Entanglement Scar Acquisition Rates for Bowhead Whales
From Interyear Photo-ID Matches

J. Craig George¹, Barbara Tudor¹, Geof Givens², Julie Mocklin³, and Linda Vate Brattstrom⁴

North Slope Borough Department of Wildlife Management, 10611 Willow Street, Barrow, Alaska 99723
Givens Statistical Solutions, LLC, 4913 Hinsdale Drive, Fort Collins CO 80526, 3Shearwater Consultants, Seattle, WA; 4 Bardval, Mountlake Terrace, WA.

Background and Overview
We used interyear photo-recaptures of the same individuals to estimate the rate at which bowhead whales acquire entanglement scars. Bowhead whales (Balaena mysticetus) of the Bering-Chukchi-Beaufort Sea (BCBS) stock overwintering in the Bering Sea overlap spatially with commercial crab/fishing operations. George et al., (2017) found 12.2% of the landed whales carry entanglement injuries, mainly on large older animals. An analysis of aerial photos (n = 693) from the 2011 spring survey near Utqiagvik, Alaska, indicated that 12.6% (n = 87) show evidence of entanglement scarring, closely matching the estimates for harvested whales (12.2%). The entanglement-mortality rate is unknown, but 10 whales have been found dead or severely entangled in pot gear over a 33 year period - 1983 to 2015. Results from this study are largely consistent with entanglement frequencies and age-related scar accumulation rates on harvested whales.

Methods
We assessed inter-year matches (n = 117) from a multi-year (1985, 1986, 2003, 2004, 2005, and 2011) mark-recapture study (Givens et al., 2017) for adequate photo quality of the caudal peduncle. To determine an entanglement rate, we examined the interyear matches with adequate photo quality (n = 68) and identified whales that had acquired entanglement injuries to the peduncle during the study period, i.e., between the first photo capture and subsequent recapture (photos right).

Results & Discussion
We estimated the probability of a bowhead acquiring an entanglement injury using two statistical methods: interval censored survival analysis and a simple binomial model. Both methods give similar results suggesting a 2.4% (1.2%, 3.6%) annual probability of acquiring a scar and that about 40% of adult whales will be scarred after ~25 years. These estimates agree with our other analysis where ~50% of large (~17 m) and presumably old, harvested whales carried entanglement scars. Further, we found that about 47% of the whales >50 years carried entanglement scars. The BCBS bowhead population is increasing at a relatively high rate (3.7% annually); however, the findings reported here together with examinations of harvested whales suggest that commercial fishing/crab gear entanglement is a larger concern for BCBS bowheads than previously thought. We recommend continued monitoring of entanglement injuries both by aerial survey-photography and careful examinations of harvested whales.

Acknowledgements
Analysis was funded through the Alaska Coastal Impact Assistance Program and the North Slope Borough. Thanks to Gay Sheffield and the Savoonga Whaling Captains for their contributions to this work. We thank the NSB-DWM and NOAA/NMFS for financial support of the 2011 survey. We appreciate the patience, support and guidance of the Barrow Whaling Captain's Association and the Alaska Eskimo Whaling Commission on this project.

References

Photo credits: NOAA, Marine Mammal Laboratory, Seattle, WA; LgL Limited, King City, Ontario, Canada; NSB Department of Wildlife Management, Box #9, Utqiagvik, Alaska 99723; Gay Sheffield, Alaska Sea Grant, University of Alaska Fairbanks, Pouch #400, Nome, Alaska 99762

Permits: Aerial surveys: NMFS Permits 782-1719 and 14245 issued to NMML. Examinations of harvested whales: NMFS Permits 814-1899-01, 814-1899-02, 17350-00, and 17350-01 issued to North Slope Borough.