ICES CM 2014/M:05

A balanced harvesting strategy to counteract the effect on fisheries yields of reduced body size of organisms in the future ocean

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Summary:

Large bodied individuals suffer disproportional from human activities because they tend to have smaller population sizes, longer turnover rates, and hence longer recovery times, consequently they are more prone to extinction. Of special interest are those changes in the biogeochemical carbon cycle that can potentially alter the metabolic balance of ecosystems, which determines whether an ecosystem acts as a source or sink for atmospheric carbon dioxide. Using the EcoTroph model, and from information of trophic spectrum from different types of ecosystems (e.g. pelagic, demersal, benthic-demersal), the effect of fishing was simulated considering two scenarios, one where the abundance and size structure of the community were the same described in actualized literature, and a second scenario where an increase and a reduction in the amount of smaller and bigger individuals, respectively, was considered, in order to simulate the effect on fisheries and metabolic balance, of reduced body size of organisms in the future ocean and a balanced harvesting fisheries management strategy. A synergistic effect between fisheries and reduced mean body size of a community is noted. Applying a balanced harvest strategy increases the capacity of ecosystems to sequester carbon compared to traditional management strategies.

Introduction

Evidence of ecological impacts from global warming on individual stocks have begun to become quite well understood, including the expansion of their geographic ranges and migration towards the poles, however, the potential response of the entire ecosystem is still uncertain. Generally, large bodied individuals suffer disproportionally from human activities because they tend to have smaller population sizes, longer generation times, and hence longer recovery times, consequently they are more prone to extinction. Of special interest are those changes in the biogeochemical carbon cycle that can potentially alter the metabolic balance of ecosystems (Yvon-Durocher *et al*. 2010). This balance determines whether an ecosystem acts as a source or sink for atmospheric carbon dioxide. In the present work we compare different fishing management scenarios in order to assess their effectiveness in counteracting the known effects of fishing on reducing body size of organisms in the future ocean. Different kind of ecosystems were considered.

Materials and methods

Using the EcoTroph model (Gasche and Gascuel 2013), and from information of trophic spectrum from different types of ecosystems (e.g. pelagic, demersal, benthic-demersal), the effect of fishing was simulated considering two initial biomass scenarios, one where the abundance and size structure of the community were the same described in actualized literature, and a second scenario where a change in size spectrum slope causing an increase (x2) and a reduction (x 0.5) in the amount of smaller and bigger individuals, respectively. In order to simulate the consequences on fisheries and metabolic balance, of reduced body size of organisms in the future ocean we simulated two different fishing

scenarios: 1) actual fishing mortality and a balanced harvesting fisheries management strategy (García *et al*. 2012). Metabolic balance of ecosystems (Yvon-Durocher *et al*. 2010) is defined as the rate of carbon fixation by photosynthesis on remineralization by respiration.

Results and Discussion

A synergistic effect between fisheries and reduced mean body size of a community is noted. In all cases the scenarios where the reduced body size of organisms was considered the reduction in the total accessible biomass was stronger than in those cases where we considered the actual size distribution of communities. The distribution of this biomass tend to be higher in the smaller body sizes in all cases, but in the reduced body size of organisms was more evident.

For the second fishing management scenario (balanced harvest strategy), an increase in the capacity of ecosystems to sequester carbon compared to the actual management strategies was observed. However, this not always represent a net carbon sequestering, only a higher level relative to actual fishing strategy in all cases. Those cases where fishing was stablished a long time ago the balanced harvest strategy only help in a small degree. In those ecosystems less impacted by human activities the balanced harvest strategy represent the possibility to actually sequester carbon from atmosphere.

References

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