Examining the usefulness of trophic level-based indicators in assessing ecosystem-level changes in the ocean

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Abstract

Trophic level (TL)-based indicators have been widely used to examine fishing impacts in aquatic ecosystems and induced biodiversity changes. However, there has been much debate concerning the use of landings data from commercial fisheries to calculate TL indicators because commercially caught species and their relative catches likely do not reflect the whole ecosystem and strongly depend on fishing strategies. Subsequent studies have started to look at survey-based and model-based TL indicators. Further, the use of a fixed TL per species in the calculation of TL-based indicators has been questioned, given that species' TLs vary with ontogeny, as well as over time and space. In this contribution, we report on two studies that contribute to this discussion: (i) a data-based extensive evaluation of a variety of trophic level indicators across nine well-studied marine ecosystems using model-based,survey-based, and catch-based TL indicators as well as detailed regional information, data on fishing history, fishing intensity, and environmental conditions, to examine how well TL indicators capture fishing effects at the community level of marine ecosystems; (ii) a fishing scenarios study using four different ecosystem modelling approaches in contrasted ecosystem case studies to examine the performance of TL-based indicators in tracking the effects of fishing pressure when using fixed species TL versus species' TL varying depending on the fishing scenarios. Results of the first study highlight that the differences observed between TL indicators' trends are dependent on the data source, and are not attributable to an intrinsic problem with TL-based indicators. All three data sources provide useful information about the structural

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changes in the ecosystem as a result of fishing, but only model-based indicators were found to represent fishing impacts at the whole ecosystem level. From the second study, we conclude that overall, TL-based indicators calculated with variable species' TL have a greater capacity for detecting the effects of fishing pressure than when using fixed species' TL. Across TL-based indicators, survey-based TL indicators displayed the greatest consistency regarding the use of fixed or variable species' TL and the highest capacity for detecting fishing effects. This work supports the use of community-based indicators over catch-based indicators to explore the impacts of fishing on the structure of marine ecosystems.