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# Which environmental and human indicators best predict fish community status?

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Ecosystem managers must forecast fish community responses to changing environments and human activities over multi-year time scales. Their efforts are aided by ecosystem indicators derived from a wide variety of data types. Environmental indicators include broad-scale metrics such as the North Atlantic Oscillation (NAO) and Atlantic Multidecadal Oscillation (AMO), and regional conditions such as annual mean temperature and primary production. Indicators of human activities include fishing pressure, commercial landings, and biomasses of target species. With the increasing availability of ecological data, it is becoming imperative to determine which indicators should be factored into management decisions.

The objective of this analysis is to determine which sets of environmental and human indicators can predict fish community status, defined here as the biomasses of three key functional groups (benthivores, planktivores, and piscivores). We use two quantitative approaches that simultaneously predict multivariate responses, and compare their explanatory power and ease of use: (i) multivariate multiple regression, an extension of simple linear regression; and (ii) neural networks, a type of machine learning. Both methods were applied to three decades of data for two different regions in the Northwest Atlantic (Grand Bank and Georges Bank), which each represent data-rich, historically important fishing grounds with differing management strategies. Results reveal that sets of four indicators can have better predictive ability than larger sets, and that human indicators have more explanatory power than environmental indicators on these time scales. Results are discussed in the context of prioritizing future monitoring programs to align with management needs.

**Keywords:** Ecosystem based fisheries management, ecosystem indicators, neural network analysis, multivariate multiple regression, Grand Bank, Georges Bank

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