How important are body reserves for King Eider egg formation in northern Alaska?

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Background

Birds breeding in the arctic must produce eggs at a time when food availability may be low. The use of body reserves for reproduction ("capital breeding") has been assumed to be common in arctic species. Large sea ducks like eiders rely mostly on body reserves during incubation, but it is unknown to what extent they rely on body reserves for egg production.

Here we examine **to what extent King Eiders rely on body reserves acquired at sea for egg production.**

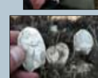
Methods

Field sampling

- captured King Eiders (*n* = 31) on breeding grounds near Teshekpuk Lake (70° 26' N, 153° 08' W) in June 2006 and 2007 to collect blood samples
- separated blood into plasma and red blood cells (RBC), and froze in liquid nitrogen
- collected one egg per nest, and all eggshell membranes remaining after hatch or predation
- collected freshwater invertebrates on breeding grounds

Laboratory analyses and calculations

- separated eggs, freeze-dried both yolk and albumen, and extracted lipids from egg yolk and invertebrates using a chloroform-methanol rinse
- analyzed RBC, albumen, membranes, lipid-free yolk, yolk lipids, and depot fat for stable carbon isotope ratios ($\delta^{13}C$)
- isotope ratio of RBC was taken to reflect isotope signal of body reserves (capital endpoint)
- used the average of eggshell membrane isotope ratios to reflect female's diets (income endpoint)
- Bayesian mixing model with two endpoints (RBC, membranes) to quantify source contribution to albumen and lipid-free yolk (SIAR)
- accounted for uncertainty in discrimination factors by using values from Hobson (1995: *Condor* 97:752), and from R. Federer (unpublished data from captive Spectacled Eiders *S. fischeri*)



Study species

King Eiders (*Somateria spectabilis*) breeding in northern Alaska winter in the Bering Sea and return to breeding grounds in early June. They lay eggs approximately two weeks after arriving on their breeding grounds.

King Eiders feed on freshwater invertebrates on breeding grounds, a food source that has a markedly different isotopic signature than food consumed at sea. We used this isotopic difference to quantify nutrient allocation to eggs.

Results

- body reserves contributed 10-30% to lipid-free yolk (Fig. 1)
- body reserves contributed <10% to albumen (Fig. 2)
- lipids highly variable (Fig. 3)

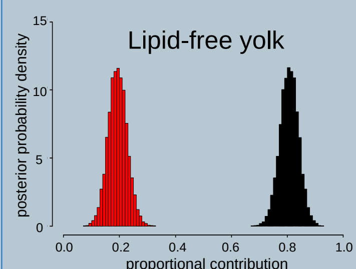


Figure 1: Posterior probability distribution of **endogenous** and **exogenous** contribution to lipid-free yolk in King Eider eggs from northern Alaska.

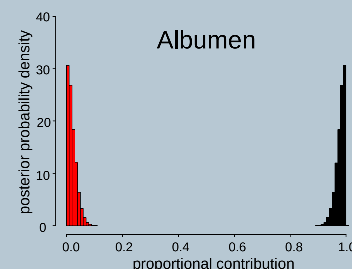


Figure 2: Posterior probability distribution of **endogenous** and **exogenous** contribution to albumen in King Eider eggs from northern Alaska.

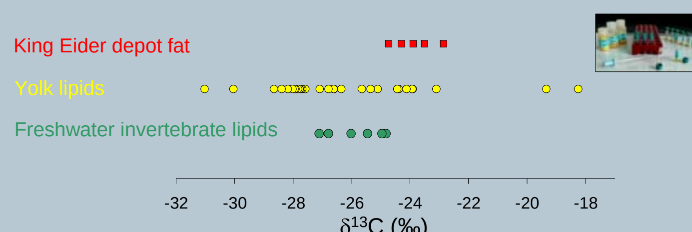


Figure 3: Stable carbon isotope ratios of **King Eider depot fat** on spring migration, **yolk lipids**, and lipids extracted from **freshwater invertebrates** on breeding grounds in northern Alaska. We could not apply a mixing model to yolk lipids due to the proximity of endpoints and the large variation in yolk lipids.

Discussion

King Eiders in northern Alaska rely mostly on nutrients from food sources on breeding grounds to synthesize egg proteins.

Lipids in egg yolk appear to be mostly derived from exogenous nutrients, but some birds rely exclusively on body lipids.

King Eiders may use exogenous nutrients for egg production to retain body reserves for incubation.

Lipid allocation to egg yolk appears highly variable in King Eiders. Future studies need to investigate whether this variation is due to laying sequence within clutches, or due to individual strategies among females. Arrival date, laying date, or age and body condition of the female may lead to different lipid allocation strategies.

Our results agree with studies at Karrak Lake, Canada (Lawson 2006, M.Sc. thesis, Univ. Saskatchewan). Both studies were conducted at the southern margin of the breeding range of King Eiders (70ºN). King Eiders breeding farther north (80ºN) may use a different nutrient allocation strategy.

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