

Project information

Project title

Modeling trophic interactions and ecosystem dynamics

Year

2011/2012

Project leader

Øystein Varpe, NPI

Participants

- Øystein Varpe, NPI
- Raul Primicerio, UiT
- Ulf Lindstrøm, IMR

Susanne Kortsch (UiT) and Elina Halttunen (UiT) have been recruited to the project, contributing to case studies 2 (Susanne) and 3 (Elina) presented below.

Flagship

Fjord and coast, Theme: Physical-biological coupling: Oceanography and habitat use by predators and their prey

Funding Source

Fram Centre

Summary of Results

We have developed a tri-trophic food chain model, based on the classic Rosenzweig -Macarthur predator-prey model. To increase the ecological realism of the model, we have included refuge use by the consumer (model modification complete), and producer phenology, which can decouple the producer and consumer (model modification in progress). We wish to use the model to study the effect of increased primary production, driven by climate warming, on the ecosystem.

We write program code and perform simulations using the R software (freeware). This allows easy sharing of the model, ideal for a cross institutional Fram Centre project, and for student training etc.

We are in the process of applying the model framework to three case studies of northern fjords and ecosystems:

1) A pelagic ecosystem where we envisage pelagic algae,

Calanus spp. (or other herbivores) and fish/macro-zooplankton as the three trophic levels. We focus on the effects of increased primary production, and the expected consequence of global warming and sea ice changes for consumers and predators.

2) A benthic ecosystem, with a benthic producer (macroalgae) and consumer as well as a predator.

3) A parasite-host system with salmon and sea lice as the case.

Two preliminary findings for case 1 can be highlighted:

A) The model predicts increasing abundance of the fish (or macro-zooplankton) predator but no change in the abundance of

Calanus spp. as the carrying capacity of phytoplankton increases. This is in accordance with food chain dynamics theory.

B) Model predictions change with the level of refuge use, refuge being a deep habitat where

Calanus spp. can seek shelter from their predators. At intermediate refuge use, *Calanus* spp. abundance is higher compared to low refuge use, but qualitatively similar. High refuge use also alters the qualitative relationship, most notably by a change in *Calanus* spp. abundance with increasing phytoplankton carrying capacity.

Planned publications conditional on further funding for the project activities:

1. One article targeting a broad audience through a journal such as BioScience. We will use case 1 and the model framework to describe and point at the complexity involved when studying how ecosystems respond to environmental change, in particular the non-intuitive results that may arise including rapid changes from one stable state to another.
2. One specialized research article focusing on the model framework and the ecological realism we add by including refuge and phenology.
3. and 4. Research articles that use the model framework to study case 2 and 3.

Communicated Results

Raul Primicerio used the project as a case study when presenting the FORUM for ecological modeling in a talk through the NPI seminar series

<http://www.npolar.no/en/events/2011/09-21-forum-for-ecological-modelling.html?cat=event/np-seminar/&y=-1>

All project participants have presented and discussed the project at various seminars and meetings within their respective institutions.

Interdisciplinary Cooperation

Disciplines involved: evolutionary ecology, population biology, ecological modeling, programming, marine biology, management

Yes, the project has greatly benefited from joining participants with expertise from different fields of biology and modeling.

Budget in accordance to results

The funding helped us meet regularly as well as arranging a particular 3 day workshop at Sommarøy. The funding allowed project participants to dedicate time to the proposed research partly by allowing some of the researcher hours to be covered.

The project boosted a lot of ideas and enthusiasm and a wish to develop the collaboration and work further. This will lead to future Fram Centre initiatives as well as proposals submitted elsewhere.

Could results from the project be subject for any commercial utilization

No

If Yes

Not likely. However, the food web processes we study are vital for understanding the population dynamics of marine resources. As such, our results are important for the management of marine resources in Arctic and coastal ecosystems.

Conclusions

a) 1) Quantitative application of food chain dynamics theory for northern fjords and coastal ecosystems. 2) The role of increased primary production for higher order ecological effects.

b) Inclusion of trait-mediated effects, such as prey refuge, and phenology as part of tri-trophic level food chain models.