

2015 ANNUAL REPORTING

GreenMAR

GREEN GROWTH BASED ON MARINE RESOURCES:
ECOLOGICAL AND SOCIO-ECONOMIC CONSTRAINTS

The deadline of the second annual reporting is 31 March 2016. The NordForsk online portal for reporting will open 45 days before the deadline.

APPLICATION INFORMATION

Call: Collaboration Projects Green Growth in an Era of Climate Change

Application: Resource-based green growth under climate change: Ecological and socio-economic constraints (ResGreen)

Application id: 61582

Submitted by: Nils Chr. Stenseth

PROGRESS REPORT

Reporting period: 01.01.2015-31.12.2015

PARTICIPANTS

Overview of participants: Per country, gender, type of participant (team leader, involved researcher, other participants, and numbers in total).

Name	Position	University affiliation	Citizenship
Nils Christian Stenseth	PI/Node leader	University of Oslo (CEES)	Norwegian
Anne Maria Eikeset	Co-PI/Cluster Leader	University of Oslo (CEES)	Norwegian
Joël Durant	Researcher	University of Oslo (CEES)	French
Leif Christian Stige	Cluster Leader	University of Oslo (CEES)	Norwegian
Marcos Llope	Researcher	University of Oslo (CEES)	Spanish
Florian Diekert	Collaborator	University of Oslo (CEES)	German
Sissel Jentoft	Collaborator	University of Oslo (CEES)	Norwegian
Kjetill Jakobsen	Collaborator	University of Oslo (CEES)	Norwegian
Tore O. Elgvin	Communicator of Science	University of Oslo (CEES)	Norwegian
Kristina Kvile	Collaborator	University of Oslo (CEES)	Norwegian
Giovanni Romagnoni	Collaborator	University of Oslo (CEES)	Italian
Bastiaan Star	Collaborator	University of Oslo (CEES)	Dutch
Anna-Marie Winter	PhD Student	University of Oslo (CEES)	German
Jon Ove Hagen	Node leader	University of Oslo (Geo)	Norwegian
Thorben Dunse	Post-Doc	University of Oslo (Geo)	German
Andreas Käab	Collaborator	University of Oslo (Geo)	German
Thomas Schuler	Collaborator	University of Oslo (Geo)	Norwegian
Carl Folke	Node Leader	Stockholm Resilience Center (SRC)	Swedish
Thorsten Blenckner	Cluster Leader	SRC	German
Susa Niiranen	Post-Doc	SRC	Finnish
Emma Björvik	PhD student	SRC	Swedish
Wijnand Boonstra	Cluster Leader	SRC	Dutch
Henrik Osterblom	Collaborator	SRC	Swedish
James Watson	Collaborator	SRC	English
Matilda Valman	Post-Doc	SRC	Swedish
Maja Schlüter	Collaborator	SRC	German
Saskia Otto	Collaborator	SRC	German
Brynhildur Davidsdottir	Cluster Leader & Node Leader	University of Iceland	Icelandic
Ragnar Arnason	Advisor/Mentor	University of Iceland	Icelandic
Dadi Mar Kristofferson	Collaborator	University of Iceland	Icelandic
Gudrun Marteinsdottir	Collaborator	University of Iceland	Icelandic
Niall McGinty	Collaborator	University of Iceland	Irish
Gunnar Olafur Haraldsson	Advisor/Mentor	University of Iceland	Icelandic
Fredrik Salenius	PhD Student	University of Iceland	Finnish
Sigurður Eyberg Jóhannesson	PhD Student	University of Iceland	Icelandic
Conor Byrne	PhD Student	University of Iceland	Irish
Simon Levin	Node leader	Princeton University	American (USA)
Malin Pinsky	Collaborator	Princeton University	American (USA)
Dane Klinger	Researcher	Princeton University	American (USA)
Emma Fuller	Collaborator	Princeton University	American (USA)
Juan A. Bonachela	Researcher	University of Strathclyde	Spanish
Andries Richter	Researcher	Wageningen University	German and Dutch
Ludmila Artemieva	Researcher	Moscow State University	Russian

Elena Rovenskaya	Collaborator	Moscow State University/ IIASA	Russian
Vera Timofeeva	Collaborator	Moscow State University	Russian
Elena Grigorenko	Collaborator	Moscow State University	Russian
Sergey Kryazhimskiy	Collaborator	Moscow State University	Russian
Alexey Smirnov	Collaborator	Moscow State University	Russian
Webjørn Barstad	Collaborator	Havfisk AS (formerly Aker Seafoods)	Norwegian
Dr. Cecilie Mauritzen	SAB (chair)	CICERO, Oslo	Norwegian
Prof. Marc Mangel	SAB	University of California, Santa Cruz	Canadian
Prof. Fiorenza Micheli	SAB	Stanford University	Italian
Prof. Sir Partha Dasgupta	SAB	University of Cambridge	Bangladeshi
Prof. James Wilen	SAB	University of California, Davis	USA
General Secretary Nina Jensen	SAB	WWF Norway	Norwegian
Anna Mazzarella	Administrative staff (Scientific Coordinator)	University of Oslo (CEES)	American (USA)
Anne Mari Bjørnæs	Administrative staff	University of Oslo (CEES)	Norwegian
Gry Gunderson	Administrative staff	University of Oslo (CEES)	Norwegian
			= 58 in total

Totals:

By Type of Participant:

Cluster Leaders: 5
Node Leaders: 5
Researchers: 6
Post-Docs: 3
PhD Students: 5
Collaborators: 23
SAB: 6
Admin: 3
Other: 2

By Gender:

Female: 24
Male: 34

By Nationality:

Norwegian: 14
French: 1
Spanish: 2
German: 7.5
Finnish: 2
Swedish: 4
Dutch: 2.5
Icelandic: 6
American (USA): 6
Irish: 2
Italian: 2
Canadian: 1
English: 1
Russian: 6
Bangladeshi: 1

SCIENTIFIC REPORTING

1) Progress and research results

Status compared to project plan

To kick-start actual collaborations, in February 2015 we held a meeting as soon as all positions were filled. The main goal of this meeting was to help newly hired Post-Docs and PhD students identify research questions and learn what skills others in the network have, and whom they would like to collaborate with. Forming a bond between the researchers is the first step to making good collaborative work come out of this project. We also had a short workshop after our February meeting for our newly hired PhDs and Post-Docs called “Innovation Incubator” which was put together by SALT (salt.nu), an independent consultant company based in Lofoten, Norway. Here they worked also with representatives from WWF Norway and Havfisk to come up with some common goals and potential projects and practiced coming up with innovative solutions to the problems we will face trying to promote green growth while dealing with the repercussions of climate change. This meeting was a huge success, and all those who participated really enjoyed getting to meet each other and starting to plan collaborations with each other.

We also had a highly successful annual meeting in Stockholm from the 28th-30th of September. After a very successful opening session on Monday we had closed sessions where we planned courses and seminar series with the PhD students and Post Docs, we got feedback from our Industrial Partner Havfisk who kindly sent a representative to our meeting, and we had numerous sessions planning our Science Policy Forum, which morphed over those few days into a Special Issue in for journal Marine Policy, which is now underway. The Early Career Researchers also met on their own in order to give the Senior Scientists feedback on their opinions and wishes for the future of *GreenMAR*. There was also a closed Administration meeting for Cluster Leaders and administrators only. During the Closing Session the Early Career Researchers gave the entire group their feedback and we discussed future plans, next steps for our special issue in Marine Policy,

Matilda Valman (PhD5 at SRC) started as PD in February 2015. During spring she did fieldwork in Norway, interviewing people from Havfisk, and has visited fishers in Kalix (Sweden) who fish bleak roe and turn this into highly priced caviar. She will use her mobility grant to visit the University of Reykjavik during the autumn 2016.

Emma Björvik (PhD2 at SRC) started as PhD in October 2014. She has participated in several paper projects with her supervisor Wijnand Boonstra and also outlined the papers that will form her PhD thesis. November 2015 she successfully defended her Extended Research Proposal which is a formal requirement at Stockholm University. Emma has also done fieldwork in the Kalix bleak roe fishery. Performed interviews and participated on fishing trips. She is now planning for another period of field work coming spring. She will use her mobility grant to work in Malin Pinsky’s lab at Rutgers University during spring 2017.

In 2015 Susa Niiranen (PD 6 at SRC) has focused on size-structured higher trophic level model development together with James Watson (SRC). Her main focus has been on describing the benthic-pelagic coupling and its effects on food web dynamics. Susa also co-organized a workshop on benthic-pelagic coupling in the Baltic Sea, work that will feed into the GreenMar modeling work. Autumn 2015, Susa established research collaboration with Nansen Centre in Bergen and received funding from them for a 1 week research visit to Bergen that was carried out in November 2015. This research visit resulted in a Hjort Scholar proposal that Susa was awarded in January 2016, and which will enable development of a regional Arctic size-structured

food web model. Susa is a lead author on a manuscript on cross-scale dynamics in the Arctic (to be submitted to the Marine Policy special issue).

Wijnand Boonstra (Cluster Leader at SRC) has so far contributed to GreenMAR with several papers. He has done some fieldwork spring 2014 and 2015, and together with Emma plans to do some more Spring 2016. He is supervising Emma, and will spend one year (Aug. 2016 – July 2017) at Rutgers University to work with Malin Pinsky.

Thorsten Blenckner (Cluster Leader at SRC) has so far contributed to GreenMAR with several papers focusing on the effect of climate and fishing on fish dynamics and their consequences on recovery and societal cost. A system comparison across GreenMar case studies (Iceland, Barents Sea and Baltic Sea) is planned for 2016. In addition, he synthesized literature and cases in Europe to highlight past and future challenges for ecosystem-based management.

Conor Byrne (PD7, now a PhD student at UoI): A plan of six potential papers was developed during the first six months of the project and was presented at the meeting in Stockholm in September. This plan is in line with the original project scope, except that (a) it does not cover green accounting and (b) it broadens the topic of fuel efficiency to efficiency in general. Work has started on three of the six papers. The current focus is on paper #3: ITQ Allocation Efficiency paper – the initially vague outline for this paper has now been developed into a more clear/focused research question; analyzing the efficiency implications of grandfathering ITQ allocations. Work is still at an early stage i.e. literature review and development of model/empirical study. Work is also progressing on planned papers 1 and 2.

Fredrik Salenius (PhD3 at UoI) is working on developing a spatially explicit multispecies bio-economic framework. He will then apply the modeling framework to the NAPSC fishery. In the context of the NAPSC, the most crucial questions relate to the potentially detrimental biological and economic effects of non-cooperation, as witnessed both theoretically and in practice. This work is underway and has been helped also by Fredrik's time spent in Oslo this year (see mobility below).

Sigurður Eyberg Jóhannesson (PD8, now a PhD student at UoI) is working to develop a method to formally and correctly assess the ecological footprint of fishing. He will also assess the Icelandic ecological footprint and to assess the ecological footprint from fishing. The combination of these two studies contributes to the original plan for PD8 on green accounting. The article from the first part of the study is being completed – e.g. the first measure of the Ecological Footprint of Iceland. This work is progressing as planned.

The work in Cluster 1 at CEES and GEO first started for full in 2014 (in quarter 2 and 3, respectively) because the scientists (Stige, Durant, Dunse) working on these tasks were hired on other projects until then. Durant was hired on GreenMAR for 1 or 2 months.

Marcos Llope (UiO) started officially working for GreenMAR in January 2015. His main task described in the GreenMAR proposal and website is to estimate/further develop threshold statistical food web models for the systems of (1) the Icelandic Seas, (2) the Baltic Sea and (3) the Barents Sea. He and his collaborators have made progress on the first point (see below under "Main Results" for Cluster One) and also on the second with the publication of the Baltic Sea model (2).

The Moscow Summer School (MSA2015) took place in the summer of 2015 as was written in

the project plan (see below for Main Results from MSA2015).

Deviations from original plan and possible budget implications

Green national accounting was in the original proposal for work at UoI but is not covered in this work plan. The reason for this is that such a study is not as academically challenging as was previously thought. However what is interesting is to develop a method to assess the ecological footprint (EF) of fishing as that has not been properly done to date, but EF metrics certainly are an important component of green accounting. Please see work above by David Byrne (PD7). This change has no budgetary implications.

PD8 (Sigurður Jóhannesson) is also a PhD student instead of Post Doc. This project is new to the *GreenMAR* project, and is in part replacing PD8, and the Green accounting study originally planned within PD7, but that was deemed academically not challenging enough. This has no implications for the work nor the budget.

The work of Fredrik Salenius (PhD3 at UoI) has emerged as a combination of the work intended for PD8 and PhD3. The deviation of the original proposal is that he will not focus on the socio-economic implications of the variability in the NAPSC, but instead focus on the macro-economic international and national implications as well as on the implications for the industry itself. Socioeconomic implications will be drawn from the macroeconomic conclusions, but not modeled directly. Not any budgetary implications.

The only potential budget issue raised so far at UoI is a request for funding support from the Marine Research Institute (Hafrannsóknastofnun) for funding support and partner status, were they to share with us confidential data on vessel behaviour (VMS data, electronic log books). This option has not been pursued so far, since the acquisition of oil consumption data is viewed as a priority. This data could, however, be very useful for detailed analysis of fuel intensity and also for the planned paper on information efficiency.

Main results including publications

In 2015 the scientists of *GreenMAR* have published a total of 27 papers, given 8 talks, presented 7 posters and done other various kinds of outreach. These are all listed at the end of this section.

Preliminary results from the work of Sigurður Eyberg Jóhannesson (PD8) show that the Ecological Footprint methodology for the fisheries component of the calculations has improved substantially in recent years. In spite of this the Icelandic case indicates that further improvements are still needed. This calls for a deeper examination of extraction rates and allocation of footprints between production and import/export categories.

Work in Cluster 1 at CEES has focused on nonadditive effects of climate and fishing on the Barents Sea ecosystem. In particular, work in progress throws new light on how fishing-driven changes in age- and size-distribution of spawners may influence the spatiotemporal distribution of spawning products of Barents Sea cod, and how this may influence the sensitivity of year-class strength to climate fluctuations. This work is possible through analysis of newly digitized data on fish eggs and larvae available through collaboration with the Polar Research Institute of Marine Fisheries and Oceanography in Murmansk, Russia.

Furthermore, work is ongoing to apply statistical state-space methods to quantify how bottom-up effects of climate and zooplankton influence population dynamics of planktivorous fishes such as capelin, which in turn exert negative feedback on the biomass of the zooplankton in parts of the Barents Sea (Stige et al. 2014 – Not a *GreenMAR* publication but is good

background for this work: Stige L.C., Dalpadado P., Orlova E., Boulay A.-C., Durant J.M., Ottersen G. & Stenseth N.C. (2014). Spatiotemporal statistical analyses reveal predator-driven zooplankton fluctuations in the Barents Sea. *Progr. Oceanogr.*, **120**, 243-253). These results have implications for our understanding of why high-latitude ecosystems appear to be particularly susceptible to cascading effects of fishing, and how climate change may influence ecosystem stability.

We also studied the effect of the timing of fishing on the breeding reproduction of Cape gannet (*Morus capensis*), an endemic seabird in South Africa. The idea behind the study is to increase the co-management of south African resources (food resources, biological diversity) by isolating simple management tools.

Marcos Llope, along with his collaborator Niall McGinty put together a dataset of fish, plankton and environmental variables for the seas around Iceland. Marcos, Niall, Guðrún Marteinsdóttir and Nils Chr. Stenseth discussed some questions that will be interesting to address from a time series point of view. Marcos then estimated, compared and selected GAMs and tGAMs models relating cod spawning stock biomass (SSB) to environmental variables and plankton and Niall estimated some preliminary tGAM models for capelin, copepods and diatoms. A similar analysis was carried out by Marcos using cod population growth rate (r) from matrix analyses as response variable. Marcos also carried out another a similar analysis using cod number at age (n) as response variable to see how the environment differentially affects age classes (Marcos).

Thorben Dunse has been working on a 10-year timeseries (2003-2013) of the climatic mass balance of glaciers on Svalbard (**publication** listed under point 3, above). This will be a highly valuable dataset for studying possible relationship between glacial freshwater runoff and components of the marine ecosystem, e.g. ocean primary production.

MSA 2015 was the third summer school on economic growth held at Lomonosov Moscow State University and co-organized by IIASA. The first two schools took place in 2009 and 2011, each attracted about 50 students from all over the world. MSA 2015 was organized in the framework of and substantially contributed and supported by the NordForsk-funded *GreenMAR* project, and this time was co-organized by the University of Oslo, Moscow State University and IIASA.

MSA 2015 attracted 57 young scientists from 24 different countries across Europe, Russia, other former Soviet countries, China and other parts of the world, who came to Moscow to study contemporary concepts of the management of natural resources and economic growth and to engage in discussions of methodological and applied challenges in this field. MSA 2015 offered an intensive and exciting two-week educational program that included ten lectures by world-leading researchers on systems analysis and mathematical modeling of critical transformations with global impact, accompanied by interactive seminars at which the school's participants acquire experience in exploring and working on these topics. The key goals of the educational program were twofold. First, provide theoretical insights and discuss contemporary theoretical models to deepen scientific knowledge and modeling skills of the participants. Second, discuss how the theories and models learnt could be applied to real world problems to derive appropriate policy recommendations.

MSA 2015 achieved two major goals. First, it contributed to the development of capacity of young scientists in different countries, notably in Russia and Scandinavian countries, in the field of sustainability science. Second, MSA 2015 also contributed to the mission of "science diplomacy" amidst the current political and economic uncertainty between the EU and Russia.

GreenMAR Publications 2015

1. **Blenckner T, Llope M, Möllmann C, Voss R, Quaas MF, Casini M, Lindegren M, Folke C, Stenseth NC** (2015) Climate and fishing steer ecosystem regeneration to uncertain economic futures. *Proc R Soc B* **282**: 20142809
2. **T. Dunse, T. Schellenberger, J. O. Hagen, A. Kääb, T. V. Schuler, and C. H. Reijmer.** Glacier-surge mechanisms promoted by a hydro-thermodynamic feedback to summer melt. 2015. *The Cryosphere*, 9, 197-215, 2015
3. Hentati-Sundberg, J., Hjelm, J., **Boonstra, W.J.**, & Österblom, H. 2015. Management forcing increased specialization in a fishery system. *Ecosystems*, 1-17.
4. Fuller, E., E. Brush, **M. L. Pinsky.** *accepted.* 2015. The persistence of populations facing climate shifts and harvest. *Ecosphere*
5. Varjopuro, R, E. Andruliewicz, **T. Blenckner**, T. Dolch , A-S. Heiskanen, M. Pihlajamäki, U. S. Brandt, **M. Valman**, K. Gee, T. Potts & I. Psuty. 2014. Coping with persistent environmental problems: systemic delays in reducing eutrophication of the Baltic Sea. *Ecology and Society*, in press
6. Conversi, A., V. Dakos, A. Gårdmark, S. Ling, **C. Folke**, P. Mumby, C. Greene, M. Edwards, **T. Blenckner**, M. Casini, A. Pershing & C. Möllmann. 2015. A Holistic View of Marine Regime Shifts that Spans Multiple Ecosystems and Stressors. *Philosophical Transactions of the Royal Society of London, B: Biological Sciences* DOI: 10.1098/rstb.2013.0279.
7. Rocha, J. , J. Yletyinen, R. Biggs, **T. Blenckner** & G. Peterson. 2015. Marine regime shifts: drivers and impacts on ecosystem services. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, DOI: 10.1098/rstb.2013.0273.
8. **Blenckner, T.**, A. Kannen, A. Barausse, C. Fischer, J. J. Heymans, T. Luisetti, V. Todorova, **M. Valman** and L. Mee. 2015. Past and future challenges in managing European seas. *Ecology and Society* 20 (1): 40. [online] URL: <http://www.ecologyandsociety.org/vol20/iss1/art40/>.
9. Weigel, B, Andersson HC, Meier HEM, **Blenckner T**, Snickars M, Bonsdorff E. 2015. Long-term progression and drivers of coastal zoobenthos in a changing system. *Marine Ecology Progress Series* 05/2015; 528:141-159. DOI:10.3354/meps11279.
10. Elmgren R, **Blenckner T**, Andersson A. 2015. Baltic Sea management: Successes and failures. *AMBIO* 06/2015; 44 Suppl 3:335-44. DOI:10.1007/s13280-015-0653-9.
11. **Blenckner T, Österblom H**, Larsson P, Andersson A, Elmgren R. 2015. Baltic Sea ecosystem-based management under climate change: Synthesis and future challenges. *AMBIO* 06/2015; 44 Suppl 3:507-15. DOI:10.1007/s13280-015-0661-9
12. Selkoe KM, **Blenckner T**, Caldwell MR, Crowder LB, Erickson AL, et al. 2015. Principles for managing marine ecosystems prone to tipping points. *Ecosystem Health and Sustainability* 1 (5), art17. <http://dx.doi.org/10.1890/EHS14-0024.1>
13. Lade SJ, **Niiranen S**, Hentati-Sundberg J, **Blenckner T, Boonstra WJ**, Orach K, Quaas MF, **Österblom H**, Schlüter M. 2015. An empirical model of the Baltic Sea reveals the importance of social dynamics for ecological regime shifts. *Proceedings of the National Academy of Sciences* 112 35, 11120–11125, doi: 10.1073/pnas.1504954112
14. **Boonstra, W.J.**, Ottosen, K.M., Ferreira, A.S.A., Richter, A., Rogers, L.A., Pedersen, M.W., ... & J.D. Whittington (2015) What are the major global threats and impacts in marine environments? Investigating the contours of a shared perception among marine scientists from the bottom-up. *Marine Policy* 60: 197-201.
15. Pedersen, M.W., Kokkalis, A., Bardarson, H., Bonanomi, S, **Boonstra, W.J.**, Butler, W., Diekert, F.K., Fouzai, N., Holma, M., Holt, R.E., Kvile, K.Ø., Nieminen, E., Ottosen, K.M., Richter, A., Rogers, L., Romagnoni, G., Snickars, M., Weigel, B., Woods, P., Yletyinen, J.,

- Ferreira, A.S.A. (2014) Trends in marine climate change research in the Nordic region since the first IPCC report. *Climatic Change*. DOI 10.1007/s10584-015-1536-6
16. **Watson J. R.**, C. A. Stock, J. L. Sarmiento 2015. Exploring the role of movement in determining the global distribution of marine biomass using a coupled hydrodynamic–Size-based ecosystem model., *Progress in Oceanography* 138 (Part B), 521–532.
 17. Uusitalo L, Korpinen S, Andersen JH, **Niiranen S**, Valanko S, Heiskanen A-S and Dickey-Collas M (published online). Exploring methods for predicting multiple pressures on ecosystem recovery: A case study on marine eutrophication and fisheries. *Continental Shelf Research*, doi:10.1016/j.csr.2015.11.002.
 18. Øyvind Paasche, Henrik Österblom, Stefan Neuenfeldt, Erik Bonsdorff, Keith Brander, Daniel J. Conley, **Joël M. Durant**, **Anne M. Eikeset**, Anders Goksøyr, Steingrímur Jónsson, Olav S. Kjesbu, Anna Kuparinen & **Nils Chr. Stenseth**. 2015. Connecting the Seas of Norden. *Nature Climate Change* **5**, 89–92
 19. Maack M., and **B Davidsdóttir**. 2015. Five capital impact assessment: Appraisal framework based on theory of sustainable well-being, *Renewable and Sustainable Energy Reviews* **50**, 1338-1351.
 20. Cook, C., **B Davidsdóttir**, JG Petursson. 2015. Accounting for the utilisation of geothermal energy resources within the genuine progress indicator—A methodological review, *Renewable and Sustainable Energy Reviews* **49**, 211-220.
 21. Shafiei, E., **Daviðsdóttir, B.**, Leaver, J., Stefansson, H. & Asgeirsson, E. I., 2015 ‘Economic impact of adaptation to climate change in Iceland’s energy supply sector’. IEEE Proceedings of 12th International Conference on the European Energy Market (EEM), 20-22 May 2015, Lisbon, Portugal. <http://dx.doi.org/10.1109/EEM.2015.7216623>
 22. Shafiei, E., **Daviðsdóttir, B.**, Leaver, J., Stefansson, H. & Asgeirsson, E. I., 2015. ‘Cost-effectiveness and potential of greenhouse gas mitigation through the support of renewable transport fuels in Iceland’. In: *Renewable Energy in the Service of Mankind*, Vol. I, Springer International Publishing, pp. 145-157, 2015. http://dx.doi.org/10.1007/978-3-319-17777-9_14
 23. Shafiei, E., **Daviðsdóttir, B.**, Leaver, J., Stefansson, H. & Asgeirsson, E. I., 2015 ‘Simulation of alternative fuel markets using integrated system-dynamics model of energy system’ *Procedia Computer Science* 51: 513–521. <http://dx.doi.org/10.1016/j.procs.2015.05.277>
 24. Shafiei, E., **Daviðsdóttir, B.**, Leaver, J., Stefansson, H. & Asgeirsson, E. I., 2015 ‘Comparative analysis of hydrogen, biofuels and electricity transitional pathways to sustainable transport in a renewable-based energy system’ *Energy*, **83**: 614–627 <http://dx.doi.org/10.1016/j.energy.2015.02.071>
 25. **Richter, A.** & V. Dakos. 2015. “Profit fluctuations signal eroding resilience of natural resources”, *Ecological Economics*, **117**: 12-21.
 26. K. S. Aas, **T. Dunse**, E. Collier, **T. V. Schuler**, T. K. Berntsen, J. Kohler, and B. Luks. 2015. Simulating the climatic mass balance of Svalbard glaciers from 2003 to 2013 with a high-resolution coupled atmosphere-glacier model, *The Cryosphere Discuss*, **9**, 5775-5815.
 27. L. Gray, D. Burgess, L. Copland, M. N. Demuth, **T. Dunse**, K. Langley, and **T. V. Schuler**: CryoSat-2 delivers monthly and inter-annual surface elevation change for Arctic ice caps, *The Cryosphere*, **9**, 1895-1913, doi:10.5194/tc-9-1895-2015, 2015.

Talks:

1. **Dunse, T.** 2015. “Climatic mass balance simulations of Svalbard: from validation to application” Talk at the CRYO-MET Final workshop, Gerdi, Iceland, 26-30 September 2015.
2. **Stige LC.** 2015. “Climate effects on ecosystem dynamics in the Barents Sea” Invited lecture at the Tømte Symposium, Oct. 1 2015, Norw. Acad. for Science and Letters, Oslo.

3. **Durant, Joel.** 2015. "Prey abundance and Competition with fish as drivers for kittiwake population in the subarctic." Talk at the 2nd World Seabird Conference 26-30 October 2015 in Cape Town, South Africa
4. **Matilda Valman.** 2015. "Big Fisheries actors" Invited talk at conference "Hav och Samhälle: arranged by the Swedish Agency for Marine and Water Management, 21 October 2015 in Marstrand, Sweden
5. **Levin, Simon.** 2015. "Dealing with Public Goods and Common Pool Resources," Invited lecture at IMBS Colloquium, University of California, Irvine, February.
6. **Levin, Simon.** 2015. "Channeling Luca Pacioli: Multi-Disciplinarity and a Sustainable Future," Invited Lecture Given on Receiving the Luca Pacioli Prize, Ca'Foscari University of Venice, Italy, March 2015.
7. **Levin, Simon.** 2015. "The Challenge of Sustainability," Invited Lecture ay the C.C. Mei Distinguished Speaker Series 2015-16, Civil and Environmental Engineering, MIT. October 2015.
8. **Levin, Simon.** 2015. Keynote Lecture, "Current Revival of Systems Thinking and Major Challenges for Systems Analysis," IIASA Systems Analysis Conference November 2015.

Posters:

1. **Klinger, Dane.** 2015. *Future global finfish under climate change.* Aquaculture 2015: Cutting Edge Science in Aquaculture. August 24, Montpellier, France.
2. **Winter, Anna-Marie.** 2015. *Impact of fishing, climate and Allee effect on the collapse and recovery of Atlantic cod (Gadus morhua).* GreenMAR and NorMER annual meeting, 28-30 September 2015.
3. **Valman, Matilda.** 2015. *Adaptive Governance of the Baltic Sea.* GreenMAR and NorMER annual meeting, 28-30 September 2015.
4. **Jóhannesson, Sigurður Eyberg.** 2015. *The Ecological Footprint of Icelandic Fisheries.* GreenMAR and NorMER annual meeting, 28-30 September 2015.
5. **Salenius, Frederik.** 2015. *Implications of variability and change on international fisheries: the case of the North Atlantic pelagic stock complex.* GreenMAR and NorMER annual meeting, 28-30 September 2015.
6. **Byrne, Conor.** 2015. *Reducing Greenhouse Gas Emissions from Fishing.* GreenMAR and NorMER annual meeting, 28-30 September 2015.
7. **Dunse, T.** and K.S. Aas, J.O. Hagen, T.V. Schuler, T. Schellenberger, L.C. Stige, *Svalbard glacier-mass balance: Freshwater discharge and possible implications for the marine ecosystem* presented at:
 - a. GreenMAR and NorMER annual meeting, 28-30 September 2015
 - b. IGS Nordic Branch Meeting 2015, Copenhagen, Denmark, 29-31 October 2015
 - c. 2015 FRAM Science Days, Tromsø, Norway, 10-11 November 2015
 - d.

Other Outreach:

Joël Durant: Teaching course in Ecology, Evolution & Society, BioResources & BioDiversity, 2015 – Master BioSciences ENS de Lyon, France (04.06.2015)

Stige LC. 2015. "Hvordan påvirker klimaet økosystemet i Barentshavet?" *Biolog* 33: 19-23. (Popular science article about climate effects on the ecosystem in the Barents Sea in Norwegian-language journal for biologists).

Blog post by **Andries Richter** “Can we use economic information to anticipate a fishery collapse?”: <http://www.mn.uio.no/cees/english/outreach/blogs/marine-science/fishcollapse.html>

Blog post by **Marcos Llope**: “Changes in ecological baselines can be notably amplified when translated into socio-economics” link: <http://www.mn.uio.no/cees/english/outreach/blogs/marine-science/codbaltic.html>

Blog post by **Joël Durant**: “Highway to Marine Science: the Seas of Norden” link: <http://www.mn.uio.no/cees/english/outreach/blogs/marine-science/highway.html>

Blog post by **Giovanni Romagnoni**: “Evaluation of a spatial ecosystem model: predictions and data” link: <http://www.mn.uio.no/cees/english/outreach/blogs/marine-science/ecopath.html>

Collaboration with new partners

See above request for funding support from the Marine Research Institute (Hafrannsóknastofnun) for funding support and partner status, were they to share with us confidential data on vessel behaviour (VMS data, electronic log books).

Mathis Wagnagel at The Global Footprint Network and Jukka Heinonen at University of Iceland will be collaborating with Sigurður Eyberg Jóhannesson (PD8).

Our ‘new’ collaborators from Iceland are Niall McGinty and Guðrún Marteinsdóttir. Niall is a new contact while Guðrún is involved with CEES through NorMER. Both of them are new collaborators to me. Unfortunately, Niall left Island in 2015 (currently in Canada) but I am in touch with him and he is willing to continue his collaboration and do as Iceland contact as much as possible.

Thorben Dunse is now working with Laurence Gray, University of Ottawa, Canada on a new processing method for deriving glacier elevation and elevation change from Cryosat-2 radar altimetry data. This technique allows monitoring of glacier volume change, including both climatic and dynamic mass balance components, i.e. the total freshwater contribution of glaciers to the ocean (surface melt and runoff, as well as calving of icebergs. A publication in The Cryosphere has resulted from this collaboration (Gray *et al.* - please see publication list).

Thorben is also working with Shin Sugiyama and Yoshihiko Ohashi, Institute of Hokkaido University, Sapporo, Japan. They are developing of project idea to compare glacier freshwater runoff with ocean colour/ocean primary production.

External funding (funding acquired in addition to NordForsk funding)

In addition to funds provided by GreenMAR, MSA2015 was funded by CMC MSU (in kind); a grant from Russian Foundation for Basic Research (450,000 RUB); a grant from Eltsyn Fund (150,000 RUB) and by fees from non-GreenMAR participants (626,064 RUB)

Funding was awarded to B. Davidsdottir (PI) and IoES from IEA to assess the cost of GHG mitigation in fisheries and shipping as a part of a larger project on Nordic Energy Technology Perspectives. Project ends 2016.

Funding was awarded to B. Davidsdottir (PI) and IoES from the Icelandic Government (Ministry of Environment and Natural Resources) to assess mitigation of GHG emissions in Iceland. Roject ends 2016.

Funding was awarded to B. Davidsdottir (PI) and DM Kristofersson from the Nordic Council of Ministers to assess sustainability criteria of bioresources in the Nordic countries. Focus among other resources on fisheries. Project ends 2016.

In 2015, CEES was awarded an Innovative Training Network under Marie Skłodowska-Curie Action (Horizon 2020) associating some partners of GreenMAR (MARmaED www.marmaed.eu). MARmaED is designed to explore and investigate marine ecosystem change in careful detail from physical and biological effects to economic management implications and is unique in the way it will integrate effect studies with economic perspectives. In this, MARmaED will complement GreenMAR by adding 15 PhD students to our team.

CEES also obtained funding from the Research Council of Norway for a three-year researcher project on long-term effects of local scale oil pollution on fish populations and communities in the Lofoten-Barents Sea system (OILCOM). This complements GreenMAR by investigating the possible ecological consequences of petroleum activities, which are currently increasing in arctic areas.

Thorben Dunse was awarded funding through **CryoEAST** (SIU High North Programme 2013-2018) to fund his research stay at Hokkaido University, Sapporo, Japan and also from **CRYOVEX** (ESA-Prodex) to attend the Cryosat workshop at the Department of Geosciences; this was at the invitation of guest researchers, incl. Laurence Gray, at the University of Ottawa.

Gender aspects of the research and the organisation of the project

As we said also in last year's report, in terms of the PhDs and Post-Docs hired as a direct result of *GreenMAR*'s funding, we have a very balanced ratio of males to females (4 males and 4 females). The network as a whole is 65% male participants and 35% are female, but there are simply more males in research which makes it hard to have a truly equal representation of good male and female scientists. We do think that because we have been very equal in our hiring of male and female PhDs and Post-Docs that our actions will help this endemic imbalance to even out in the future.

We have women in leadership roles, namely Anne Marie Eikeset is our co-PI and is very much involved in the running of the center, particularly as Nils Chr. Stenseth has a demanding schedule and is often unable to direct day-to-day business at *GreenMAR*. Brynhildur Davidsdottir is both a cluster leader and a node leader. Our Administrative staff is also two women (Anna Mazzarella and newly hired Ane Mari Bjørnæs).

Among MSA2015 speakers, 2 were females and 8 were males. We admit we were unhappy with our ability to recruit a balanced panel of speakers for this summer school, however we did make every attempt and had bad luck that many of the invited female speakers were not able to attend. However as for the MSA2015 participants, 33 were females and 24 were males which we hope will get more females educated in these topics.

For this year's annual meeting, our invited speakers for our Opening Session were two women and one man, and our panel discussion (called "Where do science and policy meet in the anthropocene? Future challenges, seafood production, and marine management in the human era.") we had two women and three men participating. We strive for a balance especially when we invite speakers as we feel that it is discouraging for young female researchers (of which we have employed 4) to sit and see presentations by male scientists only in this kind of scenario

where the talks are invited.

We also think that Nina Jensen from our SAB and WWF can be a role model to our young female scientists, as she is a young female global leader.

To Conclude, we plan to continue working together as we have already been able to do. In 2016 we have many of our PhD students and Post Docs planning lengthy mobility visits to other universities in the network, and we will also be finishing our Special Issue in the journal Marine Policy. Our annual meeting in 2016 will be in Iceland and the planning for that is already underway. We feel that the fruits of our hard work are already beginning to show and we are excited to see how this project will develop into the next year and through to the project end.

2) Researcher mobility

Please specify research stay abroad as well as visits by foreign researchers. Here mobility is defined as a stay abroad of at least 4 weeks duration.

Name, job title, organization	Site of work	Purpose of Visit	Duration of Visit	Comments, output of visit
Fredrik Salenius, PhD student, IoES	CEES, UiO	Collaboration, course work	4 months	Advice, help and input from the collaborators. (I was not able to complete the course because of absence due to illness)
Anna-Marie Winter, PhD student, UiO	Wageningen University	Course work, visit supervisor Andries P. Richter	6.5 month	
Marcos Llope, CEES	MARICE (UoI)	collaboration on the Icelandic system	January (1 month)	Contact established Discussion of ideas Preliminary model results
Marcos Llope, CEES	MARICE (UoI)	Icelandic system	16-30 August (15 days)	Discuss models
Thorben Dunse, Postdoc, UiO	Hokkaido University, Sapporo, Japan	collaboration	3 weeks (April 2015)	Developing project ideas
Dane Klinger, researcher, Princeton	Stockholm Resilience Center	collaboration	4 weeks (May 2015)	Working with James Watson

Number of:

Visiting months

~14

Visiting researchers

6