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Image Analysis Procedures for Aging Calcified Structures: An Example with Lake Michigan Lake Whitefish

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Abstract.−Image analysis procedures for aging calcified structures have been recently developed for fisheries science to improve and standardize the interpretation of fish age and growth, thereby reducing reader subjectivity. Because of improvements in image analysis software, a new system, Image-Pro PLUS (Media Cybernetics®), is being implemented within the Michigan Department of Natural Resources (MDNR) Fisheries Division to provide a more systematic means of reading and archiving calcified structures electronically. This system will improve the precision of aging by creating high quality image files of the calcified structures and allow for reproducibility by saving images and the associated assignment of ages. To make image analysis systems effective, however, procedures must be standardized for the Division and implemented at each station where age and growth data are collected. This procedure has been developed using Lake Michigan whitefish scales (Whitefish Macro), but it can be easily modified for use on different calcified structures (e.g., spines, otoliths) and for other species. The techniques include aspects of physical processing, image acquisition, and image analysis that require specialized hardware and software. In addition to improving the precision in aging, implementation of an image analysis approach will provide a precise record of how the MDNR collects age and growth data, making our methods available for peer review.

Introduction

Our understanding of fish population dynamics is dependent on accurate estimates of age. In exploited fisheries, information concerning the age structure of the harvest is critical to evaluate mortality rates and to develop harvest limits (Beverton and Holt 1957). Error in estimating fish population age structures can impede our ability to manage fish populations effectively (Beamish and McFarlane 1995). Because of problems with sample preparation and subjectivity in determining fish age, standardization of aging protocols is necessary (Campana and Moksness 1991). In addition, standard procedures for aging should include a validation component for all ages and for each species to estimate the precision of determining age (Beamish and McFarlane 1983).

Fish growth is related to food quantity and quality, but influenced by physiological parameters. Daily and seasonal changes in growth are evident in calcified structures because calcium and organic deposits appear as rings (e.g., circuli on scales). Early life stages can be evaluated for age by examining daily growth whereas the age of adult fish can be estimated by examining annual growth. On a scale, fish age is determined by interpreting changes in growth through the identification of annuli. Annuli are defined as an area on the scale where circuli are incomplete and an