EVALUATING AGE- AND LENGTH-BASED MODELS FOR ASSESSING LAKE TROUT

Richard D. Clark, Mark Ebener, and James R. Bence

Quantitative Fisheries Center, Department of Fisheries and Wildlife, 375 Wilson Road, Room 101, UPLA, Michigan State University, East Lansing, MI. 48824-1101

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ABSTRACT:

Stock assessment models use data from fishery catches and biological surveys to estimate fish population demographics, such as abundance, mortality, and recruitment. These estimates can help managers formulate proper fishing regulations or stocking policies. Statistical catch-at-age assessment (SCAA) models are the most common type used in the Great Lakes and so are considered the more conventional approach. We refer to SCAA models as age-based because they condition estimates on inputs of the age compositions of catches. Although less commonly used, size-based assessment models have been developed in which estimates are conditioned on the size compositions of catches. Both age- and size-based models have strengths and weaknesses. The best model to use in each situation depends on the availability and reliability of data and the life history of the species being assessed. Lake trout (*Salvelinus namaycush*) occur in a variety of data-rich to data-poor situations and their life history can support reasonable arguments for using size-based models in place of age-based models. For example, they are long lived and slow growing which makes aging from calcified body structures costly and prone to errors. Thus, a common scenario in lake trout assessment is that the age compositions of catches needed for age-based models are too sparse or possibly unreliable. Size-based models might be the better choice in these scenarios because size compositions are cheaper and more reliably measured and are usually more abundantly available. Lake trout fisheries in southwest Lake Michigan (SWLM) are a good example of this scenario: catch-at-age data are sparse, catch-at-length (size) data are abundant. In fact, concern about sparse catch-at-age data was one of the things that had delayed attempts to develop stock assessment models here. Our objectives in this study were to: 1) develop and apply both age- and size-based models to lake trout in SWLM; and 2) compare and evaluate the performance and suitability of each model type. We acquired fishery catch and effort data and biological information on lake trout in Lake Michigan during 1985-2019 from five tribal, four state, and two federal agencies and organized them in a Microsoft ACCESS database. We defined two new stock assessment regions for lake trout in SWLM, WI345 and WIIM. The addition of these regions completed the lake-wide coverage of stock assessment models for lake trout. We coded age- and size-based models for SWLM that included two fishery types, recreational and commercial, and one fishery independent survey. We chose to use a type of size-based model known as a length-based, age-structured assessment (LBASA) model. LBASAs condition estimates on inputs of the length compositions of catches but also maintain and track the population age structure. Despite the sparse data for catches-by-age, we were able to estimate age compositions by combining catch and survey data into an age-length key and applying it to catches by length. We then used the age compositions in the age-based versions of the models to complete the lake-wide assessment of lake trout in an age-based context. Under the Great Lakes Fishery Commission Lake and Technical Committee framework, we transferred the models to management agency biologists and helped them integrate the models into ongoing lake-wide assessments. Finally, we applied both age- and size-based models to lake trout in the WIIM region, then compared and appraised key estimates and ran

diagnostic tests to help judge which models performed best. We found that the length-based models performed about as well as the more conventional age-based models in most of the statistical tests and that they had some important advantages over age-based models from a fisheries management perspective. Most notable was that length-based models can be designed to make the same demographic estimates under a sampling design that substantially reduces the number of age samples needed. We concluded that length-based models should be seriously considered when the accuracy of aging might be low and the growth rate is thought to be relatively constant over time, which is the case for lake trout in SWLM and sometimes the case elsewhere.