Environmental changes in the Bering Sea basin over a 100 year period as chronicled in red-legged kittiwake feathers.

Alexis Will[1,2], Evgenia Kitaiskaia[2], and Alexander Kitaysky[2]
[1]*NIPR*
[2]*Institute of Arctic Biology, University of Alaska Fairbanks, Fairbanks AK 99775 USA*

There is evidence that changes in climate regimes correspond to changes in marine food web structure and function. Long-term data-sets documenting dynamics of carbon and nitrogen stable isotopes are available for the Bering Sea and suggest that the ecosystem may have shifted during the past century. It is unclear, however, how much of this signal is attributable to the Seuss Effect, an increase in global carbon-13 due to fossil fuel emissions, and whether structural changes within the ecosystem affected marine predators. In this study we used a seabird, the Bering Sea endemic red-legged kittiwake (*Rissa brevirostris*), to detect climate associated changes in food web structure and its consequences. This species forages almost exclusively in the Bering Sea basin, a relatively poorly understood oceanographic region. To detect changes in food web structure and function we used a historical ecophysiology approach. We collected head feathers (grown during the end of the wintering period) and first primary feathers (grown during the breeding season) from St. George Island, the species' principle breeding location, from 1913 to the present (n = 24 and 27 years; and 194 and 122 individuals, respectively). To detect changes in the food web we analyzed feathers for stable isotope signatures of carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and sulfur ($\delta^{34}S$) to characterize birds' foraging niche. Changes in stable isotope values may indicate changes at the base of the food web, changes in trophic structure, or changes in where birds are foraging and at what trophic level they are obtaining prey. To detect changes in the function of the food web, in this case the availability (abundance and quality) of food to predators, we also measured the concentration of the avian stress hormone corticosterone in feathers. Both summer and winter feather corticosterone (fCORT) was lower when values of the annual Pacific Decadal Oscillation Index were positive, suggesting warmer conditions result in better foraging conditions for this seabird. Winter fCORT concentrations and $\delta^{15}N$ signatures increased when February sea ice coverage was extensive, suggesting birds may lose access to preferred foraging habitat and may experience higher stress during cold winters. We found no evidence of sudden shifts in the trophic level ($\delta^{15}N$) at which kittiwakes were feeding, but did find a strong signal of the Seuss Effect in the $\delta^{13}C$ data. $\delta^{34}S$ values, however, indicate that not all of the decline in $\delta^{13}C$ is due to anthropogenic processes, and that changes in prey distribution may have occurred. This study demonstrates how a marine predator can provide insight into the responses of a remote ecosystem to climate variability on a seasonal as well as century time scale.