

**DK-Proposal 19**

Submitted by

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**Climate and Northern Shrimp**

Conditions for growth and survival of shrimp larvae in different oceanic regimes and an assessment of the adaptability of local shrimp populations to climate-induced changes.

Place:

Waters off West Greenland

Disciplines:

Marine ecology, population dynamics and management

Motivation:

We propose to investigate the sensitivity and the vulnerability of a key species for the Greenland Fisheries to climate variability and change. Shrimp *P. borealis* the most important fisheries resources in Greenland and eastern Canada. The proposed study is focused on conditions for shrimp larval survival and recruitment in the Northwest Atlantic and the Lower Arctic.

Research:

One major difficulty in studying the impact of climate change on any species is to know the degree of adaptability of the life cycle in response to environmental variability. A relatively simple but rarely possible approach to estimate the adaptability of a species would be to study a population over a long period encompassing important environmental fluctuations. But, a more feasible approach that would allow to anticipate (rather than to follow) the local response of a species to the climate change predicted by the models would be to study the dynamics of populations along a latitudinal environmental gradient. Shrimp *P. borealis* distribution in the Northwest Atlantic, from its southern limit in Gulf of Maine to the northern limit in Davis Strait, gives us that opportunity. Moreover, in response to an anticipated warming of the Arctic waters, we must consider the possible northward expansion of *P. borealis* distribution and the adaptation of the Greenland and Canadian Arctic Fisheries to a new resource.

The primary objective of this project is to investigate shrimp larvae development, growth and survival along an environmental gradient characterizing the species latitudinal distribution. *P. borealis* live and reproduce in ecosystems where ice and surface temperature regimes, and the annual cycle of biological production, varies significantly. Abundance fluctuations are associated with variations in year-class strength and the success of settlement of post-larvae in the deeper waters plays a large role in determining the strength of a year class. Determination of larval survival and the characteristics of the early juveniles (e.g., timing and size at the descent in deeper waters) are, therefore, critical to understand recruitment and abundance fluctuations in the populations. Current climate models all conclude that the Arctic and sub-Arctic regions will experience earlier and more intense warming of the lower atmosphere than other regions. In ice-covered seas, a consequence of this warming

should be reduced ice coverage (area and duration), a warming of the surface layer and modification of the biological production cycles. A comparative study of shrimp larvae development along this latitudinal gradient would allow to model and predict the response of local populations to expected changes in the oceanic climate. This innovative approach to the study of climate change impacts on shrimp population will provide the necessary information to develop adaptation strategies for fishers and managers of this important resource for Greenland, Eastern and Northern Canada. The project is an attempt to empirically determine the ecological position of the shrimp larval stages in current oceanic ecosystems and to identify key factors that can be used to predict the impacts of changes in the ecosystems on shrimp stocks. As much as possible, the same information and standard sampling and experimental protocols will be used in each region/population under investigation to meet specific objectives:

(1) To describe the oceanic environment when shrimp larvae are present in the spring:

- Ice cover, temperature and depth of surface mixed layer, water mass identification;
- Timing and intensity of the phytoplankton bloom and shrimp larvae occurrence;
- Timing of zooplankton (selected species) production and shrimp larvae occurrence.

(2) To describe the fine-scale vertical distribution of the different larval stages (and vertical migration) in order to identify conditions for development and growth:

- Temperature range experienced by each larval stage;
- Trophic links, e.g., gut contents, biochemical analysis (fatty acid, digestive enzyme activity);
- Structure of the zooplankton community and identification of key (prey/predator) species associated with the shrimp larval stages.

(3) To determine the timing of settlement in deeper waters in the different regions:

- Determine and compare growth (size at stage) and development (stages, morphology) for each environment,
- Estimate development time (molt frequency) and growth rates as a function of local variables (e.g., temperature);
- Determine the timing and size (stage) at settlement in each environment.

Research team member(s) (names and affiliations):

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Collaboration:

We expect collaboration and support within the EcoGreen Program (An integrated program of research into the structure and function of the West Greenland ecosystem), the Greenland Institute of Natural Resources, the Canadian ArcticNet research network for the Davis Strait ^ West Greenland component, and others.

Recent works and publications relevant to the proposal:

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Pedersen, S.A., M.H. Ribergaard & C.S. Simonsen 2003. Micro- and mesozooplankton in Southwest Greenland waters - Juni 1999, May and July 2000. Greenland Institute of Natural resources, Technical Report no.53. 59 pp. ([www.natur.gl](http://www.natur.gl))

Pedersen, S.A., Madsen, J., and Dyhr-Nielsen, M. (ed.), 2003. Global International Water Assessment (GIWA) - Greenland - GIWA regions 1, 15, and 16. December 2003. Report for the National Environmental Research Institute. 132 pp.

Ribergaard, M.H., Ådlandsvik, B., Pedersen, S.A., and Kliem, N., 2004. Modelling the ocean circulation on the West Greenland shelf with special emphasis on northern shrimp recruitment. Submitted to Continental Shelf Research, 28. August 2003.

Pedersen, S.A., M.H. Ribergaard, and C.S. Simonsen. 2004. Micro- and mesozooplankton in Southwest Greenland waters in relation to environmental factors. Manuscript submitted to Journal of Marine Systems, Feb. 2 2004.

