A unified model of walleye recruitment

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ABSTRACT:

Understanding and predicting recruitment, longstanding goals in fisheries science and ecology, are complicated by variation in the importance of environmental drivers coupled with the dynamic nature of individual ecosystems. Developing an understanding of recruitment from well-monitored stocks offers an opportunity to overcome these complexities. We combined a systematic literature review, a survey of experts, and a workshop attended by professionals with expertise in Walleye (Sander vitreus) recruitment, to identify common environmental drivers of Walleye recruitment and additional sources of variation (i.e., context-dependencies) among populations. The importance of individual environmental drivers, as well as the direction of their influence, differed as a function of geographic region, lake surface area, and walleye life stage. The literature suggested abiotic conditions (e.g., temperature) during the first year of life were influential in determining recruitment. Professional opinion noted the importance of biotic factors, with prey availability and predation risk having the most consistent relationships with recruitment. We synthesized this information to propose a conceptual model that illustrates the suite of characteristics that shape walleye recruitment over large spatial and temporal scales and how they may differ between populations in the Great Lakes compared to smaller, inland lakes. We then collated data on walleye recruitment to fall of the first year from 968 stocks over 40 years comprising 8,189 unique observations of walleye recruitment across both Great Lakes and smaller inland lakes. Across these diverse populations, we identified a consistent decline in walleye recruitment from 1990 to 2021.

We quantified the influence of climatic drivers as well as lake area to show that moderate growing degree days, moderate winter severity, and high spring warming rates all benefit walleye recruitment, although these variables were less important than lake surface area or location. Our findings emphasize the importance of first-year growth and survival as influenced by system-specific contextual factors, which can alter the relative importance of the environmental drivers of recruitment. This work illustrates potential shifts in walleye population sustainability as environments continue to change and speaks to the utility of long-term datasets in designing future management and conservation strategies.