Supplementary materials

Additional information related to inferring and interpolating spawning rises

Spawning rises can be some of the most extreme ascents and descents a fish conducts throughout the year (Fisher et al., 2017), so we looked for tag data with a peak in extreme ascents and descents coinciding for males and females. To identify the time of year with the most extreme ascents and descents, the top 0.1% ascent and descent rates (first-order change in depth between samples) for each fish were combined and binned by 5-day increments for the entire year (Suppl. Fig. 1). Simulated depth profiles show other possible behaviors that include extreme ascents and/or descents in comparison to those we were identifying as a female spawning rise, which required an extreme ascent immediately followed by an extreme descent (Suppl. Fig. 2). Extreme ascents or descents in isolation (e.g., migrating to deeper or shallower depths), extended periods at the top of an extreme ascent (e.g., feeding), and extreme descents immediately followed by an extreme ascent (e.g., diving) were not further analyzed (Suppl. Fig. 2).

To assess whether or not the simple linear model method for estimating the apex depth was appropriate, we utilized the only tag on a female Greenland halibut that sampled at 1-min intervals and had putative spawning rises identified (3 separate years). Our estimate of the apex depth from the 1-min interval was treated as the best estimate and compared to the two alternatives: simple linear model to interpolate the minimum depth at 1-min intervals (described in the methods section) and minimum depth achieved with 15-min interval sampling. For each year, 1-min interval data from the putative spawning rise was subsampled to 15-min intervals, such that there are 15 iterations for each year (Suppl. Fig. 3).

The estimated apex from the simple linear model applied to 15-min sub-sampled data was much closer to the 1-min interval estimate with a much smaller range when compared to just using the minimum depth from the 15-min interval (Suppl. Fig. 3). Also note that the minimum depth from 15-min subsampled data will always be equal to or less than then 1-min interval estimate, and will thus always be a greater (or equal) depth. In 2012, the simple linear model consistently estimated a shallower depth, but only by ~10 m, whereas 2013 and 2014 estimates were both slightly above and below with median estimates nearly the same as the 1-min interval estimate (Suppl. Fig. 4). This result gives us confidence that using the simple linear model method for sampling intervals greater than 1 min more accurately reflects the actual depth of the

apex of putative spawning rises rather than just taking the minimum depth recorded during a rise. This was only applied to females, as males often exhibited more staggered ascents and descents and not being easily interpolated with linear methods.

Reference

Fisher, J. A. D., D. Robert, A. Le Bris, and T. Loher.

2017. Pop-up satellite archival tag (PSAT) temporal data resolution affects interpretations of spawning behaviour of a commercially important teleost. Anim. Biotelem. 5:21. Crossref