**Ecosphere**

**Coastal and Marine Ecology**

**Availability of Chinook and Sockeye Salmon as Prey to Cook Inlet Beluga Whales**

**Appendix S2: Estimating the proportion of belugas by age class from photo-identification mark-resight data.**

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To use the integrated population model (IPM) developed in this paper, the annual proportion of belugas by age class must be estimated. This appendix details how these proportions were derived from photo-identification mark-resight data published by Himes Boor and colleagues (2022) through the published GitHub link (https://github.com/gkhimesboor/HimesBoor\_etal\_2022\_MEE).

We begin by defining the following random variables:

* is the number of YOY belugas detected with adults during year .
* is the number of calves, one year of age and older, detected with adults during year .
* is the number of adults detected during year .

Additionally, we define the following parameters:

* is the probability of detecting a YOY beluga when it is present with an adult.
* is the probability of detecting a calf, one year of age and older when it is present with an adult.

Then the proportion of belugas in each age class by year can be estimated using the following equations:

In practice, the detection probabilities, and , and number of calves detected with adults, and , are not known without error. For this reason, Monte Carlo integration was utilized when estimating the proportion of belugas by age class and year from estimated detection probabilities and interval estimates of the number of calves detected with adults. This procedure is outlined below:

Let be the number of belugas in age class , with , that were detected with certainty in year . By “with certainty” we mean that it is clear which age class these individuals belong to. Additionally, let be the number of belugas in age class , with , that could have been detected in year . By “could have been detected”, we mean that individuals with unclear age class assignments are included in the estimate.

The detection probabilities, and , were estimated using the results of Himes Boor et al. 2022. Himes Boor estimated the probability of detecting the combined age group of YOY and one year old calves to be 0.546 (SD = 0.029) and the probability of detecting juveniles 2-year-old to be 0.473 (SD = 0.050).

To integrate this uncertainty into our estimates of the proportion of belugas by age class and year, we drew from a distribution for , from a distribution, and from a . This process was repeated 10,000 times and was estimated Equations 1-3. These estimates are shown in Figure S1.

Chart, line chart

Description automatically generated

Figure S1. Estimates of the proportion of belugas by age class, derived using the Monte Carlo sampling routine described above.