

2011 ESSAS Open Science Meeting Comparative Studies of Climate Effects on Polar and Sub-polar Ocean Ecosystems: Progress in Observation and Prediction

by Kenneth Drinkwater

The GLOBEC/IMBER Regional Program on *Ecosystem Studies of Sub-Arctic Seas* (ESSAS) was established in 2005 to use a comparative approach in developing predictions of how climate variability and change affects and will affect the sustainability of goods and services obtained from the Sub-Arctic seas. ESSAS recently held its second Open Science Meeting (OSM) entitled “*Comparative studies of climate effects on polar and sub-polar ocean ecosystems: Progress in observation and prediction*”, on May 22–26, 2011, in Seattle, USA. Co-sponsored by the international organizations, PICES (North Pacific Marine Science Organization), ICES (International Council for the Exploration of the Sea), IMBER (Integrated Marine Biogeochemistry and Ecosystem Research) and GOOS (Global Ocean Observing System), as well as several U.S. marine science organizations, this symposium was attended by 195 scientists (of whom 23 were early career scientists and 28 were students) from 13 countries. There were 98 oral and 61 poster presentations. The meeting showcased the progress made in understanding the role of climate variability and change on the ecosystem structure and function within Sub-Arctic seas.

The OSM began on Sunday with a series of three 1-day workshops. The workshop on “*Biological consequences of a decrease in sea ice in Arctic and Sub-Arctic seas*” was organized by the ICES/PICES Working Group on *Forecasting Climate Change Impacts on Fish and Shellfish* (WG-FCCIFS). This workshop reviewed life history information and habitat associations to assess the risk of immigration and settlement of new biological populations in the Arctic and surrounding shelf seas in response to the retreat of sea ice. Criteria necessary to establish new species in the Arctic Ocean and surrounding areas were discussed and compared to expected conditions based on climate scenarios. Another workshop on “*Arctic–Sub-Arctic interactions*”, co-sponsored by ESSAS and ASOF (Arctic–Subarctic Ocean Fluxes), brought together several disperse groups studying the fluxes between the Arctic and the Sub-Arctic and their biophysical effects. Following presentations, discussion focused upon some of our knowledge gaps, what research could be carried out to address these gaps, and how the research on these issues can be better coordinated. The workshop on “*Zooplankton life histories: Developing metrics to compare field observations and model results in order to predict climate effects*” brought together researchers interested in understanding how climate and life history patterns of zooplankton interact to produce the observed distributions and abundances of key species found throughout the boreal

Sub-Arctic and Arctic seas, especially *Calanus* copepods. Two additional half-day workshops were held. The ESSAS Working Group on *Gadid–Crustacean Interactions* convened one on “*Comparative analyses of gadid and crustacean dynamics across sub-Arctic ecosystems*” to summarize and synthesize the main findings to date of their work and to discuss future directions for this Working Group. The second half-day workshop on “*Comparative analyses of marine bird and mammal responses to climate change*” focused on how to best integrate on-going and new research on marine birds and mammals into long-term PICES and ESSAS programs and objectives.



Top: The workshop on “*Arctic–Sub-Arctic interactions*” in session, bottom: William (Bill) Sydeman co-chairing the marine bird and mammal workshop with Co-Chairs, Yutaka Watanuki and Rolf Ream seated to his right.

The main OSM began on Monday. Instead of the usual introductory speeches by dignitaries, 8 elementary and junior high students from the Pribilof Islands of St. Paul and St. George gave a joint presentation entitled “*Discovering the Pribilof Domain*”. The human inhabitants of these islands, who are mostly of Aleut descent, depend almost exclusively upon the sea for their livelihood and food. The students have been studying and conducting research into the marine ecosystem around their islands through the help of their teachers and scientist Michelle Ridgway. They attend Marine Science Camps during the summer where they have the opportunity to use some of the latest oceanographic techniques in their studies.



Students from the Pribilof Islands, Alaska, posing with award certificates and Symposium Convenor, George Hunt, Jr., scientist, Michelle Ridgway (with flowers), and teachers Tonia Kushin (fifth from right, and Juan Leon Guerrero, right).

The presentation touched upon the climate of the Pribilofs and the physical oceanography surrounding the islands, the phytoplankton and zooplankton, some of the principal fish and shellfish species and their life histories, marine mammals, and the socio-economic consequences of the fish and fisheries. During their studies of the flora and fauna, they discovered the second-known population of a new species of large brown marine algae, *Aureophycus*, near St. George Island. The students have also been working to blend traditional knowledge with conventional scientific knowledge to learn more about their marine ecosystem. The presentation was extremely interesting and given in a very professional manner. A job well done! These students also stayed for the entire meeting, presenting a poster on their work, and asking several questions of the scientists during their presentations and talking with them through the breaks.

Following the students' presentation, 6 invited speakers gave plenary talks that covered various aspects of the 3 parallel sessions that were held in the afternoon. This format of morning plenary presentations and afternoon parallel sessions continued through Wednesday. The parallel sessions covered a total of 8 separate topics:

1. Comparative studies of polar and sub-polar ecosystems
2. New observations and understanding of eastern and western Bering Sea ecosystems
3. Modeling marine ecosystem dynamics in high latitude regions
4. Nutrients, biogeochemistry and acidification in a changing climate
5. New insights from the International Polar Year (IPY) studies
6. National ESSAS Programs: Recent advances and contributions
7. Anticipating socio-economic and policy consequences of global changes in sub-polar and polar marine ecosystems
8. Interactions between Gadoids and Crustaceans: The roles of climate, predation, and fisheries.

Most of the presentations, including those of the students from the Pribilofs, are posted on the OSM website at <http://www.pices.int/publications/presentations/2011-ESASS/ESSAS-2011-presentations.aspx>.



Top: Plenary speakers, Anthony Lekanof, presenting with colleague, Feofaneya Rukovishnikoff, looking on; bottom left: Eddy Carmack (Fisheries and Oceans Canada), and Anthony Gaston (Environment Canada).

Awards were given for the best presentations by early career scientists. Honourable mention was given to Kristin L. Laidre (University of Washington, USA) for her talk entitled "*Climate change and baleen whale trophic cascades in Greenland*". She described tagging and tracking studies of bowhead and humpback whales off West Greenland done in conjunction with the Greenland Institute of Natural Resources. The award for the best presentation went to Joel Heath (University of British Columbia, Canada) for his talk on "*Winter ecology of*

common eiders in polynya and floe edge habitats in Eastern Hudson Bay, Nunavut". He gave a fascinating account using underwater video to help model the bioenergetics of the eiders and also described the changing environmental conditions for these birds around the Belcher Islands through changes in river runoff because of hydroelectric developments. These changes are threatening the eider populations and hence the Inuit people of the islands who depend upon them. Special awards were also given to the students from the Pribilof Islands for their presentation and participation in the OSM.



Top: George Hunt with his wife, Peggy, and young Pribilof scientist, William Lekanof. Bottom: Lots of enthusiastic conversation during the ESSAS poster session.

Sixty-one posters were on display throughout the meeting, with each covering some aspect of one of the session topics; all sessions were represented. A dedicated poster session was held on Wednesday evening during which the many participants were able to discuss the science and results behind the posters. The session with the most posters was that on results from the Bering Sea, which was bolstered by a good turnout from the local oceanographic community in Seattle. Again, awards were given for the best posters by early career scientists. Honourable mention went to Laurinda Marcello (University of Alaska, USA) for her lead on the poster entitled "*Effects of temperature and gadoid predation on snow crab recruitment: Comparisons between the Bering Sea and Atlantic Canada*". She and her co-authors found that temperature change seems to be a more important and consistent factor controlling snow crab recruitment than that of gadoid predation. It is still unclear

whether the temperature effect is through direct forcing or indirectly, *e.g.*, through temperature effects on their prey or predators. The award went to Xuehua Cui (University of Tennessee, USA) for her poster on "*Spatial distribution of groundfish in the northern Bering Sea in relation to environmental variation and feeding habitat*". Her study suggested strong linkages between physical conditions (*e.g.*, water temperature and hydrography) and biological conditions (*e.g.*, bloom status) in structuring fish communities in the northern Bering Sea.

Thursday, the last day of the OSM, was initially taken up with brief reports from each of the parallel topic sessions in order to inform all of the participants of some of the main findings under each topic. Following the reports, a special musical presentation was given by a group from Norway known as "*Science Fair*". Led by Oded Ben-Horin (vocals), with Svein Folkvord on bass and Stein Inge Brækhus on drums, they have been performing science-inspired music at scientific meetings and conferences. They performed a number of pieces, some of which were presented for the first time, based on their impressions gathered during the ESSAS OSM. In addition, two of the Pribilof students joined in to sing a song about St. George Island (in English), and then one of them sang a solo in the Aleut language about going to gather blueberries in the fall. The efforts of both *Science Fair* and the students were enthusiastically applauded and greatly appreciated.

The wrap-up to the OSM on Thursday afternoon was in the form of 3 special invited lectures. The first was by Dr. Kevin Arrigo (Stanford University, USA), who discussed the impact of climate change on lower trophic levels in polar and sub-polar seas in a talk entitled "*Phytoplankton production in the Bering Sea and Arctic Ocean: A Satellite remote sensing study*". He showed that sea surface temperatures (SSTs) in the Bering Sea have warmed over last 30 years, but there has been no trend in sea-ice cover or primary production. The exception has been the Chirikov Basin where annual primary production increased by 40% from 1998 to 2007. Dr. Arrigo speculated that in the future, a warmer, more ice-free Bering Sea is likely to be more productive than today. In the Arctic, changes in sea-ice extent and duration have resulted in a 20% increase in primary production over the last 12 years, and with reductions in sea ice, Arctic productivity could increase even more in the future. However, he noted that much work is needed before we will have reliable quantitative predictions.

The second presenter was Dr. Steve Murawski (University of South Florida, USA) who spoke on "*Understanding ecosystem processes: The key to predicting climate effects*". He noted that global patterns and ecological gradients of productivity, species richness, species distributions, and their variability form the patterns of adaptation of biodiversity to the Earth's climate, and pointed out just how complicated it will be to forecast future warming-induced impacts. Complex co-evolved dynamics defy simple

depiction with single drivers. Dr. Murawski stressed the value of the comparative approach for studying ecosystem responses to variations in ocean climate and as a powerful method for inferring biophysical processes. He went on to state that much of the “first order” science done up to now has shown just how complicated things are, and pointed the way towards a mix of comparative studies, paleoecology, and laboratory analyses that are needed to advance the field — reductionistic approaches will not reveal complex interactions. There is the need to understand how species respond not only on a taxonomic basis, but in the presence of other species, *i.e.*, competitors, prey and predators. He noted the importance to assemble the global patterns of environmental information and biological data, including biological responses to environmental change, and wondered who will take on this important work.

The final speaker was Dr. Keith Criddle (University of Alaska Fairbanks, USA), whose presentation was entitled “*Adaptation and maladaptation: Factors that influence the fitness of fisheries and fishing-dependent communities*”. Using examples from the salmon, halibut and pollock fisheries off Alaska, he showed that the fitness of fisheries and fishery-dependent communities depend on the characteristics of social, economic, and legal systems that determine who is allowed to fish and how fishing takes place, as well as the attributes of the stock. The unique legal foundations, culture, and traditions of each nation or state affect the range of viable alternative fishery governance structures. There are tradeoffs between economic efficiencies gained through management measures such as single species individual fishing quotas (IFQs) and heightened exposure to factors that affect individual stocks, associated product markets, *etc.* In contrast, generalist fleets trade reduced economic efficiency and possible losses of management precision for reduced exposure to losses associated with variations in the abundance or value of any one species. Durable individual entitlements to shares of the allowable catch increase profitability which helps fishermen adapt to modest adverse changes in stock abundance, vessel prices, and input costs, but their vulnerability to larger perturbations is increased. While catch shares increase choice and therefore, resilience from the perspective of individuals, catch shares can increase or decrease the resilience of fishery-dependent communities.

In addition to the scientific presentations and discussions, participants and some family members enjoyed a wonderful reception at the Seattle Aquarium on the waterfront on Monday evening. They were encouraged to wander through the Aquarium, and Aquarium staff were on hand to inform and answer questions. The large octopus that was very actively moving around its tank and the feeding of the seals were big hits with many of the attendees. Great food and further entertainment in the form of two local bands, as well as catching up with old friends and colleagues or meeting new ones, made for a very enjoyable evening.



During the reception at the Seattle Aquarium: Hoisting brews (top), and Michael Klages (right) making friends with a potential young scientist (bottom).

Based on numerous comments from participants, the ESSAS OSM was an overwhelming hit. Many commented on the high quality of the talks (check out the website!), the good feeling and friendly atmosphere of those who attended, the efficiency of the PICES Secretariat in running the meeting, the enjoyable time and good food at the Aquarium and during the poster session, and finally, but certainly not least, the involvement of the students from the Pribilofs and the musical session of Oded Ben-Horin and his group *Science Fair*. A big thanks to all of these people, as well as to all of the other participants and the many sponsors who helped make the meeting a big success.

The work is not complete, however; there are papers to write, review and edit. Results from the OSM will be published in several special issues of scientific journals. Papers from many of the topic sessions will appear in a special volume of the *ICES Journal of Marine Science*. This issue will be dedicated to our colleague and good friend, Dr. Bernard Megrey, a long time member of the ESSAS Scientific Steering Committee (SSC) and co-leader of the Working Group on *Modelling*, who unfortunately passed away unexpectedly last October. Papers from the workshop on gadid–crustacean interactions will appear together as a special section in *Marine Ecology Progress Series*. The papers from the session on “*New observations and understanding of eastern and western Bering Sea ecosystems*” will be published in a special issue of *Deep-Sea Research II*, and papers from the session on “*Modeling marine ecosystem dynamics in high latitude regions*” in the

Journal of Marine Systems. The latter special issue will also be dedicated to Bern, and modelling papers from some of Bern's former colleagues who did not attend the OSM will be considered for this special issue in addition to those from the meeting.

During the 2 days following the OSM, ESSAS held its annual SSC meeting. On Friday, several special invited guests attended to discuss the future direction of ESSAS science. Of particular note was the continuation of ESSAS existing Working Groups. The Working Group on *Modelling* will continue to develop an end-to-end model in conjunction with PICES and ICES scientists. They will also guide the papers submitted to the modelling session and solicited from Bern Megrey's former colleagues through the editorial process. The Working Group on *Gadid-Crustacean Interactions* will continue to complete the papers for the special issue and continue studies of predator-prey interactions through comparisons of the different Sub-Arctic regions, with a special emphasis on spatial dynamics. A new Working Group on *Arctic-Sub-Arctic Interactions* was formed. This group will seek to promote research on this important topic and will begin by holding theme sessions and workshops over the next 1 to 2 years on the role of the advection and water exchanges between the two regions on the biology. A proposal for a theme session on Arctic-Sub-Arctic interactions has been forwarded to the Ocean Sciences meeting for consideration at their February 2012 meeting in Salt Lake City, USA. Additional theme sessions for the IPY meeting in Montreal and at the 2012 PICES Annual Meeting and ICES Annual

Science Conference are being considered. A Working Group on *Human Dimensions* was discussed but no firm commitment has been made, and this topic will be revisited at the next SSC meeting. The next ESSAS Annual Science Meeting and SSC meeting will be held in Hakodate, Japan, in January of 2013. The over-arching theme of this meeting will be on spatial dynamics, with sessions expected from all Working Groups as well as one already planned on human dimensions.

It was not all work, as George Hunt and his wife Peggy hosted a gathering of the SSC at their place on Friday night that included both good wine and great food. Not only did this give us time to discuss more of the science, but it also allowed us to get to know each other better and discuss other, non-scientific, issues. This SSC meeting was the last with Dr. George Hunt as Co-Chairman of ESSAS. Dr. Franz Mueter, a quantitative fisheries ecologist from the University of Alaska, Fairbanks, Juneau campus, takes over as Co-Chairman from the Pacific, and Dr. Ken Drinkwater remains as Co-Chairman from the Atlantic. All of the ESSAS SSC members wish to thank George for the untiring work he has done on behalf of ESSAS during the past 9 years, 3 years leading the push to establish ESSAS and have it recognized as a GLOBEC regional program, and 6 years as Co-Chairman from ESSAS's formal inception in 2005. Thankfully, however, George will continue to remain on the SSC as an *ex-officio* member and work toward its continued success. The SSC also wishes to welcome Franz and looks forward to working with him in the coming years.



Members of the ESSAS Scientific Steering Committee with guests, back row, from left: Yasunori Sakurai (SSC) Kenneth Drinkwater (Co-Chairman SSC), Seth Danielson (guest), Ólafur Áttórhósson (SSC), and Michael Sigler (SSC). Front, from left: Enrique Curchitser (SSC), Franz Mueter (replacing George Hunt as SSC Co-Chairman at the end of the OSM), James Overland (SSC), Kai Wieland (SSC) Margaret McBride (ESSAS IPO), Jackie Grebmeier (guest), Erica Head (SSC), George Hunt (Co-Chairman SSC). Missing: Earl Dawe and Hyoung Chul Shin.

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