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Estimating survival of acoustic telemetered walleyes in the Great Lakes and comparison of survival rates between Lake Huron and Lake Erie spawning populations

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June 2021

ABSTRACT:

Mortality rate has a critical influence on the sustainability of exploited fish populations; despite its importance, accurately estimating mortality rates can be challenging. Acoustic telemetry technology can provide information both on movements and mortality rates of tagged fish. The Great Lakes Acoustic Telemetry Observation System (GLATOS) has been collecting acoustic data on a number of important fish species in the Great Lakes basin over the past decade. Many of these acoustic studies have focused on Lake Erie and Lake Huron walleye (*Sander vitreus*), with an interest in how detection data can be used to estimate mortality rates. This study first evaluated two potential methods for estimating mortality using acoustic telemetry data: a spatial and a non-spatial approach. A simulation framework was used to evaluate the accuracy and sensitivity of these two estimation techniques. Data were generated assuming different receiver configurations (grids versus lines), numbers of receivers (39 versus 64), and true total instantaneous mortality rates (0.1, 0.4, and 0.6) of tagged fish in a large lake. Relative error rates for total mortality ranged from 0.1% to 83% for the non-spatial model and from 1% to 141% for the spatial model. Both the true mortality rate and receiver configuration affected accuracy and precision. Models performed better at moderate and high rates of true mortality, with an error rate range from 0.1 to 22% for the non-spatial model and 1% to 32% for the spatial model. Models also performed better with the higher density grid receiver configuration, particularly at the moderate and high rates of true mortality, with an error rate

ranging from 0.1% to 19% for the non-spatial model and 1% to 15% for the spatial model. Relative error obscures the consistency of the positive bias among mortality rates: the absolute error rates for total mortality ranged from 0.00 to 0.11 for the non-spatial model and from 0.01 to 0.15 for the spatial model and was fairly consistent across mortality rates; however, the high-density grid still resulted in lower error rates than the other receiver configurations. The positive bias we saw across scenarios likely results from confounding between receiver detection probabilities and fish death, both of which result in fish not being detected.

Both estimation models were then applied to GLATOS walleye data from Lake Erie to estimate mortality rates for different cohorts of tagged and released fish (river vs reef spawners). The more recent cohort of reef spawning fish tagged in 2016 experienced a higher density of receivers relative to the earlier cohorts. The estimate of total instantaneous mortality was 0.52 and 0.50 for spatial and non-spatial models respectively, with narrow credible intervals. Two cohorts from 2014 were used to compare between river and reef spawners. The reef spawning fish mortality estimate was 0.72 and 0.69 for the spatial and non-spatial models. This estimate was much higher than the Sandusky River spawning fish mortality estimate of 0.40 and 0.36 for the spatial and non-spatial models. The reef spawning fish also had more fish reported as being harvested in the fishery compared to the Sandusky River walleye. For all three cohorts of fish, mortality appeared to be concentrated in the western basin near spawning areas, although all cohorts included fish whose last known location was in the central or eastern basins of Lake Erie. Based on the simulation results, it is likely that these empirical estimates were positively biased. However, the similarity of estimates from the spatial and non-spatial models was encouraging.

The spatial models used in this analysis were computationally intensive, which limits their usefulness for management and the annual stock assessment process. However, the potential benefit of spatial models by providing insight into movement patterns of fish and how that movement interacts with mortality warrants additional research into ways to streamline and improve these models. Behavior of future species under investigation is important to consider when using spatial models, as we hypothesize that fish that move less will provide less information on population mortality rates because of lower detection probabilities. Increasing acoustic receiver densities could help to compensate for low detection probabilities of less mobile species. In addition to evaluating survey design, the simulation framework used in this project could be used to further evaluate spatial approaches to using acoustic telemetry to estimate mortality.