



NEWSLETTER no. 5, 2019

ARCTic Marine Resources under Climate Change:
Environmental, Socio-Economic Perspectives and Governance

In the Arctic, higher temperatures and retreating sea ice will redefine boundaries of biological life, ecological structure, and commercial and social opportunities. Complex interactions exist, from the physical impacts in terms of temperature, ocean currents, and sea ice, via biological and ecological adaptations in terms of changing habitats, growth, and species interactions, via social and business enterprises in terms of new fishing areas and trade routes, to governance implications in terms of pressure on existing agreements, surveillance, and commercial activity. ARC-Change will study some of these interlinkages while bringing together expertise from an array of disciplines and institutions.

Newsletter no. 5, headlines:

- *New publication*
- *Warming ocean north of Svalbard*
- *Bergen Fisheries Economics Workshop 2018*
- *Arctic Frontiers 2019*

New publication

Recently, ARC-Change affiliated Leif K. Sandal co-authored the following article:

Seasonality matters: A multi-season, multi-state dynamic optimization in fisheries, by Y. Ni and L.K. Sandal (in *European Journal of Operational Research*, Vol. 275, no. 2, pp. 648-658).

Warming ocean north of Svalbard

The following is a summary of the article *Varmere og isfritt hav nord for Svalbard* (Aftenposten Viten, October 18, 2018), written by ARC-Change researcher Angelika Renner (Institute of Marine Research), together with her colleague Arild Sundfjord (Norwegian Polar Institute).

Atlantic ocean currents, going through the Fram Strait and along the continental slope north of Svalbard, transports large amounts of heat into the Arctic Ocean. There are significant seasonal changes in this inflow. A recent study shows that the largest inflow happens during fall and early winter. Related oceanographic changes with less sea ice and Atlantic water high in the water column

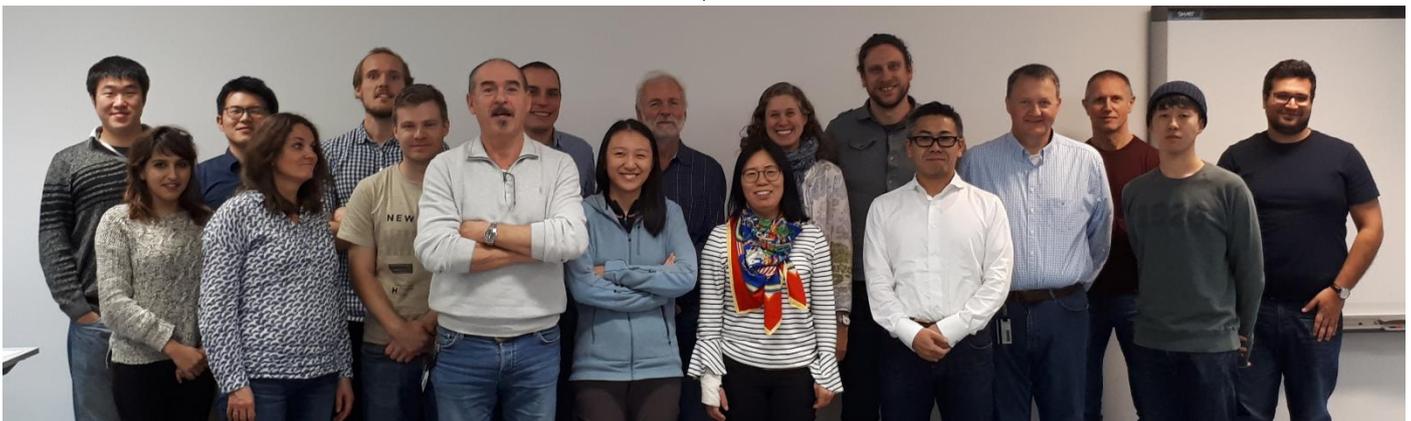
may lead to changes in Arctic ecosystems. The Atlantic water carries nutrients that sustain phyto- and zooplankton. Plankton growth paves the way for fish that earlier mainly was found in the Barents Sea. Less sea ice also affects seals and other marine mammals.

There are many feedback mechanisms between sun light, sea ice, wind, and oceanographic conditions, all with large seasonal variations. This complexity makes predictions for future Arctic ocean conditions difficult and highly uncertain. More and better observations of natural variations and trending changes, and improved understanding of the underlying processes, will contribute to make predictions for Arctic oceanography and ecology viable and more reliable.

A link to the full article can be found on the ARC-Change webpage (goo.gl/rxMhHP).

Bergen Fisheries Economics Workshop 2018

On October 18-19, 2018, ARC-Change researchers met with colleagues at the Bergen Fisheries Economics Workshop 2018. Sturla Kvamsdal (SNF – Centre for Applied Research at NHH and ARC-Change project leader) and Nils-Arne Ekerhovd (SNF) organized the workshop at the Norwegian School of Economics. Sturla, Anne Britt Sandø (Institute of Marine Research), Yuanming Ni (Norwegian School of Economics), and Alf Håkon Hoel (University of Tromsø) all presented research from the ARC-Change project. Further key contributions were given by Martin Quaas (Leipzig



Participants at the Bergen Fisheries Economics Workshop 2018

University), Gaku Ishimura (University of Iwate), and Corbett Grainger (University of Wisconsin). Results from the ARC-Change sister project, the REGIMES project (regimes.w.uib.no), were presented by Dorothy Dankel (University of Bergen) and Yajie Liu (University of Tromsø). The wide range of topics included climate change and cod spawning, ecosystem wealth and temperature changes, gear regulations and quotas, seasonal management, the Arctic Fisheries Agreement, and catch shares allocation rules, illustrating the wide scope of challenges facing ARC-Change researchers.

In a post workshop session, some of the workshop participants discussed possible outlines for the ARC-Change synthesis paper and plans for the work. The synthesis is currently being drafted and will be further discussed and finalized during meetings in 2019.

The workshop program and a full list of participants can be found via a link on the ARC-Change webpage (goo.gl/rxMhHP).

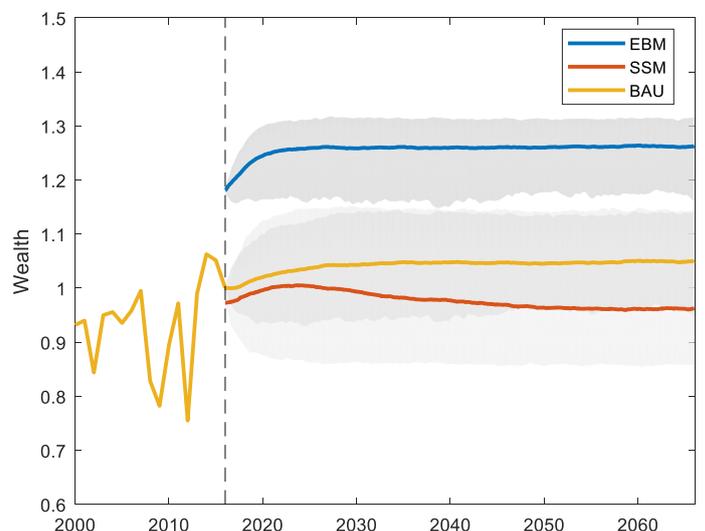
Arctic Frontiers 2019

On January 20-24, Arctic Frontiers 2019 took place in Tromsø. Several ARC-Change researchers participated: Alf Håkon Hoel, Sturla Kvamsdal, and Alexandra Stocker. Alf Håkon was part of the scientific committee for the theme 'The future of governance and handling vulnerability in Arctic ecosystems' and took part in a panel discussion on knowledge based ocean management. Sturla presented the paper 'Ecosystem wealth in the Barents Sea' and took part in a panel discussion on handling vulnerability in the Arctic. Alexandra presented the paper 'Ice edge retreat: influence on maritime traffic around Svalbard.'

The paper 'Ecosystem wealth in the Barents Sea' is co-authored by Diwakar Poudel (Norwegian Polar Institute) and Leif Sandal (Norwegian School of Economics) and develops further a method for estimating wealth stored in marine ecosystems under various management regimes. The wealth in the key fish stocks in 2016, under the present management regime, is estimated to NOK 50.6 billion. The present regime is predicted to maintain wealth near its current level (expected 5% increase in the long run) and is, on this basis, sustainable. An alternative, ecosystem-based management plan is

estimated to increase ecosystem wealth significantly, with almost 20% in the short run and more than 25% in the long run. How wealth is expected to develop over time is illustrated in the figure below. A potentially surprising finding is that most of the benefit from the ecosystem-based management plan accrues in the short run. Estimated accounting prices differ from market prices and suggest that evaluations based on market prices may undervalue resources.

The paper 'Ice edge retreat: influence on maritime traffic around Svalbard' is co-authored by Angelika Renner and Maaïke Knol (University of Tromsø) and considers how ice edge variability affects maritime activities such as expedition cruise tourism and fishing around Svalbard. Merging data on the ice edge and vessel trajectories and resulting maps of correlations will shed light on how these industries evolve and adapt to changes. The analysis may be important to understand changes in the regional economy and in safety assessments. Future work will combine the data analysis with interviews with captains, port authorities and others to further enhance the understanding of ice edge variability and economic developments in a cross-disciplinary setting.



Expected ecosystem wealth (with 95% probability intervals) under ecosystem-based management (EBM), business as usual (BAU), and single-species management (SSM). Curves are scaled to the BAU 2016-level.

Main project partners:



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Web: goo.gl/rxMhHP