Project information

Keywords
ECOURCHIN
Project title
Sea urchin harvest: ecosystem recovery, integrated management of social-ecological system, ecosystem service and sustainability
Year
2015
Project leader
Wenting Chen (NIVA) and Hartvig Christie(NIVA)
Participants

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Flagship
MIKON
Funding Source

MIKON - research theme 3: "Impacts of industrial development on ecosystem services and social-ecological systems in the North".

Summary of Results

The first year of the project mainly involved the following work and results.

- Qualitatively identifying the environmental impact of urchin harvesting and the relevant ecosystem services which may be affected from literature review. Several potential impacts were identified, i.e. food production service (cod and other commercial fishery), cultural regulation service (diving, recreational fishery), and carbon regulation service (carbon storage in the kelp biomass), other services like wave damping, water cleaning . The results were obtained by collaborating “Sea urchin-kelp” project in Flagship “Fjord and coast”.

- By reviewing the results from other flagship project we do find that urchin density, size, and roe quality vary with distance to kelp. The green sea urchin aggregate, and the largest individuals (test diameter about 50-60 mm) can aggregate in densities between 50 and 100 per m2 close to kelp vegetation. Data from Vega show that sea urchins grow faster and develop larger gonads close to kelp. Resent unpublished results from Porsanger (Finnmark) revealed 5 times higher gonad weight close to kelp than far from kelp vegetation. Gonad index vary with season, but in autumn, sea urchins close to kelp vegetation may reach size and gonad index ready for marked quality. Detailed results are shown in the following two tables.

Table 1: Density and size distribution of sea urchins, Strongylocentrotus droebachiensis, recorded quantitatively by SCUBA at different types of substrates. At some locations estimates were not recorded (na).

Area	Substrate type	Density (n/m^2)	Mean size (mm)	Size range (mm)
Vega				
Torghatten	rocky surface	9	33	7-50
Torghatten	maerl beds	241	6	2-12

Rørøy	maerl beds	0	na	na
Søla	rocky surface	44	18	4-35
Sandøy N	cobble stones	79	24	8-44
Sandøy N	rocky surface	21	33	11-44
Andholmen	rocky surface	20	23	13-46
Andøy	rocky surface	24	25	9-46
Skogsholmen	rocky surface	42	28	11-54
Skogsholmen	rocky surface	25	25	14-49
Skogsholmen	cobble stones	81	26	10-47
Skogsholmen	maerl beds	142	11	3-19
Tuvøy	rocky surface	15	22	10-44
Tuvøy	cobble stones	2	19	9-37
Igerøy	kelp holdfast	0	na	na
Arctic circle				
Hestmann	rocky surface	26	16	4-31
Lofoten				
Lyngvær	rocky surface	19	40	2-63
Lødingen	rocky surface	14	38	9-61
Tysfjord	rocky surface	36	35	21-48
Troms				
Meløyvær	rocky surface	8	44	9-60
Løksefjord	rocky surface	35	27	10-46
Musvær	rocky surface	64	29	9-46
Kvalsund	cobble stones	23	26	13-48
Buvika	rocky surface	21	23	5-49
Buvika	maerl beds	575	16	2-63
Leirpollen	maerl beds	150	12	2-19
Leirpollen	rocky surface	82	20	9-31
Leirpollen	rocky surface	23	18	7-34
Hyseskjær	maerl beds	716	6	1-14
Humpen	maerl beds	725	5	1-15
Humpen	rocky surface	17	24	7-44
Lemmingsver	kelp holdfast	na	8	3-14
Flua	kelp holdfast	na	8	3-17
Senja, inner	kelp holdfast	na	7	3-13
Senja, outer	kelp holdfast	na	10	5-17
Porsanger				
Hamnholmen	rocky surface	56	45	17-63
Hamnholmen	cobble stones	23	30	9-51
Veineset	cobble stones	37	29	4-68
Hamnholmen	cobble stones	45	30	3-69
Hamnholmen	rocky surface	154	45	25-58
Kongsfjord				
WP 298	maerl beds	1225	6	3-16
WP 325	maerl beds	175	9	2-32
WP 353 (Kua)	cobble stones	21	21	2-64
WP 357	rocky surface	79	31	3-54
WP 357	cobble stones	101	15	3-58
WP 356	rocky surface	58	34	16-49
WP 356	cobble stones	45	21	7-50
WP 358	maerl beds	629	5	2-28
Kirkenes				
WP 54	cobble stones	20	32	8-62
Kjelmøy	cobble stones	103	14	4-37
Kjelmøy	cobble stones	18	28	4-60
Kjelmøy	cobble stones	71	na	na
Kjelmøy	rocky surface	0	na	na
WP 89	cobble stones	na	10	6-26
WP 89	kelp holdfast	na	7	3-13

Table 2: Average data (with StDev) on sea urchin density on different depth levels, sea urchin diameter and gonad index, total cover of macroalgae on three depth levels. Data from before experiment (2005) and on treated and control stations after

treatment with quicklime (2010 and 2011). Number of replicate stations sampled for each measurement is mainly between 4 and 14.

	Control sites 2005	Control sites 2010	Quiclime sites 2010	Control sites 2011	Quiclime sites 2011	Harvest site 2010
Sea urchin density 0m n/m2	43 (33)	41 (23)	1 (2)	34 (34)	3 (5)	0
Sea urchin density 2m	45 (23)	35 (15)	15 (19)	54 (25)	46 (34)	6
Sea urchin density 5m	37 (13)	23 (17)	16 (12)	20 (8)	21 (8)	19
Mean Sea urchin diameter (mm)	38			38	43	49
Sea urchin gonad index (%)				4.8	13.6	7.2
Macroalgal cover 0 m (%)	19 (18)	19 (28)	85 (33)	22 (16)	74 (26)	100
Macroalgal cover 2 m	4 (10)	1 (1)	63 (40)	0	27 (8)	64
Macroalgal cover 5 m	0	14 (13)	31 (31)	13 (12)	31 (16)	23

- We then developed a simple bioeconomic model to quantify how much economic value of urchin harvesting will be over the years under the harvesting scenario "repeated harvest of sea urchins on barren grounds". It is a social planner model for harvesting urchins on the barrens. The model considers the regime shift between barrens and kelp forests and follows deZeeuw (2014) and Wilen and Sanchirico (1999). All the relevant data for the modelling were collected and the simulations are carried out to obtain the economic benefits from long term sustainable harvesting. As no cost data on urchin farming and harvesting available this year, we only calculated the gross revenue of the urchin harvesting when harvest is done from barrens. Our result shows that the maximum sustainable yields could be up to 0.81 mill tonne per year if we do not consider harvesting capacity constraints. With the current harvesting capacity constraints, the maximum harvesting is estimated to be 0.5 mill tonne per year. If we assume the wet raw urchins are sold at a fixed market price at 48 NOK/kg before farming, the gross annual revenue without considering harvesting costs will be 39000 million NOK per year. As costs and capacity constraints are not considered in the model this year, we should treat the number of revenue carefully. Further study in the coming two years is needed.

For the Management

Sea urchin harvesting industry is still at the cradle stage in Norway. While in the past two years, urchin harvesting has caught more and more attention in the research world (e.g. EU project: ResUrch and the Northern Peripheries and Arctic pre-project (Sea urchin fishing in the European Northern Periphery Area). Long coast line with abundant sea urchin population in the North and the high demand in the international market provide a unique potential for Norway to develop large scale urchin harvesting. The increasing sea urchin demand and the shortage of sea urchins supply in the world market provide Norway with a unique opportunity to develop a profitable sea urchin harvesting industry. Developing sea urchin industry in Northern Norway will not only affect local economy and ecosystem services, but also have effects on marine ecosystem and habitats in the northern coastal region. The project establishes a knowledge base for estimating the effects of a potential sea urchin harvesting industry on ecosystem and habitat recovery and the effects on ecosystem services and economy in the local communities, and to develop an integrated management strategy for social-ecological system and

sustainable industry development. The proposed project is the first comprehensive study on ecological and economical sustainable industry development of sea urchin harvesting with consideration on how urchin harvesting will affect kelp-urchin dynamics and marine ecosystems as well as its impact on ecosystem services and economy in the Northern Norway. The knowledge is highly demanded by both local fishery management , national and international environmental NGOs as well as the publics.

Published Results/Planned Publications

No manuscript has been submitted in the first year as most of the work are on the ecosystem impacts identification and constructing the bioeconomic model for urchin harvesting.

Communicated Results

Project results have been communicated both within project group and to the local and international stakeholders as well as general publics.

A **pre-kick-off meeting** between NIVA and NOFIMA on 12 March 2015: discuss the synergy between ECOURCHIN and URCHIN (EU Northern Periphery and Arctic Program). Data and results sharing among the two projects were agreed upon.

- **Kick-off meeting** on 4 May 2015: The kick-off meeting was hold via skype due to the limited funding this year. NOFIMA, UiT and NIVA discussed the plan for the project this year and each institute. Action plan was made during the meeting. UC Berkeley was in a roll of consultancy this year due to the budget limit.

- **Discussion** on economic modelling was done via two meetings on 20 May and 11 June in Tromsø between NIVA and UiT.

- **Dissemination 1**: ECOUCHIN project idea is promoted among Norwegian and international urchin harvesters from Finland, Scotland and Canada during the NOFIMA URCHIN (EU) prject kick-off meeting on 19 May in Tromsø Local industry on urchin industry.

- **Dissemination 2**: NIVA is collaborating with Kaston International, an industry partner who interested in urchin harvest and aquaculture to further promoting the idea to e.g. USA, Hellas, Japan and Netherland.

- **Dissemination 3**: ECOURCHIN project was NIVA flagship project on Oslo Forskningstoget on 18-19 Setember. The idea of “sustainable harvesting/eating sea urchins and saving the kelp forest” were presented to the general public particularly school children.

- **Dissemination 4:** Part of the results will be presented at Fram Science Day in November 2015.

- **Dissemination 5:** An article on Aftenposten of the project is under preparation, a NIVA report and a manuscript.

- **Dissemination 6:** Another seminar had be hold in Tromsø in November 2015 where results and project idea has been presented within the project group.

Interdisciplinary Cooperation

ECOURCHIN is a project cross several disciplines. The research team has expertise on biology, ecology, economics and geology. During the first year, the project focuses on qualitatively quantify the potential ecosystem impact of urchin harvesting, the dynamic relation between kelp and urchin, and the bioeconomic model for urchin harvesting under one scenario. In 2016 and 2017, GIS map of future urchin distribution will be projected. Input will be used to predict optimal harvest of urchins when harvesting happens along the kelp forests. Socioeconomic benefits to the local community will be future estimated in details.

Budget in accordance to results

Funding from MIKON is the only funding for the project and has been essential to perform the studies planned in the project. There is no other funding sources.

Could results from the project be subject for any commercial utilization

No

Conclusions

No major conclusion can be drawn yet after only one-year pre project. Further results including optimal harvesting strategies under kelp-urchin dynamics could be expected in the second and third year.