Age determination in bowhead whales using the tympanic bone of the ear

Jennifer D. Sensor1, Craig J. George2, Mark T. Clementz3, Raphaela Stimmelmayr2, Robert Suydam2, and J.G.M. Thewissen1

1 Northeast Ohio Medical University, Rootstown, 44272, USA, jsensor@neomed.edu; 2 Department of Wildlife Management, North Slope Borough, Barrow, 99723, USA; 3 Department of Geology and Geophysics, Lamar University, 82071, USA

Abstract
As human pressures in the Arctic increase, it is essential to understand the population dynamics of marine mammals living in this area. For this, we must know the age of individuals in the population. The main methods of aging bowhead whales have been involved assessing baleen plate lengths and isotopic cycles, aspartic acid racemization of the eye, numbers of corpora ambiens and measurements of body length. Laminations in the periosteal zone of the tympanic bulla have been used as a way to determine age in fin, minke, and grey whales. Here we investigate if growth layer groups (GLGs) occur in the bulla of bowheads and whether they can be used to age these whales.

We sampled a tympanic bone and a baleen plate for a number of whales during the Inupiat subsistence hunts in Barrow, Alaska. We studied the histology of the tympanic and histologically, and isotopically and return (young born on the way) to the Beaufort Sea when the winter ice melts in spring. Samples taken along the length of baleen have been shown to record these isotopic cycles, aspartic acid racemization of the eye, and return (young born on the way) to the Beaufort Sea when the winter ice melts in spring. There is little to no remodeling in the tympanic and we hypothesize this animal is about 2.5 years old. Ten baleen isotopic oscillations are recorded. This method may be particularly useful in estimating the age for whales older than 10 (baleen baleen does not grow past age 10), and before 30 (when the GLGs become so thin that they are hard to read).

Future Work
In land vertebrates, cyclical growth marks in bone are usually due to environmental day-night cycles. This is unlikely in bowhead, because arctic day and night patterns vary widely throughout the year. Instead, banding in bowhead tympanic baleen could record feeding-fasting periods or environmental stress. More detailed histological and stable isotope work can be used to test this.

References (continued)


δ13C samples of the structural carbonate in biopsate (mineral) from Zones 1 and 2 of the tympanic bulla follow the same fluctuation pattern as δ13C from keratin (protein) in baleen, although the excursions differ (∼1285 and ∼1306). This further supports the hypothesis that life history events recorded in baleen are also recorded in bowhead tympanics.

Materials and Methods
We extracted tympanic baleen and longest baleen plates from whales during the Inupiat subsistence hunts in Barrow, Alaska between 2011-2015 (under NMFS permit # 17350). Bone samples of the tympanics were taken at the thickest part of the bulla. We mounted, ground, polished, and histologically evaluated samples under plain brightfield light. Baleen plates were sampled along the labial side, at intervals of one centimeter for carbon and nitrogen isotopic analysis (δ13C, δ14N).

Stable isotopes in baleen record pre-natal (yellow), nursing (pink) and post-nursing (blue) periods. At birth, baleen growth changes in direction, leaving a neonatal notch in the plate. Baleen δ13C values also decrease post-birth. Baleen δ13C values during nursing record the first year migration of the mother/calf. After weaning, baleen δ13C values track changes in the isotopic composition of diet associated with the migration between Beaufort and Bering/Chukchi Seas (blue).

References


