at any time of the year, however fasting is a natural part of a sea lions maternal attendance pattern during summer (Boness & Bowen 1996). Attempts have been done to calculate total energy and consequently food requirement of Steller sea lions (Winship et al. 2002). However a missing part in these calculations is the alteration in energy expenditure and foraging ability after a period of fasting.

We have, as the first research team ever, been able to measure how a period of fasting affect the cost of diving and consequently foraging in a freely diving marine mammals, in this case the Steller sea lion. This was done by measuring and comparing resting metabolic rate (RMR) and diving metabolic rate (DMR) before and after a period of fasting.

RMR decreased significantly after fast during both summer (16.4 %) and winter (8 %). The decrease indicates that the sea lions employ metabolic depression to save energy and tissue catabolism while fasting, seen in previous studies among fasted Steller sea lions (Rosen & Trites 2002). However, DMR did not change after fast in the summer but increased with 13.5 % in the winter.

The decrease in RMR and absence of change or increase in DMR after fast can be explained by the change in insulative fat store. During fast insulative lipid store is used as a nutritional resource (Øritsland 1990), consequently increasing body heat loss. While stationary the body loses 26 times more heat than in air and when moving in water the heat loss can be a 1000 times greater. While resting in water the metabolic depression employed during fast was greater than the increase in thermoregulatory cost (increase in heat loss), seen as the decrease in RMR after fast. The ratio further decreased with decrease in temperature. On the other hand, when swimming actively in water the increase in thermoregulatory costs after fast was equal to the metabolic depression in the summer but greater than the metabolic depression in the winter (13.5 %). This increase in DMR in the winter after fast is therefore most likely due to the additional increase in heat loss due to convection while diving, particularly seen during winter and declining temperature.

In addition, during a 14 day recovery after fast RMR return to pre fast values shortly after refeeding. However, DMR remained elevated throughout most of the recovery period. This further supports the increase in thermal challenge when diving after fast.

This increase in heat loss and consequently metabolic rate consequently decrease the amount of oxygen store available for diving. The decrease in oxygen store results in a decrease in diving time and foraging ability, particularly in the winter. This suggests that sea lions are vulnerable to food shortage after fast, particularly in the winter. An alteration in prey availability and an increase in challenge to find food could consequently have a severe effect on a sea lions foraging ability after fast. These results can be incorporated in bioenergetic

models when trying to estimate total energy and food requirements of Steller sea lions. This is important knowledge when trying to understand how Steller sea lions are affected by alteration in food availability in the wild.

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