Are there biases in biopsy sampling? Investigating the potential drivers of sex-skew in projectile biopsy samples from two small delphinids

Kellar, Nicholas M. [1]; Trego, Marisa L. [1]; Chivers, Susan J. [1]; Archer, Frederick I. [1]; Carretta, James V. [1]; Minich, Jeremiah J. [1]; Perryman, Wayne L. [1]

(1) NOAA Fisheries, Southwest Fisheries Science Center, Protected Resources Division, 3333 North Torrey Pines Court, La Jolla, CA, 92037, USA

Corresponding author: nick.kellar@noaa.gov

Skin biopsies are increasingly used to study various aspects of cetacean biology, however, little is known about how representative these samples are of their respective populations. This is particularly important for small cetaceans given their speed, size, and erratic movements such that the majority of biopsies are obtained from bowriders (i.e., animals riding the forward pressure waves of boats). Here we investigate whether bow-riding is random with respect to sex and if not how its effects compare with other factors contributing to skew in biopsy sex ratios. Sex was determined for 1294 common dolphins (658 long-beaked, *Delphinus capensis*, and 636 short-beaked, *D. delphis*) biopsied during a 3-month research cruise off California and Baja, Mexico. Sex ratios were vastly different between the species; 241 females (36.6%) from *D. capensis* and 410 females (64.5%) from *D. delphis*. Using Bayesian statistical models, we found moderate evidence of males bow-riding more than females in *D. capensis* but not in *D. delphis*. For *D. capensis*, the effect of differential bowriding behavior on the sex ratio was similar in magnitude to that of group size (disproportionately more females in smaller schools), longitude, and latitude (disproportionately more females in the southern and eastern parts of their range). However, the factor most likely to influence the sex ratio of either species was an operational restriction on biopsying cow/calf pairs (common to many cetacean field projects). In response, we present a mathematical model that corrects for this bias based on estimates of proportion calves. The results show that, at the extreme, a large sample set with 25% females can be consistent with a population sex ratio of 1:1. In our study, we used aerial photographs to estimate 4.5% and 5.7% calves for *D. capensis* and *D. delphis*, resulting in corrected estimates of 41.0% and 66.1% female, respectively.