

## Project information

### Project title

Reduced sea urchin grazing – effect of climatic change or predator change?

### Year

2013/2014

### Project leader

Hartvig Christie, NIVA

### Participants

- Hartvig Christie, NIVA, project leader
- Hege Gundersen, NIVA
- Eli Rinde, NIVA
- Nina M. Jørgensen, Akvaplan-niva/NP
- Torstein Pedersen, UiT

### Flagship

Fjord and coast, Theme: Structure, function and change in Arctic and boreal ecosystems

### Funding Source

Fram Centre

### Summary of Results

This project has shown a further reduction of sea urchins northwards. The goal of this year was first to get updated presentations on distribution of sea urchins and kelps (*Laminaria* and *Saccharina* kelps) along the coast of North Norway. Further, the data have been analyzed to determine if climatic changes influence sea urchin reduction or if other factors as top down effects are involved. A large scale reduction of sea urchins will benefit coastal ecosystems and resources as kelp forests provide higher production, higher biodiversity, and more habitats and shelter for invertebrates and fish.

About thousand observations of distribution of kelp and sea urchins in Nordland, Troms and Finnmark revealed that revegetation of kelp forests have occurred in small and larger patches in Nordland south of Lofoten and in eastern parts of Varanger. Former kelp forests were still totally denuded by sea urchins between Lofoten and Varanger. The decline of sea urchins in Nordland can be linked to increasing sea temperature and to crab (*Cancer pagurus*) predation. The crab population has increased northwards and is probably also linked to increasing temperatures. The patchiness in revegetation can be explained by local variation in temperature and other physical factors enhancing mortality and reduce recruitment of sea urchins, and also in distribution of predator refuge habitats. In Varanger, the mortality of sea urchins can be linked to king crab (*Paralithodes camtschaticus*) predation and the patchiness is clearly linked to predator refuge habitats. Temperature does not seem to affect recruitment there. There are so far no large crab populations in the area between Lofoten and East Finnmark where sea urchins still dominate.

The increase of crab densities may be an effect of temperature in Nordland and introduction of king crabs in East Finnmark, and may also be facilitated by reduced predation as the possible predator, coastal cod (*Gadus morhua*), has decreased during the period of crab increase.

### Highlights:

- Large areas of the Nordland coast are now covered by productive kelp forests after about 40 years of sea urchin grazing.
- The gradual reduction of sea urchins in Nordland can be linked to a direct effect of climatic change (increasing temperature) or indirectly by climatic changes that benefit the predator *Cancer* crab north going distribution.
- The areas with sea urchin reduction overlap areas with high population density of *Cancer* crabs along large coastlines in Nordland, and along smaller coastlines where the introduced king crab has shown increasing densities in east Finnmark.
- The shift from sea urchins to kelp forests may be facilitated by climate change and multilevel top down processes.

### Further questions:

- Will the reduction of sea urchins and crab influence continue to move further northwards in Nordland and westwards in Finnmark?
- Can sea urchins persist on predator refuge habitats?
- The trophic interaction between kelp and sea urchins is well documented and quantitatively described, but there are less strong documentation on relations between crabs and sea urchins and cod and crabs.
- There are no studies on the development of the kelp forest as ecosystem and habitat for fish (particularly juvenile and smaller cod) on the reforested areas.

### For the Management

The large scale shift from underwater desert to rich kelp forests is of great importance for environmental management. The new kelp forests will probably contribute with many million tons of nutrients (biomass production) to the coastal areas and lead to increased biodiversity at many trophic levels, included fish production.

The increasing crab populations is probably facilitated through predator release when cod predation is low, and their effects on prey

populations will be a challenge for coastal management. Also the role of climate changes, particularly increasing temperature in this system will be a factor for consideration.

#### Published Results/Planned Publications

There are so far no publications from this project, but three manuscripts are in preparation: One is already submitted<sup>1</sup>, one is planned submitted during 2013<sup>2</sup>, and one is planned submitted during the winter 2014<sup>3</sup>.

<sup>1</sup>Rinde, Eli, Hartvig Christie, Camilla W. Fagerli, Trine Bekkby, Hege Gundersen, Kjell Magnus Norderhaug, and Dag Ø. Hjermmann. The influence of physical factors on kelp and sea urchin distribution in previously and still grazed areas in the NE Atlantic. Submitted to PLOS Biology.

<sup>2</sup>Hartvig Christie, Hege Gundersen, Eli Rinde, Kjell Magnus Norderhaug, Camilla W. Fagerli, Trine Bekkby, Janne K. Gitmark, Nina M. Jørgensen, and Torstein Pedersen. Can multitrophic interactions and climatic changes regulate large scale kelp-sea urchin distributions and alternate state resilience?

<sup>3</sup>Working title: Climate change and Fishing Transforms the North Atlantic Coastal Ecosystem. NIVA group in cooperation with Prof. Bob Steneck, Maine, USA.

#### Communicated Results

The results concerning sea urchin decrease, crab increase and kelp reforestation have been communicated directly to environmental and fishery authorities, and to the kelp harvest industry.

Results have been presented shortly in two newspaper articles, and on talks and posters at national events (NHF and the NFR funded RESTORE workshop with participants from USA and Denmark).

Two oral presentations from the project (same title as the two first listed manuscripts) will be given at the International Temperate Reef Symposium in Australia in January 2014.

#### Interdisciplinary Cooperation

There has not been any direct inter-disciplinary cooperation in this project, but the results have been basis for a recent proposal to NFR with socioeconomic scientists on community economic benefits and ecosystem services connected to these large scale ecosystem shifts.

#### Budget in accordance to results

The Fram Centre funding has been the major funding of the 2013 activity. The project has in earlier years benefited from activities funded by DN and NFR for completing the large field activities. Field activities over larger areas are connected to high expenses.

#### If Yes

Both kelp and sea urchins are at present commercial utilized resources. Regrowth of millions of tons of kelp may be a future resource directly and may contribute to increased production of commercial resources as fish and crabs.

#### Conclusions

This project gives perspectives for large scale management and utilization of coastal resources belonging to four trophic levels that interact. In a future management of this system and dealing with conflicts between exploitation and conservation, there is a challenge for more quantitative knowledge about the interactions, phase shifts and resilience within the system.