

## Effects of cetacean depth on acoustic distance sampling surveys

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**Abstract:** Passive acoustic monitoring is an increasingly popular survey approach for cetaceans. In general, acoustic monitoring equipment is either towed behind a vessel or fixed in the water column. In some circumstances, the collected acoustic data can be analysed using traditional density estimation methods such as distance sampling. However, monitoring vocalising marine animals poses particular challenges. Firstly, a volume of water is monitored by acoustic instruments, so three-dimensional distance sampling must be considered. Secondly, animals are unlikely to follow a uniform distribution with respect to depth (many cetacean species dive to particular depths to forage on specific prey species). Finally, locations of calling animals are often not available. Previous work on krill swarm density estimation (an analogous problem, as krill swarms also exhibit non-uniform depth distributions) relied on estimates of the vertical bearing and slant range to each detected krill swarm, which were obtained using active acoustic techniques (Cox *et al.*, 2011). In the case of passive acoustic cetacean surveys, such information is difficult to obtain – often a slant range is estimated with no vertical bearing, or *vice versa*. In this presentation, we will (1) discuss the modifications that we have made to distance sampling methods to analyse data from both towed and fixed passive acoustic surveys (specifically, information about the depth distribution of the study species is incorporated into the maximum likelihood estimator of the detection function parameters), (2) present simulation results, verifying the newly developed methods and (3) apply the methods to beaked whale survey data.

### References

Cox, M. J., Borchers, D. L., Demer, D. A., Cutter, G. R. and Brierley A. S. (2011) Estimating the density of Antarctic krill (*Euphausia superba*) from multi-beam echo-sounder observations using distance sampling methods. *Journal of the Royal Statistical Society: Series C (Applied Statistics)*, 60: 301-316.