Assigning sea ducks to wintering regions in the Bering Sea using stable isotopes of feathers

Steffen Oppel[1] and Abby N. Powell[1,2]

[1]Dept. of Biology and Wildlife, University of Alaska Fairbanks

[2]U.S. Geological Survey, Alaska Cooperative Fish and Wildlife Research Unit, Fairbanks, Alaska

contact e-mail: steffen.oppel@gmail.com

Background

Determining the spatial distribution of sea ducks outside the breeding season is important for management, but is logistically challenging.

Sea ducks can be readily captured on breeding grounds, and feathers can be sampled non-intrusively. Stable isotope analysis of feathers is a promising tool to explore spatial distribution of sea ducks during the non-breeding period.

In this study we explored whether feathers grown in different regions of the Bering Sea showed different stable carbon and nitrogen isotope ratios that could be employed to assign sea ducks to one of those regions.

Methods

We collected **head feathers from King Eiders** (*Somateria spectabilis*) captured on breeding grounds in northern Alaska 2005-2007. King Eiders grow head feathers in winter, hence we used head feathers to assign King Eiders to winter regions (Figure 1).

We first analyzed $\delta^{13}C$ and $\delta^{15}N$ of head feathers from birds tracked with satellite transmitters. Based on the assumption of winter region fidelity these feathers were of **known origin**. We used a linear discriminant function analysis (DFA) to classify feathers into three wintering regions based on $\delta^{13}C$ and $\delta^{15}N$.

We then used this DFA to assign 84 birds of **unknown origin** to a wintering region in the Bering Sea based on $\delta^{13}C$ and $\delta^{15}N$ of their head feathers. We compared the proportions of birds assigned to different regions to estimates derived from a large-scale satellite telemetry study (Oppel et al. 2008, *Condor* 110: 296-305) to assess whether geographic assignment using stable isotopes provides plausible results.

Results

Feathers of known origin

Feathers from the three regions in the Bering Sea differed in $\delta^{13}C$ and $\delta^{15}N$ (Table 1, Figure 1). A discriminant function analysis was able to correctly classify 88% of 32 feathers.

Feathers of unknown origin

We assigned 84 birds of unknown origin to wintering regions using $\delta^{13}C$ and $\delta^{15}N$ of head feathers: 27% wintered in SW Alaska, 45% in the northern Bering Sea, and 27% along the coastline of Kamchatka. This agrees with results from satellite telemetry.

Geographic Region	*n*	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)
northern Bering Sea	*14*	-17.0 ± 1.0	15.0 ± 0.8
SW Alaska	*6*	-16.9 ± 0.6	17.5 ± 1.4
Kamchatka	*12*	-15.0 ± 0.8	14.1 ± 1.1

Table 1. Mean ± SD of carbon and nitrogen isotope ratios measured in head feathers of King Eiders tracked with satellite transmitters to wintering regions in the Bering Sea. Color coding matches with regions in Figures 1 and 2.

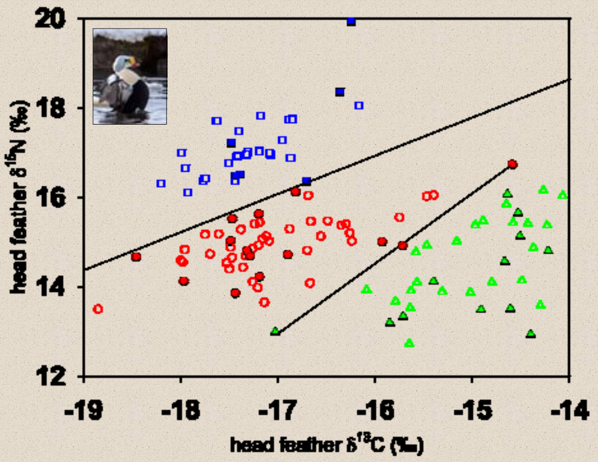

Figure 2. Isotope ratios of King Eider head feathers differed among regions in the Bering Sea. Green: Kamchatka, blue: SW Alaska, red: northern Bering Sea. Filled symbols represent birds of known origin, unfilled symbols represent birds of unknown origin assigned via DFA (black lines).

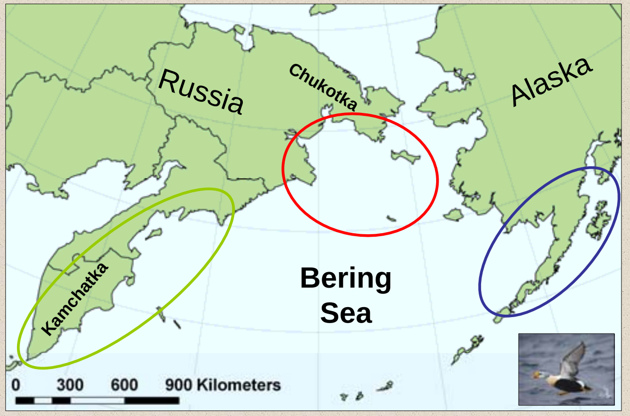

Figure 1: Location of three distinct regions used by wintering king eiders (*Somateria spectabilis*) in the Bering Sea as derived from satellite telemetry of 95 adult king eiders between 2002 and 2007 (Oppel et al. 2008, *Condor* 110: 296-305). Green: Kamchatka, blue: SW Alaska, red: northern Bering Sea.

Future applications

We showed that feathers grown in the three regions of the Bering Sea differ in their carbon and nitrogen isotope ratios. These differences can be employed to assign benthic-foraging sea ducks to one of those regions.

We propose that our method can also be used to expand the approach of Knoche et al. (2007, *Waterbirds*) to assign birds to **molting areas** by using $\delta^{13}C$ and $\delta^{15}N$ of flight feathers.

We believe this model could also be used to assign **other species of sea ducks** to the same regions in the Bering Sea. A basic requirement is a clear understanding of the molt strategy of the species, so that appropriate feathers are sampled.

Acknowledgements: We thank the North Slope Borough, U.S. Geological Survey, Minerals Management Service, and Sea Duck Joint Venture for funding and logistical support. We would also like to thank assistants for their help, as well as D. O'Brien, S. Bearhop, R. Suydam, and E. C. Murphy for valuable comments.

USGS science for a changing world