

## **Title**

Does industrial fishing reverberate in the marine community size-structure for generations to come?

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## **Purpose of the visit**

To visit Ken H. Andersen at DTU Aqua, Charlottenlund, Denmark to address the research question: 'What is the expected impact of the (industrial) forage fishery on the whole fish community?' Fish species whose main diet is zooplankton are termed 'forage fish', such as sprat, sand eel, and Norway pout in the North Sea. They occupy intermediate positions in the marine food chain, have high abundance and productivity, so are an important food source for many larger fish species. For the past few decades, forage fish have been increasingly targeted in an 'industrial' fishery for fishmeal. Due to their high production/biomass ratio, forage fish are thought to be able to sustain high fishing mortality. What has not been considered, though, is that this fishery may produce distortions of the community size-structure which propagate through trophic cascades, causing, for example, indirect negative effects on the predators of forage fish.

## **Description of the work carried out during the visit**

We used a dynamic, size-based modeling approach (Hartvig 2011) to investigate two scenarios: 1) the ecosystem effect of forage fish exploitation as compared to an un-fished ecosystem, and 2) the effect of commencing forage fish exploitation in an ecosystem with an existing fishery for larger fish for direct human consumption. We built on the work of Andersen and Rice (2010) by quantifying ecosystem effects in terms changes in size- and species- based abundance, growth, and mortality. We examined the interaction of forage and consumer fisheries by comparing yield and SSB in the presence of forage, forage and consumer, and only consumer fisheries.

## **Description of the main results obtained**

The reduction of forage fish biomass from industrial fishing causes a trophic cascade in the ecosystem. Compared to an un-fished ecosystem, the reduction in abundance of forage fish from fishing increases the abundance of species in both larger and smaller neighboring trait classes through effects from size-based predation and food-dependent growth. Our results suggest that the forage and consumer fisheries do not have significant interaction. The consumer fishery does not significantly affect yield and SSB of the forage fishery and vice versa. These results are robust to fishing pattern, fishing effort level, and trait class range fished.

## **Future collaboration with host institution**

We plan to continue developing this research with distant communication. We will investigate the ecosystem effects of bycatch of large adult fish in the forage fishery, and the sensitivity of our results to model parameters and assumptions.

## **Projected publications/articles resulting or to result from the grant**

We plan to publish a paper based on the work started on this visit examining the ecosystem effects of forage fishing.

**Literature Cited**

K.H. Andersen and J.C. Rice: Direct and indirect community effects of rebuilding plans. ICES J. Mar. Science. doi:10.1093/icesjms/fsq035 (2010)

M. Hartvig, K.H. Andersen, and J.E. Beyer: Food web framework for size-structured populations. J. Theor. Biol. doi:10.1016/j.jtbi.2010.12.006 (2011)