TITLE

Understanding precision and directional bias of fisheries abundance estimates across 24 commonly used survey methods

ABSTRACT

The effectiveness of fisheries management and conservation policies cannot be assessed without surveys designed to estimate the abundance of target species over time. A variety of survey methods are employed for these purposes, each characterized by some inherent level of precision and potentially directional bias. While low levels of precision in survey methods lead to low confidence in point estimates of population abundance or forecasts, directional bias presents a more pernicious problem as it may lead to the mismanagement of imperiled species, invasive species, and commercially valuable populations, due to over- or under-estimation of their numbers (Tracey and Fleming 2022, Satterthwaite and Shelton 2023). This research estimates levels of precision and relative bias associated with 24 survey methods commonly used by the Oregon Department of Fish and Wildlife to estimate the abundance of 68 populations of Chinook (Oncorhynchus tshawytscha) and coho salmon (O. kisutch) and steelhead trout (O. mykiss) from 1980 to 2022. This is accomplished by employing multivariate autoregressive state space (MARSS) which are designed to mathematically distinguish observation error from process/state error and assign separate variance parameters to each (Holmes et al. 2012). These models find that, while some survey methods are generally more precise than others, the same survey methods can have very different levels of precision and biases when applied to different species. Better understanding levels of precision and directional bias in survey methods will enable fisheries managers to better understand the reliability of abundance estimates upon which they must make decisions and to determine the long-term effectiveness of conservation efforts.

References

Holmes, E. E., E. J. Ward, and K. Wills. 2012. MARSS: Multivariate Autoregressive State-space Models for Analyzing Time-series Data. *The R Journal* 4(1): 11-19.

Satterthwaite, W. H., A. O. Shelton. 2023. Methods for assessing and responding to bias and uncertainty in US West Coast salmon abundance forecasts. *Fisheries Research* 257: 14 pp.

Tracey, J. P., Fleming, P. J. S. 2023. Recounting bias can affect abundance estimates from intensive helicopter surveys of feral goats. *Wildlife Research* 50(5): 389-397.