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Practical application of food web indicators in a fisheries context.

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This paper reviews recent progress in ICES to build consensus on practical food web indicators based on their key roles in ecosystem structure, functioning and resilience. Indicators of the abundance /distribution of key species or trophic groups, and their productivity (production per unit biomass), were recommended as necessary for comprehensive food web assessment. Specific indicators of the biomass of trophic guilds, mean weight of zooplankton and integrated size-based indicators scored well against structural criteria, while primary production, seabird breeding success and mean fish weight at age were favoured to describe food web function. The need for regional seas cooperation in the development of these indicators was highlighted to ensure they were coherent and representative. Use of other indicators was encouraged, where already developed, particularly the indicator set established under the EU Data Collection Framework for fisheries. The importance of commercial landings data and fisheries independent survey data in indicator development was highlighted.

Introduction

There is a well-established need to use indicators of food webs that reflect characteristics of energy flow, resilience, structure and functioning in the management of marine ecosystems, and which ensure appropriate management of components in those marine ecosystems. Food web indicators are central to U.S. government Ecosystem Based Management activities, are an integral part of Canada's Oceans Act, and support the 2020 targets of the Convention on Biological Diversity and for global fisheries management in the context of climate variability and change. They also provide necessary information on Good Environmental Status and support the European Commission's Marine Strategy Framework Directive (MSFD), an overarching plan to reach and maintain Good Environmental Status (GES) for all marine waters bordering the EU. The MSFD characterises the status of the marine environment into 11 Descriptors. One of these, D4, addresses specifically *Elements of marine food webs*. Other Descriptors, such as D1 (*Biological diversity*), D3 (*Population of commercial fish / shell fish*), D5 (*Eutrophication*), D6 (*Sea floor integrity*), cover additional information relevant to interpreting the status of food webs. Building on the work of a joint JRC/ DG ENV task force (Rogers *et al*. 2010), a Decision by the European Commission provided provisional guidelines for setting targets and defining indicators for GES under D4 (2010/477/EU). A workshop on Food Web Indicators (ICES, 2014) brought together experts in food webs, marine ecology, and management, to identify available indicators that can be used to inform marine management.

Materials and Methods

There has been considerable international effort to develop selection criteria for indicators. The workshop drew on this experience, and generated the following five high level criteria that were suitable for assessing indicators. Indicators were assessed in three categories, food web structure, function and resilience.

1) **Availability of data**. *Measurability*, robust quantifiable data covers the range of spatial & temporal natural variability of suitable (historic) duration and resolution, availability of historic data or other reference points for benchmarking,

2) **Quality of underlying data.** Data that are *Sensitive* to the magnitude and direction of response to underlying attribute/pressure, with high signal to noise ratio, and *Responsive* at an appropriate time-scale. A *tangible* indicator that is intuitive to understand.

3) **Conceptual,** *Theoretical basis*, with indicator behaviour (in response to pressure) that is understood to support management advice,

4) **Communication**, an indicator that is simple, credible, *unambiguous, comprehensible* and can be easily communicated

5) **Manageable**, an indicator that is relevant to management, with estimable targets and thresholds and which are *responsive, sensitive* and *cost-effective* to develop,

Forty potential food web indicators (grouped by attribute and linked to a relevant ecosystem component) were assessed by the group, and scored according to their suitability.

Results and Discussion

Indicators of the abundance/distribution of key species or trophic groups, and their productivity (production per unit biomass), were recommended as necessary for comprehensive food web assessment. Specific indicators of the biomass of trophic guilds, mean weight of zooplankton and integrated size-based indicators scored well against criteria, while primary production, seabird breeding success and mean fish weight at age were suitable for describing food web function.

The outcome of the indicator assessment was a suite of specific functional and resilience indicators, while those allocated to the structural category were also appropriate indicators for other ecosystem components. This suggested that suitable indicators for food webs may also be appropriate for other ecosystem components, particularly 'biodiversity' and fisheries. Member States should therefore encourage the common use of suites of indicators for broad ecosystem assessment. They should also develop and agree on the technical specification of selected indicators for each region.

An indicator set has also been developed under the data collection framework (DCF) to evaluate the effects of fishing on the ecosystem. Some of these indicators, such as the proportion of large fish, are used in common with the MSFD, and should be encouraged. The future role of fishery-independent surveys to collect fish community data and associated ecosystem metrics is crucial to effective data provision.

The majority of the proposed food web indicators are surveillance indicators that are not tightly linked to a management action and are unlikely to support target setting. These indicators still provide valuable contextual information for an informed assessment of ecosystem change as well as a broad insight into changes that may affect our ability to achieve specific targets. Implications for managers, however, must be made clear.

There is considerable academic development of food web theory and modelling of potential indicator performance. Less effort has been invested in operational food web management, and it was evident that there is a further suite of indicators ready for future development. Such knowledge may be required if none of the proposed indicators are suitable for a regional sea.

References:

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